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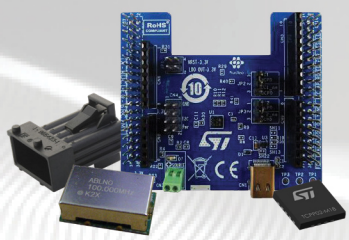

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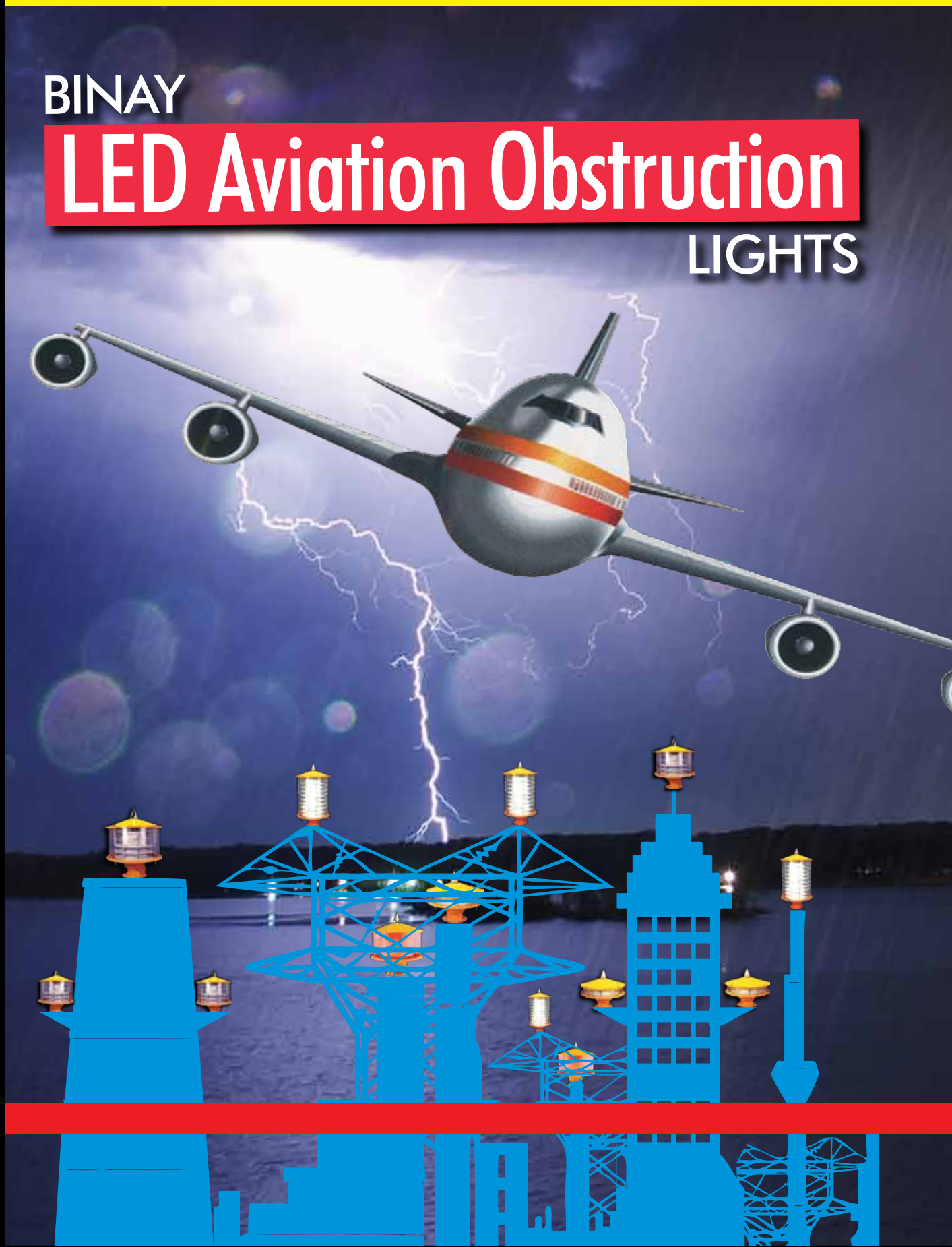

TECHNOLOGIES SINCE 1983

BINAY LED-based HIGH, MEDIUM and LOW Intensity Aviation Obstruction Light Beacons

As per International Civil Aviation Organisation (ICAO) requirements
Available in Low Intensity, Medium Intensity and High Intensity versions (as per International Civil Aviation Organization guidelines), BINAY's patented LED Aviation Lights come with 5-year/3-year warranties

High Intensity
200,000 candela
(Flashing White LEDs)

Medium Intensity
20,000 candela
(Flashing White LEDs)

Medium Intensity
2,000 candela
(Flashing Red OR Fixed Red LEDs)

All BINAY Aviation Lights are based on Non-switching passive type circuitry (NO SMPS)

The circuitry incorporated inside the LED Aviation Obstruction Lights is passive electronic (solid-state) in nature, and does not use internal SMPS driver switching units to control the light unit. Internal LED current control is by non-switching electronic means only. No electrolytic capacitors are used inside the Aviation Obstruction Light unit.

The above is necessary to ensure reliability of the LED Aviation Obstruction Light. This system design effectively eliminates any active components and circuits inside the aviation light itself, and enhances the solid-state passive reliability of the LEDs (mounted in relatively inaccessible locations at the height of tall structures). This drastically reduces the possibility of component failure - and hence possibility of any maintenance requirement – in the LED Aviation Obstruction Lights themselves (which are mounted at extreme heights in the system).

The BINAY LED Aviation Obstruction Light offers the following advantages:

- Fit-and-forget maintenance-free operation
- A long life of 100,000 hours (20 years at 12 hours daily burning)
- Pays for itself within a short period of operation in the form of reduced installation, maintenance and servicing costs
- Quick Installation; Reliable operation 365 days per year
- Shock-proof and vibration-resistant
- Over-Designed Intensity to allow for natural LED intensity degradation over its operating lifetime

LED Obstruction Lighting for:

- Industrial chimneys and smokestacks
- Transmission, microwave and cellular towers
- Radio, TV and similar structural towers
- High-rise buildings and structures
- Airports and airfields

THE BINAY LED OBSTRUCTION LIGHT IS UNDER ACCEPTED PATENT, AND AS SUCH IS A PROPRIETARY PRODUCT

Binay Opto Electronics Pvt. Ltd.
(An ISO 9001:2015 Certified Company)
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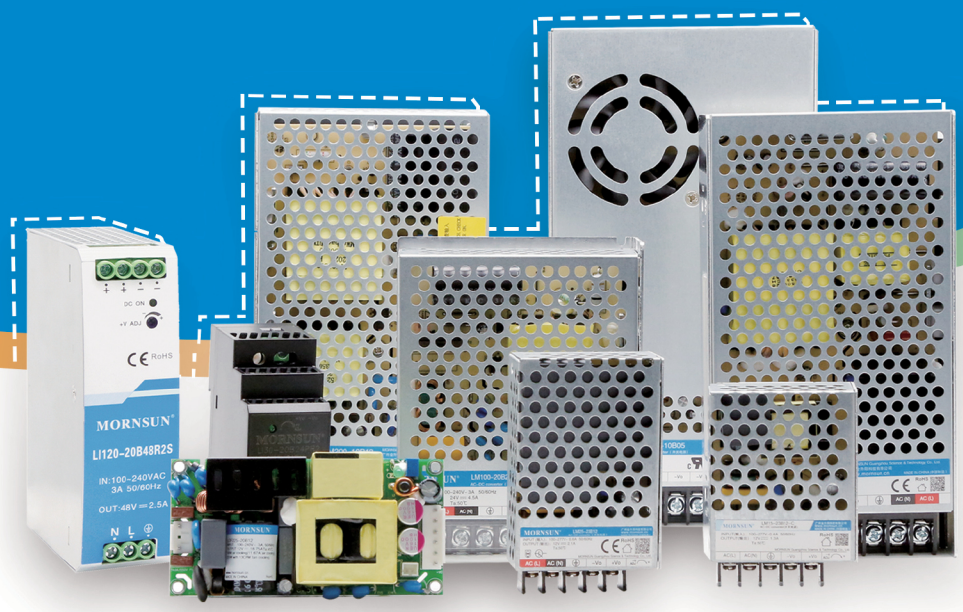

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I suggest you bring EFY magazine to Uganda.

Alfred Nobel

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• • •

IoT PROJECTS

Please let me know some IoT projects published in EFY.

Manish Hosamani

EFY. Following are some IoT projects recently published in EFY:

1. Remotely Control TV With Alexa IoT TV Controller (December 2021)
2. Control Lights Through Thoughts Using EEG Based IoT Controller (November 2021)
3. IoT Based Automated Table Lamp (October 2021)
4. IoT On The Eyes: To Control Home Appliances (October 2021)

• • •

OPTICAL COMMUNICATION

I am interested in optical communication. Please let me know the links or EFY issues in which the topic was covered.

Subhash Arya

EFY. You may please go through the following articles available on our website:

1. An Overview Of Wireless Optical Communication: *https://www.electronicsforu.com/market-verticals/communication/wireless-optical-communication*
2. Optical Networks Create Huge Demand: *https://www.electronicsforu.com/tech-zone/test-measurement-electronics/optical-networks-create-huge-demand*

• • •

UV STERILISATION BOX

This is regarding the 'Make Your Own UV Sterilisation Box' DIY article published in November 2021 issue. Where can I find the chokes required for this UV project? I couldn't find them online. Also, can you please share the video of the UV project?

Ammar

The author Ashok Baijal replies:
I purchased the items online from Amazon, but these should be available in local electrical markets as well. They are commonly used in water filters. I used the Osram brand. Video of the project was not made, but photos are included in the article. It is simple to build. The chokes and tubes are held to the box using zip ties. I am using it without any problem till date for sanitising masks, keys, and phone after every use.

• • •

SEMICONDUCTOR MANUFACTURE

This refers to the article 'Industry 4.0 Can Boost Implementation Of Semiconductor Manufacturing' published in April issue. On the first page, EMS is wrongly mentioned as "environmental management services" while it actually stands for "electronics manufacturing services."

Sunil Banwari (The author)

EFY. Thanks for pointing out the mistake!

• • •

555 TIMER ASTABLE MULTIVIBRATOR

Where can I get the details of 555 timer based astable multivibrator using MATLAB?

Dhanush Shetty

EFY. Please see 'Demo of 555 timer-based astable multivibrator using MATLAB' DIY article available on our website at *https://www.electronicsforu.com/electronics-projects/demo-555-timer-based-astable-multivibrator-using-matlab*

• • •

REPAIRING BOSE STEREO SYSTEM

I have been using a Bose stereo system for about 15 years but now it is not working. I sent it to a Bose service centre, but they could not repair it because some spare parts are not available. I had seen in good old days that local radio repair mechanics used to find the fault and repair within no time. Why it can't be done now? Please let me know if there is solution to this problem.

D.C.S. Gaitonde

EFY. Any audio system running for 15 years must be a good-quality product. However, as the technology evolved, the components used in audio systems and their technology have improved considerably. So, getting the old components now is very challenging. Even the authorised dealers may not have the old parts with them.

In this situation, first identify the exact part number of the faulty components and then check with some local radio mechanics. They may help you get the components either from their old stock or from some other sources. Once the parts are available, the local radio mechanic can fix your stereo, or you can get it done at an authorised service centre.

You can also search for other Bose servicing centres in India on the internet and check whether the parts are available with them.

Letters and questions for publication may be addressed to Editor, Electronics For You, D-87/1, Okhla Industrial Area, Phase 1, New Delhi 110020 (e-mail: **onedit@efy.in**)

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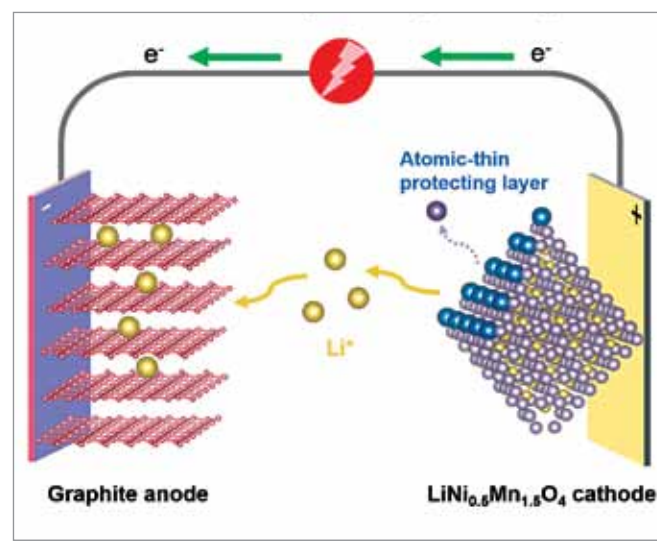
You may soon be able to stretch your TV

Stanford University researchers have developed a proof-of-concept of a re-shapable display made up of a stretchy polymer called 'super yellow' and the synthetic plastic material polyurethane. It has a maximum brightness of at least two times that of a cellphone screen and can be stretched up to twice its original length without tearing. The display can be stuck to your skin, making wearable electronics a valuable market for this technology. "Imagine a display where you can both see and feel the three-dimensional object on the screen," says Stanford University chemical engineer Zhenan Bao.

Zhitao Zhang wears the flexible light-emitting film, featuring a Stanford logo, on the knuckle of their finger. This shows how the film can hold up to flexing and wrinkling (Credit: Zhitao Zhang and Jiancheng Lai of Bao Group Research Lab)

The lifespan of lithium-ion batteries doubled

Researchers at the University of Queensland have developed a technology that more than doubles the lifespan of highly sought-after high-voltage lithium-ion batteries, which achieve higher energy density but last only several hundred cycles. The researchers have demonstrated a battery that remains stable for more than 1000 charge/discharge cycles. They designed a uniquely-grown atomic-thin functional layer on the surface of a high-voltage cathode, which is the source of lithium ions and is a critical aspect that limits the cycle life in a battery. It should be noted that with the industry under increasing pressure to decarbonise, the development of lithium-ion batteries of lower cost, higher energy density, and longer cycle life is vitally important.



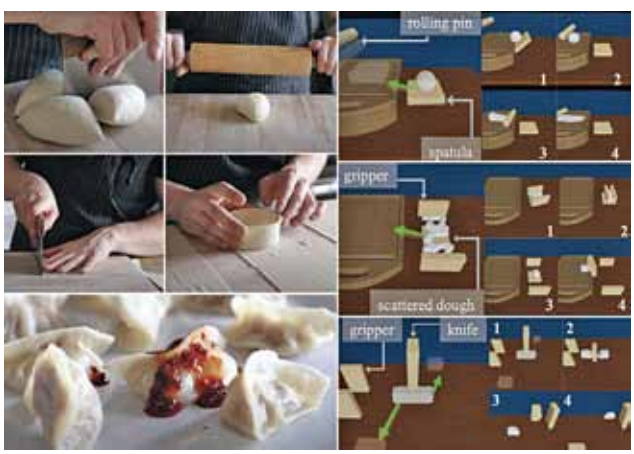
Atomic-thin layer grown on cathode enables long-lasting battery (Credit: https://www.uq.edu.au)

Honey based memristor for neuromorphic computing

Researchers at Washington State University have demonstrated prototype of a memristor made from an unusual material—honey! The memristor is the most crucial component in neuromorphic computing; it is literally a neuron realised on hardware. The researchers created this honey based memristor by turning real, bee-sourced honey into a solid form that was held between two metal electrodes. This design resembles synapses in the brain and how they are kept between pairs of neurons. The researchers anticipate that their findings lay the foundation for biodegradable, long-lasting, organic based computing systems that are much more efficient than traditional computing designs.

This ML framework helps robots make pizzas

Researchers at MIT, Carnegie Mellon University and the University of California, San Diego have developed a framework called DiffSkill for a robotic manipulation system that



Researchers from MIT and elsewhere have created a framework that could enable a robot to effectively complete complex manipulation tasks with deformable objects, like dough or cloth, that require many tools and take a long time to complete (Credit: https://news.mit.edu)

employs a two-stage learning process. This new machine-learning (ML) framework can enable robots to do sophisticated manipulation tasks using deformable objects, such as dough or cloth, over an extended period of time. Each step the robot must take to complete the objective is solved by a 'teacher' algorithm. Then it trains a 'student' ML model, which learns how to perform each skill required during an activity, such as rolling a pin. The researchers discovered that the student neural network could even surpass the teacher algorithm!

Artificial fingertips with e-neurons for soft robotics

Researchers at the University of Bristol have developed an artificial fingertip that emits signals that appear to be similar to those produced by the human touch nerve. The device is essentially a hollow elastomer dome with a thin

Robotic finger tip makes human-like 'nerve' signals (Credit: https://www.electronicsweekly.com)

wall that measures around 25mm wide. Short rigid rods in a contrasting colour are printed through the rubber. They found that their 3D-printed tactile fingertip can produce artificial nerve signals that look like recordings from real, tactile neurons. This is an exciting development in soft robotics—being able to 3D-print tactile skin could create robots that are more dexterous.

Manufacturing as an online service through 3D printers

Hui Wang (left), associate professor of industrial engineering and An-Tsun Wei, a PhD student, are the co-authors of a paper detailing how learning cloud data collected from interconnected 3D printers improves quality control and printing accuracy (Credit: FAMU-FSU Engineering)

FAMU-FSU College of Engineering researchers are working to improve 3D printing technology by teaching machines to learn from one another—a great example of group intelligence. The researchers used a cloud platform to connect different printers, and then had the machines communicate data on accurate processing, reducing the time it took to prepare and calibrate them. They also constructed a mathematical model to better understand the printing process. The technology demonstrates that data generated from multiple production machines can be shared with each in a timely manner, and manufacturing can be done as an online service for meeting diverse market demands.

Smartphone cameras may soon capture 3D images

Stanford University researchers have developed a novel method for ordinary image sensors to sense light in three dimensions using lidar. The research team's lidar system

The lab-based prototype lidar system that the research team built, which successfully captured megapixel-resolution depth maps using a commercially available digital camera (Credit: https://news.stanford.edu)

was able to capture megapixel-resolution depth maps with a commercially accessible digital camera. Simply put, their all-new approach is simple and integrates into everyday cameras like cellphones. With this technology, cameras will be able to estimate the distance between objects, resulting in a three-dimensional image that can be viewed on smartphones. This way, smartphone cameras may be able to capture three-dimensional images (3D).

New gate-oxide tech can produce better transistors

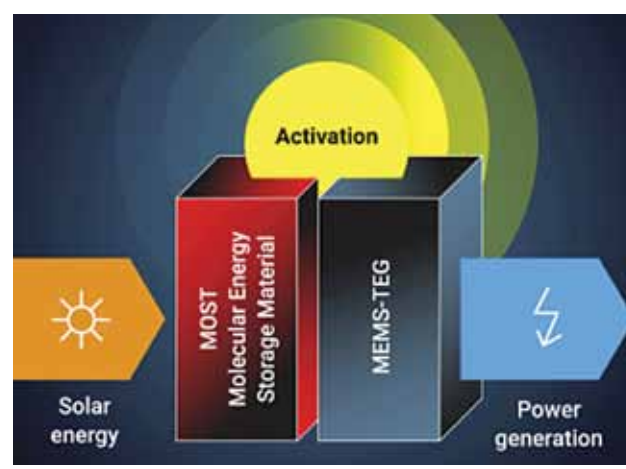
Engineers from the University of California, Berkeley have demonstrated a major breakthrough in the design of gate-oxides of transistors that could significantly reduce their energy consumption without sacrificing speed, size, or performance. They did this by leveraging negative capacitance to make better transistors with the help of engineered crystal structures. The research shows how negative capacitance may be obtained in an engineered crystal made up of a layered stack of hafnium oxide and zirconium oxide that is compatible with modern silicon transistors. They were able to show that their gate-oxide technology is better than commercially available transistors.

Speech tech for information in seven northeastern languages

IIT Guwahati researchers are developing a speech technology tool that will enable retrieval of healthcare related information in seven northeastern languages. This new technology uses spoken keyword spotting (KWS) in northeastern languages. The project's KWS systems will be able to detect a list of predefined terms in a given voice signal in one of the project's target languages. Modeling speech with state-of-the-art deep neural network techniques will be part of the endeavour. People in far-flung parts of Northeast India should be able to obtain healthcare-related information in their own languages as a result of this project.

Electricity on demand from solar energy stored up to 18 years

Researchers at Chalmers University of Technology in Sweden have devised an energy system that can capture solar energy, store it for up to eighteen years, and then release it as needed. By connecting the system to a thermoelectric generator, scientists have now succeeded in making



The concept of MOST (Credit: https://www.sciencedaily.com)

it produce electricity. The new technique is based on the solar energy system called MOST—molecular solar thermal energy. Simply put, the technique works by using a specifically designed molecule that changes shape when exposed to sunlight. Then, a generator can be used to release the energy and transform it into power.

Probe to track soil moisture and density for agriculture

A research team at Cornell University has designed a new form of instrumentation tool called capacitance probe. It uses a number of sensors to track everything from solid

Jin Xu, one of the co-authors of the study, surveys sand dunes (Credit: https://www.azocleantech.com)

concentration to velocity and water content. All of this is done with unparalleled spatial resolution. The probes can reach deep and are small, hence collecting data on a millimetre scale to determine the right quantity of moisture and sand density. The investigation revealed how porous sand is, with a small quantity of air seeping through it. The scientists believe that their probe will be used for a variety of purposes, including studying how soils absorb and drain water in agriculture, and calibrating satellite measurements over deserts.

E-textiles could replace messy adhesive sensors for animals

Purdue University biomedical engineers and veterinarians have created a new remote horse slicker (a sort of coat) that can monitor a horse's cardiac, respiratory, and muscular conditions. It is made using e-textiles technology and uses Bluetooth for communication. They developed a dual regime spray to directly embed a pre-programmed pattern of functional nanomaterials into the slicker's fabrics. Adding e-textile qualities to clothes allows scientists, researchers, and clinicians to take advantage of the

The horse slicker is being tested on a horse running on a treadmill (Credit: Purdue University)

garments' already-existing ergonomic designs to achieve a commercial grade of wearability, comfort, air permeability, and machine washability.

A system that protects solar farms from cyberattacks

A new study from the University of Georgia recommends a novel strategy to protect solar farms, which might be a target of cyberattacks. A team from UGA's College of Engineering proposed a sensor system that monitors a crucial electrical component of solar farms for indicators of cyber-intrusion in real time. They devised a system that can identify anomalies in a power electronic converter's operations in real time, using only one voltage sensor and one current sensor. The system can discern normal conditions, open-circuit faults, short-circuit faults, and cyberattacks using deep learning approaches. Even if the firewall or security software fails to identify an attack, the sensors would detect unusual activity in the device's electrical current. The system can also perform diagnostic tests to discover the nature of the issue.

This 3D printing tech could help in cancer detection

Researchers at the USC's Viterbi School of Engineering have devised a highly specialised 3D printing process that permits microfluidic channels to be built on chips at a microscale previously unattainable. The researchers employed vat photopolymerisation, a sort of 3D printing process that uses light to manipulate the conversion of liquid resin material into its solid state. They were able to print even where the channel height was at 10 micron level and controlled it accurately to an error of plus or minus one micron. The new 3D printing platform's microscale channels enabled various applications, such as particle sorting. This could have a huge impact on cancer detection and research.

TRULY INNOVATIVE ELECTRONICS

INNOVATION UPDATES

Amongst numerous press releases of new products received by us, these are the ones we found worthy of the title *Truly Innovative Electronics*

Sensor for continuous measurement of liquids

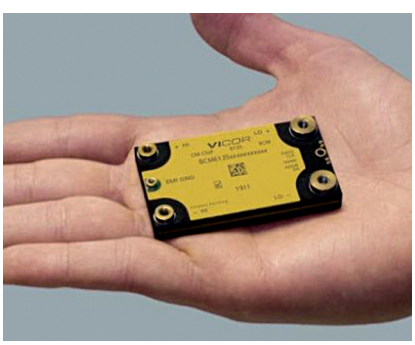
VEGAPULS 6X from Vega is a universal sensor for continuous level measurement of liquids and bulk solids. The sensor is capable of measuring under all process conditions and

offers a self-diagnosis system. It is IEC 62443-4-2 compliant, which ensures secure communication and access control. The non-contact working of the sensor enhances the working life and ensures a maintenance-free operation.

Vega
https://www.vega.com/en-us

High-density power module for automotive applications

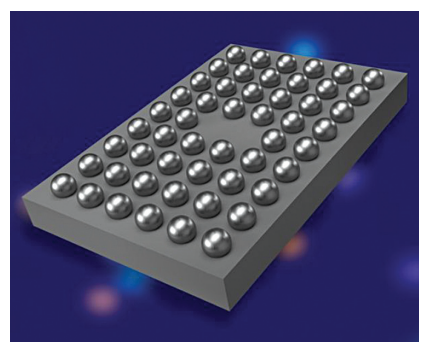
Vicor's BCM6135 is a high-density power module for automotive applications. The 2.5kW module has a small form factor that can easily fit inside the palm of one's hand. The reduced size and weight of the power-dense module provides design flexibility, scalability, and space savings for all kinds of electric vehicle development. According to the company, this module can help reduce automotive power system size, weight, and number of components by up to 70%.



Vicor
https://vicorpower.com

Industry's first Qi v1.3 certified wireless power receiver

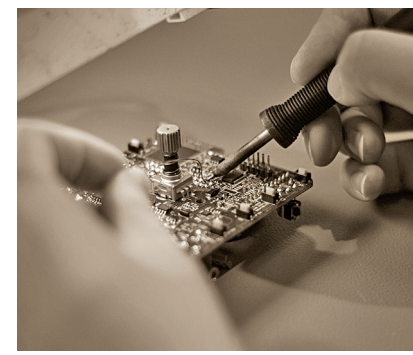
Wireless Power Consortium (WPC) has certified Kinetic Technologies KTE7000 product as the first wireless power receiver to achieve Qi version 1.3 status. The KTE7000 is a single-chip 5W wireless power receiver that conforms to WPC/Qi v1.3 Baseline Power Profile (BPP) standards. The Qi v1.3 specifications provide improved foreign object detection and enables device authentication. The Qi v1.3 can enhance automation of compliance testing, which reduces testing time and decreases potential interoperability problems.



Kinetic Technologies
https://www.kinet-ic.com

World's first image compression DTV SoC

BXE-4-32 GPU from Imagination Technologies has been integrated into Realtek's RTD2885N to optimise image quality and significantly reduce system bandwidth for an ultra-responsive user experience. Imagination's IMGIC technology available in BXE-4-32 provides lossless, frame buffer compression technology. The BXE enables higher resolution capability, lower silicon cost, and reduced bandwidth requirements.



Imagination Technologies
https://www.imaginationtech.com

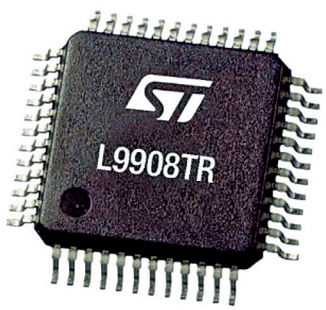
Single-antenna IoT connectivity solution

ELS62 from Thales' is a single-antenna solution that is compliant with

LTE-Cat.1bis standard. It provides a low-cost solution and simplifies design, thereby reducing development cost and time. The ELS62 module integrates security features to protect both the device and data, by ensuring robustness against cyberattacks, with strong device authentication and data encryption. It can be used in applications such as medical wearables, smart meters, and home alarm systems.
Thales
https://www.thalesgroup.com/en

3-phase GDU for 48V automotive applications

ST Microelectronics L9908 is a 3-phase gate driver unit (GDU) developed for 48V automotive applications. The GDU



is capable of controlling 6 N-channel FETs for brushless motors. It has flexible I/O channels and three current sensors. The module is capable of operating in 12V, 24V, and 48V systems. It features a 32-bit SPI interface to offer diagnostic and protection features, such as real-time phase voltage monitoring along with open load detection and a few others.
ST Microelectronics
https://www.st.com

Ultra-sensitive capacitive barometric pressure sensor

The BMP581 is a barometric sensor from Bosh Sensortec that detects fluctuations equivalent to one-thousandth of a mosquito's weight. The energy-efficient sensor is a highly accurate altitude tracking IC that can provide precise location information for applications such as indoor localisation, floor detection, and navigation. The portable size and low power consumption make it suitable for smart wearables, hearables, and IoT applications.
Bosh Sensortec
https://www.bosch-sensortec.com

New-generation 3D touchless user interfaces

TouchNetix has developed fully integrated aXiom touchscreen chips that offer new 3D sensing capabilities by detecting air gestures, allowing

touchless functions in a variety of automotive, industrial, and consumer environments. TouchNetix' single-chip aXiom technology enables proximity sensing 10-15cm above the surface of the screen and provides much higher signal-to-noise ratio (SNR) than the traditional touchscreen controllers available in the market.
TouchNetix
https://www.touchnetix.com

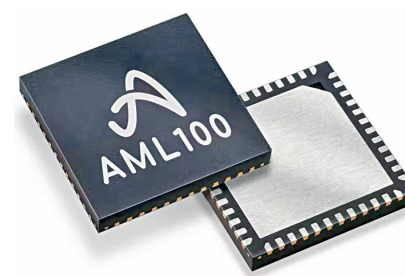
Energy harvesting and power management in same chip

Diatom NH16D3045 is a a high-performance energy harvester with an integrated power managment solution for low-power applications. The IC can be used to charge a variety of energy storage elements, such as

rechargeable batteries or supercapacitors, while it can harvest energy from light or from all types of solar PVs and from other energy sources, including kinetic, thermal, and radio frequencies. It is designed to work in the range of microwatts to a few milliwatts of power suitable for devices like smart wearables, electronic shelf labels, and wireless sensor networks.
Diatom
https://www.nowi-energy.com

World's first fully analogue machine learning chip

Aspinity's AML100 is the first product in Aspinity's AnalogMLfamily that can detect and classify sensor-driven events from raw, analogue sensor data. It allows developers to design significantly lower-power, always-on edge



processing devices. The IC consumes less than 20µA when in always-sensing, thus, enabling a ultra-low power always-on edge-processing solution for voice-first systems, acoustic event monitoring applications, predictive and preventative maintenance for industrial equipment, and biomedical monitoring.
Aspinity
https://www.aspinity.com

NEW PRODUCTS

MAKE IN INDIA

COMPONENTS

Discrete GPU series

Intel Arc-A GPU series, which includes Intel Arc 3, 5, and 7, have been developed specifically for gamers and digital creators. The Arc A-series is based on Intel's new Xe high-performance graphics microarchitecture also called Xe HPG. Intel Arc 3 is a discrete graphics family for laptops, while the Intel Arc 5 and Intel Arc 7 are for desktops and workstations. The series supports DirectX 12 Ultimate and hardware-accelerated ray tracing and Xe Super Sampling (XeSS). The XeSS is Intel's AI based imaging technology that can enhance gaming performance.

Intel
https://www.intel.com

Hardware security modules

TrustFLEX ECC608 and Trust Anchor TA100 from Microchip Technology are Qi 1.3 compatible hardware security modules (HSMs). The TrustFLEX ECC608 is an industrial grade product with a pre-configured key for Qi 1.3 authentication while the TA100 is a crypto-automotive security IC developed for automotive security applications. Both the ICs provide support for secure boot and multiple key management protocols, such as transport layer security (TLS). The secure storage subsystem offers secure key provisioning, including X.509 certificates to cryptographically verify the source and quality of the certified power transmitter.

Microchip Technology
www.microchip.com

Millimetre wave 5G chipset

Analog Devices' new millimetre wave (mmW) 5G front-end chipset is developed with the goal to reduce complexity to produce faster radios. The chipset contains four power-efficient ICs and works on a wide frequency of 24 to 47GHz radio waves. It features two single-channel (1T1R) up/down converters (UDCs) and two 16-channel dual-polarisation beamformer devices. The power-efficient ICs enable reduction of size, weight, power, and cost in mmW phased array designs.

Analog Devices
https://www.analog.com

Energy extracting PMICs

These ICs are optimised for intermittent and pulsed power inputs and are self-configurable with the ability to automatically switch between buck, boost, and buck-boost operations. The PMICs come with selectable and adjustable storage elements and protection mechanisms, which make them suitable for a wide range of applications, such as automation and IoT.

e-Peas
https://e-peas.com

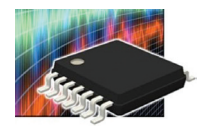
GaN converter

The 50W GaN converter from STMicroelectronics integrates a 650V GaN power transistor and has a very low power standby mode that consumes less than 30mW. It requires minimal additional components for designing an SMPS, thus simplifying the design. The VIPer50GaN also offers good efficiency at all line and load conditions along with multiple protection features.

STMicroelectronics
www.st.com

Digital potentiometers

Omni Pro has released six digital potentiometers featuring direct interface with incremental encoders and an adjustable debounce for mechanical encoder/switch. These three terminal ICs have 64 viper control for adjustment of resistance and are suitable to replace mechanical potentiometers in high vibration, automotive applications. The ICs are available in 20k, 50k, and 100k versions.



Omni Pro
Omni Pro Electronics

HV cartridge fuse

Littlefuse has released the 828 Series of high voltage cartridge fuse that has been designed and tested for use in compact automotive applications. The fuse has a high interrupting rating and provides overcurrent protection. Its small form factor along with the high operating temperature range makes it suitable for applications as a protection device in the power distribution unit and onboard charger of electric vehicles.

Littlefuse
https://www.littelfuse.com

Smart TV chips

Pentonic series of smart TV chips will enable TV manufacturers to offer

Dolby Vision gaming features. The chips can enable the Dolby Vision IQ with precision detail in the 8K and 4K smart TVs. These also allow users to watch multiple media sources in Dolby Vision in several windows at the same time. Besides, Pentonic chips improve latency through the auto low latency mode (ALLM) and variable refresh rate (VRR).

MediaTek
https://www.mediatek.com

BOARDS & MODULES

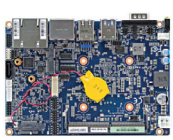
eFPGA module

Flex Logic Technologies' INFERX X1M provides great design flexibility and high performance at relatively low power requirements, making it suitable for edge AI applications. The eFPGA module comes in a compact M.2 form factor and offers an edge logic accelerator. The module is suitable for edge AI applications, such as industrial machine vision, smart wearables, image processing, robotic vision, and analytics.

Flex Logic Technologies
https://flex-logix.com

Embedded single board computer

Avalue Technology Inc. has released an embedded single board computer, ECM-EHL, equipped with the Intel Pentium/Celeron/Atom SoC BGA processor. Compared to its predecessors, it has improved performance, I/O capability, and better security features. It supports Linux as well as Windows 10. The module has extended temperature tolerance from -40°C to +85°C (with 0.5m/s air flow), which is suitable for industrial and outdoor applications under harsh operating conditions.



Avalue Technology Inc.
https://www.avalue.com.tw

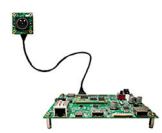
Linear power supply

Silent Angel has released the Forester F2, a linear power supply specifically made for the home Hi-Fi system. It offers four different linear power outputs that are optimised for improving the musical performance in various approaches. The power supply has toroidal transformers and low-noise MOSFETs. Its circuitry is designed to eliminate high-frequency electrical noises, make the transmission steadier, and reduce jitter and latency issues. The power supply is housed in an SECC galvanised steel box for better durability.

Silent Angel
https://www.silent-angel-audio.com

AI vision kit

qSmartAI80_CUQ610 from e-con Systems is a ready-to-deploy AI vision kit. It features a Qualcomm QCS610 SoC based SoM, e-con's 4K MIPI low-light camera module, Sony's STARVIS 4K camera module, IMX415, and a carrier board. This ready-to-deploy kit is designed for running image based machine learning (ML) and deep learning models on the edge.



e-con Systems
https://www.e-consystems.com

1200W power supply

Powerbox OFI1200A, designed for conduction cooling applications in industries, can operate between -40 and +95°C without a fan. The 1200W power supply is suitable for a wide input range between 85 and 305V AC with power factor correction. The module is available in three versions of single-output DC voltage: 12V/84A, 28V/43A, and 48V/25A. Each can provide 'near to zero' to the maximum rated output voltage and current.

Powerbox Systems
https://www.powerbox-systems.com

T&M SOLUTIONS

Automated test solutions

The Rohde & Schwarz ZNrun K410 and K411 are capable of automatically analysing the Ethernet cable assembly precisely. The ZNrun K410 software automates the time-intensive manual Ethernet cable testing procedure following the IEEE 802.bj, by, and cd standards while the ZNrun K411 is capable of testing much faster IEEE 802.3ck Ethernet standard.

Rohde & Schwarz
https://www.rohde-schwarz.com

Cable plus network software

Fluke Networks has upgraded its LinkIQ Cable + Network Tester soft-

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ware. The software is suitable for testing and troubleshooting IP networks and testing industrial Ethernet cabling. It provides reports including the expanded network testing and allows users to document their work. The software now supports users in twelve languages and is available in all-new LinkIQ units, It is also available as a free upgrade to the existing customers.

Fluke Networks
https://www.flukenetworks.com

Wi-Fi 6E testing solution

The Microwave Vision Group (MVG) and Anritsu Corporation have jointly developed a solution for testing the new Wi-Fi 6 spectrum extension, Wi-Fi 6E. The new solution combines MVG's multi-probe system and Anritsu's MT8862A wireless connectivity test set. The new product supports an effective, simple, and stable test environment for RF evaluation of the IEEE 802.11ax 6GHz band (Wi-Fi 6E) OTA measurements.

Microwave Vision Group: www.mvg-world.com, Anritsu Corporation: www.anritsu.com

SOFTWARE

EDA tool

The Pulsonix version 12.0 offers a 3D collision detection for both multi-board designs and board folding, and significant speed improvements over previous versions. The software adds around 100 new features compared to its previous version. Pulsonix V12.0 also has a dark mode, which reduces strain on the user's eyes and a simpler interface that reduces complexity for a new user.

Pulsonix
https://pulsonix.com

NEW FEATURES

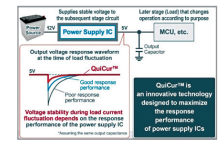
Power loss protection feature

Swissbit has launched a new power loss protection (PLP) feature called 'powersafe,' which is capable of protecting their industrial SSDs in the event of sudden power outages. During sudden power outages, extra power is provided to the SSDs to safely execute the write commands and flush data. This is achieved by using an additional PLP level to secure the data from the DRAM to NAND (cached data) or while the data is being transferred from host to controller (dynamic data). The tantalum capacitor used is one of the key components that makes the powersafe feature possible.

Swissbit
https://www.swissbit.com

Improved response of power supply ICs

ROHM has unveiled QuiCur, a technology developed to improve the response of power supply ICs that are used as DC/DC converter ICs and LDOs. The response performance involves voltage stability and response speed of subsequent stages. This technology is said to simplify the power supply circuit design by providing stable operation even with fewer external components, which will reduce the mounting area and thereby reduce the size of the product.



ROHM Semiconductor
www.rohm.com

ENTERPRISE SOLUTIONS

Dome cameras for surveillance

The Project series dome cameras from Matrix Security Solutions feature 8Mp back-illuminated CMOS sensor developed by Sony and a high MTF lens that enhances video quality in low light conditions. These cameras can support SD cards up to 512Gb and have H.265 compression and motion based frame rate reduction system that reduces the memory requirement by up to 50%. The cameras offer a fixed and motorised varifocal lens that enables options to zoom in and out of the video footage and have an IP67 rating for dust and water resistance.

Matrix Security Solutions
https://matsecurity.in

THE COMPLETE MAGAZINE ON OPEN SOURCE
OpenSource ForYou
The latest from the Open Source world is here.
OpenSourceForU.com
Join the community at facebook.com/opensourceforu
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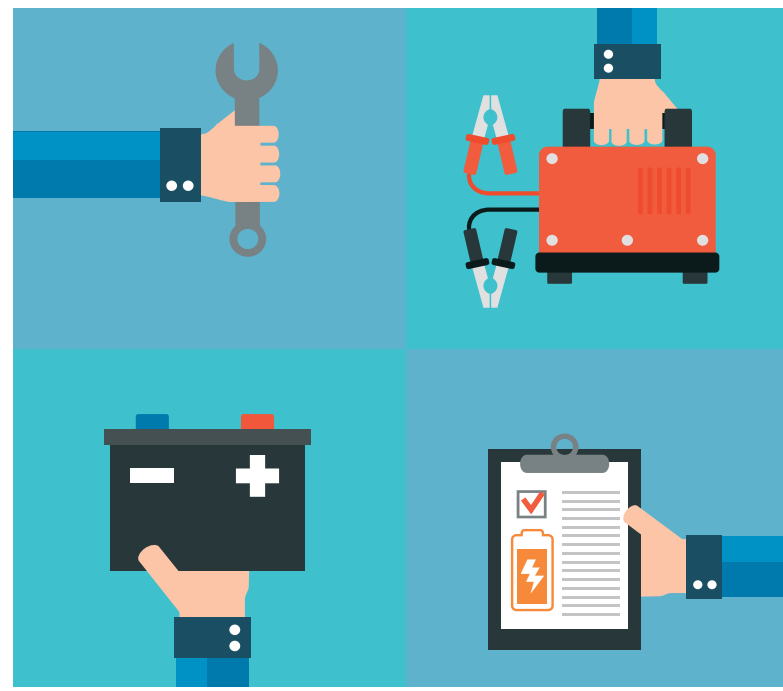
Essentials Of A BATTERY MANAGEMENT SYSTEM

We take our batteries for granted and often misuse them, unknowingly. But there is much that goes behind designing a battery and, especially, its management system, without which it can run amuck. Read on to find out how the battery management systems are designed



VISHAL SAPRE is an electronics design professional working with Righill Electrics as GM (Technical). His interests include embedded control systems, IoT, power electronics, and the use of interpreted language systems, such as Python in microcontrollers

To a user a battery looks like a black-box, which magically produces electrical energy. And it looks like no active control is required for the battery to perform well. The truth, however, is that most batteries require some kind of electrical control to keep them from going bad and have a long working life. For some battery chemistries this control may be intermittent and simple, while for others it could be continuous and essential.

An intelligent system that takes care of the batteries is called battery management system (BMS). Here we shall discuss some essential parts of a BMS that apply to most types of batteries, and specifically to lithium-ion (Li-ion) based batteries.

A BMS manages the circulation of electrical energy to and from the battery and the distribution of this energy across its constituent cells. It tries to manage the charging and discharging of the battery to achieve some health goals for the battery. The most basic goals for a BMS are:

1. Always monitor the health of the battery
2. Control its charging and discharging to maximise battery health and performance
3. Protect the battery by maintaining its cells' voltage within the specifications
4. Report the battery's health status to the user

The BMS is a complete system and, like any other embedded system, it has following important parts:

1. Supervisory control element (microcontroller and/or application specific integrated circuit)

2. Sensors for voltage, current, temperature, and vibration
3. Controlled switches (MOSFET/IGBT/relays/contactors)
4. Indicators (optional)
5. Communication peripherals, either as part of the MCU or a separate IC

Let us first understand the various aspects that need to be controlled/monitored, so that we can later on assign each of these jobs to specific entities of our hypothetical BMS. Before we start, remind yourself of the adage, *Design is all about choices and trade-offs!*

A typical connection diagram of a 4S3P battery type is shown with its BMS in Fig. 1. Please notice the following important things here:

1. The BMS is an integral part of the battery. Unprotected Li-ion batteries are unsafe and unusable
2. The BMS is connected to each cell pack (cells in parallel) in series
3. The BMS controls the charging and discharging of the battery pack
4. As the number of series string cell packs increases, so does the BMS complexity

Monitoring health of the battery

Battery health has multiple parameters, the most essential of which are its terminal voltage, charge capacity, and cell temperature. So, monitoring battery health involves monitoring these parameters continuously.

Voltage monitoring. A battery, as the name suggests, comprises individual electrochemical cells that are connected in series or parallel. So, each cell voltage should also be monitored. Let us understand what the cell voltage represents.

The specific energy (or energy density or energy per unit volume) of a particular cell chemistry is unique to its molecular composition. This specific energy directly affects the terminal voltage of a cell. Thus, higher the terminal voltage of a particular chemistry, higher is its specific energy.

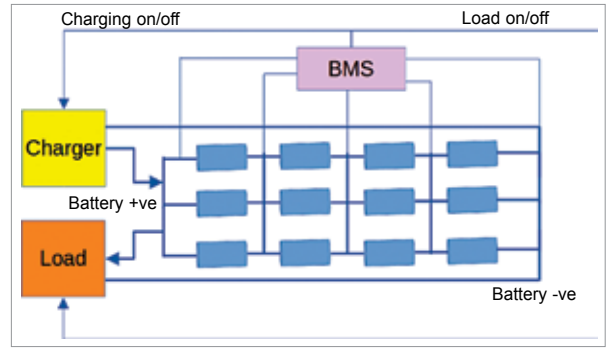


Fig. 1: Typical connection of a BMS to a 4S3P style battery

To sustain the reversible nature of the cells' electrochemical properties, it is necessary that the energy content in the cell should not fall below a certain level or rise above a certain level. In simpler words, to keep the cells healthy, and in turn the battery healthy, it is essential to keep the cells' terminal voltage within a given voltage envelope.

This safe voltage envelope (SVE) is different for every chemistry. For example, the lead-acid chemistry has an open circuit voltage (OCV) of approximately 2.1V and an SVE of 1.8V to 2.35V. The lithium-iron-phosphate (LiFePO4) cell has an OCV of approximately 3.2V and an SVE of 2.5V to 3.65V.

Since each cell of a battery is made individually, and because it is impossible to make completely identical cells in a batch or across batches, nominal cell voltage of each cell may be different inside the battery. Thus, if a battery has 100 cells, would the designer have to monitor voltage for all the cells? Just ponder over it. We shall try to answer this while looking at energy redistribution strategies later in this article.

Charge capacity monitoring. The charge capacity of the cell is of primary importance when cell health is considered. The interesting part of the charge capacity is that for most chemistries it is reflected in some part as the terminal voltage of the cell.

In case of Li-ion cells, the change in terminal voltage with respect to its charge capacity is quite flat. This means that the terminal voltage does not change much with reduction in charge capacity. Thus, the depth of discharge (DoD) levels or the state of charge (SoC) levels cannot be faithfully calculated all along their charge/discharge curve based solely on the terminal voltage.

If we consider the discharge curve of a Li-ion cell, major changes in the OCV of the cell occur only at the extreme ends, and all through the curve the OCV almost stays flat with change in the DoD. This is in stark difference from lead-acid cells, where the OCV changes quite a bit with increasing DoD.

This unique nature of the Li-ion cells means that a BMS must use an advanced approach to ascertain the running DoD levels. The typical BMS achieves this by using multiple techniques, such as the use of high granularity analogue front-end and using Coulomb Counting to track the charging and discharging levels and rates. Some advanced BMSes may also employ a square wave load at a frequency of 1Hz to 1kHz, to get an idea of the internal resistance of the battery and thereby infer its state of charge.

Cell temperature monitoring. Another parameter to monitor is the cell temperature. Cell temperature affects the electrochemical reactions and intercalation processes in the cell. An excessively high cell temperature can result in gasification in lead-acid cells and can result in a thermal runaway failure in Li-ion cell chemistries. An excessively low temperature can permanently damage a Li-ion cell.

This means that a BMS should monitor cell temperature all the time. But doing this for each individual cell would be quite sub-optimal for the overall battery design. This is where the BMS designer must take a call on placement of temperature

sensors. It must be assumed by the designer here that cell temperature (either internal or ambient) will affect adjoining cells as well, and so overall temperature of the battery can be estimated by using only a few temperature sensors.

Ideally, once the battery is fabricated, a temperature distribution analysis must be carried out while the battery goes through at least a single charge and discharge cycle. Such an analysis will show the hot spots of the battery and would help the BMS installer to decide on points of installation of the temperature sensors.

Simpler BMSes either provide a single temperature sensor for the entire battery or do not provide any. A good and responsible BMS should have at least 4-5 temperature sensors. Typically, the temperature sensors used for BMSes are resistive temperature devices and sometimes thermocouple modules. Advanced BMSes may also provide ways to control the battery temperature by either using forced air/liquid cooling or heating up the battery using Peltier elements.

Controlling charging and discharging

Charging and discharging a battery of cells is the primary process that the battery goes through. Controlling the process of charging and discharging ensures that the battery remains healthy for the longest time possible. However, this kind of control is mostly an on-off type control.

Discharging depends mostly on the load connected to the battery and the BMS has no control over the load, and so it controls the discharge rate by limiting the discharge current. Similarly, the BMS also does not have any control on the charger capacity, and it only controls the charging rate by limiting the charging current. The BMS almost stays transparent to charge movement until the charge or discharge current reaches the specified maximum value, at which point it kicks-in and disconnects or reconnects the load or source from the battery.

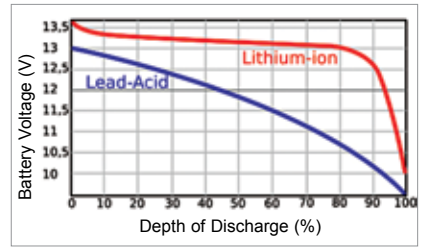


Fig. 2: Depth of discharge against OCV of Li-ion and lead-acid batteries (Source: https://www.zwerfcat.nl/en)

It is interesting to note that the maximum charging and discharging rates of a battery depend directly on its capacity. This capacity is typically expressed in the unit of ampere-hour (AH), which is mostly a glorified unit of charge (remember, $Q = I \times T$). Different batteries having the same nominal OCV can differ from each other based on their capacities. For example, a standard 12V battery is available in various capacities, such as 7AH, 35AH, 50AH, 80AH, 100AH, and so on. Battery cell capacities are typically specified in mAH, which is milli-ampere-hour.

Since the current capacity of the above batteries is different, this means the BMS used for each one of them must also be different. The BMS designer, therefore, must specify a current capacity against which the BMS will work. BMSes are always specified in terms of the typical voltage and maximum current that they can handle.

The BMS voltage is usually specified in terms of the series connection of the constituent cells. For example, a 3S Li-ion BMS means that it expects to be connected to a battery having 3 Li-ion cells connected in series. This means that when choosing a BMS for battery, the user must look at both the battery capacity and the application requirement, and choose a BMS such that:

Battery Current Capacity≥BMS Current Specification≥Application Current Requirements.

Some BMSes allow a single connection point for charging and discharging. This is the simplest design, while some others allow different points for charging and discharging connections. The logic behind a single connection is typically lower price. However, with only one connection point, the battery can only be connected to either the load or the charger.

With two connection points, the BMS allows connecting the battery to the charger and to the load at the same time. This is the most common scenario in our day-to-day use. But the mobile phone BMS allows use of the battery to power the mobile phone while also being charged via its USB device port.

The BMS also needs to use different cut-off switches for the charge and discharge current paths of the battery. This is because the charging path is from the charger to the battery, while the discharging path is from the battery to the load, and a BMS typically uses a MOSFET (or other static switches) for connecting and disconnecting the battery from the external world.

These devices are unidirectional, so two different FETs have to be used. In this case, they are connected back-to-back and use each other's body diode to complete the charge and discharge paths. While this allows independent control of the charging and discharging current limit, the BMS still needs to provide different connection points, in case the battery has to be connected to the load and the charger simultaneously. If there is a single connection point, either of the current limits can lead to the port being disconnected, stalling the other process as well.

Even though we can provide two connection points, the battery itself can function only in one mode at a time, either charging or discharging. Let us understand this in some more detail. The typical voltage condition of a battery system would be such that:

Charging Voltage > Battery Voltage > Application Requirement

This must hold at all times, so that

the battery can accept charge from the charger and also provide charge to the application. So, if the charger is connected, while the battery is still supplying to the load, it is obvious that only a part of the charge goes to the battery, while the rest is used by the application. Thus, in this case, the battery is not in a discharging mode.

It may also happen that, if a heavily discharged battery is connected in the above arrangement, all the charge is first absorbed by the battery. Here the application suffers until such time that the battery voltage rises to a certain level and the charging supply has excess charge available to power the application. Users must have seen this happening when their mobile phones reach very low levels, and a charger is connected. For some time, until the charging indicator shows a small percentages of battery capacity (typically 2% or more), the mobile phone does not switch on completely.

When the charging voltage is removed, and the load is still connected, the battery enters the discharge mode. So, even though technically the battery may allow both charging and discharging path to be connected, the net battery current at any point can only be either positive (charging) or negative (discharging), but not both.

As mentioned earlier, the BMS also controls the charging and discharging process by ascertaining the running charge capacity of the battery by using a simple technique called coulomb counting. Coulomb counting, at its simplest, is the count of the amount of charge that is present in the battery and is a way to track the state of charge of a battery.

Mathematically, coulomb counting refers to the integral of the current over time. In discrete terms, coulomb counting is a Sigma function, that is:

Σ(current_in_amps × hours_in_operation)

The BMS keeps a running record of the current levels over a given time

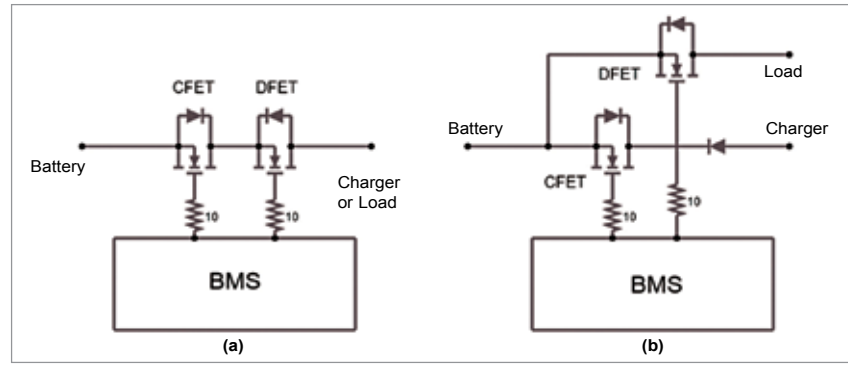


Fig. 3: Cut-off FET schematic illustrations for (a) single connection for the load and charger and (b) two-terminal connection that allows for charging and discharging simultaneously

period, and thereby tries to estimate the relative charge capacity of the battery. The important word to note here is 'relative,' because coulomb counting gives an account of the change in the charge capacity of the battery. Therefore, unless the BMS is calibrated at either ends of the charge/discharge curve, it is not possible for the BMS to estimate the actual state of charge or depth of discharge of the battery.

Barring a few important limitations, coulomb counting can be an effective technique to track the SoC of the battery. The limitations are: (a) the leakage current or self-discharge of the battery, which will not be registered by the BMS, and (b) the offsets in current measurements.

As already mentioned, BMSes solve these issues by using high granularity analogue front-ends and calibrating themselves at the end and start of the charge and discharge curve. Using a BMS of the same current capacity as the battery also helps in this process of tracking the SoC. Thus, at low charge capacities, the BMS can initiate a battery disconnect, even though the discharge current is less than the discharge current limit.

To know the charge and discharge current separately, the BMS may use a single current-sense element or two different current-sense elements, and this is left to the BMS designer. The BMS designer must make a trade-off here between cost and convenience of measurement. The BMS is said to be operating in the charge controller mode in this case.

Maintaining cell voltage

A battery is typically made from series/parallel combination of cells. Parallel connected cells form a local closed circuit and stay at the same voltage. Any difference in their voltage gets distributed based on the Ohms Law. However, series connected cells are not intrinsically in a closed circuit, and hence they can assume different maximum and minimum voltages. This means that a BMS needs to look at individual series cells (or packs of parallel cells) and ensure that the cells stay within their specified voltage range.

But why will cells move to different voltage levels? Here comes the law of probability of microscopic differences between cells, which compound to make one cell weak and another cell strong. A weak cell is one that gains voltage faster than others and loses voltage faster than others. Fig. 4 shows a condition where individual cell differences combine to create widely differing voltages on individual cells, whilst the overall battery voltage remains the same.

Fig. 4 shows various possibilities of charge distribution within a 12V LiFePO4 battery pack. As shown in Fig. 4(c), a weak cell (C-3) causes the battery pack to reach full charged voltage before all the cells have reached their full voltage. This causes

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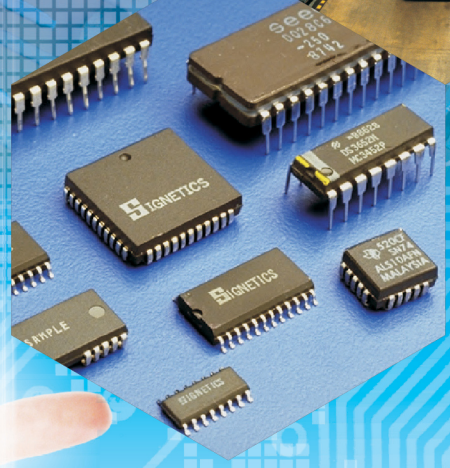

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the problem that C-3 goes out of safe voltage envelope and some other cell is left uncharged to its full voltage. Since the battery pack has reached its full voltage, the BMS would have to open its charging FET and stop any charging current.

On the extreme end, at the time of full discharge, as shown in Fig. 4(d), the weak cell (C-3) discharges much faster than other cells, because of which the overall battery voltage reaches its discharge limit before the last cell (C-4) can be discharged fully. This means the battery has spare capacity that cannot be used any more.

In practice, Fig. 4(a) and Fig. 4(b) represent cases which cannot be achieved without active intervention from a BMS, while Fig. 4(c) and Fig. 4(d) represent cases that are almost always found in battery packs.

So, the BMS tries to either expend excess energy from weak cells or redistribute energy within the battery pack to avoid cells going out of their specifications. This process of correcting the distribution of energy is quite literally called balancing. Balancing the cells by expending excess energy is best done either during or just after the charging process, so that cells being expended are also replenished and, if required, the flow of current continues, and thus it is called top-balancing.

Redistribution of energy can be done while charging or while discharging, or while the battery is not being used for any load. So, redistribution allows either top-balancing or bottom-balancing operations. Balancing by expending excess energy is carried out by connecting the weak cells across a burden resistance, which converts the excess energy into heat. The rate of balancing is limited by the resistance value. This is also called passive balancing, because only a connection to the burden resistance is required for top-balancing to happen.

Generally, since the BMS does not know which cells could be the weak

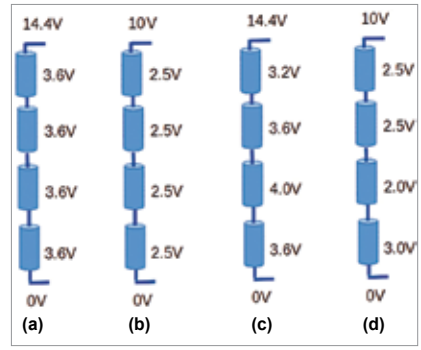

Fig. 4: Various stages of a LiFePO4 battery pack: (a) balanced and charged, (b) balanced and discharged, (c) unbalanced and charged, and (d) unbalanced and discharged

ones in practice, they are designed to provide a burden resistance across each cell in the series connection. The value of the burden resistance is chosen such that balancing happens within the shortest time possible while keeping the resistance temperature within safe limits.

Redistribution of energy is much more complex because, to redistribute energy some form of energy storage device is required, which can swap energy from one cell to the other cell. This is carried out by creating a matrix of capacitors or inductors (transformers) that are then switched across cells to allow for rebalancing. Some innovative designs also use a separate cell itself as the energy swapping container.

Since we use reactive energy storage here and the BMS also needs to actively switch the energy storage devices so that balancing can happen, such an arrangement is called active balancing. It has the advantage that it can be performed at any time during the charge-discharge cycle, and it tries to conserve energy rather than simply expending it has heat.

Many complex schemes are possible when it comes to active balancing. These schemes are out of the scope of this article, so the designers may go through the available research papers to figure out a scheme that is feasible for the design at hand. It suffices to say here that active balancing has the potential to increase the available battery life. But a BMS with active balancing will almost always increase the cost of the battery pack.

Reporting battery condition

Reporting the present state of the battery is an important function of the BMS. The simplest BMSes provide visual feedback on the state of charge of the battery by using LED based indicators (LED bars or individual LEDs). Some more advanced BMSes may have a screen or a touch-screen interface. This allows the user to not only monitor the live parameters of the BMS but also easily setup the BMS parameters at the time of connection to the battery. This suffices in most stationary applications.

A BMS that goes into the industrial setting may use the RS232 or RS485 physical bus and a simple protocol, such as MODBUS, to allow an external supervisory control unit to read and write parameters. Some others may allow this information exchange to happen over Bluetooth (so that your smartphone can watch the battery over an app) or make it available over IP networks, either via regular Ethernet ports or a Wi-Fi port.

If the battery is being used in an electric vehicle of some kind, the vehicle's main electronic control unit (ECU) will expect the BMS to make all the relevant information available in some kind of known digital format. The most common data connection scheme used in the automotive world is the CAN bus. Accordingly, the BMS may be required to make its data available over the CAN bus. Setting up the BMS with all its parameters may also be done over the same connection.

The reporting arrangement used by the BMS directly affects the cost of the BMS, with more exotic schemes making the BMS more expensive. As always, the designer must exercise choice and trade-off to choose the feature that is most suited for the project at hand. EFY

Career

"VOLTX.AI Is A Productivity Suite For BATTERY DESIGNERS... A Free Version Is Available"

EFY chanced upon Voltx.ai, a firm that claims to offer an innovative design tool for battery designers, and spoke to Anton Doos, the CEO, to understand the tool better and their revenue strategy

ANTON DOOS
CEO, VOLTX.AI

Can you please explain your product in detail?

Voltx.ai is a productivity suite for battery designers. It has multiple tools along with a dashboard with a materials database where users can search, compare, edit, and add parts.

One of our tools, the Pack Designer, combines parts and generates over 1000 battery pack designs per second. Then it compares all the designs and shows you the best. Doing this manually would be impractical because it would take too long (in mathematics, it is known as a combinatorial explosion problem). So, by using automation tools, engineers can much more quickly gain insight and come up with the best designs.

Another tool, the Configuration Designer, is a digital grid paper for battery designers. We see many businesses relying on MS Paint or Excel to draw their configurations because there are no better alternatives. Our Configuration Designer lets engineers draw and flip cells and connections, change cell models, and in real time simulate short-circuit, current load, and others. These automation features lead to faster and better designs.

How can users access Voltx.ai?

Voltx.ai is still in the alpha stage. A free version is available for users to use and submit feedback.

Any indication of the kind of fee that you are expecting to charge?

We are planning to charge US$500 per month for five users. There is also an early adopters' discount for companies who provide us with feedback.

By when do you plan to turn this into a paid product or service? And are we correct to assume that it will be a software-as-a-service (SaaS) model?

Yes, it is a SaaS model with a freemium account. We are on track to go live with paid accounts before summer (2022). Our intention for the free accounts is that DIY users can get sufficient utility and business users can try out the software before deciding to upgrade.

Since you may add more features to Voltx.ai later based on user feedback, won't that delay industry-readiness of your product?

I believe industry-readiness looks like a sine-wave adoption curve. Our modus operandi to advance adoption is to continuously identify user problems and add solutions as features. It is all under the umbrella of the overall vision of using automation to reduce the time between concept and manufacturing. When enough problems are solved, users will find enough value, and the product will be ready for market.

Through feedback from our early adopters, we believe our next set of features will make our software market-ready. One example of this is, while talking to our users we identified that many wanted to export our designs to CAD to integrate into their existing workflow. Most businesses have standard operating procedures, and almost every engineering team relies on CAD at one point or another in their process.

Our solution created a new Export to FreeCAD button, where within twenty seconds of clicking the button the battery design will open as a CAD model on your computer and can be integrated into any existing workflow.

Why do you consider your product to be a milestone for battery design and production?

The algorithm we invented solves some difficult problems with very accurate results. We have compared the batteries designed manually by professionals with the batteries designed through our software. The results have shown very little difference. There is a considerable

efficiency gain from this, going from tasks that take hours to tasks that take seconds.

Can you provide examples of some difficult problems solved by your algorithm?

One problem with battery design is that of a combinatorial explosion of possibilities due to the number of different cell models, configurations, and other parts.

Think of it like chess. The first chess computers quickly outperformed humans because they could analyse hundreds of thousands of moves quickly. The way people design battery packs now is like chess—humans use knowledge, experience, and intuition to constrain the total search size. This must lead to less than optimal results since the full search space of potential battery designs has not been created or analysed.

One of the ways we solved this problem is with a highly optimised algorithm that can generate the designs thousands of times per second. A second part is how we analyse and sort the results from most to least useful to present users with the optimal design.

What benefit can battery design engineers receive compared to any other similar product? What is your USP?

Other battery software we have seen focus on simulations, especially for EV packs. We focus on automating the design of any battery pack so that users can start manufacturing as soon as possible.

How is that different from other battery design tools?

From what we have seen, other battery design software are usually a sub-feature of their main software. They have high-cost software for enterprises that are designing electric vehicles and large-format battery packs. These tools focus on simulations, particularly thermal simulations.

Think of a company like Toyota designing a new electric vehicle. Our software is for any business that designs battery packs, everyone ranging from DIY to startups to enterprises. It is lower-cost than competitors, and we are more focused on small and medium format packs, although we can produce large format packs as well. That means robots, drones, home power systems, or anything else you can imagine powering is what can benefit from our software.

Another big difference is our vision and overall focus on automation and Industry 4.0. The tools we provide are intended to speed up the engineering workflow—both to find the optimal design quickly and output the necessary information to begin manufacturing. What we are building today will run tomorrow's smart battery factories while our competitor products are not guided by this vision.

Which companies and institutions are using your software? What kind of products are they developing?

There is a wide range of people using the software. We have seen one company build a battery design for a giant solar yacht. We have seen electric bikes, robots, drones, home solar systems, and many other applications. EFY

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NFTs – Not Frivolous Tech

A web search for 'non-fungible token' or NFT throws back endless news about limited-edition virtual sneakers, digital art, memes, tweets, and trading cards being sold for unrealistic prices. But NFT means much more. It is serious tech with extremely great potential in the digital and physical worlds. Here is what you need to know about NFTs and their applications

JANANI G. VIKRAM is a freelance writer based in Chennai, who loves to write on emerging technologies and Indian culture. She believes in relishing every moment of life, as happy memories are the best savings for the future

A non-fungible token (NFT) of Chris Torres' *Nyan Cat*, a video of a flying cat with a pop tart body leaving behind a rainbow trail, sold for $580,000, while *Everyday: The First 5000 Days*, a collage of 5000 digital images by Mike Winkelmann, sold for $69 million. A 21-year-old Dutch student recently put up his soul for sale as an NFT, and at the time of writing this article its price had crossed $3.4 million. Closer home, four Thar based NFTs auctioned by Mahindra & Mahindra in March 2022 sold for a sum of ₹26,00,000!

Seeing these examples, one may be fooled into thinking non-fungible tokens or NFTs are all about people burning cash in collectibles and memorabilia. However, NFT as a technology means much more, and can potentially be used for many more real applications that can affect our daily lives, including medical record maintenance, improving supply chain efficiency, industrial design prototyping, and protecting intellectual property (IP). It can be a very effective way of digitising real-world objects and processes.

Fig. 1: Mahindra's Thar based NFT - Standing Tall (Source: auto.mahindra.com)

Let us take a quick look at what NFTs are, a deeper look at their role in the art, collectibles and memorabilia space, and about other uses they can be applied to.

What is an NFT?

A non-fungible token or NFT is a unit of data stored on a digital ledger, such as the blockchain. It is also a crypto-token like digital currency, but here the unit of data is associated with a particular digital or physical asset—say, a file, a work of art, a degree certificate. The data is used to give important information about the asset, such as the creator's signature, current ownership, history, and terms of use or license.

Let us take a look at its characteristics.

It is non-fungible. Cryptocurrencies like Bitcoin or Ether are fungible tokens. That is, if you take two Bitcoins, they represent the exact same value, which makes them interchangeable or fungible. On the other hand, NFTs represent assets that are rare and unique, and not replaceable by one another, which makes them non-fungible.

It is tradeable. You can sell or trade NFTs in digital marketplaces, such as OpenSea, Foundation, Sorare, or Decentraland, using supported digital currencies stored in digital wallets.

It is immutable. Once an NFT has been encoded using blockchain technology, you cannot alter the metadata, ownership information, or history. A blockchain is a decen-

Process of selling or buying NFTs

- Setup a digital wallet, compatible with the marketplace you have chosen. Metamask, Trust Wallet, Coinbase Wallet, and AlphaWallet are some of the popular ones.
- Buy cryptocurrency using your credit card on platforms like PayPal or Coinbase. Expect the exchange to charge a percentage of your transaction as fee.
- Load your wallet with the cryptocurrency.
- Connect the wallet to an NFT marketplace, like OpenSea, Foundation, Sorare, SuperRare, Nifty Gateway, Rarible, or Decentraland.
- Mint/list your NFT, or start bidding for one. Expect to be charged a 'gas fee'!

tralised mechanism, open to scrutiny. This makes an NFT a trustable certificate of uniqueness and ownership.

It is verifiable. Not only is an NFT immutable, it is also verifiable. That is what makes it so special. At any point of time, you can quickly and easily verify the authenticity and ownership history of an asset using a block explorer for that specific blockchain, such as Etherscan for Ethereum and PolyScan for Polygon.

It is interoperable. Technically, NFTs can be traded across online platforms, wallets, and marketplaces because of the open nature of blockchain standards.

It can use any blockchain. Today, most NFTs are programmed using Ethereum standards, though technically they can be based on any blockchain like Algorand, Tezos, or Polkadot.

This ability to record and validate digital creations, and to digitise real-world objects, makes NFTs a force to reckon with in the emerging metaverse that aims to integrate real and online experiences, using extended reality tools and the Web3 paradigms of decentralisation and token based economics.

2014 to 2021—a quick recap

The first-known NFT was a small video clip called Quantum, which was registered on the Namecoin blockchain in 2014 and sold for $4. It was a small experiment by techie Anil Dash and artist Kevin McCoy, who paired at an event for sparking new ideas. The duo termed it as monetised graphics.

"McCoy used a blockchain called Namecoin to register a video clip that his wife had previously made, and I bought it with the four bucks in my wallet. We didn't patent the basic idea, but for a few years McCoy tried to popularise it, with limited success. Our first demo might just have been ahead of its time. The system of verifiably unique digital artworks that we demonstrated that day in 2014 is now making headlines in the form of non-fungible tokens, or NFTs, and it's the basis of a billion-dollar market," wrote Dash in *The Atlantic*.

In October 2015, the first NFT project Etheria was launched at Ethereum's first developer conference. They released 457 purchasable, tradeable hexagonal tiles. Most remained unsold.

In 2017, the online game CryptoKitties started selling tradeable cat NFTs. It became so popular that it temporarily slowed down the Ethereum network! "CryptoKitties has become so popular that it's taking up a significant amount of available space for transactions on the Ethereum platform," says Garrick Hileman of the University of Cambridge in a 2017 BBC News report. "Some people are concerned that a frivolous game is now going to be crowding out more serious, significant-seeming business uses." However, you will not find the term NFT in any of the news reports of that time!

The term NFT became popular only after the advent of the Ethereum based ERC 721 (Ethereum Request for Comments 721) standard in 2018. ERC 721 implements an application-programming interface (API) for tokens within smart contracts. It ensures the uniqueness or non-fungibility of tokens and adds more functionalities to know the owner of a specific token, transfer tokens from one account to another, and so on.

NFTs slowly picked up steam, and several NFTs and in-game assets were sold in platforms like Decentraland and Gods Unchained. In the first three months of 2021, more than $200 million was spent on NFTs. NFTs caught the attention of the art world, when a digital art by Mike Winkelmann or Beeple sold at a Christie's auction for more than $69 million in March 2021. In the same month, Ethereum relaunched the unsold tiles of 2015, and they sold within 24 hours for a total of $1.4 million. In August 2021, Jack Dorsey, co-founder of Twitter, sold an NFT of his first tweet—'just setting up twttr'—for $2.9 million. In December 2021, digital artist Pak's *The Merge* fetched $91.8 million on Nifty Gateway!

Auction houses started tying up with digital artists, celebrities started making NFTs of their milestones and memories, sports leagues started launching NFT based trading cards embedded with top shots and historic moments, and companies ranging from fashion to food started launching themed NFT collectibles.

NFTs became so popular in 2021 that many experts found it a bit crazy! Some connected it to the boom in cryptocurrencies at that time. The price of cryptocurrencies skyrocketed in the first quarter of

What is an NFT Drop?

- It refers to the release of an NFT or a collection of NFTs on a digital marketplace
- It specifies the exact date and time
- Will often have White Lists to get in early
- To get into the list, you have to be active on social media and garner the attention of the creator or organiser of the drop
- It is worth getting in because you will get NFTs cheaper at the drop
- There will be purchase limits
- And, there might also be a limit on how many NFTs can be minted

2021. The price of Ether skyrocketed more than 1000% year on year, and that of Bitcoin rose more than 600%. This meant major returns for early crypto-buyers, which they started investing in digital assets. The Beeple, for example, was bought by Vignesh Sundaresan *aka* Metakovan, and Anand Venkateswaran *aka* Twobadour, two South Indian crypto-billionaires based in Singapore.

A few analysts even attributed the NFT trend to the Boredom Markets Hypothesis. The theory, proposed by lawyer and Bloomberg columnist Matt Levine in 2020, says that people will buy stocks when buying stocks is more fun than other things they could be doing for fun. So, many experts thought that since many missed their usual fun activities during the 2021 lockdown, they resorted to trading intangibles. Most predicted that the bubble would burst once people got back to their usual activities. But it does not seem to be so; NFTs are still on a bullish run!

Shaking up the art world

Considering that it is art that threw NFTs into the limelight, we think this demands some special attention before we delve into other segments of NFTs.

Digital art. NFTs offer a great way to monetise digital art. Artists can mint NFTs of their digital art and sell them on digital marketplaces. They can engage directly with their fans on social media and create enough awareness (or hype) about the NFT to ensure it sells when launched. International art dealer, Stephen Howes of Thomas Crown Art, remarked in a recent press release on NFTs, "It allows artists to make some money and exercise control over their work, to sell it more easily, reach a global audience, to more strongly protect against others appropriating it without permission, and sidestep the traditional biases of the 'art industry mafia'."

There have been stories of people who made their fortune through NFTs. Robness, popularly known for his trash can art, was living out of his car and doing odd jobs when he started dabbling in the crypto world in 2014. He is now an NFT artist, with projects hosted across many marketplaces. His NFTs depict many elements of modern life—including trash cans, and an application he made to McDonalds! Most notable is his *64 Gallon Toter*, an NFT made from a photo of a trash can, which sold for $252,000 on OpenSea, and is currently valued at around $80,848,305.

"As the crypto and blockchain space evolves further we should be seeing decentralised management of copyrights, which then could be linked or encoded with the NFTs instead of just residing as a metadata."

—Jothi Krishnan Menon, Co-Founder & CEO, RtistiQ

Not ones to miss the trend, leading auctioneers like Christie's and Sotheby's have also tied up with famous digital artists like Sara Zucker and Refik Anadol to sell NFTs associated with their digital artwork, showcasing them in virtual galleries and real-life screens. Sotheby's even has a gallery in the virtual world Decentraland.

Physical art. NFT helps to build trust and transparency into the traditional art market too. Considering that art has usually been a high-value space and one shrouded in mystery (there have been gruesome crimes committed for the sake of art) a reliable method of authentication and the ability to track-and-trace can solve many headaches, including counterfeiting, theft, and fraud.

Fig. 2: 'The Coquette'—a privately-held painting of Raja Ravi Varma, recently digitised and launched with the exclusive digital signatures of the Raja Ravi Varma Heritage Foundation (Source: RtistiQ)

"NFTs (off-chain) represent a digitised proof of ownership of an asset (or even a liability) irrespective of its nature. In the case of physical art, it effectively replaces the physical Certificate of Authenticity issued by the creators, which have always been susceptible to tampering, in the absence of an issuing authority. As an extension to the tokenisation of physical art, we also offer a tamper-evident microchip, which acts as the physical-digital link for the artwork and can be verified for authenticity using any near-field-communications (NFC) enabled mobile device. Further, the token transfer is linked to the shipment of the artwork to ensure a proper transfer of asset and acceptance before the transaction is reflected on the chain," explains Jothi Krishnan Menon, Co-Founder & CEO, RtistiQ, an online art marketplace based in Singapore. They use NFTs in the sale of traditional physical art as well for modern digital art.

Phygital art. A use case that melds physical and digital art is where a traditional piece of artwork is digitised to extend an artist's legacy beyond geographical boundaries. RtistiQ ventured to digitise some of Raja Ravi Varma's privately-held paintings, which are considered national treasures and cannot be taken outside India. A gifted artist, Varma was ahead of his times. He thought that his work

Ownership versus Copyright

So, when you buy an NFT, what do you get? An NFT is not to be confused with copyright – an NFT only gives you a proof of ownership. There is no copyright transfer, unless explicitly mentioned. You get ownership of the artwork, with licensing terms encoded as metadata along with it. Some creators will let you use your copy only for personal use, while others might permit commercial uses. You will be free to showcase the NFT in a digital or physical gallery and resell it in a secondary marketplace. Some creators may demand a royalty every time someone resells the piece. For example, RTFKT takes a 5% cut of every sale and resale of an avatar, and 10% for all other products including virtual shoes. This is an example of royalties being built into the NFTs.

Since the copyright still exists with the creators, they can create more NFTs based on their art. They can even make more copies of the exact same NFT, but those can only be sold as 'copies' as someone has already bought the 'original.' There is a tool called CloneMyNFT, which the developers describe as an NFT backup service. It lets the creator keep a copy of the NFT in their wallet even after selling the original. According to the London based software company, "The system works by creating an exact digital copy of the artwork but with another unique contract on the blockchain, effectively making it an almost exact clone of the original NFT. The digital art copy will lack the provenance of the original NFT but will look identical in appearance and could even be sold as a copy."

"Where the confusion starts is when we mix ownership with copyrights, which are totally independent and governed by the what the creator is offering. NFTs in its current form only resolve the ownership aspect of digitised assets, and not essentially the copyrights. As the crypto and blockchain space evolves further we should be seeing decentralised management of copyrights, which then could be linked or encoded with the NFTs instead of just residing as a metadata," comments Menon.

should reach everyone and not just the elite, and for that he set up a lithographic press in Mumbai as early as 1894! Raja Ravi Varma's paintings of Indian gods and goddesses frequently featured on calendars, and it became a habit of the previous generation to carefully frame the pictures at the end of the year to deck up their puja rooms! Today, people across the world have a chance to own NFTs of Raja Ravi Varma's works.

"At RtistiQ we probably started the reverse order of using NFTs for traditional mediums first, and that has started to gain acceptance as a model to meet some of the existing challenges of the industry. More recently, we have been working on different use cases extended to digital NFTs, to bring forward works of a unique nature, which may not be transactable in the physical form. In the case of the Raja Ravi Varma collection, brought out in collaboration with the Raja Ravi Varma Heritage Foundation, we tried two different models. Two of the paintings, which are privately-held and have been greatly admired, were brought out with the exclusive digital signatures of the Foundation and represented by gallery g in Bengaluru, India. Popular lithographs, recreated and embellished for enhancing the works further, were auctioned as a dual-combination of digital and physical works," explains Menon. In March this year, tokenised versions of Raja Ravi Varma's works were launched online by RtistiQ in collaboration with the Raja Ravi Varma Heritage Foundation and gallery g.

Recently, they have been helping Ukrainian artists who lost access to their physical paintings due to the war with Russia. They are minting digital editions using available images of the paintings, so the artists can still make a sale of their painstakingly created works. "We are working towards bringing forward more use cases as a combination of traditional and digital mediums for the art community through NFTs, where the original is difficult to experience or transact in the current form," says Menon.

Fig. 3: A famous lithograph of Raja Ravi Varma, recreated and auctioned as a combo of digital and physical works (Source: RtistiQ)

As artists struggle to salvage some of their works, multiple organisations, including Holy Water, Vandalz for Ukraine, Forze Ikonia, Ukraine DAO, and ArtWaRks Ukraine, are auctioning NFT collections for funding relief in the war-torn country.

Music and videos too. Art NFTs are not restricted to images but also extend to music and videos. In 2021, the background score of the film Triumph was launched as an NFT. American rapper Snoop Dogg is collaborating with Clay Nation to launch some of his unreleased music and limited-edition pitches as NFTs on the Cardano (ADA) blockchain. When you read this story, South Indian playback singer Karthik would have launched his first collection of music NFTs on India's first fully-curated NFT marketplace, Jupiter Meta, through his special metaverse solo concert on April 14, 2022.

Twitter, Instagram, and YouTube are all planning to integrate NFT features. In a blog post about the company's Web3 plans for 2022, YouTube mentioned introducing NFT and blockchain features to allow creators to build deeper relationships with fans and monetise their creations, while also providing fans an opportunity to own unique content. Twitter has been experimenting with hexagonal profile pictures to use NFT avatars. It will also bring in NFT authentication features along with Bitcoin and other crypto-payment systems.

Collectibles of every imaginable kind

Collectibles and memorabilia of every kind are floating around in NFT mar-

ketplaces—and pretty strange ones too. People buy NFTs of newspaper clippings, magazine covers, tweets, and memes. They buy GIFs featuring tacos, toilet paper, and cards. They buy NFT trading cards featuring key moments from the sporting world, and NFTs that represent key experiences or milestones from the lives of their favourite actors or musicians. Note that much of this, like Jack Dorsey's first tweet or a football top shot, is already available on the Web for all to see. Why would people spend money on collecting such NFTs?

To answer this, ask yourself why people have historically collected seemingly small-value things like stamps, scale models, and sports trading cards. Well, the logic behind a collection is that its value increases when there is scarcity of the object being collected. When stamps go out of print, their value increases. Trading cards with MS Dhoni or Virat Kohli can be bought off shelves today for an insignificant price, but some years later, when cards with other faces fill the shelves, these will become scarce and valuable!

Then there is the hero worship aspect too. Fans want to own a piece of their hero's journey—like buying the ball that went for a winning sixer, or the sneakers that an athlete wore while winning a key race. They want to collect trivia and trinkets associated with their favourite brands.

So, people buy NFT collectibles hoping that scarcity and fan-following will increase the value of these collectibles in the secondary market.

Brand marvels. Taco Bell launched a collection of taco-themed GIFs and Pizza Hut sold pixelated pizzas, while Charmin sold non-fungible toilet paper, and TIME Magazine auctioned NFTs of some of its famous covers! Adidas debuted NFTs in December 2021 and sold $23 million worth within hours. Some of their "Into the Metaverse" NFTs purchased at $765 at drop are now selling for over $2500 on OpenSea. Mahindra & Mahindra launched a collection of four NFTs featuring the all-new Thar, on Tech Mahindra's NFT marketplace, Mahindra Gallery. The amount raised was donated to Project Nanhi Kali for the education of underprivileged girls in India. Anand Mahindra tweeted about the new experiment, "We believe it's not just a make-believe world, it's also a place where we can explore solutions for making the real world a better place. Only fitting that the Thar—our flagship off-roader—leads us into the uncharted landscape of NFTs."

The hidden charges

Reading about all this makes every other person eager to try their luck in minting NFTs! With mobile apps like Sketchar, you can even create NFTs on-the-go, right? While technically speaking anyone can mint an NFT, practically it is not so easy. First, you need a wallet, and it needs to be loaded with crypto, even to mint and sell an NFT. Most sites charge for buying and selling—very few let you list an NFT for free, and then charge a commission on the sale price. Along with this, many marketplaces also charge a 'gas fee' to compensate the energy consumed to complete the transaction, considering that it is an extremely energy-intensive process.

Add to this the conversion fees charged by crypto-exchanges to convert your money into cryptocurrencies, the rapid fluctuations that the crypto-market is known for, and the need for a reasonably advanced computer system to mint an NFT, and you might just end up spending more than you bargained for.

Buying NFTs is also not easy—at least not the ones with high potential—because many NFT drops are by invite. To get into one, you need to be active on the project's or creator's social media, and garner enough attention to be considered worth being in the White List.

Brands around the world are trying to engage with their customers in the emerging digital world. Some of the brand based NFTs are assets or accessories that can be used in the virtual world, like digital sneakers or sunglasses that your *avatar* can wear, while others are merely collectibles that are expected to increase in value.

Fig. 4: An NFT from Adidas' Into the Metaverse collection (Source: Adidas)

Sometimes, the brand based NFT comes coupled with some tangible reward—after all, the customers have shown great loyalty! For example, some of the sneaker NFTs developed by RTFKT, which Nike recently acquired, include a tradeable ticket for a physical shoe that you can collect in the future. Similarly, the winners of Mahindra's NFTs also got a chance to experience the all-new Thar in one of Mahindra's 4x4 off-roading tracks. Adidas' debut NFTs offered the holder virtual wearables and the right to redeem them for physical freebies like a hoodie, a tracksuit, and a beanie! NFTs can be a great way to presell physical products in the virtual world!

Hero worship. When Under Armour launched a series of sneaker NFTs to commemorate Stephen Curry's NBA three-point record, it sold out in less than a minute! A single LeBron James highlight NFT sold for $200,000. Guardian Link and BeyondLife.club recently launched an exclusive collection of 250 NFTs dedicated to Indian-origin astronaut Kalpana Chawla, with never-before-seen images shared by her family. The proceeds were donated to an Indian charity for education. World over, celebrities like Snoop Dogg and Lindsay Lohan are launching unique memories and moments as securitised NFTs.

Sports collectibles. The US basketball league NBA is selling officially licensed digital collectibles under the

Creating scarcity

The value of a collectible increases with scarcity. In a physical market, scarcity is inevitable at some point of time. Products get sold out, technologies get phased out, fashions change—it just happens with time. However, digital creations usually have a huge or infinite supply. For example, an audio track can be downloaded any number of times, and any number of years later from some web source. NFTs aim to create digital scarcity to increase the value of associated assets. NFTs that are rare and few have a greater value than those that are mass-minted. So, when the NFT is no longer available in the primary market, its value in the secondary market increases, especially if it is something that people want to own.

Here is the story of someone who took this concept too seriously! In March 2021, a group of private investors purchased Banksy's 'Morons' for nearly $100,000. They digitised and minted this as an NFT. They then burnt the original print in a live-streamed video and put up the NFT for sale. It sold for approximately $380,000!

Ironically, 'Morons' by graffiti artist Banksy depicts a Christie's auctioneer pointing at framed paintings in a crowded auction room. Next to him is a framed image accompanied by a phrase including the words, "I can't believe you morons actually buy this!"

banner NBA Top Shot. These are basically NFT trading cards embedded with notable basketball moments. After tasting success, they are now expanding into NFTs of virtual jewellery, accessories and clothing that can be used across social media.

Crictos is a series of official digital collectibles being launched by the International Cricket Council in association with FanCraze, which aims to build the ultimate cricket metaverse. Crictos gives fans a chance to own pieces of cricketing history. Different levels of Crictos are minted—ranging from common (extensively minted) to Genesis (the rarest ones). Each represents a highlight-worthy event in cricketing history. The current collections include clips from ICC World Cup 2015 and 2019. The packs are dropped on FanCraze.

"NFTs are a golden money-making opportunity for the sports industry and also a great way for sports fans to engage with their favourite teams, athletes, and historical moments. People have always loved to own sports collectibles," says James Green, Group Investment Director at deVere, which has recently launched the dV Gems Platform to help clients identify and invest in winning NFTs.

Avatars

According to CoinMarketCap, the top seven NFT collections by market cap are avatar NFTs—headshots of cartoon characters or pixelated people. The most popular of these collections are CryptoPunks, Bored Ape Yacht Club (BAYC), and Pudgy Penguins. Quite a few studies show that avatar NFTs are overtaking metaverse game assets, fine art pieces, and sports NFTs.

Avatar NFTs can be your digital profile in the metaverse—across virtual worlds and social media platforms. Twitter, for example, lets you sport your avatar if you own one, so it becomes like a trendy and tech-savvy status symbol for many! Tonight Show host Jimmy Fallon and Grammy-winning producer Timbaland have Bored Ape NFTs as their Twitter profile pics, along with many other celebrities. Last year, Visa purchased a CryptoPunk avatar for $150,000, and Adidas purchased an Adidas-clad ape named Indigo Herz from BAYC, which is one of the key collaborators in Adidas' NFT projects.

You can get membership to the BAYC by purchasing one of 10,000 ape profile picture NFTs, which cost at least $200,000 each. The membership gives you access to exclusive features, product drops, and events too. It allows users to mint art for the group. It gives IP control to the community, thereby having an unending source of fresh ideas. Primary and secondary resell rights ensure that the artists get paid for their efforts.

In-game assets

NFTs enable you to own characters or items on gaming platforms and virtual worlds. In-game assets come in many forms—ranging from creatures in Axie Infinity and trading cards in Gods Unchained to virtual real estate in Decentraland. Gaming platforms often use tokens to reward players. In the play-to-earn model followed by platforms like Axie Infinity, you earn NFT rewards within the game, which you can monetise by selling in secondary markets.

With gaming platforms growing in scale to become virtual worlds with thriving marketplaces, real-world brands are also entering the space and selling their wares. You can, for example, buy virtual sneakers from Nike or Adidas for your avatar to wear in the virtual world.

The trend is advancing towards interoperable NFTs that enable cross-platform playability. You can take your NFTs along with you to other platforms to create personalised experiences or for trading. The Enjin generic axe is one such gaming NFT that you can take along to multiple platforms!

"NFTs are a standard protocol, so they can be traded across NFT marketplaces as long as the wallet holding

Showcasing (showing off?) your treasures

Some collectors are secretive about their collections, while others love to flaunt it. One visit to the GD Naidu Car Museum in Coimbatore, and you will instantly understand what I mean. The flair with which the vintage cars are displayed resonates the pride of the collector. So, if you have collected a couple of good NFTs and want to display them, where would you and how would you?

- You can print, frame, and hang the NFT on a cosy wall in your house, if the contract permits.
- You can display the NFTs in digital marketplaces.
- You could download and install an app like token.art that lets you view NFTs easily on your phone. Most wallet apps also let you do that.
- If you own some space on the metaverse in virtual worlds like Decentraland or Cryptovoxels, you can display your NFTs there.
- You can use software platforms like Samsung Smartthings or Tokencast to download NFTs from your wallet and view them on state-of-the-art televisions.
- However, if you have a good collection, the best option might be to invest in a suave and smart NFT display with direct wallet integration, like Netgear's Meural, Lago's NFT Frame, Blockframe, or Tokenframe.

the tokens is compatible and on the same blockchain network. So, anyone buying an NFT from one platform can resell it on another platform by connecting their wallet and having the smart contract listed in that platform. Cross-chain compatibility (cross-chain bridge) has recently been established across a few chains for NFTs but has also been a source of vulnerabilities and hacks," says Menon.

With the advent of currencies and assets, gaming platforms are coming under the influence of market forces much to the displeasure of traditional game developers. According to the Game Developer's Conference 2022 Annual Report, 70% of the developers surveyed said their studios were not interested in integrating NFTs or cryptocurrencies in their games.

Nascent real-world applications

NFTs have the potential to transform several real-world processes. Experiments are underway but it will probably take time to become mainstream, because of the high costs and energy-related issues surrounding NFT usage. Nevertheless, let us take a look at some of the most promising applications:

IDs, certificates, and other documents. NFTs being immutable can result in accurate record-keeping with no risk of tampering. An NFT birth certificate can serve as a lifelong ID on the blockchain. Other medical records can be appended to the same, with complete trust and confidentiality. Some graduate schools like Emlyon in France are planning to issue NFT based diploma certificates to avoid certificate related frauds. Going forward, other important documents like passports, driving licenses, and other documents can also be encoded in the blockchain. This would help iron out kinks in several administrative processes ranging from public distribution to voting.

Real estate. In the real world, NFTs could be an efficient way to check titles and verify ownership history. Timestamped NFTs are a good way to track changes in property value. Smart contracts can be used to simplify and speed up transactions. It becomes possible to create decentralised home rental services with auto payments facilities, while taking care to protect sensitive information. In February 2022, the sale of a physical house in Tampa Bay, USA, was executed using NFTs, for a value of 210 Ether, approximately $653,000!

IP and patents. If IP is minted with a timestamped token, its current ownership and history can be easily verified and proved. Patent wars would be so easy to sort out! Sometimes, an inventor develops certain innovative IP along the way as a means to the whole. If the attempt is successful, he or she might file for a patent. If, unfortunately, the final result is not as expected, the creator can at least tokenise the successful components developed along the way and make them available to the community. These IP NFTs can also be monetised. Some researchers are considering self-publishing their work as NFTs so that their work can quickly reach the world, without the delay that is inherent in the patenting process.

Supply chain and logistics. NFTs can be used to authenticate products, verify their origin, and ensure quality. NFT based supply chain data cannot be tampered, and helps avoid counterfeiting in food, medicine, and high-value luxury products. In eco-sensitive industries, it can be used to track and trace recyclable and sustainable materials and ensure their proper recycling or reuse. Carrefour Supermarket uses NFTs to guarantee secure and unfalsifiable traceability of products. The Ownest platform also enables you to track ownership on supply chains using NFTs.

Industrial design and manufacturing. By tokenising the CAD data or files, manufacturers can ensure that their designs are not tampered or copied by contract manufacturers. File management and revisions can also be handled efficiently. Using NFTs, a manufacturer can track and trace components to ensure authenticity, and at each stage include information about the manufacturing process for the benefit of the next player in the workflow. NFT.SMARTMFG.IO from blockchain company Smart MFG Tech is a comprehensive tokenisation and marketplace solution for the creation, storage, sale, and transfer of industrial design assets as NFTs. It allows users to create and list unique NFTs, participate in auctions and commission custom-made industrial design and 3D models.

To buy or not to buy

To buy or not to buy an NFT is a difficult decision because there is no thumb rule. At present it is highly speculative, and hence a very personal choice. The price of an NFT is entirely demand-driven and depends on how badly people want to buy it. A promising NFT might just fizzle out, or a seemingly dumb one might end up as a cash cow just because it caught someone's fancy! You buy an NFT hoping someone will want to buy it for a greater price in the secondary market—something that you have no control over. So, here are a few tips from experts on how to buy NFTs:

- Since it is a new trend with not much historic data, invest a small amount initially and see how it goes.
- Buy only what you can afford to lose.
- Make sure it offers some value to you—either emotional satisfaction or physical utility. You can buy it if you like the art or the artist, or believe in the cause behind it. You can buy it if it is something you really wish to own—a collectible close to your heart. That way, you do not feel the loss even if it does not sell in the secondary market!
- Do not buy NFTs just for the fear of losing out, or because you were invited to a drop.
- If you cannot get proper information about the art and the artist, avoid putting money in it.
- Look out for the good NFTs from social media, NFT marketplaces, and NFT drop calendars.

Do your due diligence each and every time, because no two NFTs are the same—remember they are non-fungible. "As not all stocks are same, so is the case for NFTs as well, and it is dangerous to bucket them all under one umbrella when thinking about investments. Just like we do research on which stocks or even property offers the potential of appreciation, we should be looking at individual NFTs in the same light. Each project has been created with different set of utility surrounding it, being just for the artistic nature, access to some kind of associated utility, or even managing loyalty programs with multitude of variations," explains Menon.

Problems aplenty

NFTs are not without their share of problems. Being a blockchain based technology, just like cryptocurrencies, it faces a lot of flak over its heavy energy usage. The proof-of-work system that keeps records secure on a blockchain is very energy-intensive. CrytoArt.wtf calculated that a simple GIF NFT can use around 200kWh for its creation, which is close to two weeks' power consumption of an EU resident.

Some players like Sega and ArtStation dropped their NFT plans after they faced a heavy backlash from the community over energy concerns. Beeple has promised to create carbon neutral work in the future. New blockchains like Palm and Flow claim to be low-energy and carbon-neutral, and plant trees to compensate for the environmental damage, if any. Polygon claims that you can mint an NFT on its blockchain using just as much energy as it takes to send three emails. Ethereum is also rolling out Ethereum 2.0 in phases. The 2022 and 2023 upgrades will enable the platform to process thousands of transactions per second and scale globally, thereby reducing energy consumption and gas fees significantly.

Trading transactions can also be very expensive and slow because of the on-chain nature of NFTs. Experts suggest sidechains and rollups as possible solutions. Sidechains are separate blockchains that run parallel to Ethereum. A rollup takes multiple Ethereum transactions and rolls them up into a single piece of data before submitting them all to the blockchain.

Another risk is that of bit rot—the tendency of digital information to degrade or become unusable over long periods of time.

There is also the effect of frequent fluctuations inherent in the crypto-world. According to a Financial Times report, NFTs saw $41 billion in sales and huge VC investment in 2021.

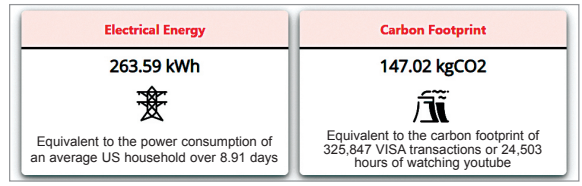


Fig. 5: Footprint of a single Ethereum transaction (Source: Digiconomist)

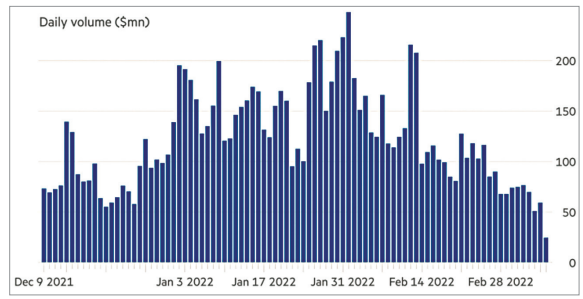


Fig. 6: Trading on OpenSea in decline (Source: Richard Chen/ Dune Analytics)

However, daily trading volumes in OpenSea went down by 80% in March 2022. The average selling price of NFTs and the number of accounts buying and selling NFTs also went down. This shows the fluctuating nature of this business and raises questions about its future. However, considering that the values in the crypto-world fluctuate rapidly, there is a high possibility of these figures being up when you read this article!

Despite its merits, the future of NFTs seems to be uncertain—but that is how most of today's mainstream technologies were in their nascent stages.

Should you invest in NFTs yet?

The blockchain and its spin-offs like cryptocurrencies and NFTs seem to be swerving from their intended path.

Ethereum co-founder Vitalik Buterin is not a big fan of NFTs as they are perceived today. Buterin, who hopes for the Ethereum to be a launchpad for all sorts of socio-political experimentation like fairer voting systems, urban planning, universal basic income, and public-works projects, is concerned about the dangers to overeager investors, the soaring transaction fees, and the shameless display of wealth that have come to dominate public perception of crypto. "The peril is you have these $3 million monkeys, and it becomes a different kind of gambling," he says, referring to Bored Apes, when speaking to TIME magazine in March this year.

"People may have lost their mind," says C.Z. Zhao, founder of Binance, a leading cryptocurrency exchange, who told Fortune recently, speaking of the NFT craze. He was quick to add that there is an undeniable plus, as NFTs allow artists to monetise their work globally and reach a much wider audience.

The Indian government is also discouraging crypto-investments. Amidst fear of it being banned in the country, Finance Minister Nirmala Sitharaman announced in this year's annual Budget presentation that income from cryptocurrencies and NFT trade will henceforth be taxed at 30%. This is seen by optimistic investors as a step towards regularising crypto-investments, although the government said that it has not decided yet on the status of crypto in the country.

Surprisingly, the man who struck gold, Mike Winkelmann, also seemed worried about NFTs when speaking to Fox News Sunday last year! "I absolutely think it's a bubble, to be quite honest. I go back to the analogy of the beginning of the internet. There was a bubble. And the bubble burst. But it didn't wipe out the internet. And so, the technology itself is strong enough where I think it's going to outlive that," he remarked.

Yes, NFT as a technology is a worthy one—but better put to use to induce efficiency and transparency in existing systems. While minting and trading of NFTs can be used for meaningful engagement with fans and customers, it must not become unethical and destabilising like gambling! Over time, quick-money fads will disappear, leaving more room for beneficial applications. EFY

AGRICULTURAL ROBOTS: The Next-Gen Farmers

Agriculture is the base of our survival, the source of what we consume. Traditionally, agriculture has been a 'manned' sector. But of late challenges in the form of labour shortage threaten its very survival. So, should agriculture finally give up its stubbornness and adopt technology? Let us find out

DR MICHAEL DENT is technology analyst at IDTechEx

YULIN WANG is technology analyst at IDTechEx

Agricultural robots are semi-autonomous machines capable of carrying out soil preparation, seeding, weeding, pest control, and other agricultural tasks. By automating many of the labour-intensive, repetitive tasks, farming efficiency can be increased.

In recent times, agriculture has been facing immense challenges. While the global population continues to grow, available agricultural land has been declining. The Covid-19 crisis has further aggravated the issue. Labour shortage had always been a major problem, but with the recent spate of lockdowns and labour movement restrictions, things have become worse. Adding insult to injury are the skyrocketing labour prices.

> As per UN projections, the world population can reach 8.5 billion by 2030, which can further increase to 9 billion by 2050. To adequately feed these many people, global food production has to increase by 70%. So, anything that can help boost agricultural productivity for improved food security will be a welcoming respite.

Much like in other major industries, technology offers a solution. The good news is that robotics and automation costs have been falling throughout the past two decades, which makes the possibility of automation too good to ignore.

Existing trends in agricultural robotics

As of autumn 2021, nearly fifty field and harvest robots were commercially avail-

Fig. 1: Common types of agricultural robots (Credit: IDTechEx)

able or in the advanced stages of development. These included:

- Weed and pest control robots
- Seeding robots
- Fully autonomous tractors
- Fresh fruit and vegetable harvesting robots
- Agricultural drones
- Milking robots
- Autonomous carriers and platform robots

The most commercially developed robots are milking robots and agricultural drones. Milking robots can be operated indoors and under unpredictable conditions. Cows can be easily trained to work with them.

Agricultural drones are best suited for imaging applications. Unmanned aerial vehicles (UAVs) can also be used for the delivery of organic herbicides to a field. The only issue here is that drones can only carry small payloads and have limited autonomy.

Another popular field robot is the weeding robot, which is meant for weed removal. The weeding robot helps eliminate manual weeding, which is quite labour-intensive.

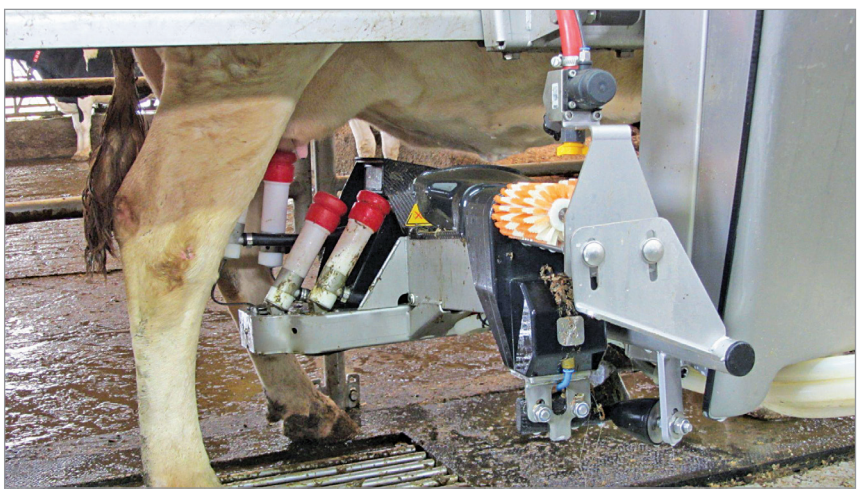


Fig. 2: Milking robot (Credit: Flickr)

> Chemical usage in agriculture is not only harmful to the environment but also makes crops less organic. Precision agriculture is one of the best solutions to reduce this. It is a measurement strategy that processes and analyses temporal, spatial, and individual data and combines them to support management decisions, resource use efficiency, productivity, quality, profitability, and sustainability of agricultural production.

The robot also helps in cutting down the use of synthetic herbicides.

The state of development for a large diversity of depends upon how technically demanding it is. So, while milking robots are less complex to develop, making them highly commercially available, robots for fresh fruit and vegetable harvesting are undergoing research as they require complex AI systems for distinguishing crops at different stages of lifecycle and under different weather conditions.

Autonomous tractors: A possibility?

While it is nice to conceptualise the development of autonomous tractors thanks to all the talk going around advanced driver-assistance systems

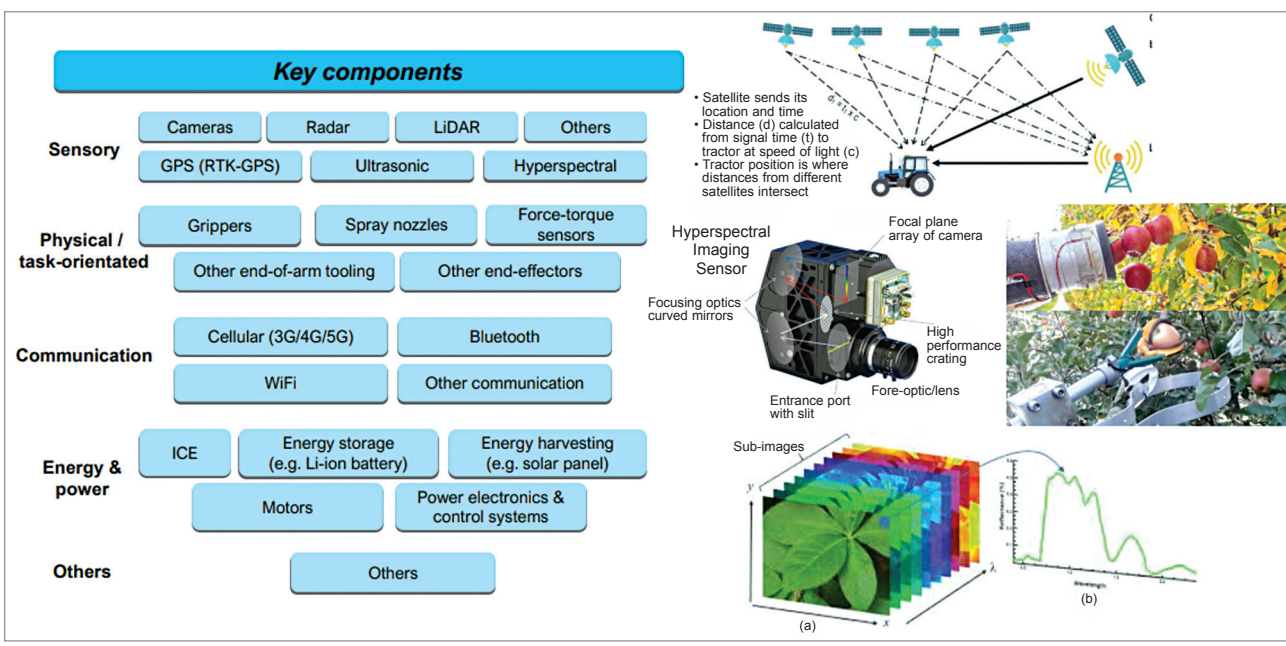


Fig. 3: Key components of agricultural robots (Credit: IDTechEx)

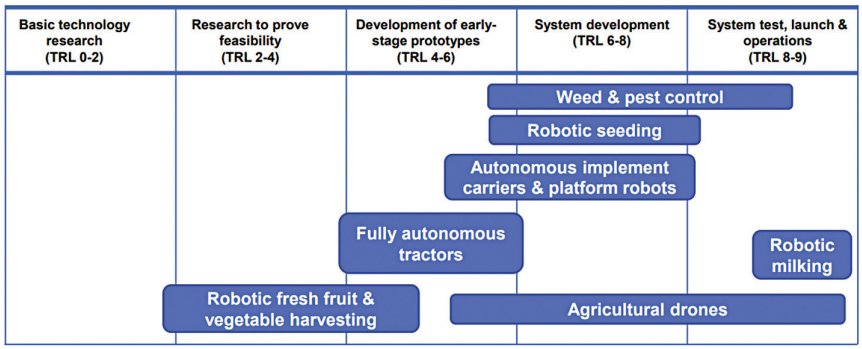


Fig. 4: Technology readiness of different types of agricultural robots (Credit: IDTechEx)

Fig. 5: Progression of tractor development. The extreme left shows a conventional heavy manned tractor while the extreme right shows a swarm of light robots that can cover more field than conventional tractors (Credit: IDTechEx)

Data ownership and management is an ignored issue that encompasses all the other challenges. Whether the data belongs to farmers, landowners, or robot manufacturers is not clear yet. There is an ongoing debate around this. No common consensus has emerged yet. Future policies regarding the use of agricultural robotics will be largely based around the outcome.

(ADAS) and autonomous vehicles (AVs), an evolutionary pathway is ideal before self-driving tractors emerge. The first type is guidance tractors that help farmers drive tractors with less fatigue. It should also enable farmers to work under dark lighting conditions and ensure the entire field gets covered. A robust GPS technology is the best tool for assistance.

The next logical step would be the introduction of 'follow-me' tractors or a series of unmanned tractors controlled by a manned vehicle that effectively boosts driver productivity without facing any technical or legal complexity of creating a fully autonomous farm vehicle.

And, finally, there are fully autonomous driverless systems where operators control the vehicle from afar and human intervention is largely restricted to supervision and repair. Whilst this may happen before 2040, it is unlikely it will fully occur within the next few years, mostly due to the technical challenges and regulations.

Challenges faced by agricultural robotics

Compared to industries such as automotive, adoption of robotics and other digital technologies has been slow in agriculture, mainly due to agricultural robotics being immature. Farmers would not risk their harvest and entire yearly revenue at the expense of adopting a piece of machinery that does not demonstrate benefits.

A decline in need for labour is another issue. So, it does not look like the transition to robotics will be rapid. Restrictions caused by the Covid-19 pandemic, coupled with lower profits, may also prevent farmers from investing in agricultural robotics.

And even if agricultural robots are used on a large scale, the operating costs, including subscription of software packages and RTK GPS systems, will be quite high. Only skilled people would be able to operate and repair different robot parts.

The US and Europe currently dominate robotics development. France has the highest proportion of agricultural robots, with over 10,000 robots (majority of which are milking robots or animal husbandry robots) already operating in farms across the country. Some active players in the agricultural robotics industry include John Deere (heavy machinery), Ecorobotix (smart weeding robots), and Traptic (fruit picking).

To mitigate the high upfront costs, robotics companies can offer a robot-as-a-service (RaaS) model where the farmer pays a subscription fee to the company that leases out the robot to the farmer. It would also mean that the farmers do not need to go through extensive training to operate the robot.

Attractive as it may seem, the RaaS model works only where there are trained operators nearby. Farms are often located in rural areas where there is no reliable 3G or 4G coverage. Robots need to be continuously connected to the internet for sending data in real time. It is doubtful whether robotic agricultural companies will be willing to get engineers or technicians out on the site for operating and repairing the robots.

What next?

Answers to most of the challenges stated above lie in the problems. The agricultural sector has always been stubborn to adopt technology. But with rising food shortages and declining labour supply, there is no other option left. Once robotics is embraced by the agricultural sector on a wider scale, its global market will rise and continuously do so for the next ten years. EFY

The article is based on IDTechEx webinars hosted by Dr Michael Dent and Yulin Wang, technology analysts at IDTechEx. It has been transcribed and curated by Vinay Prabhakar Minj, an IoT and audio electronics enthusiast at EFY.

IMAGING SENSOR TECHNOLOGY
And The Latest Developments

The camera technology has come a long way. Recently, a salt-grain size camera was built that could capture high-quality images. Smartphone manufacturers are planning to use bigger sensors, AI, and high-quality lenses to improve camera capabilities

(Source: Link)

SHARAD BHOWMICK

Imaging technology has seen tremendous advancements in recent times. In just a little over a decade, a feature that was considered a novelty has so drastically improved that each of us now carries a sophisticated camera in our mobile phones. In this article we will be talking about camera sensors, some important terminologies, and a few latest camera sensors that have been launched recently in the market.

Development in camera technology has not just improved casual photography but has also impacted imaging in other fields. The production lines have become automated because of machine vision cameras, and autonomous driving has become a reality thanks to improved imaging technology along with machine language (ML) and artificial intelligence (AI).

When talking about cameras and photography, especially the casual hobby photography, we cannot ignore the smartphone cameras. According to Rise Above Research reports, smartphones are the most used

devices for clicking photographs in the past three years. Smartphone cameras have almost uprooted a segment of compact cameras for casual photography and camera specification has become one of the key considerations for any buyer while selecting a new smartphone. Fig. 1 shows the comparison of number of photos taken with smartphones, digital cameras, and tablets since 2019.

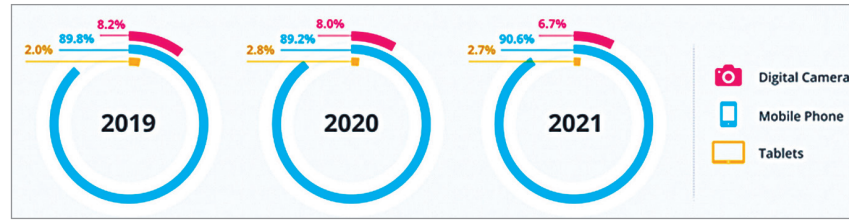


Fig. 1: Statistics of pictures taken with different devices (Source: Link)

Most important components in a camera

Cameras come in all shapes and sizes. But irrespective of their performance, the digital cameras have three essential parts: A sensor that is the heart of the system, lens or lenses that act as eye(s) of the camera, and the software that converts the analogue data into a usable image. All the three components need to perform well to achieve a good result. But in this article, we are dealing only with the camera sensor.

The camera sensor

A camera sensor is a solid-state device that captures light in small light-sensitive elements called pixels. The sensor detects light as an analogue signal, which is then amplified and converted into a digital signal to store and reproduce later. Sensors cannot produce colours and require a special filter to sense colours.

There are various types of sensors available in the market, such as CCD sensor, CMOS sensor, LiveMOS sensor, or Foveon X3 sensor. The CCD and CMOS sensors are the most common types of sensors in use.

CMOS sensor. Complementary metal oxide semiconductor (CMOS) sensors use rolling shutters and are the most widely used sensors as they can achieve faster data transfer rates (speed) and thus can click pictures at higher frames per second (fps) for a video picture. But as the pixels are read in line-by-line fashion, it causes the rolling-shutter effect. However, CMOS sensors do not produce any smear or blooming effect on the pictures. Further, they have higher dynamic range. But these days CMOS sensors, such as Sony's IMX661 sensor, also come with a global shutter.

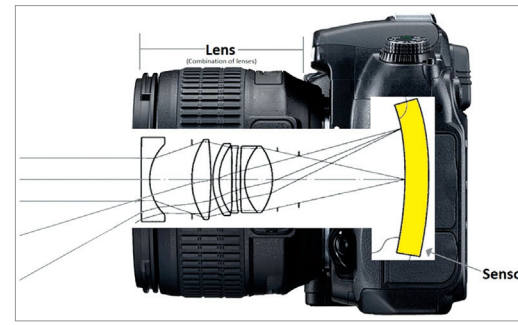


Fig. 2: Path of light falling on the sensor (Source: Link)

CCD sensor. Charge coupled device (CCD) sensors use a specialised fabrication technology and do not have a conversion electronic circuit on the sensor surface. The absence of electronics from the surface means that CCD can capture more light and have a lower noise factor. Besides, these sensors have higher colour fidelity, making them a better choice in low-light, low-speed use. These sensors feature a global shutter.

The comparison of CCD sensors with CMOS sensors is given in Table 1.

TABLE 1
CCD SENSORS VS CMOS SENSORS

Specification	CCD	CMOS
Power consumption	Very high	Low
Cost	High	Low
Speed (fps)	Low	High
Image noise	Low	High
Manufacturing	Difficult	Simple
Uses	Professional cameras	Smartphones, compact cameras, etc
Shutter	Global shutter	Rolling shutter

Applications

Cameras are used in a variety of applications, including monitoring the movement of people or objects in surveillance systems, such as traffic monitoring systems, drones, etc. Cameras are also used for process automation in factories as a part of machine vision systems, or in automobiles for assisting a driver or enabling self-driving of autonomous vehicles. But the most evident use is in our smartphones for capturing moments.

Each of these applications have different requirements. A comparison of machine vision camera, surveillance camera, and consumer cameras is given in Table 2.

Imaging sensor parameters

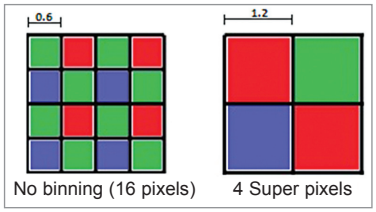
The camera is used in various applications and hence has a lot of different needs and specifications. To understand which imaging sensor is best for our application, we must know some basics about camera sensors. Some important terminologies and technologies are mentioned below.

Pixel and resolution. Before understanding resolution, let us understand what a pixel is. Picture

When doing a 2×2 binning, the size of the pixel is doubled whereas the effective resolution gets divided by 4.

For example, a binned image from a 16MP sensor with pixels measuring 0.6μm would only output a 4MP image, but the size of each pixel would double to 1.2μm.

Fig. 4 shows the result of 2×2 pixel binning on a segment containing sixteen pixels.



element most commonly known as a pixel is the smallest addressable element of any picture. Pixels are uniformly arranged in a 2D grid to form a picture. The total count of pixels is denoted by megapixels, while the number of pixels in the horizontal and vertical axes determine the resolution of an image.

Resolution in photography means spatial separation and determines the quality of an image. The camera resolution is specified simply by multiplying the pixels available in horizontal and vertical lines within a unit area. Image sensors with higher resolution (more pixels) enable pictures with greater detail and therefore enlargement.

A general rule of thumb is that the sensors with smaller pixels require higher resolution than sensors with larger pixels to achieve the same quality of image. Fig. 3 shows how different resolutions can be compared with each other for similar sized pixels.

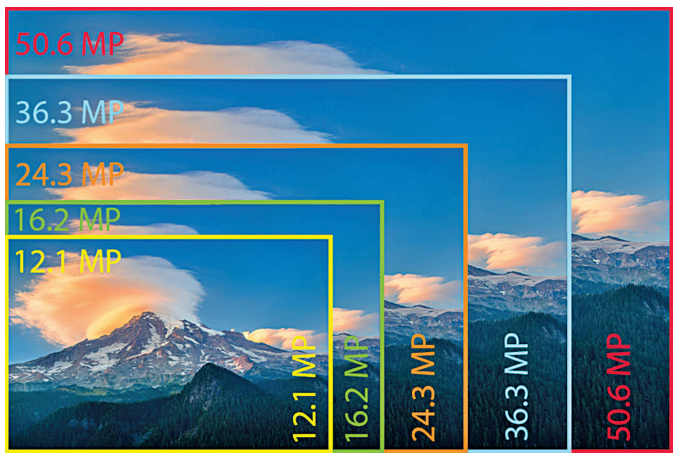


Fig. 3: Comparison of different resolutions with same pixel size (Source: Link)

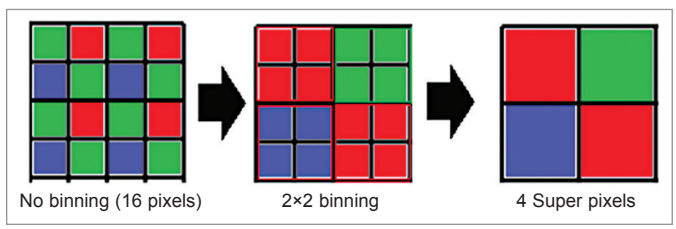


Fig. 4: How 2×2 pixel binning works

Pixel binning. Pixel binning is a technique used to improve the low lighting photography of a portable camera. The quality of image depends on the amount of light captured by the pixels, and larger pixels are better at capturing more light due to their greater surface area. The pixel size is measured in microns.

The latest smartphone cameras are sporting extremely high resolution but with smaller pixel width. The higher resolution works well in bright lighting but sadly not so well in poor lighting conditions. That's where pixel binning comes into play. Pixel binning is a technique where multiple pixels are combined to form a single larger pixel.

As shown in Fig. 4, sixteen pixels undergo 2 × 2 binning to create four super pixels. These super pixels will have better balance between brightness and colours.

Devices with very high resolution prefer to use pixel binning. Some smartphones using pixel binning are Redmi Note 10, Google Pixel 6 series, Samsung Galaxy S21, and Xiomi Mi11.

Monochrome and colour sensor. Cameras can detect a wide range of electromagnetic waves. Cameras can be classified into 2 categories, a colour camera and a monochrome camera.

Colour cameras are capable of distinguishing different shades of colours, whereas monochrome cameras can only produce output in different shades of a single colour. As shown in Fig. 5, the colour sen-

TABLE 2
COMPARISON OF DIGITAL, MACHINE-VISION, AND SURVEILLANCE CAMERAS

Machine vision	Surveillance camera	Digital cameras
Need for monitoring production line	Need for monitoring people	Mostly used for clicking casual pictures and videos
Sends uncompressed data for processing	Sends compressed data for processing	Sends compressed data for processing
Can be employed with casing	Needs to be extremely robust	Needs to be small and power-saving
Less tolerant to poor lighting	Tolerant to poor lighting	Able to work in various lighting conditions
Used in a closed protected environment	Mostly used in open unprotected environment	Mostly used in open unprotected environment
For example, used for quality control in factory automation	For example, used for intelligent traffic monitoring system, such as road tolling	For example, used for casual photography and videography

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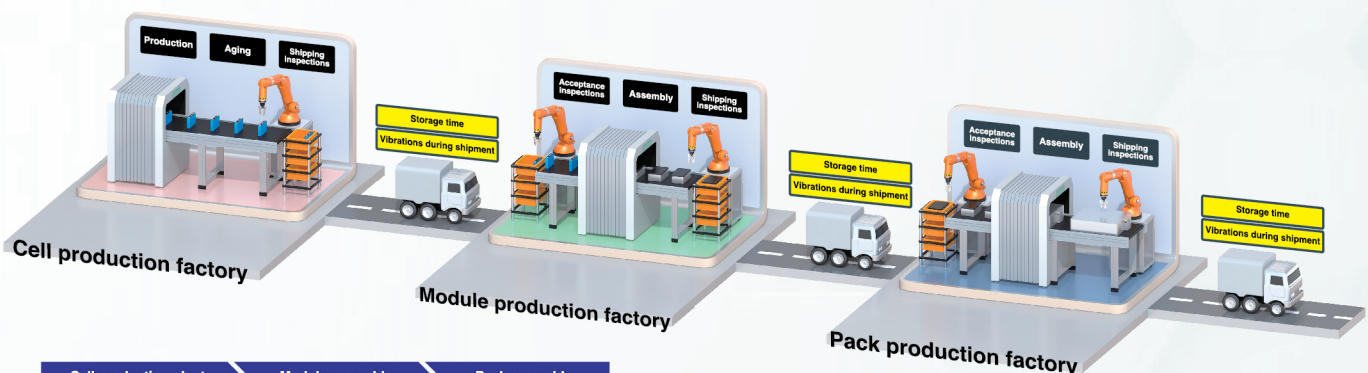

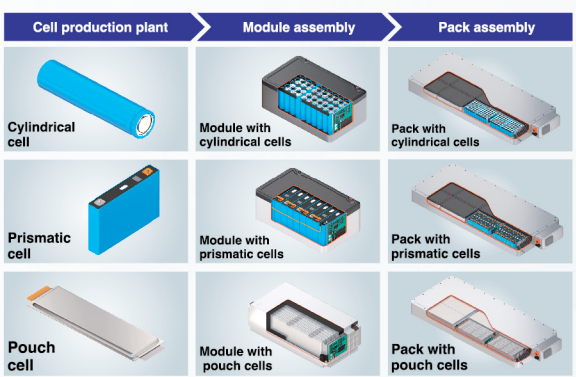

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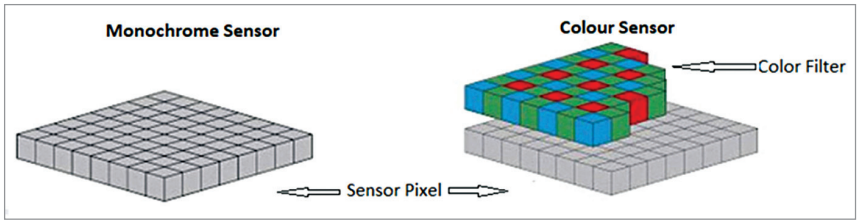


Fig. 5: Monochrome sensor (left) vs colour sensor (right)

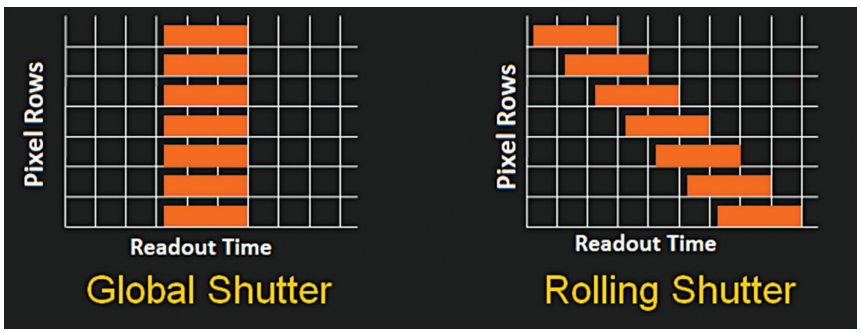


Fig. 6: Pixel row vs time graph of global shutter compared with rolling shutter

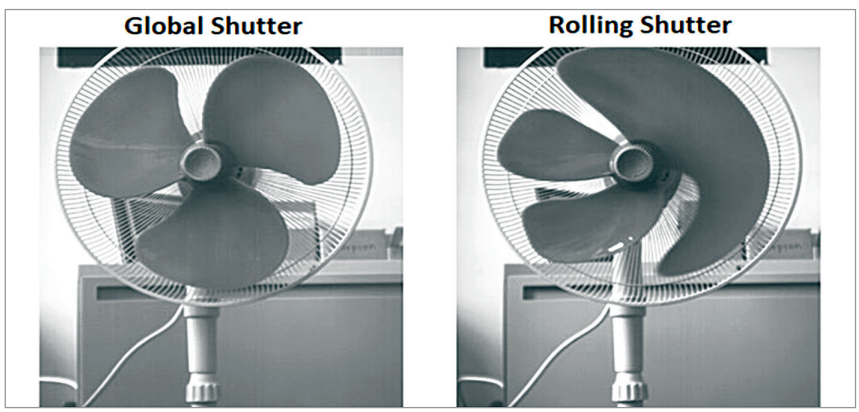


Fig. 7: Comparison of image from camera with a global shutter (left) and rolling shutter (right) (Source: Link)

sor has an extra layer of colour filter that enables it to capture the colour details. But this filter also reduces the intensity of light falling on the image sensor and thereby slightly reducing the quality of the image. If the application does not require colour detection, a monochrome camera is a better option as it produces better clarity, higher contrast ratio, and does not require any filter.

Global vs rolling shutter. Global shutters were previously available only in CCD sensors, where the whole sensor surface gets exposed to light at the same time, capturing the entire frame at once, which makes it great for high-speed photography. Rolling shutter exposes the sensor in a progressive way, as shown in Fig. 8, which causes images of fast-moving objects to be distorted.

In rolling shutter technology, each row or column of the image is taken one at a time. The readout process of every row (or column) happens in a few microseconds (µs), but due to the very high number of frames, the total readout time for the whole image is in the range of a few milliseconds.

Fig. 6 compares the frame time of the rolling shutter with the global shutter. It can be noticed that the complete frame in the rolling shutter is taken over a period of time, whereas the whole frame in the global shutter is taken at the same time.

The difference between rolling shutter and global shutter can be understood from Fig. 7. Applications requiring high dynamic range and low noise should employ CCD sensors, whereas applications with faster speed, low power consumption, and tight budget should go for CMOS sensors.

Frame rate. Frame rate (fps) is the number of images that the sensor can capture and transmit per second. The human brain detects approximately 14 to 16 images per second; the frame rate of a movie is usually 24fps. For fast-moving applications like inspection of newspapers the camera needs to 'shoot' in milliseconds. On the other end there are microscopic applications which require low frame rates comparable to the ones of the human eye.

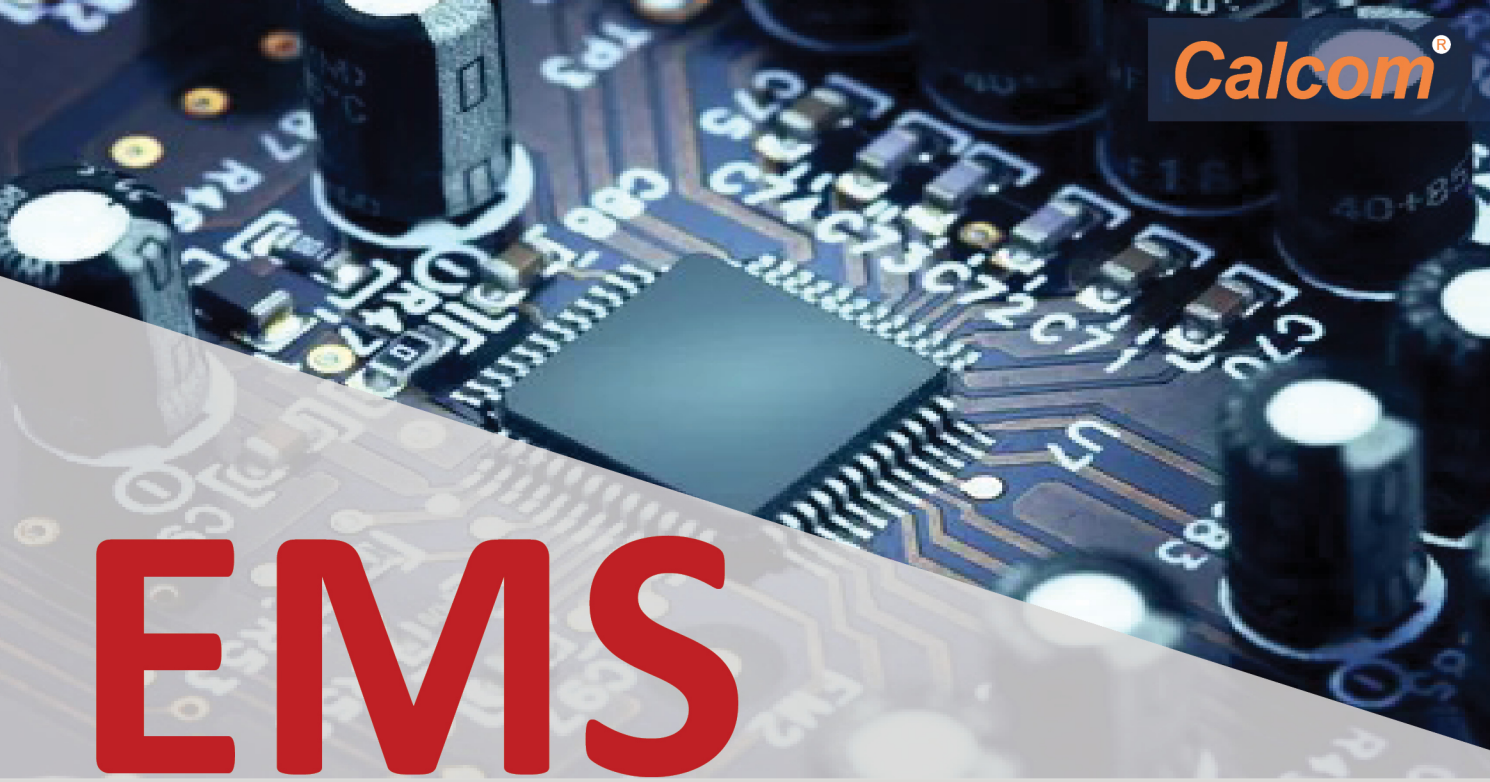
The key considerations while selecting a camera

- Pixel count
- Resolution
- Sensor size
- Sensor technology
- Frame rate
- Chroma
- Shutter speed

Recently launched imaging sensors

There have been a lot of technical advancements in imaging technologies, and 2021 has witnessed a lot of imaging sensors developed for smartphones, machine vision, etc. Some of the sensors that have brought something new to the imaging technology are mentioned below.

On Semiconductor XGS 16000. On Semiconductors has introduced the new XGS 16000 to its XGS line-up of CMOS image sensors. It is a 16MP sensor with low power consumption of 1W at 65fps. The



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sensor features a global shutter and has both monochrome and colour options in its line-up. XGS 16000 sports one of the highest resolutions of 4000 × 4000 pixels for a standard dimension of 29 × 29mm industrial camera. The use of a standard size makes this sensor compatible with many lenses and camera bodies. It uses the HiSPi output interface for communicating.

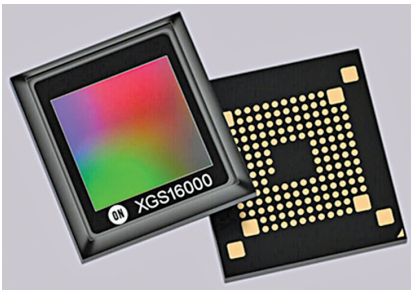

Fig. 8: On Semiconductor XGS16000

Fig. 9: Toshiba Teli DDU1607MG/MC which uses XGS 16000 (Source: Link)

The XGS 16000 is ideal for inspection and industrial camera systems, security cameras, and other machine vision application. This sensor being used in Toshiba Teli Corporation's DDU1607MG/MC is available in an iLGA package that measures 29 × 29mm. It is ideal for industrial camera systems, inspection systems (food, bottles, recycling labels, etc), security systems, and machine vision camera systems.

SonyIMX 478. Sony launched the IMX 478 in September 2021. The imaging sensor can take pictures up to 8.13 megapixel with an astounding speed of 194fps. The 1.7cm CMOS image sensor is optimised for UV wavelengths between 200 and 400mm and has one of the smallest pixel size of 2.74 × 2.74µm currently available in any UV sensor. It features Sony's Pregius S global shutter, which claims to provide distortion-free image and high-speed performance.

The UV wavelength sensors are widely used in semiconductor industry for pattern defect detection. It is also used for plastic sorting, scratch detection and various other applications. Fig. 10 compares images of the protection resin applied on the substrate line under visible light (left) and UV light (right).

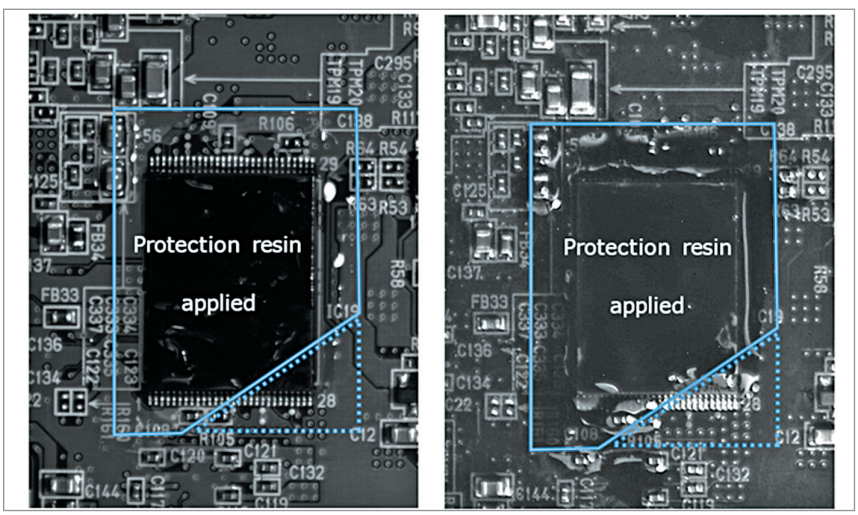

Fig. 10: Images of protection resin applied on the substrate line under visible light (left) and UV light (right). The protection resin appears black under UV lens (Source: Link)

G-Pixel GTOF0503. The GTOF0503 is a CMOS image sensor featuring the indirect Time of Flight (iTOF) technology. The sensor has a resolution of 640 × 480 pixels, which is around 0.41MP with pixel size of 5µm. It is capable of taking good-quality pictures in challenging light conditions. It uses industry standard MIPI CSI-2 interface, making it a very versatile option. The imaging sensor can be used for 3D mapping, depth sensing, and distance measurement applications thanks to its iTOF technology. It can also be used in vision guided robots, pick and pack robots, etc. Fig. 11 shows the 3D point cloud generated from IR depth map.

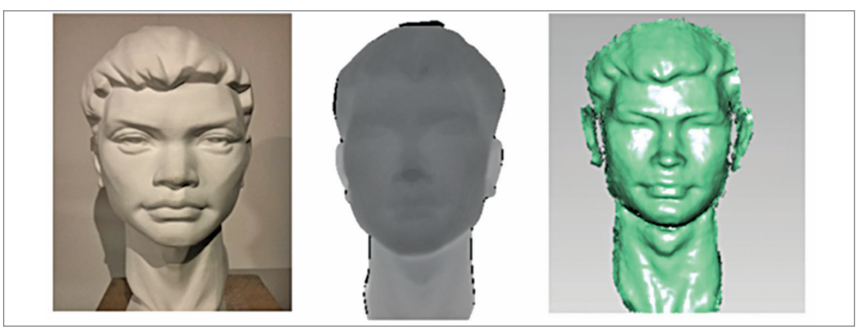

Fig. 11: The 3D point cloud generated from an IR depth map (Source: Link)

On Semiconductor AR0821CS. The AR0821CS from On Semi was released in the last quarter of 2021. The new 1.5mm CMOS sensor can capture 8.3MP pictures and features a rolling shutter and embedded High Dynamic Range (eHDR) technology. The company claims that it provides best-in-class dynamic range in challenging lightning conditions. This sensor has been used in Basler area scan sensor module daA3840-30mc shown in Fig. 12. The imaging sensor is specially designed for machine vision cameras, drones, scanners,

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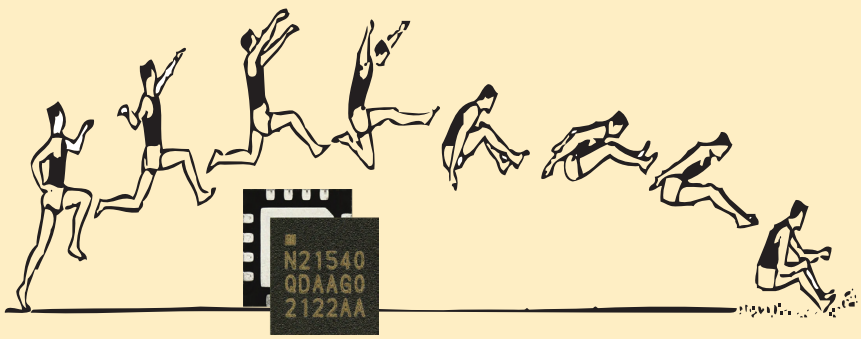
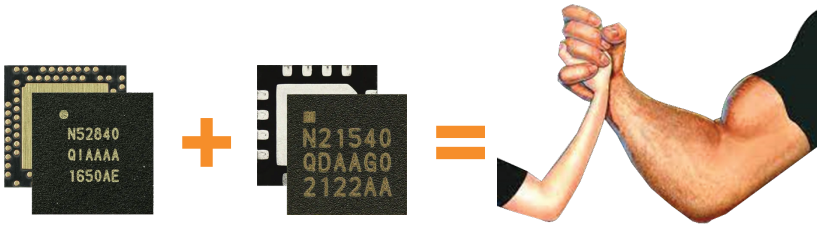


The nRF21540 is a 'plug and play' range extender offering enhanced link robustness with an integrated power amplifier (PA) and low noise amplifier (LNA) for use in our low power short-range wireless solutions. It is a complementary device optimized to boost the link budget of the nRF52 and nRF53 Series advanced multiprotocol wireless SoCs. When combined with an nRF52 or nRF53 Series SoC, the nRF21540 RF FEM's +20 dBm TX output power and 13 dB RX gain ensure a superior link budget for between 16 and 20 dB improvement. This equates to a 6.3 to 10 times theoretical range improvement.



nRF21540 SiP includes below features:

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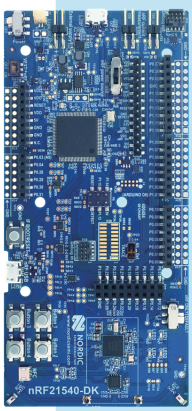

1. nRF52840DK + nRF21540DK
2. nRF52833DK + nRF21540DK
3. nRF5340DK + nRF21540DK

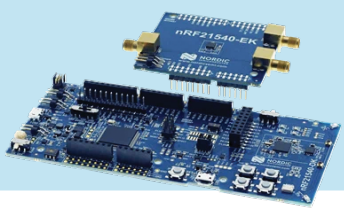

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TABLE 3
COMPARISON OF DIFFERENT IMAGING SENSORS

Model	Company	Type	Chroma	Resolution	Megapixels	Max Frame rate	Shutter type	Sensor size	Interface	pixel size (in μm)	Usage
XGS 16000	On Semi	CMOS	Colour, Monochrome	4000 x 4000	16	65	Global shutter	29mm x 29mm	HiSPi	3.2 x 3.2	Machine vision
IMX 487	Sony	CMOS	Colour, Ultraviolet	2856 x 2912	8.13	194	Global shutter	20mm x 16.8mm	SLVS-EC	2.74 x 2.74	Machine vision
GTOF0503	G-pixel	CMOS	Monochrome	640 x 480	-	30	Global shutter	5.3mm x 4mm	MIPI CSI-2	5 x 5	Machine vision
AR0821CS	On Semi	CMOS	Colour	3848 x 2168	8.3	60	Electronic rolling shutter	-	MIPI	2.1 x 2.1	Survillance, Drone, Machine vision
imx 661	Sony	CMOS	Colour, Black & White	13400 x 9528	127	21.8	Global shutter	75mm x 63.6mm	SLVS-EC	3.45 x 3.45	Machine vision
ISOCell HP1	Samsung	CMOS	Colour	16384 x 12288	200		Electronic rolling shutter and Global reset	1/1.22”	D-PHY, C-PHY	0.64 x 0.64	Mobile
OVB0B	Omnivision	CMOS	Colour	16384 x 12288	200	90	Rolling shutter	1/1.28”	mipi	0.61 x 0.61	Mobile
GN5	Samsung	CMOS	Colour	8160 x 6144	50	90	Global shutter	1/1.57”	D-PHY, C-PHY	1 x 1	Mobile
Gjoo422	Gigajot	CMOS	Monochrome, Colour	2048 x 2048	4.2	60	Rolling shutter	1/1.28”	28 LVDS	2.2 x 2.2	Scientific, astronomy

readers, and surveillance systems.

Sony IMX 661. Sony launched the 127MP IMX 661 in the first quarter of 2021. When launched, this sensor had the highest pixel count for any industrial CMOS sensor equipped with a global shutter. This image sensor features an astounding resolution of 13400 × 9582 pixels with a maximum frame rate 21.8fps . The imaging sensor is quite a lot bigger than any other sensors on the list with its diagonal size measuring 56.73mm. It features multiple exposures, trigger synchronisation, and Pregius Global Shutter technology, which allows the camera to take high-resolution images with very low distortion.

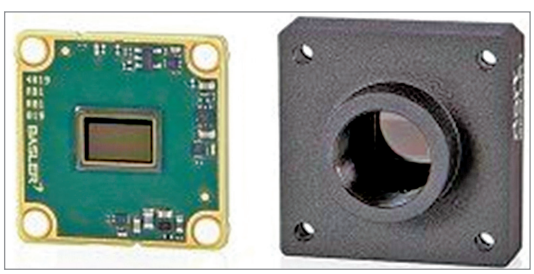
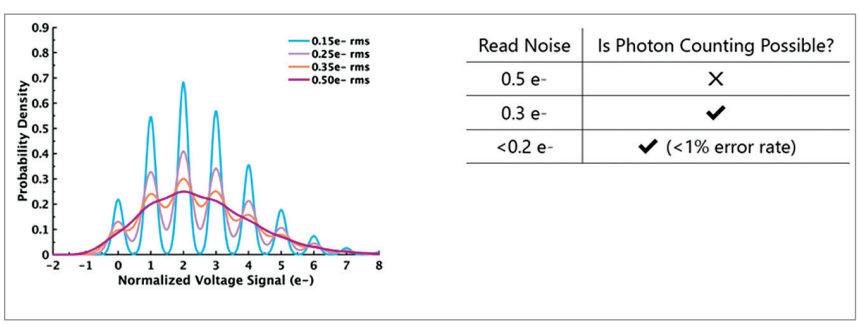


Fig. 12: Basler daA3840-3 with AR0821CS (Source: Link)

Samsung ISOcell HP1. The ISOcell HP1, launched in the third quarter of 2021, is the industry’s earliest 200MP sensor specially developed for handheld devices, such as smartphones. This sensor features a small pixel of 0.64μm and employs Chameleon Cell pixel-binning technology. Depending on the ambient lighting, Chameleon pixel-binning can capture full resolution pics or employ a 2 × 2 pixel binning with an output of 50MP picture, or even 4 × 4 binning to provide a 12MP image in extremely low-light conditions. The sensor can capture 8k videos at 30fps and can deliver data at rate up to 4.5Gbps per lane using D-PHY interface.



Read Noise	Is Photon Counting Possible?
0.5 e-	✕
0.3 e-	✔
<0.2 e-	✔ (<1% error rate)

Fig. 13: Photon counting capability at different noise ratio (Source: Gigajot)

Samsung GN5. Samsung launched the GN5 imaging sensor alongside the HP1 in the first week of September 2021. It is a 50MP sensor with extremely fast autofocusing capabilities. Samsung claims that the GN5 is the industry’s first 1.0μm sensor with a Dual Pixel Pro technology, which can place dual photodiodes and recognise pattern changes in all directions to enable an all directional autofocusing. It also has Samsung’s proprietary pixel technology. Sam-

sung claims that with these two technologies the sensor can instantaneous autofocus even in extreme lightning conditions.

Omnivision OVB0B. In January 2022, Omnivision launched its first 200MP camera sensor, which claims to have the smallest pixel measuring just 0.61µm × 0.61µm. For superfast autofocus, it employs 100% Quad Phase Detection (QPD), which also makes it the first 200MP sensor to offer this feature. Like Samsung's HP1, it also features a 4 × 4 pixel binning to provide an output of 12.5MP at 30fps with 3-exposure staggered HDR timing. The sensor supports CPHY, DPHY, and dual DOVDD for interfacing.

Gigajot Gj00422. Gigajot has released the Gj00422, a photon counting, Quanta Image Sensor (QIS). This is the first sensor capable of photon counting at room temperatures at full speed while achieving full high dynamic range. The Gj00422 is a 4MP sensor with square pixels measuring 2.2µm. Unlike the traditional CMOS sensor, where numerous photons are collected inside a pixel well and converted into electrons, QIS operates by detecting individual pixels in order to work in a poor-light environment with much higher fidelity than other types of CMOS sensors. It also features an on-chip temperature sensor and high intra-scene dynamic range. This sensor is suitable for astronomy, medical, industrial, defence, and other high-performance applications.

Future of imaging sensors

The camera technology has come a long way, and the advancement does not seem to be slowing down any time soon. The improvement in SSD devices means that higher resolution in smaller-size sensors is a safe bet to place.

Recently, researchers from Princeton University were able to fabricate a camera the size of a salt grain that can capture high-quality images, which means that the size of imaging sensors can be reduced to unperceivable sizes.

With the growth number of individual content creators, smartphone manufacturers are forced to improve the cameras in their devices. Many smartphone manufacturers are planning to use a bigger 2.5cm (one-inch) sensor, artificial intelligence, and high-quality lenses to improve camera capabilities. But only time will reveal how cameras improve in the coming years. EFY

The author, Sharad Bhowmick, works as a Technology Journalist at EFY. He is passionate about power electronics and energy storage technologies. He wants to help achieve the goal of a carbon neutral world.

AI HARDWARE That's Tailored For COMPUTER VISION

Neural networks, AI, ML, and neuromorphic computing are technologies that are actually ways to make machines behave more like humans! Similarly, computer vision focuses on imitating the complex human vision system and leveraging it in applications

AARYAA PADHYEGURJAR

Computer vision is a type of artificial intelligence (AI). The aim is to make computers visualise and understand images or videos as humans do. The field has grown a lot over the last decade, especially due to the new hardware and algorithms that came into the picture. Not just that, this type of computation has become faster and more accessible since the amount of data that is generated has also increased. Thanks to improved training models, deep learning, and better hardware, we are able to identify objects more accurately today.

Computer vision works by recognising patterns in images and videos. You feed the computer with an image of a particular object and then make the computer analyse it using algorithms—the borders, colours, shades, and shapes. We are essentially training a computer to understand and interpret the world.

Computer Vision at Work!

For the 2018 Masters Golf event, IBM employed computer vision to produce My Moments. IBM Watson was given hundreds of hours of film, after which it was able to recognise the sights (and sounds) of key scenes. These pivotal moments were chosen and distributed to viewers as individual highlight clips!

Drone Skygrid, an airspace management system built on AI and blockchain, uses computer vision for near real-time object detection through a drone's live video stream (Credit: Skygrid)

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Computer vision: Then and now

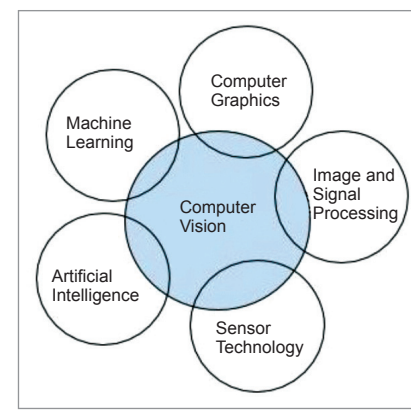
In his whitepaper titled 'Everything You Ever Wanted To Know About Computer Vision,' Ilija Mihajlovic, an iOS developer who is passionate about machine learning (ML), explains how ML and deep learning have simplified computer vision. Before deep learning came into the picture, computer vision did not have as much scope as it does today, mainly because a lot of manual coding was required, such as creating a database, annotating images, capturing new images, etc.

"With machine learning, developers no longer needed to manually code every single rule into their vision applications. Instead, they program features or smaller applications that could detect specific patterns in images," writes Mihajlovic. Today, we use deep learning for computer vision, and all of the work is done by neural networks. When we provide neural networks with lots and lots of labeled images of a particular object, they are able to identify patterns in them.

Hardware for computer vision

Capturing data is an important aspect of computer vision applications, and hardware platforms play a major role here. The main components required for computer vision applications are cameras and image sensors for capturing images, I/Os, a communication interface, and a processing unit. Imaging sensors present in cameras are characterised by their resolution (number of pixels), speed (frames per second), and number of colours.

Depending on the type of computer vision application, the processing unit might vary from CPUs



Fields that drive computer vision (Credit: IFA)

Components of Computer Vision

Hardware: Cameras/Imaging sensors
Software: Machine learning models for processing the images
Hardware: Processing units or conditional logic to automate application-specific use cases

COMPARISON OF SOME COMPUTER VISION BOARDS

	Arduino Nicla Vision	OpenMV Cam H7	Huskylens	VC Picosmart	iVS-AWV3-AR0521
Processor	STM32H757AII6 Dual Arm Cortex M7/M4	ARM 32-bit Cortex-M7 CPU	Kendryte K21 (AI Chip with 64bit RISC-V dual core CPU)	FPGA module, High-end FPU processor	Allwinner V3 system on module
Camera/ image sensor	GC2145 (2MP colour camera)	OV7725 image sensor (can be interfaced with other sensors too)	HuskyLens – OV2640 (2MP camera), Husky-Lens PRO – OV5640 (5MP camera)	1-Megapixel CMOS sensor	ON Semiconductor AR0521 sensor module
Notable characteris-tics and features	MP34DT06JTR digital MEMS microphone, LSM6DSOXTR 6-axis IMU, NXP SE050C2 Crypto chip	Double-precision floating point unit (FPU), Hardware JPEG encoding	It can be used as a stand-alone product or as a peripheral for a microcontroller or microcomputer	VC realtime-OS for real-time image processing	H.264, 1080p60 video codec, integrated ISP supports up to 8MP with auto image function
Connecti-vity and communic-ation	Bluetooth, Wi-Fi, SPI, I2C, UART	Wi-Fi, BLE, SPI, I2C, UART, CAN	UART, I2C	FPC connector	Multiple wireless connec-tivity options available
Supported battery/ power source	Li-ion/LiPo single cell, 3.7V	3.7V LiPo battery	Two power pins on the 4-pin JST connector, micro USB connector	N/A	N/A
Suitable for	Asset tracking, object recognition, predictive maintenance	Object detection, line detection, video recording, QR code detection/deco-ding, eye tracking, colour tracking, frame differencing	Face recognition, object tracking, object recognition, line tracking, colour recognition, tag recognition	Object recognition, position control, barcode reading, Web edge and level control	Autonomous vehicle and aftermarket home auto-mation camera systems
Compatibi-lity/ integrations	Arduino IDE, Arduino CLI, Arduino IoT Cloud, OpenMV IDE	Edge impulse CLI, OpenMV IDE.	Mind+Editor, Arduino IDE	N/A	N/A
Primary programm-ing language	C/C++	Python	C/C++	N/A	N/A
Edge capability	Yes	Yes	Yes	Yes	Yes
Industry-ready?	Yes	Yes	More suited to prototyp-ing	Yes	Yes
Dimensions in mm (l x w x h)	22.86 x 22.86	45 x 36 x 30	52 x 44.5	22 x 23.5	N/A
Weight	2gm	19gm	N/A	N/A	N/A
MSRP	$115.00	$65.00	$54.90	Quote based	Quote based
Datasheet	https://docs.arduino.cc/static/592480018567f53345d4f2b18199cd67/ABX00051-datasheet.pdf	https://cdn.shopify.com/s/files/1/0803/9211/files/OpenMV-H7.pdf?10726770933929369108	https://wiki.dfrobot.com/HUSKYLENS_V1.0_SKU_SEN0305_SEN0336	https://www.vision-components.com/en/products/oem/arm-linux/board-cameras/vc-picosmart/	https://www.ienso.com/product/ivs-awv3-ar0521/

to embedded boards. Here are a few examples:

- CPUs
- GPUs
- Heterogenous systems (CPUs + GPUs + others)
- FPGAs
- ASICs
- Microcontroller boards
- Embedded systems (smart cameras)

So where do development boards stand?

Traditional computer vision systems used a camera connected to a general-purpose computer, which used to run the application. In a smart camera though, the whole system can be integrated, right from capturing the image to processing to the final application. Today, the distinction between smart cameras and development boards has slowly started to fade, since many development boards have inbuilt cameras and are tailored for computer vision applications.

With more and more applications being deployed on edge, it makes more sense to deploy such devices on development boards. Here are some critical features that you need to consider while selecting a development board for your computer vision application:

- High processing speed
- Edge processing ability
- Faster access to memory
- Low power consumption
- Portable
- Inexpensive

While there are embedded platforms specifically for AI like NVIDIA Jetson and Raspberry Pi Compute, AI accelerators like Google TPU, SOMs/SBCs containing high-quality imaging sensors, we will focus on a few boards that were designed for computer vision and compare some of their features.

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Current trends in computer vision

Computer vision on edge. To successfully deploy computer vision on edge, neural network design must be integrated into embedded platforms. Then, there are also difficult design decisions to be made around power consumption, cost, accuracy, and flexibility. Overall, for bandwidth, speed, and security reasons, edge computing is critical to computer vision processes. Still, hackers could take advantage of emerging security flaws in artificial intelligence. Designers must take this into consideration too.

However, there are some challenges when it comes to vision AI on edge, such as involving all edge endpoints can lead to complex device architectures. This makes device management and edge computing implementation harder. Edge computing differs from cloud architecture as it is spread out rather than centered around a single cloud. For large enterprises, it may be assumed that such an infrastructure will have higher maintenance costs than one centered upon the cloud.

Embedded vision and IoT embedded vision. Embedded vision is when we combine cameras with the processing unit, like smart cameras mentioned before. Many companies, like Lattice Semiconductor and Blaser AG, provide embedded vision solutions. For example, Basler's AI Vision Solution Kit comes with cloud connectivity and contains a dart MIPI camera module, an NVIDIA Jetson Nano development board, lens, and cable. It allows developers to test AI based IoT applications on an optimised vision system and to access cloud services.

Blaser's AI Vision Kit (Credit: Blaser AG)

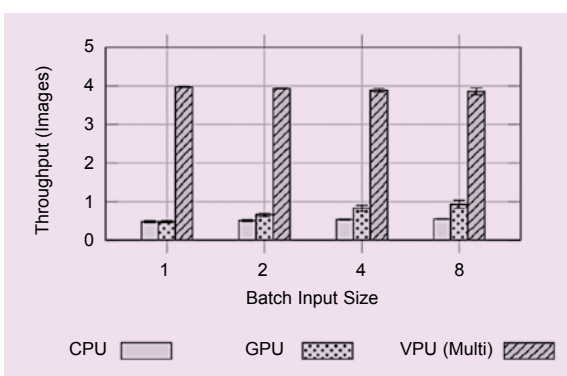
But we are about to enter the next stage of the Internet of Things. So far, the focus was on connecting devices, accumulating data, and creating big data platforms. Now, our focus will move to making the 'things' smarter using technologies like computer vision and deep learning on edge. This way, the things will be able to make informed decisions about their surroundings. That's IoT embedded vision.

Vision processing units (VPUs). A VPU is a specific type of AI accelerator designed for computer vision tasks. It is well suited for parallel processing. A very popular edge AI accelerator is the Intel Neural Compute Stick 2, which is built on the Myriad X VPU. It offers an easy-to-use USB interface.

Pre-trained convolutional network (CNN) models are used in the VPU chips to execute inference tasks. Studies have shown that VPUs are superior to CPUs and GPUs in terms of performance as well as power consumption. Moreover, a combination of multiple VPU chips can even reduce the thermal-design power (TDP) by up to eight times.

Software 2.0 and computer vision. As we move towards Industry 4.0, software development is also moving towards Software 2.0. Software 1.0—the technology stack that includes languages like C/C++, python, etc—is the one that we are familiar with. It needs a coder. On the other hand, Software 2.0 literally writes itself when we feed enough data to a neural network that knows how to code.

This is yet another reason why the computer vision market will continue to grow exponentially. It will drive Software 2.0. Andrej Karpathy, Director of AI at Tesla, is a big proponent of Software 2.0. He notes that with Software 2.0, the computer vision library (for example, OpenCV) could even be auto-tuned on our specific data! EFY



Throughput performance comparison per watt using the CPU, GPU, and multi-VPU configurations (Credit: https://arxiv.org)

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast at EFY with a keen interest in innovation and research.

EFY TESTED Sani Theo

MULTI-USER CALL BELL
For Up To Nine Persons

S.C. DWIVEDI

This unique but simple call bell can be used to call an office boy or a help at home from up to nine different places. Besides ringing, it shows the number of caller's room or place from where the call is being made.

The author's prototype is shown in Fig. 1 while its block diagram is shown in Fig. 2. The call bell is built around LM7805 voltage regulator IC1, ICs 74LS147, 74LS04, and 74LS247 (IC2-IC4), NE555 timer IC5, BC547 transistors T1 and T2, and 1N4148 signal diodes D1-D4.

IC1 provides 5V regulated power supply to the circuit except piezo buzzer PZ1, which is connected to the 9V battery directly.

IC2 is 10-line to 4-line priority encoder. It encodes nine data lines to four-line BCD. Zero condition requires no input, as zero is encoded when all nine data lines are at a high logic level.

IC3 is hex inverter, which inverts output of 74LS147. Only gates IC3(A) through IC3(D) are used to invert the four-line BCD. The inverted outputs of IC3 are given to IC4 and the four diodes.

IC4 is a BCD-to-seven-segment decoder/driver. It has active-low outputs to directly drive the signal diodes. Output of IC4 is given to the common anode display LTS-6960HR/LTS542 (DIS1), which is used to display the caller's room number.

The input switches (S1 through S9) are used to trigger timer IC5 through four signal diodes (D1 through D4). IC5 drives the piezo buzzer for a pre-set time. Output of IC5 is decided by resistor R13 and capacitor C1.

The nine switches (S1 through

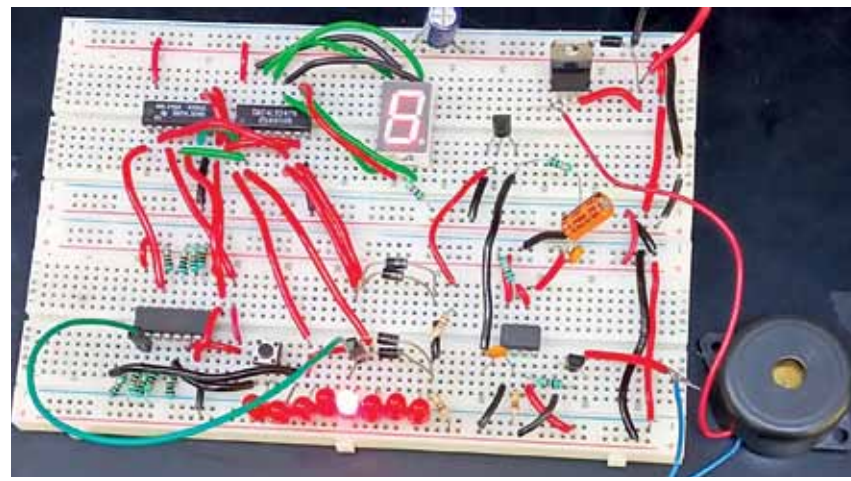


Fig. 1: Author's prototype

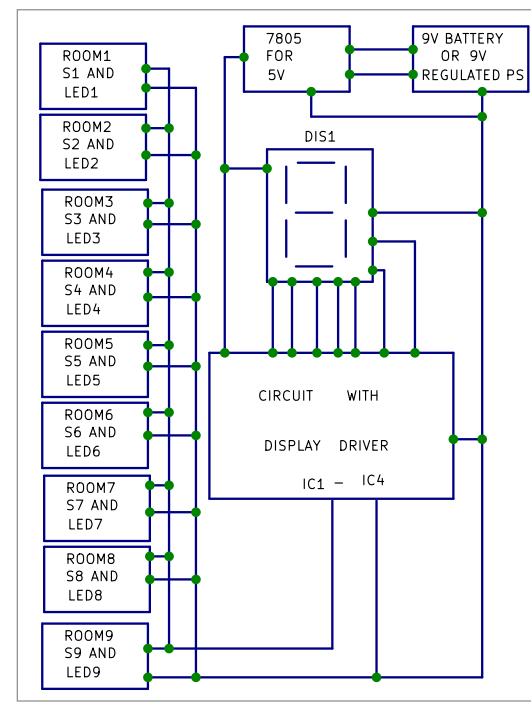


Fig. 2: Block diagram

PARTS LIST

Semiconductors:

IC1	- LM7805, 5V voltage regulator
IC2	- 74LS147 10-line to 4-line priority encoder
IC3	- 74LS04 hex inverter
IC4	- 74LS247 7-segment decoder driver
IC5	- NE555 timer
T1, T2	- BC547 NPN transistor
D1-D4	- 1N4148 signal diode
LED1-LED9	- 5mm LED
DIS1	- 7-segment display LTS-6960HR/LTS542

Resistors (all 1/4-watt, ±5% carbon):

R1-R9, R11, R14	- 1-kilo-ohm
R10, R12, R13, R16	- 10-kilo-ohm
R15	- 2.2-kilo-ohm

Capacitors:

C1	- 220µF, 35V electrolytic
C2	- 0.01µF ceramic disk
C3	- 0.1µF ceramic disk

Miscellaneous:

S1-S10	- On/off switch
PZ1	- Piezo buzzer
BATT.1	- 9V battery/regulated power supply

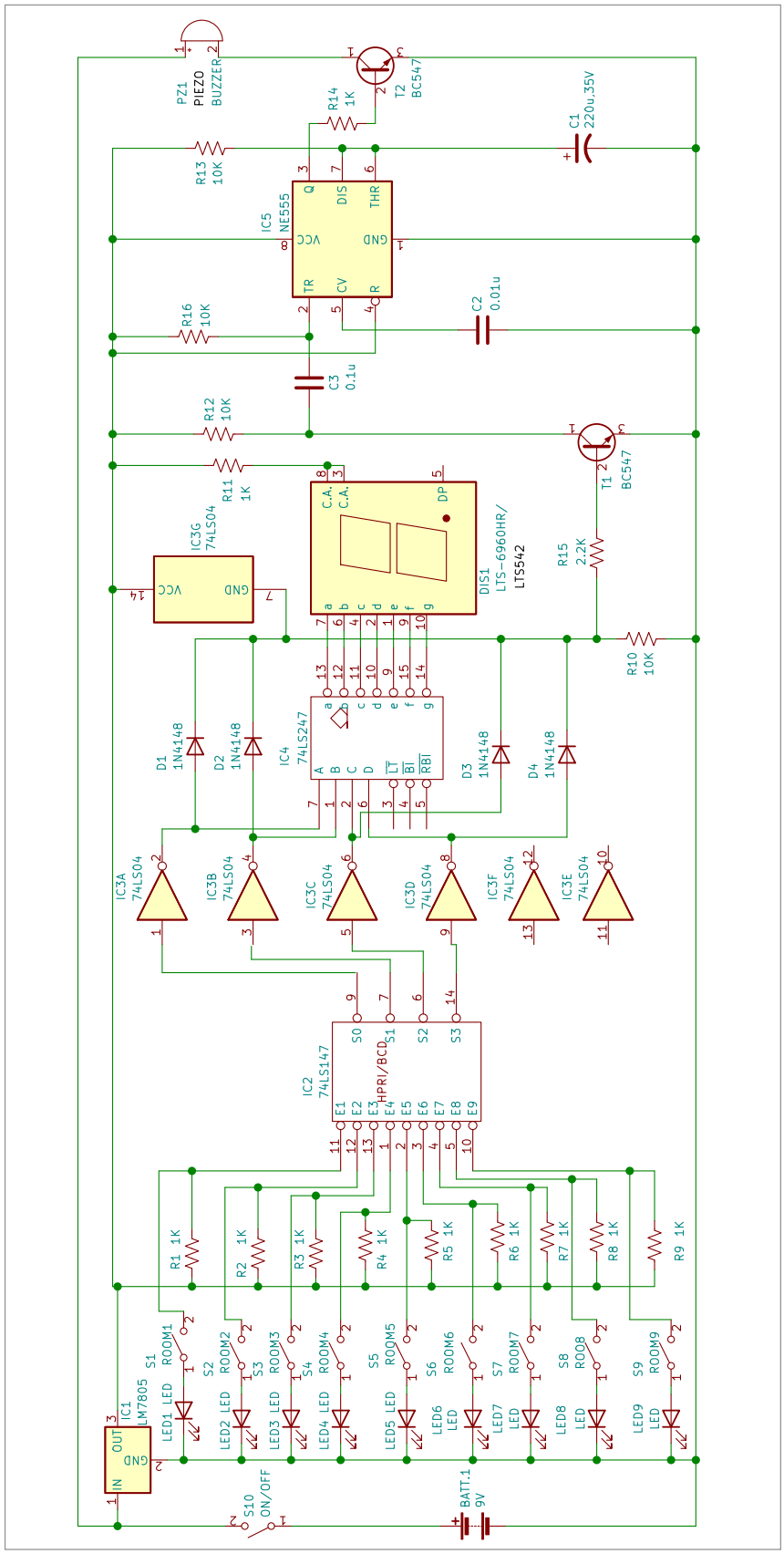


Fig. 3: Circuit diagram

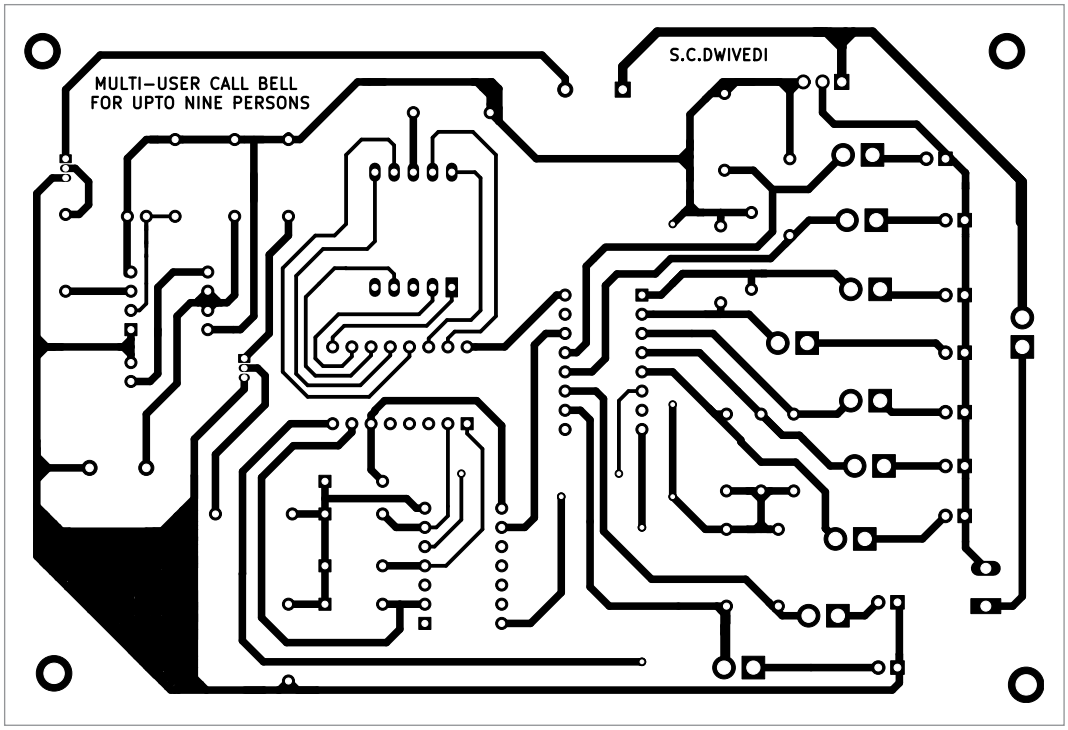


Fig. 4: Actual-size PCB

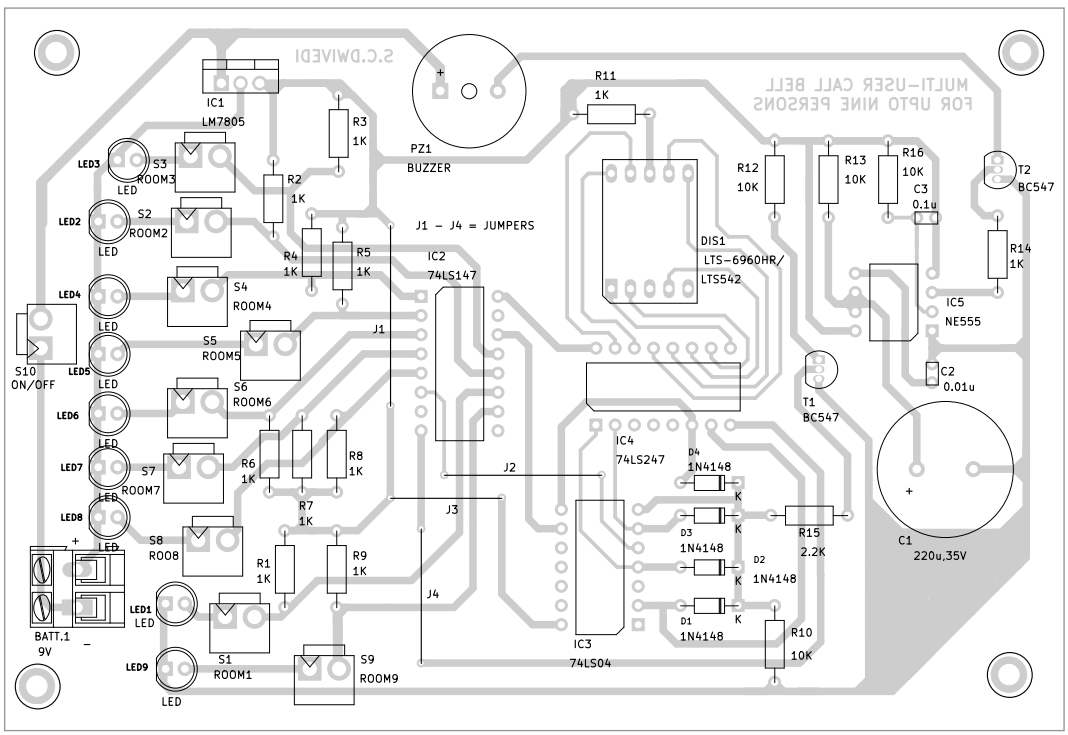


Fig. 5: Component layout of the PCB

S9) are installed at nine different places or rooms along with their corresponding LEDs (LED1 through LED9) for caller indications. IC2 encodes nine data lines into four BCD outputs.

When switches S1 through S9 are open and no LED is glowing, the seven-segment display DIS1 shows 0. If any of the switches is closed, the BCD output goes low and is inverted by IC3(A) through IC3(D). Then that room number LED glows, and at the same time the seven-segment display DIS1 shows that room number.

Working of the circuit is simple. When, say, room number 1's switch S1 is turned on, its LED1 glows and DIS1 displays 1 besides sounding an alarm through piezo buzzer PZ1. The caller should switch off S1 after the call has been attended so that the system is ready to receive the next call.

An actual-size, single-side PCB layout for the call bell is shown in Fig. 3 and its component layout in Fig. 4. After assembling the circuit on PCB, enclose it in a suitable box. Install switches S1 through S9 along with their respective LEDs (LED1 through LED9) in nine different rooms or locations. The assembled PCB, including DIS1 and speaker, should be placed where the attendant is stationed. EFY

S.C. Dwivedi is an electronics enthusiast and circuit designer at EFY

EFY TESTED
Ashwini K. Sinha

First Ever Finger-Size FULL-TOUCH E-INK PHONE

ASHWINI KUMAR SINHA

Phones are getting smarter and complex with many functions that most of us find difficult to use. The modern smartphone uses either backlight display or an OLED display that can harm our eyes on prolonged use.

You may have wondered how phones are designed and whether you could make your own smartphone. So, here is how you can make your own smartphone having an impressive E-ink technology. This full-touch, finger sized phone uses UI-powered Linux operating system (OS) that can be accessed using any OS and VNC HDMI. It can perform all the basic functions of a phone.

Fig. 1: Author's prototype

The author's prototype is shown in Fig. 1 and the prototype with its calling screen is shown in Fig. 2. It is so small (see Fig. 3) that it can be strapped to your little finger.

E-ink technology saves power due to absence of backlit display and is good for those who want to avoid the glare of OLED and backlit displays. E-Ink display, like the printed paper, remains visible even when power is cut off, until you refresh it.

However, this is not all. We are going to develop the E-Ink phone,

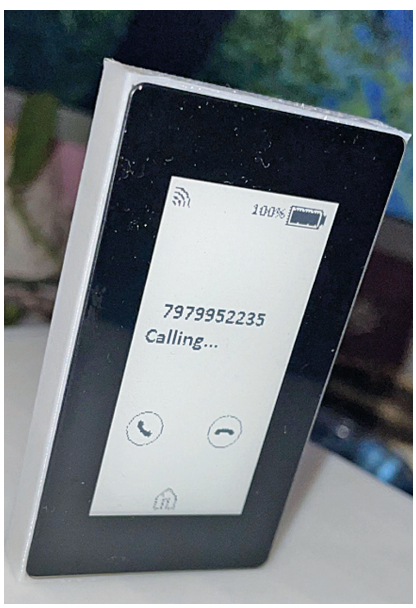


Fig. 2: Author's prototype with calling screen

Fig. 3: E-ink phone size compared to a finger

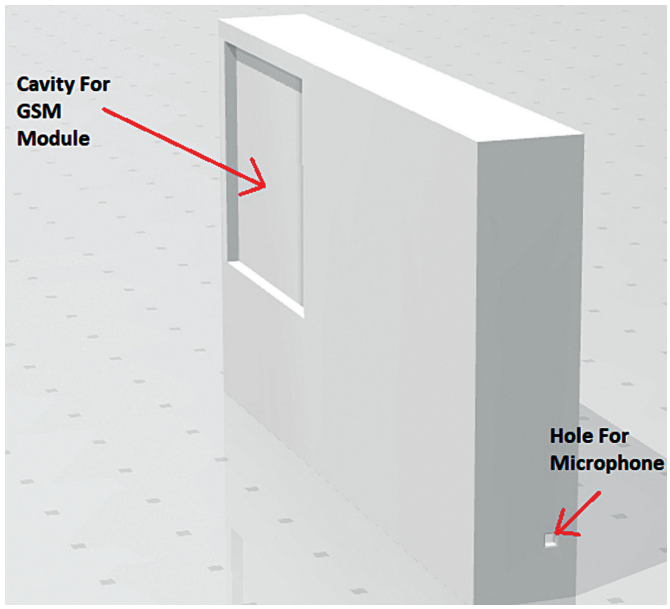


Fig. 4: Body design

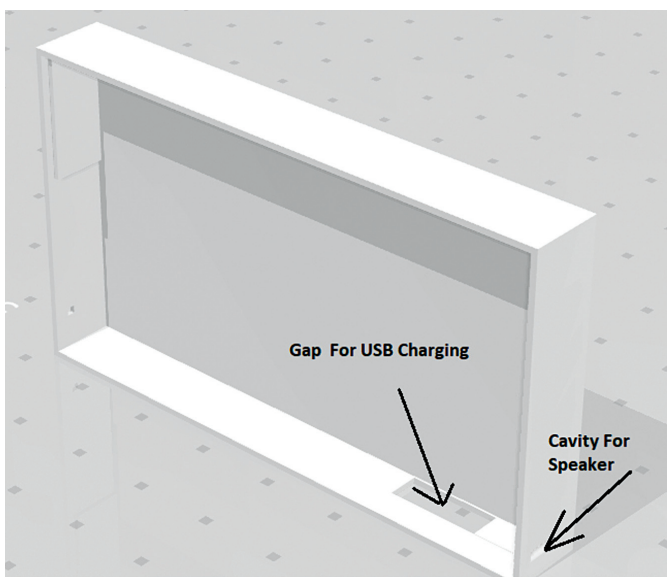


Fig. 5: Holes made in the phone's body

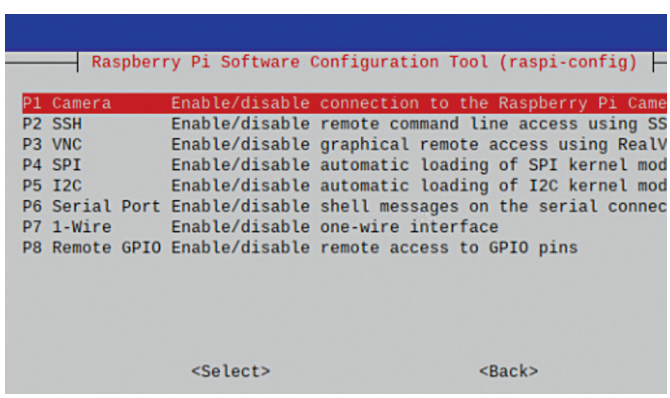


Fig. 6: Software configuration

MATERIAL REQUIRED

Component	Quantity	Description
Raspberry Pi Zero	1	Microcontroller
SIM800L	1	GSM module
Mini speaker	1	8-ohm,0.5W (mini)
Microphone	1	Micro sized mic
Battery and charger	1	3.3V rechargeable battery and charger
5.4cm E-ink touch display	1	Touch E-ink display
3D printed case	1	3D printed PLA case

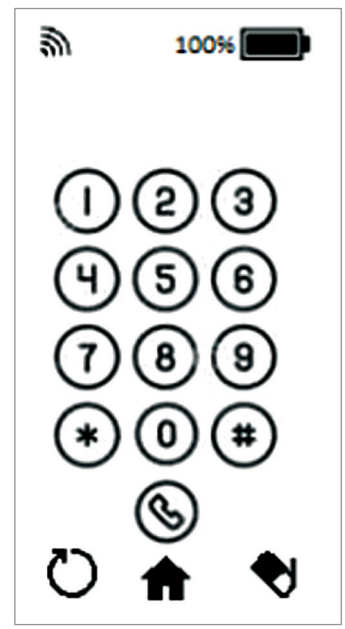


Fig. 7: UI for dialing screen

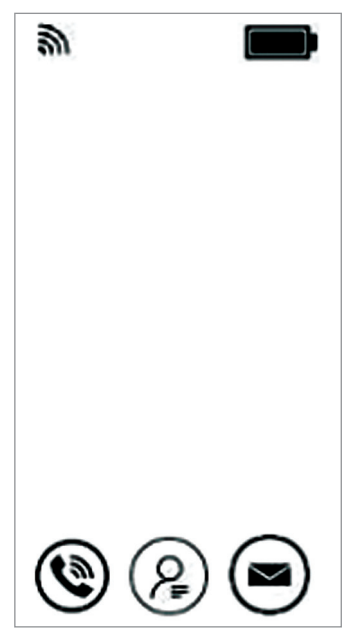


Fig. 8: UI for main screen

and, without any extra cost, you will get a full Linux based portable finger-sized computer as well! So, let us start collecting the required components, which are listed in the table above.

Designing

Though it is a totally home-made DIY phone, we can design it to look slim and attractive. So, for the phone, make its body the same size as the E-ink touch display. Then make space, as shown in Fig. 4, for embedding the GSM module inside the phone body.

Next make a tiny hole where the speaker is to be placed, so that you can hear the sound (see Fig. 5). Similarly, make holes for the mic and power input. Now, after designing the phone body, 3D print it.

Prepare the Raspberry Pi with its latest OS and then enable the SPI and I2C and serial ports of the Raspberry Pi. To do that, run the following command in

Llinux terminal and enable software configuration one by one, as shown in Fig. 6.

```
sudo raspi-config
```

Next, install driver for the E-ink touch display and the Python modules to use the display. To do that, open the Linux terminal and run the following commands:

```
wget http://www.airspayce.com/mikem/
bcm2835/bcm2835-1.68.tar.gz
tar zxvf bcm2835-1.68.tar.gz
cd bcm2835-1.68/
sudo ./configure && sudo make && sudo make
check && sudo make install

sudo apt-get install wiringpi

#For Pi 4, you need to update it:
wget https://project-downloads.drogon.
net/wiringpi-latest.deb
sudo dpkg -i wiringpi-latest.deb
gpio -v
#You will get 2.52 information if you
install it correctly
sudo apt-get update
sudo apt-get install python3-pip
sudo apt-get install python3-pil
sudo apt-get install python3-numpy
sudo pip3 install RPi.GPIO
sudo pip3 install spidev

cd ~
git clone https://github.com/waveshare/
Touch_e-Paper_HAT
```

Creating UI

We need to create the user-interface (UI) for the phone so that it looks beautiful. You can choose any icon and design a custom UI of your choice. For the prototype, round icons were used, as shown in Fig. 7. For UI, we must have the basic design to perform the basic functions. So, here is the list of UI pages for the basic phone functions:

- Main screen
- Dialing screen
- Contacts screen
- Messages
- Incoming call
- Calling screen

For every screen UI we need to

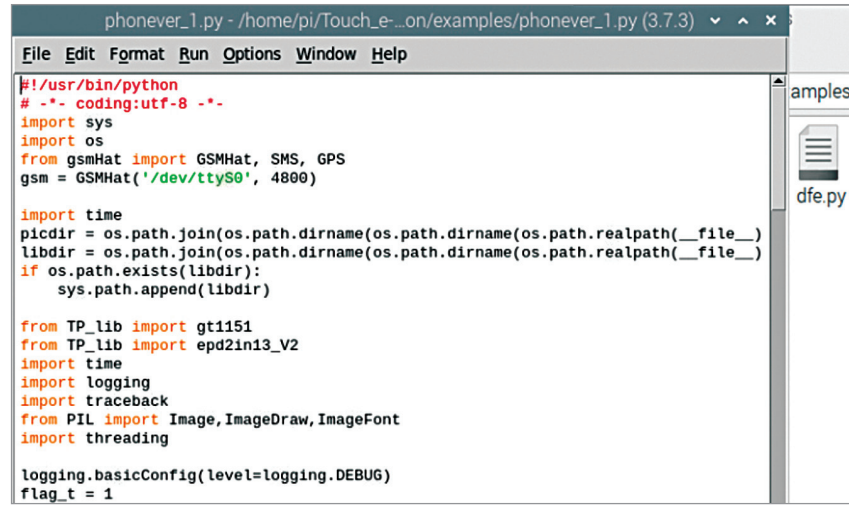


Fig. 9: Python code

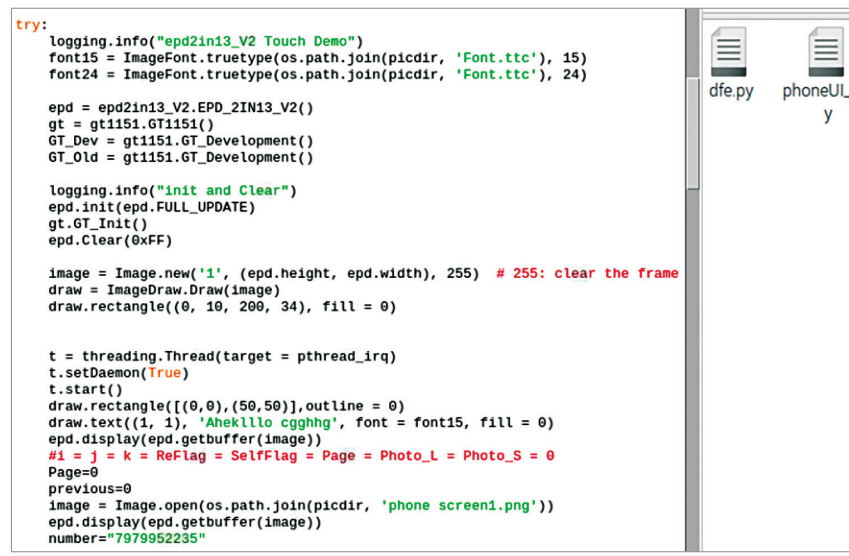


Fig. 10: Home screen

```
while(1):
    gt.GT_Scan(GT_Dev, GT_Old)
    if(GT_Old.X[0] == GT_Dev.X[0] and GT_Old.Y[0] == GT_Dev.Y[0] and GT_Old.S[0] == GT_Dev.S[0]):
        continue
    if (Page==0):
        image = Image.open(os.path.join(picdir, 'phone screen1.png'))
        epd.display(epd.getbuffer(image))
        if(GT_Dev.X[0] > 0 and GT_Dev.X[0] <15 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("h")
            Page=1
        if(GT_Dev.X[0] > 30 and GT_Dev.X[0] <60 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("contact")
            Page=2
        if(GT_Dev.X[0] > 80 and GT_Dev.X[0] <130 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("h")
            Page=3

    if(Page == 1):
        print (number)
        if(previous!=Page):
            image = Image.open(os.path.join(picdir, 'dialing screen.png'))
            epd.display(epd.getbuffer(image))
            previous=Page
        if(GT_Dev.X[0] > 0 and GT_Dev.X[0] < 20 and GT_Dev.Y[0] > 79 and GT_Dev.Y[0] < 88):
            print("1")
            number+= "1"
            print (number)
            draw.text((20, 20),"vhgvjhj", font = font15, fill = 0)
            epd.display(epd.getbuffer(image))
```

Fig. 11: Call function

get the icon, resize, and place it such that it fits inside the actual size of the phone's display (5.4cm size in prototype). For the main screen UI, battery icon is used for getting power information, tour icon for getting the signal info, and dial icon for dialing screen, contacts, and messaging screens. In the middle, it is kept blank to display time, date, etc.

Create the dialing screen UI for the numbers and other icons. Dial a number and go to home screen, or erase and refresh the screen. Similarly, make UIs for the remaining phone functions and screen.

```
    elif(GT_Dev.X[0] > 40 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 190 and GT_Dev.Y[0] < 220):
        print("call")
        gsm.Call(number)        # This call hangs up automatically after 15 seconds
        Page = 4


    if(GT_Dev.X[0] > 30 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 225 and GT_Dev.Y[0] < 250):
        print("home")
        image = Image.open(os.path.join(picdir, 'phone screen1.png'))
        epd.display(epd.getbuffer(image))
        Page=0


if(Page == 2):
    print("cintact")
    image = Image.open(os.path.join(picdir, 'contactsscreen.png'))
    epd.display(epd.getbuffer(image))

    if(GT_Dev.X[0] > 30 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 225 and GT_Dev.Y[0] < 250):
        print("home")
        Page=0
if(Page == 3):
    print("Message")

    image = Image.open(os.path.join(picdir, 'contactsscreen.png'))
    epd.display(epd.getbuffer(image))
    print("message c=screen")
    newSMS = gsm.SMS_read()
```

Fig. 12: Message function

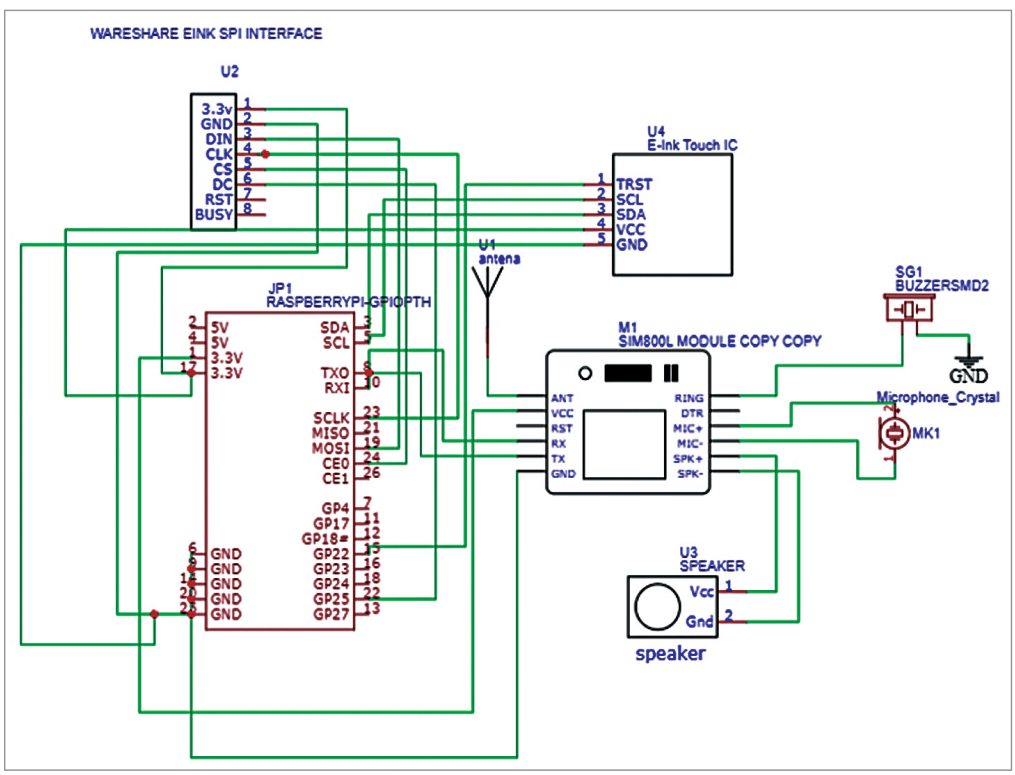


Fig. 13: Circuit diagram

Save the images from the UIs in the pic folder of the Python library that was cloned earlier. Open the code for displaying.

Coding phone OS

To create the code for OS for the phone, import the modules and library for interfacing the E-ink touch display. Then import the Python modules for using SIM 800L GSM module. Next, set the path where you keep the UI images for the phone and create the while loop to check the screen. The page to display is similar to previous, but new if its previous one has new page number. Update the display with UI pic.

For the (first) home page, check the touch points for the icons like dial icon, contact icon, or message icon. Also check the incoming call by checking the ring pin. Then create an 'if' condition where you check the touch points to match the range of icons on the UI. If you touch the phone icon, the touch point should match with the touch point corresponding to the phone.

Set the function in if condition to change the page number to next (No. 2). That is, in the UI image of dialing screen, update the phone screen and set the page number to 2. Now the phone moves to dialing screen with buttons of numbers. Create the if conditions for checking the numbers and icons.

Touch the dial pad screen if touch point range of number is one or two, or other number button. Update an empty string named number, add that number to the string. If touch point matches with the call icon, it sends the com-

EFY Note
The source code of this project is available for free download at *www.electronicsforu.com*

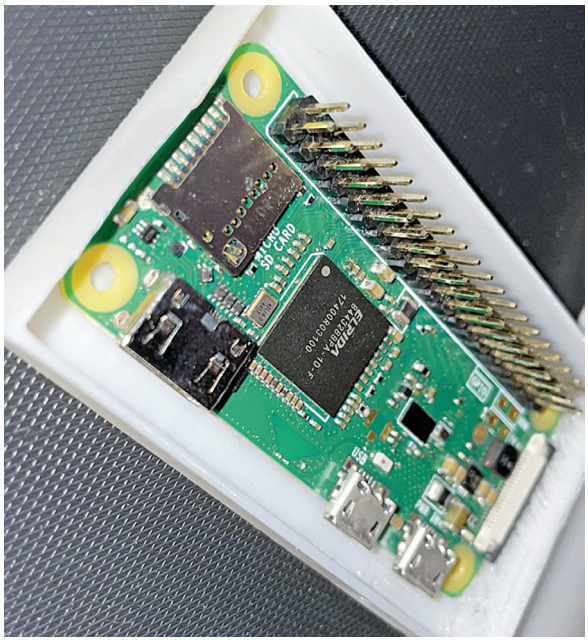


Fig. 14: E-ink header-to-header pins on Raspberry Pi

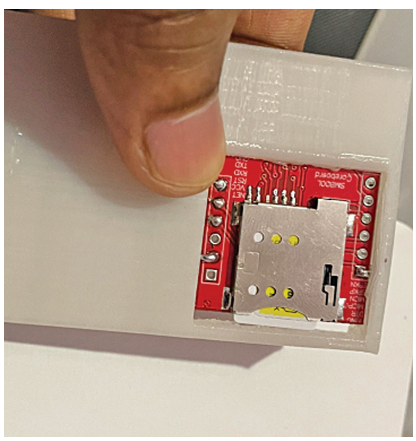


Fig. 15: GSM module fixed in the enclosure

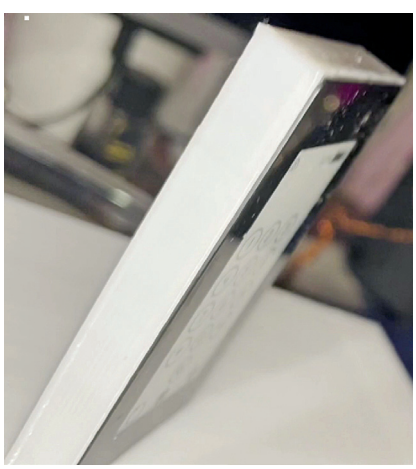


Fig. 16: Phone screen fixed on the base phone cover

mand to GSM module to call that number. It also sets the page number to the calling screen and updates the display with calling screen.

In the calling screen, check the touch points for Call Hang icon. If your touch point matches with the range of call-hang icon, touch point will send the command to SIM800L GSM module to cut the call and hang up. It will also change the page number to 0 and update the display with home screen UI.

Similarly, check the touch points and incoming call and then change the page number and update the display screen with UI for the message, contact, or ringing screen. Then in that screen, check the touch point for the button icon, touch point range, and set the function for those buttons—like hanging phone, home, main screen, calling, and other functions for the button icons. The Python code for achieving the above-mentioned actions are shown in Fig. 9 through Fig. 12.

Connection

After coding, connect the components as per the diagram shown in Fig. 13. Place the Raspberry Pi and SIM 800L module inside in the enclosure/body that has been designed. Fix the speaker and microphone against the holes made in the enclosure for them.

Fix the battery and charging unit in between the display and Raspberry Pi. Then mount the display on the enclosure with the pins matching the E-ink female header-to-header on Raspberry Pi, as shown in Fig. 14. Fix the GSM module on the slot, as shown in Fig. 15, and the phone screen on the base phone cover, as shown in Fig. 16.

Fig. 17: E-ink phone after assembly

Testing

The E-ink phone is now ready to show its magic. Insert the SIM in GSM module and run the OS code, and you are ready to use it.

Tap on on the Call icon and you get the dialing screen. Key in a phone number and touch on Call icon to make the call. Touch the Home icon to get the home screen and touch Contacts to see the contact numbers.

Next, try making a call from some other phone to your E-ink phone. When connected, the buzzer starts ringing and it takes you to the ringing screen. Here, touch the Call Attend icon to attend the call and Call Hang icon to hang up the call.

The final assembled E-ink phone is shown in Fig. 17. Enjoy! EFY

Note. This is the first version of the phone. The author keeps adding new features and improvements on *www.electronicsforu.com*

Ashwini Kumar Sinha is a technology enthusiast at EFY

EFY TESTED
S.C. Dwivedi & Sani Theo

LOW-COST AUTOMATION Using PIC16F676

PAMARTHI KANAKARAJA

There are many types of home and industrial automation systems available in the market. These include IR remote controller, Bluetooth home automation, DTMF home automation, Wi-Fi home automation, RF home automation, and voice controlled home automation. The one presented here is a low-cost automation system. It can be used at home or in an industrial environment to switch devices on and off.

IR remote controllers and receivers follow standard protocols for sending and receiving the data. Some of the standard protocols are NEC, PHILIPS RC5, JVC, and SIRC (Sony infrared remote control). We will be using the NEC protocol for this project. After understanding the frame format of IR remote, we will interface IR receiver TSOP1738 with PIC16F676 microcontroller to decode the key pressed from an NEC IR remote, as shown in Fig. 1.

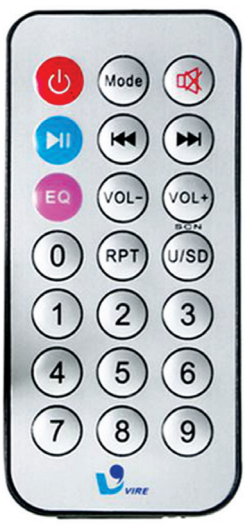


Fig. 1: VIRE NEC IR remote

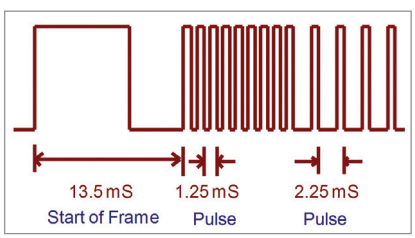


Fig. 2: Pulse distance frame

Each bit is transmitted using the pulse distance, as shown in Fig. 2. Logical '0' is a 562.5µs pulse burst followed by a 562.5µs space, with a total transmit time of 1.125ms. Logical '1' is a 562.5µs pulse burst followed by a 1.6875ms space, with a total transmit time of 2.25ms.

When a key is pressed on the remote controller, the message transmitted consists of the following in the order below:

1. A 9ms leading pulse burst (16 times the pulse burst length used for a logical data bit)
2. A 4.5ms space
3. The 8-bit address for the receiving device
4. The 8-bit logical inverse of the address
5. The 8-bit command
6. The 8-bit logical inverse of the command
7. A final 562.5µs pulse burst to signify the end of message transmission

The four bytes of data bits each are sent with least significant bit first. Fig. 3 illustrates the format of an NEC IR transmission frame for an address of 00h (00000000b) and a command of ADh (10101101b).

A total of 67.5ms is required to transmit a message frame. It needs 27ms to transmit the 16 bits of address (address + inverse) and the 16 bits of command (command + inverse).

Table 1 shows 32-bit NEC frame format and Table 2 shows the complete list of IR key codes for the NEC IR remote.

PIC16F676 controller

PIC16F676 is Microchip's 8-bit CMOS PIC microcontroller with flash memory. It comes in a 14-pin package with high-performance RISC CPU, which makes it an ideal choice for most electronic applications related to embedded systems

TABLE 1
32-BIT NEC FRAME FORMAT

Address	Compliment of Address	Command	Compliment of Command
LSB-MSB (0-7)	LSB-MSB (8-15)	LSB-MSB (16-23)	LSB-MSB (24-31)

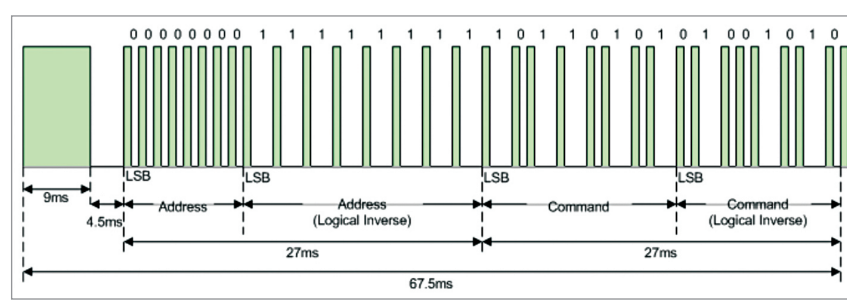


Fig. 3: Format of an NEC IR transmission frame

or industrial automation. This tiny chip incorporates everything you need to develop individual projects. Some of its features are:

• The flash memory of high-performance PIC16F676 helps in increasing the processing speed of the microcontroller.

• It comes in PDIP, SOIC, and TSOP packages, all of which are available in 14-pin configuration.

• PIC16F676 contains program memory with memory space around 1.7kB, while RAM and EEPROM memories are of 64 bytes and 128 bytes, respectively.

• One 10-bit ADC module in the device comes with eight analogue channels. This module plays a vital role for sensor interfacing and converting analogue values to digital.

• Power-on reset, comparator, in-circuit serial programming, and master clear reset are some other features incorporated in the device. These help it stay ahead of the other onboard chips and removes the need of buying external components for carrying out different operations. Pin diagram of PIC16F676 is shown in Fig. 4.

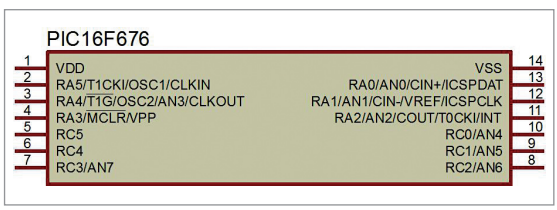


Fig. 4: Pin diagram of PIC16F676

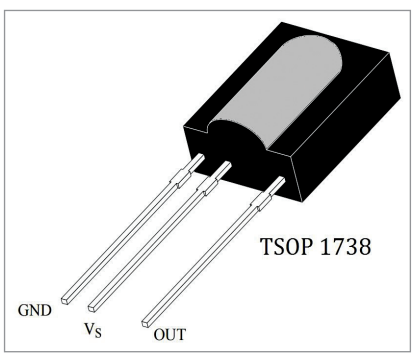


Fig. 5: TSOP 1738 IR receiver

Circuit and working

The project uses PIC16F676 microcontroller and an NEC IR remote to switch on/off any AC load, including lights and fans, from the comfort of your chair or bed. The different IR signals from the remote for the different lights and fans are received by the microcontroller, which then controls the respective relays via a relay driver circuit. These relays are used to switch the lights and fans on or off.

There are many types of IR remote controllers available for different devices, but most of them work around 38kHz frequency. This project requires an ordinary IR TV remote. For detecting the IR signals, TSOP 1738 IR receiver shown in Fig. 5 is used. It can sense the 38kHz frequency signal.

TABLE 2
NEC REMOTE LIST OF CODES

S.No.	Decimal	Hex	Key
1	33441975	1FE448B7	OFF
2	33446055	1FE458A7	MODE
3	33444215	1FE47887	MUTE
4	33446255	1FE4807F	RESUME
5	33449935	1FE440BF	PREVIOUS
6	33442575	1FE4C03F	NEXT
7	33441775	1FE420DF	EQ
8	33444415	1FE4A05F	VOL-
9	33448095	1FE4609F	VOL+
10	33440735	1FE4E01F	0
11	33447695	1FE410EF	RPT
12	33440335	1FE4906F	U/SD
13	33444015	1FE450AF	1
14	33448695	1FE4D827	2
15	33446855	1FE4F807	3
16	33445855	1FE430CF	4
17	33448495	1FE4B04F	5
18	33443615	1FE400FF	6
19	33442175	1FE4708F	7
20	33444815	1FE4F00F	8
21	33442375	1FE49867	9

The block diagram of the project is shown in Fig. 6.

In this project the digital IO pins RC0, RC1, and RC2 of Port C of PIC16F676 microcontroller are used to control the relays to switch the appliances on/off. These pins are configured as output pins in the program. The IR receiver is connected to pin RC4 of PIC16F676, which is configured as input pin in the program.

The PIC16F676 microcontroller operates at +5V. Hence, a transformer is used to step down the 230V AC mains supply, which is rectified using a full-wave rectifier. The rectified voltage is regulated to +5V by using regulator IC 7805. The complete circuit diagram is shown in Fig. 7.

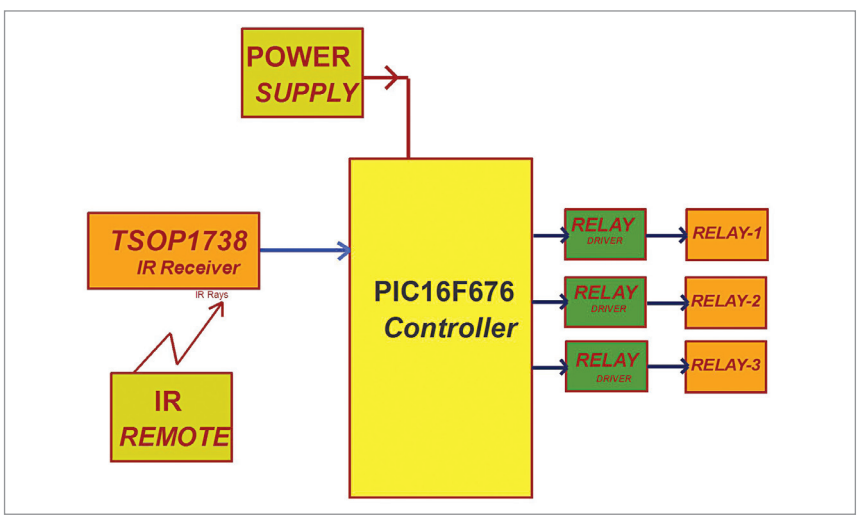


Fig. 6: Block diagram

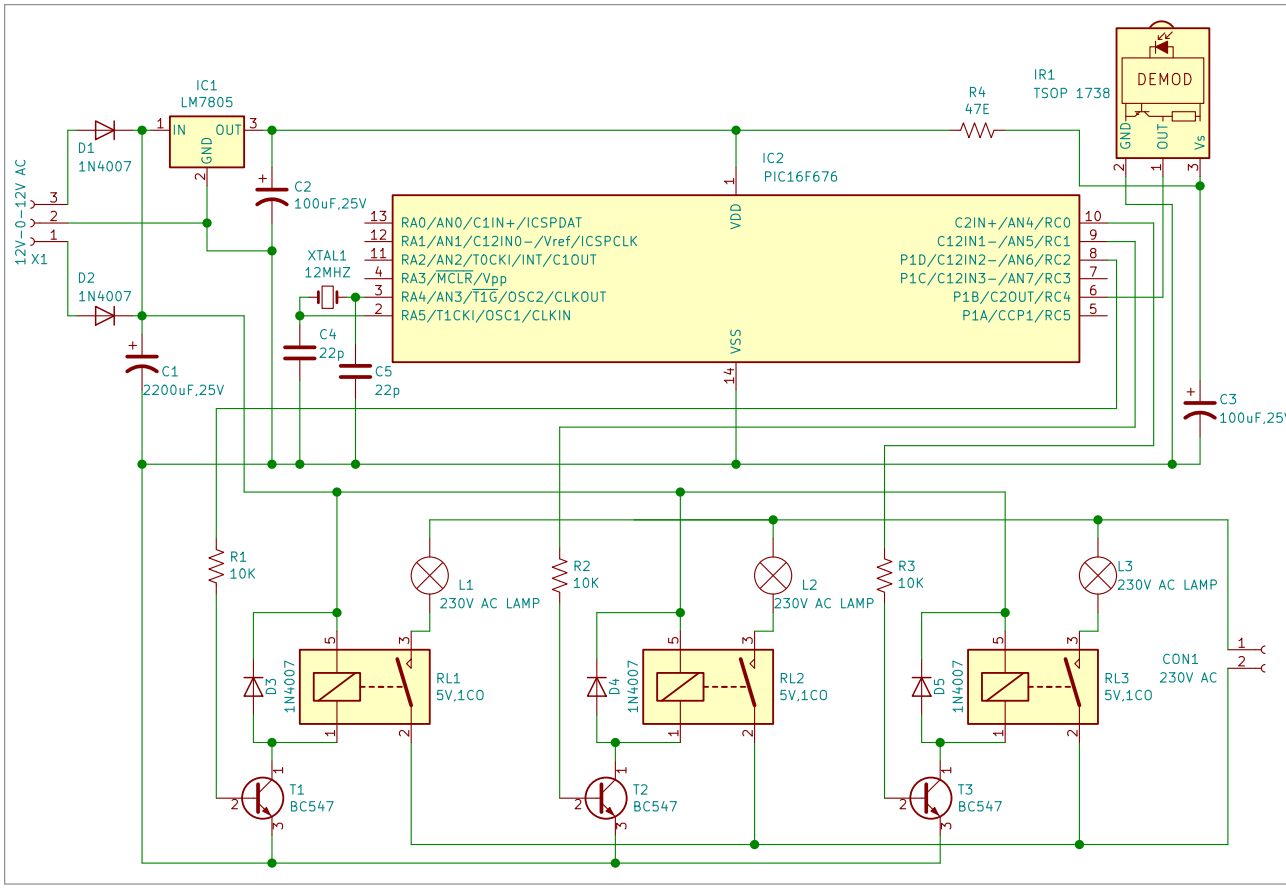


Fig. 7: Circuit diagram

The working of this project is fairly simple. When a button is pressed on the IR remote, it sends a sequence of codes in the form of encoded pulses using 38kHz modulating frequency. These pulses are received by the TSOP 1738 sensor and then read by the microcontroller. The microcontroller decodes the received train of the pulses into a hex value and compares it with the predefined hex values in the program.

Whenever a key is pressed on the IR remote, the transmitted IR signal is received by an IR receiver and the key is decoded by the software. In this project, the entire 32-bit string (4 bytes of NEC protocol) is used for decoding. In this 32-bit string, the third byte is compared in the program for controlling the lights/fans. If any match occurs, the controller performs a relative operation by triggering the respective relay through transistor BC547 and the corresponding result is indicated by an on-board LED. The three LEDs in the circuit show the status of the relays.

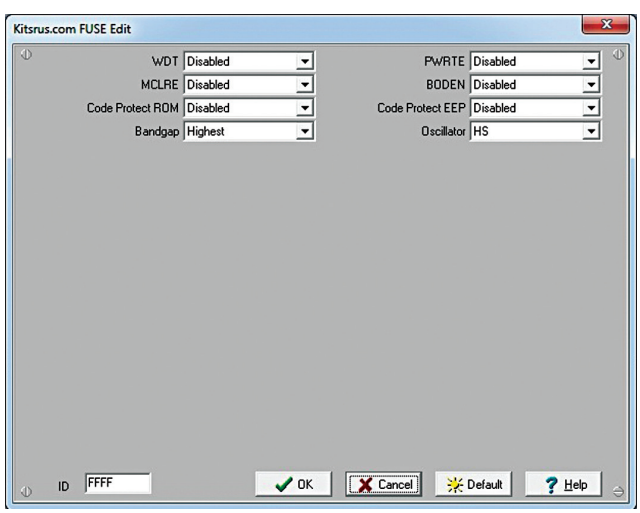


Fig. 8: Fuse bit settings

In this project, key numbers 2, 4, and 6 of the IR remote have been used for controlling the three relays. Key 2 toggles relay RL1, key 4 toggles relay RL2, and key 6 toggles relay RL3.

Software

The circuit uses the software program loaded into the internal memory of PIC16F676. The program is compiled using Mikro C PRO version 7.2.0 for PIC compiler and uploaded into PIC16F676. The software main.c is written in embedded C language, which allows writing

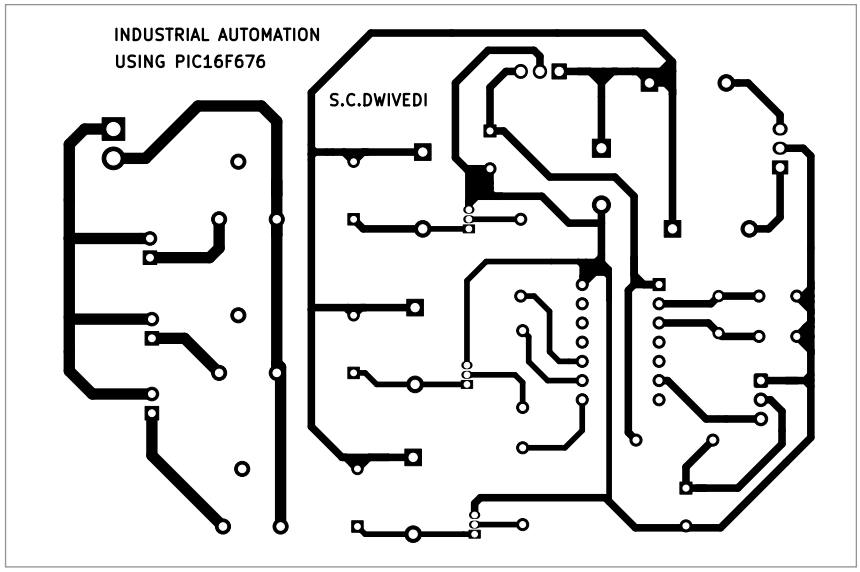


Fig. 9: Actual-size PCB layout

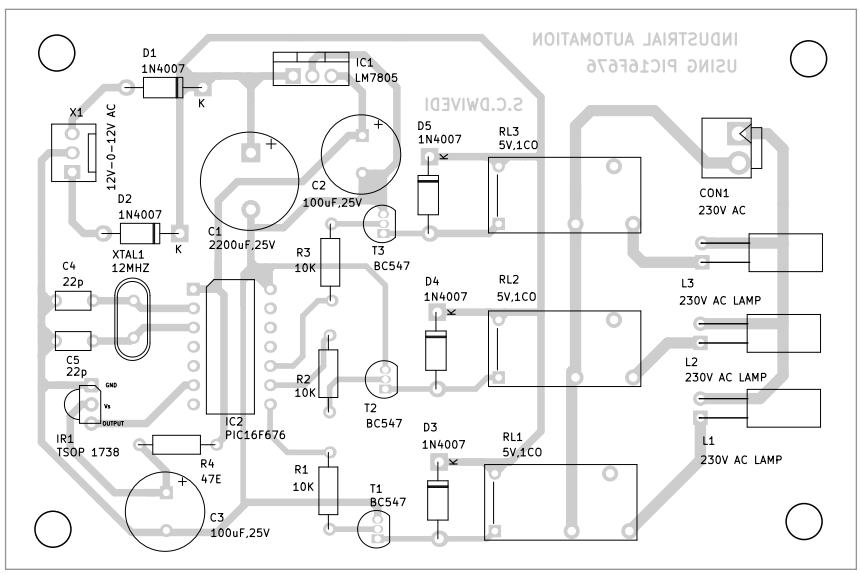


Fig. 10: Component layout of the PCB

the code within a few lines. The generated hex code is burnt into the MCU chip using PIC K150 programmer board.

No header, interrupt, or capture and compare mode is used here to detect IR signal. Digital pin RC4 reads the data, just like we read a push button. Whenever signal goes high or low, debouncing is adopted and the timer is run. Whenever the pin changes its state to another, the time values are saved in an array.

IR remote sends logic 0 as 562.5µs pulse and logic 1 as 2250µs pulse. Whenever timer detects 562.5µs pulse, the program assumes it to be 0, and when it detects 2250µs pulse, it assumes it to be 1. Then the program converts it into hex. The incoming signal from remote contains 32 bits (4 bytes).

EFY Note
The source code of this project is available for free download at *www.electronicsforu.com*

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PARTS LIST

Semiconductors:	
IC1	- 5V voltage regulator LM7805
IC2	- PIC16F676 microcontroller
T1-T3	- BC547 NPN transistor
D1-D5	- 1N4007 rectifier diode
IR1	- TSOP 1738 receiver module
Resistors (all 1/4-watt, ±5% carbon):	
R1-R3	- 10-kilo-ohm
Capacitors:	
C1	- 2200µF, 25V electrolytic
C2, C3	- 10µF, 25V electrolytic
C4, C5	- 22pF ceramic disk
Miscellaneous:	
X1	- 230V AC primary to 12V-0-12V, 1A secondary transformer
CON1	- 2-pin connector
L1-L3	- 230V AC lamp (any wattage)
RL1-RL3	- 5V, single changeover relay
	- NEC remote

Program stores all the bytes in the array and then decodes the third byte to use for comparison.

The simple programming statement 'switch' case is used to detect and control the home appliances.

Do not forget to set fuse bits before programming PIC16F676 using PIC K150 programmer. The program will not work without setting the fuse bits. The fuse bit settings are shown in Fig. 8.

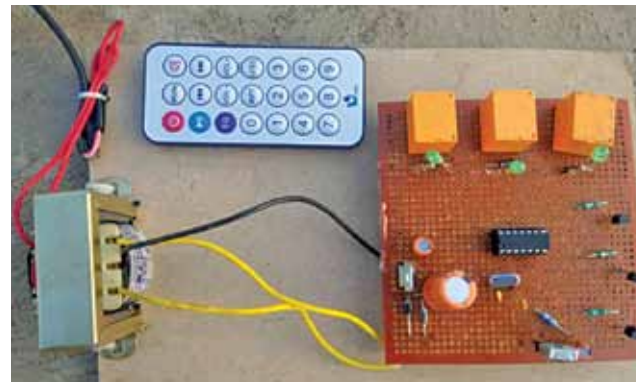

Fig. 11: Author's prototype

Construction and testing

An actual-size PCB layout for the automation system is shown in Fig. 9 and its component layout in Fig. 10. After assembling the circuit on PCB, enclose it in a suitable box. Receiver IR1 should be fixed on the front panel, so that the remote can focus on it to activate any load connected to the respective relay. CON1 should be fixed on back side of the cabinet. All the three 230V AC appliances are connected to the circuit using two wires and placed at their location. The author's prototype wired on a general-purpose PCB is shown in Fig. 11. EFY

Pamarthi Kanakaraja is an assistant professor (R&D cell) at K.L. University, Vaddeswaram, Guntur district, Andhra Pradesh

EFY TESTED S.C. Dwivedi

REMOTE CONTROLLED MP3 PLAYER With FM Radio

SANI THEO

Have you ever considered making an audio system at home? Building your own audio system can not only be fun and exciting, it can give you the same performance, if not better, at a much lesser cost. This inexpensive do-it-yourself (DIY) remote controlled MP3 player cum FM receiver with Bluetooth can be made, including its cardboard box, with easily available components and tools.

Fig. 1: Author's prototype

Fig. 2: Bluetooth MP3 player with FM receiver module

Fig. 3: Common IR remote controls

The author's prototype for the compact audio system is shown in Fig. 1. It has USB, AUX, and MicroSD/TF (TransFlash) card ports, making it very convenient to interface with external audio systems and storage devices.

Collect all the parts and tools required for the project before starting its assembly. These are listed in the two boxes for your convenience and ready reference. Significance of the parts is explained below.

Bluetooth MP3 player with FM receiver module. This is the main part of the project. The compact MP3 player module with FM receiver, shown in Fig. 2, is readily available in the market and through many e-commerce portals. It can be installed in your vehicle, desktop PC audio system, home theatre system, or any other audio amplifier.

IR remote control. The IR remote control normally comes along with the Bluetooth MP3 player module. But you can also use some other IR remote to control this MP3 audio player. The author successfully tried three different IR remote models, which are shown in Fig. 3.

Audio amplifier. You can use any audio (power) amplifier having

PARTS LIST

- Bluetooth MP3 player with FM receiver module
- IR remote control
- Audio amplifier
- 5V DC power supply or USB
- Single-strand wire as FM antenna
- 3-wire header cable for audio connection
- 2-wire header cable for power supply
- Type-A USB cable
- 3.5mm stereo audio jack with cable
- Cardboard for making cabinet

TOOLS REQUIRED

- Knife or cardboard cutter
- Scale
- Glue gun
- Scissors
- Soldering iron (25-watt)
- Pencil/pen
- Cello tape
- Screwdriver

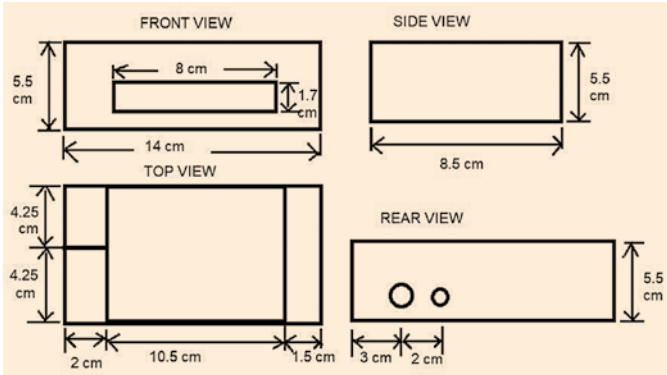

Fig. 4: Author's cabinet blueprint

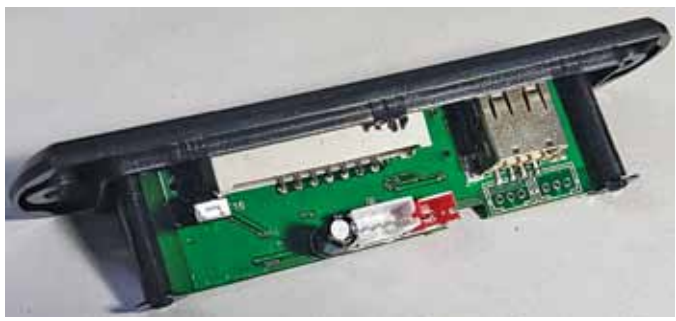

Fig. 5: Internal part of MP3 player module

Fig. 6: Antenna fixing

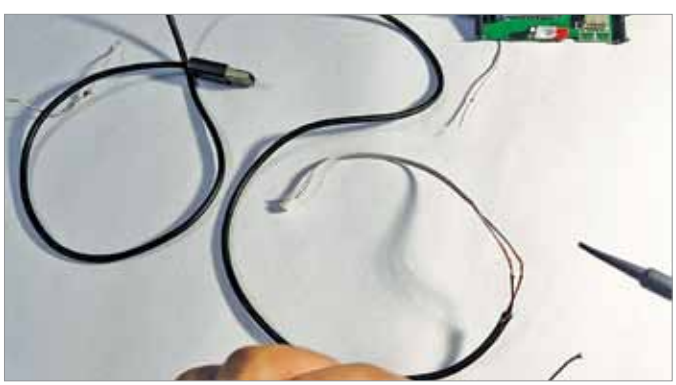

Fig. 7: Soldering the power cable to a type-A USB connector

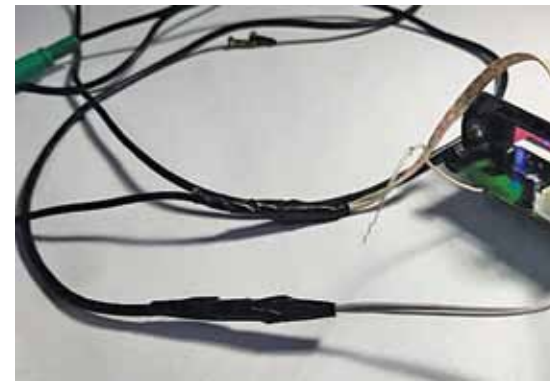

Fig. 8: Cables wrapped with cello tape

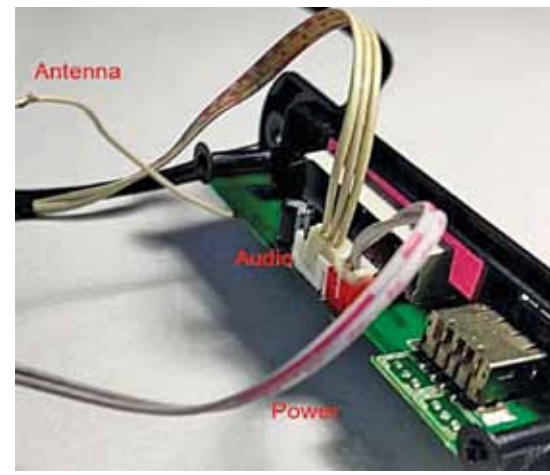

Fig. 9: Cable connections to MP3 player module

Fig. 10: Testing Bluetooth function

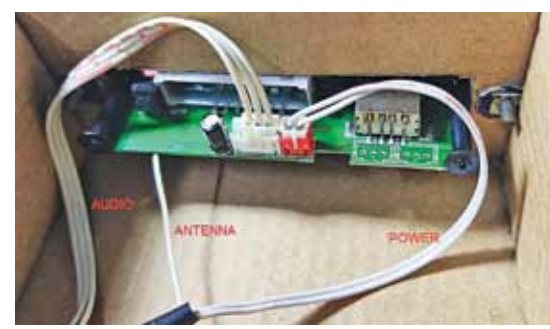

Fig. 11: Cables connected inside the cabinet

a 3.5mm audio input port.

5V DC power supply (USB). You can use a 5V, 1A or 2A mobile charger.

FM antenna. It is not very critical. As MP3 player module does not come with antenna, you can use a whip antenna or a single-strand hook-up wire as antenna.

Wires and cables. The project requires a 3-wire cable for audio connection, a 2-wire cable for power supply, and a type-A USB cable. You also need a 3.5mm stereo audio jack with cable for audio output connection to audio amplifier.

Cardboard. You can use any thick/strong cardboard having a smooth surface for making the cabinet. For a sturdy cabinet, its size should be small. Cardboard DIY cabinets in various sizes are also available on the internet.

To make your own cardboard cabinet, draw the required size for each side of the cabinet on the cardboard using a scale and pencil/pen. After cutting according to the dimensions shown in Fig. 4, place the front, rear, and sides on a cardboard of 8.5cm × 14cm size. Fix each side on the base using glue gun.

As can be seen from the top view in Fig. 4, the cabinet has four sections or parts. On the left side, there are two 4.25cm × 2cm sections, which are to be used for holding the USBs. These two sections help in keeping the USBs in vertical position, so that they can be picked up easily when needed. The middle section is for holding MP3 player and the right one is for holding the IR remote. All these can be seen in the author's prototype (Fig. 1). Next, make two holes on the rear side for connecting the audio and power cables.

Fixing MP3 player module in the cabinet. Before fixing the MP3 player module into the cabinet, look out for the antenna point and solder it to the PCB. The internal part of MP3 player module is shown in Fig. 5.

Fixing the antenna. Use a suitable length (say, 10cm) of single-strand hook-up wire as antenna. The connecting point for the antenna in the MP3 module is not clearly visible. Hole for soldering the antenna is also not provided in the PCB. However, if you look carefully at the MP3 board on the other side, you can locate the antenna point for soldering, as shown in Fig. 6. You can solder the antenna wire here using a 25W soldering iron. All soldering work should be done before fixing the MP3 module in the cabinet.

Soldering the cables. Before connecting the audio and power cables in the MP3 player module, you need to connect the audio cable to an audio

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Fig. 12: Rear side of the cabinet

jack and power cable to a USB type-A cable for external connections. Therefore, solder all the cables to respective connectors, as shown in Fig. 7 and wrap them with cello tape, as shown in Fig. 8.

Fig. 13: Multiport audio jack

Connecting the cables to MP3 player. The 3-wire cable is used for stereo audio connections, the 2-wire cable is for power supply connection, and the single-strand cable is for antenna. The inside view of the author's prototype with various cables is shown in Fig. 9.

Note that there is a 4-pin top entry header on the PCB of the MP3 module. But the module comes with a 3-pin wire for stereo audio connection. You should connect it to first three pins of the 4-pin header from right towards the 2-pin red header connector for power supply. The last pin is left unused, as shown in Fig. 9.

Fig. 14: Complete assembly of Bluetooth MP3 player and FM receiver

Before fixing the module to the cabinet, ensure everything is working properly. When you change the mode in IR remote, it should change to five modes one by one: bt (Bluetooth), USB, FM, SD, and AUX. Testing Bluetooth function in the MP3 player module is shown in Fig. 10.

Fixing MP3 player in the cabinet. Fixing the MP3 player module in the cabinet is a no-brainer. From the front side, insert the module into the 8cm × 1.7cm slot cut out in the cabinet. Fix it using nuts and bolts. Connect the cables inside the cardboard cabinet, as shown in Fig. 11.

All the cables can be extended to different points from the holes provided on the rear side of the cabinet, as shown in Fig. 12. You can connect to audio source or amplifier through a 3.5mm multiport audio jack, as shown in Fig. 13.

The complete assembly of the Bluetooth MP3 player with FM receiver is shown in Fig. 14. The MP3 player module can be powered by connecting it to a 5V DC USB power supply. Its output can be connected to an audio amplifier or amplispeaker to start listening to music. A small desktop stereo speaker system was used to test the prototype.

The MP3 player module has USB and MicroSD ports to play MP3 files. Audio from mobile phone or laptop can be listened to by connecting through Bluetooth. FM radio can also be listened to.

The MP3 player can be controlled using IR remote or control buttons provided on the front panel. It also has an AUX (auxiliary) socket, which can be plugged to a 3.5mm standard jack headphone connection. EFY

Sani Theo, technical editor at EFY, is an electronics enthusiast and circuit designer

EFY TESTED Sani Theo

SMART SOS DEVICE
That Raises Alarm And Sends Location

KAMLESH VASOYA

This project aims to develop a wearable safety and alarming device that can be operated easily, especially by children and senior citizens when in distress. It may come handy as the world is constantly witnessing increase in the number of criminal activities. Senior citizens living alone are vulnerable to panic situations due to safety reasons or, sometimes, a medical condition. This device can send an SOS call and simultaneously raise an alarm, if needed.

The device most often used for such a purpose is the SOS button. It is a discreet device that lets the user send an SOS alert to quickly communicate for help from a trusted person by using GSM, GPS, or GPRS. It is used especially for anti-aggression alarms in jewelery stores, banks, or small businesses, and for personal safety.

In this project, we aim to build a customised, cost-efficient version of the SOS button, which is stealthy and uses the best in class GSM-GPS modules along with a high-decibel buzzer. Its hardware interfacing on breadboard is shown in Fig. 1.

The components used in the project and their function is described below.

SIM800L is a miniature cellular module that allows GPRS transmission (sending and receiving), SMS, and voice calls. It is a low-cost device with small footprint and quad band frequency. The module is a perfect solution for any project that requires long-range connectivity.

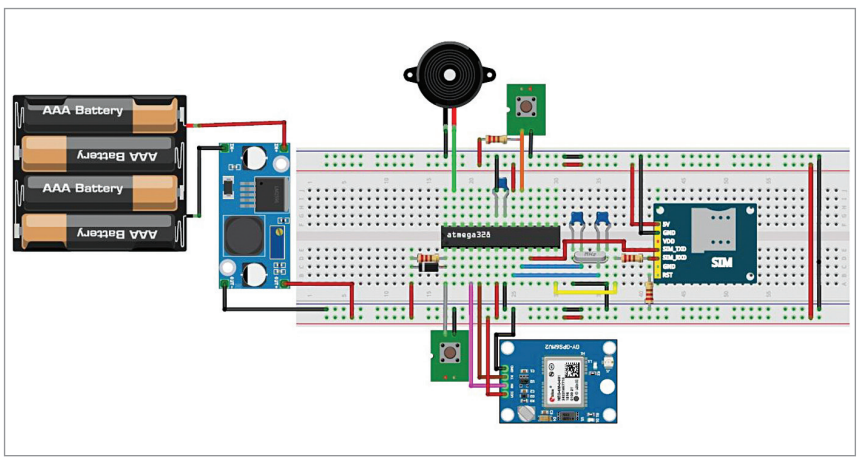

Fig. 1: Hardware interfacing on breadboard

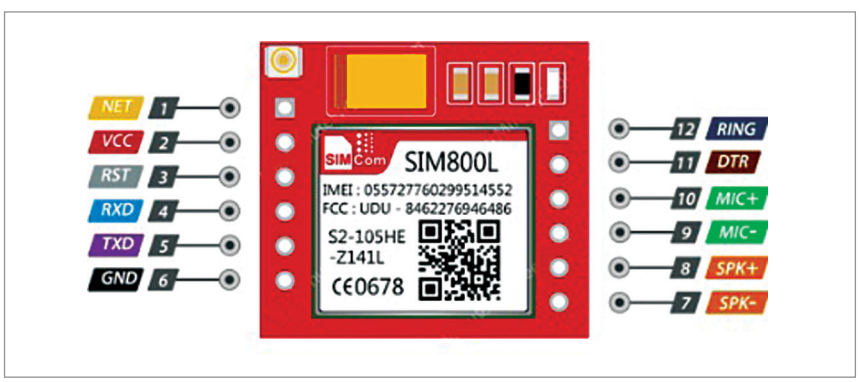

Fig. 2: Pin details of SIM800L

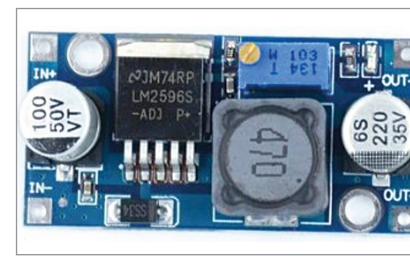

Fig. 3: Buck converter

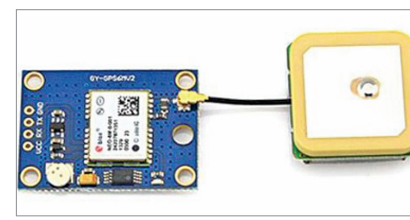

Fig. 4: Neo-6M GPS module

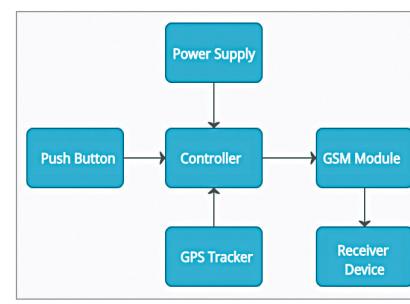

Fig. 5: Block diagram

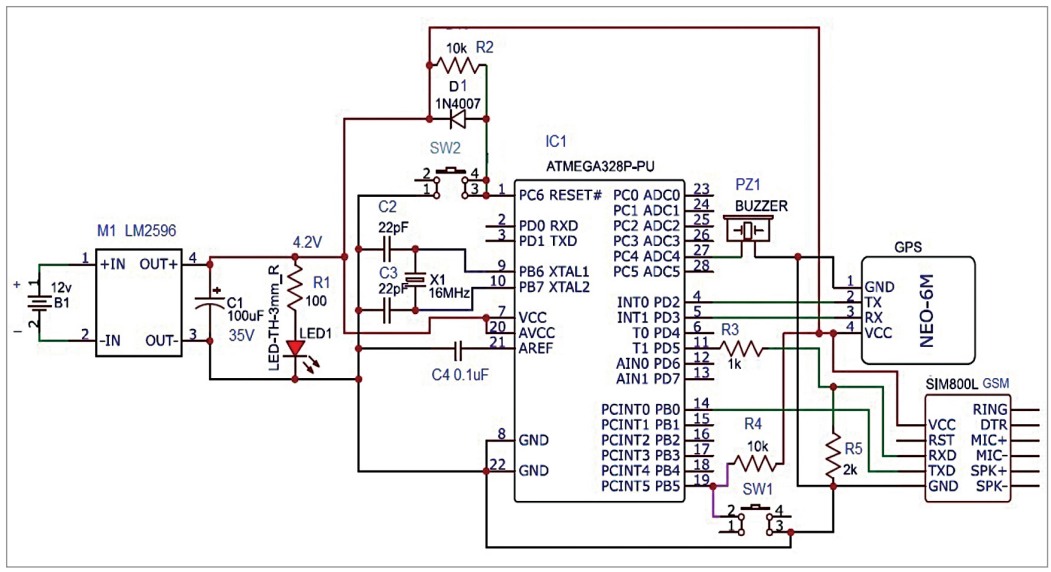

Fig. 6: Circuit diagram

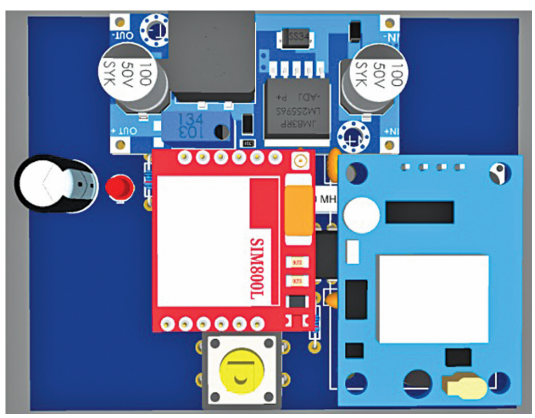

Fig. 7: A 3D view of the prototype

Pin details of SIM800L are shown in Fig. 2.

Buck converter (or step-down converter) is a DC to DC power converter, which steps down voltage (while stepping up current) from its input (supply) to its output (load). A DC-DC step-down converter basically converts a higher input voltage to a lower output voltage by 'chopping' it up by rapidly switching the output power. The buck converter module is shown in Fig. 3.

Neo-6M GPS module is a well-performing complete GPS receiver with a built-in 25x25x4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators the status of the module can be monitored. The GPS module is shown in Fig. 4.

ATmega328P is the microcontroller used in an Arduino board. After uploading the code into this microcontroller using an Arduino board, it can be plugged out and used in the breadboard prototype.

As shown in the block diagram (Fig. 5), there are also some other components like push buttons (SW1 and SW2), GPS module, GSM module, and power supply. The circuit diagram of the project is shown in Fig. 6. The microcontroller is, of course, the heart of the project.

Whenever the push button SW1 is pressed by the caller, the microcontroller gives the information about the caller, like his/her location and emergency SMS, to the registered number in GSM module. As a result, the receiver mobile receives caller's SOS message.

As shown in the circuit diagram, push button SW2 is used to reset the circuit (whenever there is something wrong in the program). LED1 is used to indicate the presence of power in the circuit. The circuit can be powered by a 4.2V supply from the converter LM2596 module.

A 3D view of the prototype generated by the software is shown in Fig. 7 and the author's prototype is shown in Fig. 8.

Software

Arduino IDE 1.8.15 is used to write, compile, and upload the code (smart_SOS_final.ino) into the Arduino board. The code requires TinyGPS++.h header file. The header file can be downloaded from *http://arduiniana.org/libraries/tinygpsplus/*

Before uploading the code, enter a valid 10-digit phone number in the code

String number = "xxxxxxxxxx"; where 'xxxxxxxxxx' is the phone number to receive the SOS message in the receiver's mobile phone.

Construction and testing

EasyEDA is a free web based EDA (electronics design automation) tool, which gives facility to design schematic diagrams as well as PCB layouts. After completing schematic diagram on EasyEDA platform, select Design→Convert schematic to PCB. Adjust all the components of the circuit in best minimum space. Then select Route→Auto route.

EasyEDA can generate 2D and 3D visualisations of the PCB. To get them, select 2D View and 3D View,

EFY Note
The source code of this project is available for free download at *www.electronicsforu.com*

PARTS LIST

Semiconductors:
IC1 - ATmega328P-PU microcontroller
M1 - LM2596 buck converter module
LED1 - 3mm LED
D1 - 1N4007 diode
GSM - SIM800L GSM module
GPS - Neo-6M GPS module

Resistors (all 1/4-watt, ±5% carbon):
R1 - 100-ohm
R2, R4 - 10-kilo-ohm
R3 - 1-kilo-ohm
R5 - 2-kilo-ohm

Capacitors:
C1 - 100µF, 35V electrolytic
C2, C3 - 22pF ceramic
C4 - 0.1µF ceramic

Miscellaneous:
X1 - 16MHz crystal oscillator
SW1, SW2 - Pushbutton switch
B1 - 12V battery or 12V DC adaptor
PZ1 - Piezo buzzer

respectively. The 3D view is shown in Fig. 7.

Assemble the circuit on a breadboard or PCB. Insert the SIM card in the slot of GSM module. When SW1 is pressed, GSM calls the mobile number already entered in the program code and the buzzer sounds. The buzzer sound is to alert nearby people.

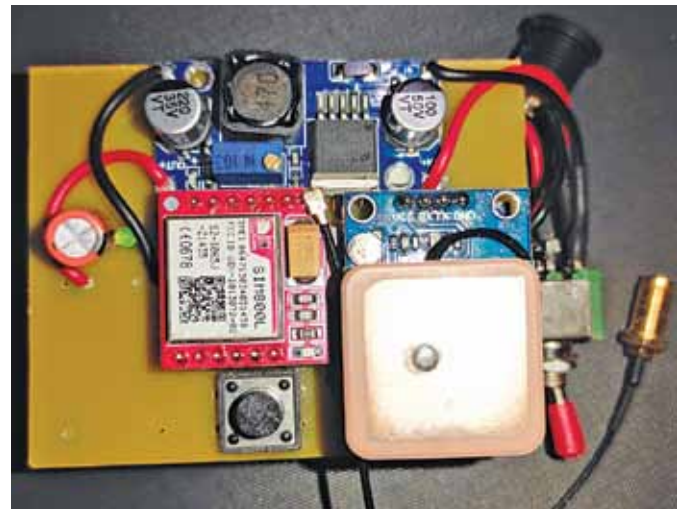

Fig. 8: Author's prototype on PCB

Once the call is established, GPS gets latitude, longitude, and altitude coordinates and thus the exact location of the caller. The link of this location is sent to the receiver's mobile phone along with the recorded SMS message. On opening the received link, the receiver gets to know the exact location of the caller on Google map. EFY

Kamlesh Vasoya is an electronics hobbyist

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THE DASHBOARD

Semiconductor Shortage Likely to Ease Significantly in H2 2022

Global semiconductor chip shortages are likely to continue easing during the second half of 2022 as demand-supply gaps decrease across most components. Across PCs and laptops, the supply gap for the most important PC components like power management ICs, Wi-Fi and I/O interface IC have narrowed. Inventory levels of 5G-related chipsets including mainstream application processors, power amplifiers, and RF transceivers have increased significantly.

Component	Shortage Level in H1 2021	Shortage Level in H2 2021	Shortage Level in 2022	Price Increase 2022 (YoY)
AP/SoC - Flagship 5G	●	●	●	Up 5-10%
AP/SoC - Mainstream 5G	●			FLAT
AP/SoC - 4G	●	● ●	● ●	Up +10%
RFIC/FEM	●	● ●		Up 5%
Memory - DRAM/MCP	●	●		Down 10-15%
Memory - Flash				Down 10%
CIS - 64MP and above			●	FLAT
CIS - 12 - 48MP	●			Up 0-5%
CIS - 2/5/8MP	● ●	●		Down 0-5%
DDIC/TDDI	● ● ● ●	● ●	●	Up 5-10%
PMIC	● ● ●	● ● ●	● ●	Up 15-20%
Packaging Substrate	●	● ●		Down 0-5%

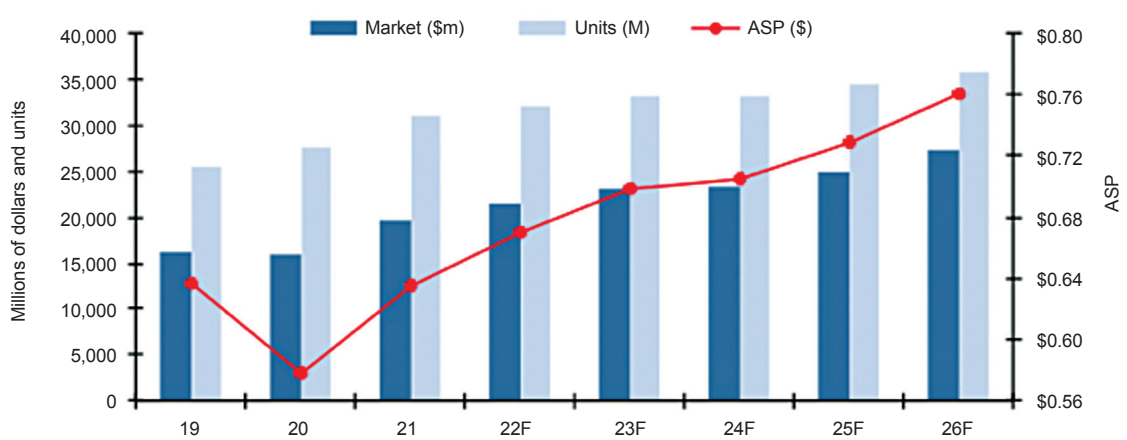
● Demand>Supply by 10%
● ● Demand>Supply by 10%-20%
● ● ● Demand>Supply by 20%-30%
● ● ● ● Demand>Supply by 30%-40%

1. Sufficient supply with price competition in 2022
2. Improving shortage to balance level in 2022
3. Slightly shortage in cetain parts in 2022
4. Remains shortage in 2022

(Source: Counterpoint Research)

Microcontroller Sales Expected to Reach $27 Billion by 2026

Microcontroller (MCU) sales boomeranged back with strong growth in the economic recovery during 2021, when the MCU market climbed 23% to a record-high $19.6 billion. Between 2021 and 2026, total MCU sales are projected to increase by CAGR of 6.7% and reach $27.2 billion in the final year of the forecast. In the next five years, sales of 32-bit MCUs are expected to grow by a CAGR of 9.4% to hit $20.0 billion in 2026.

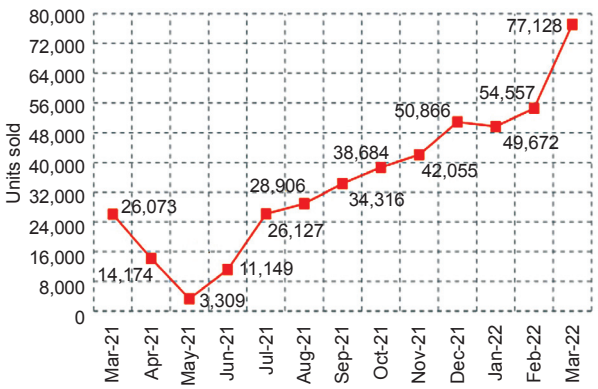


(Source: www.icinsights.com)

At-a-glance view of key industry trends that can shape the future of your business…

India's EV Sales Continue to Grow

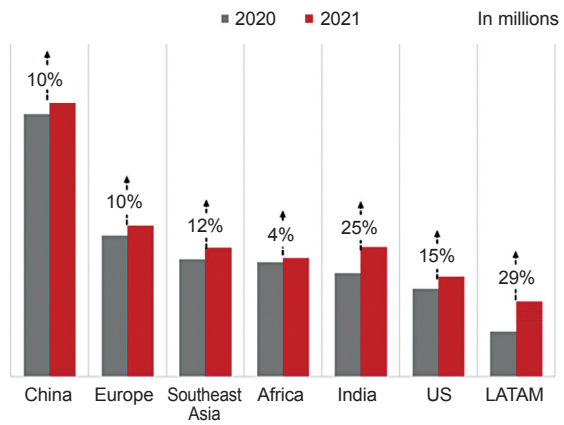
The overall EV sales in India for the month of March 2022 bounced back to its growth trajectory, clocking 77,128 units. This signifies a m-o-m rise of 41.4% and a y-o-y jump of 196%. EV registrations in March 2022 were driven by electric two-wheelers and passenger-type electric three-wheelers, which together accounted for 91.17% of total registrations in the month. The shares of these categories were followed by e-cars (4.62%), cargo-type electric three-wheelers (4.08%), and so on.



(Source: https://jmkresearch.com)

Refurbished Smartphone Market Shows Strong Growth In India In 2021

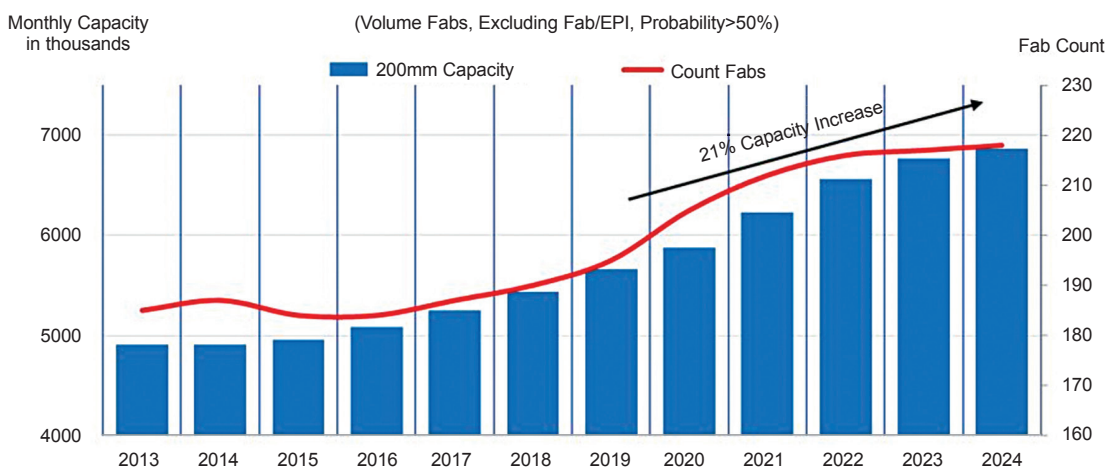
The global secondary smartphone market saw a surge in demand as well as supply in 2021. Even as new smartphone shipments grew 4.5% YoY in 2021, refurbished smartphone volumes witnessed a 15% YoY growth. Latin America and India lead with the highest growth rates, at 29% and 25% respectively. Apple remains the secondary smartphone market leader.



(Source: Counterpoint Research)

200mm Semiconductor Fab Capacity Set to Surge 21% to Mitigate Supply-Demand Imbalance

Semiconductor manufacturers worldwide are on track to boost 200mm fab capacity by 1.2 million wafers, or 21%, from the start of 2020 to the end of 2024, to hit a record high of 6.9 million wafers per month. After climbing to $5.3 billion last year, 200mm fab equipment spending is expected to be $4.9 billion in 2022 as 200mm fab utilisation remains at high levels and the global semiconductor industry works to overcome the chip shortage. Equipment investments are projected to remain above $3 billion in 2023, with the foundry sector accounting for 54%, followed by discrete/power at 20%, and analogue at 19%.



(Source: www.semi.org)

Beyond The 4Ps OF INNOVATION

If you were offered a carbonated drink in a glass, what are the chances that you could easily identify whether it was Coca Cola or Pepsi? Would you even care? Well, hold on to that thought as we talk about several types of innovations first

ANAND TAMBOLI
is a serial entrepreneur, speaker, award-winning author, and an emerging-technology thought leader

People have been talking about the 4Ps of innovation for quite some time. While these lenses have served well in the past, they are becoming outdated now. With the level of chaos that is going on around the world, I would say they are ripe for an update. But before we discuss the update, let us recap what those 4Ps are.

Product or service

The first P in the list of 4Ps is your product or service; the thing that you offer to your customers. So, when someone says innovate your product or service, they want you to create and introduce a new product or service to your customers. Sometimes, it does not have to be a completely new thing as an improved version of previous products or services qualifies. The caveat is, of course, there must be some enhancement in quality or overall performance. There must be some material change.

This type of innovation is mostly driven by technological advancements, outdated product designs, changes in customer requirements, competition, etc. What is peculiar about this type of innovation is that it is clearly visible to customers. Mostly because they are the direct receivers of it.

Process

The second P in 4Ps is the process. It is all about how you create and deliver your product or service. This may include changes in the equipment and technology used in making the product. In addition, there might be an improvement in tools, techniques, and solutions used to help in making and delivering the product or service. It also includes processes you use to maintain your goods, accounting methods, customer service, etc.

This change may not always be visible to customers, and they may not even realise it sometimes. But from a business's point of view, process innovation often leads to bottom-line impact.

Position

Third P is about product positioning in the market. It is about who do you offer your product or service to. It is about the story you tell about your product or brand. This helps create a unique position in customers' minds and the market.

Most of the time, positioning-related innovation is geography or demography-specific. Customers do not easily recognise this innovation as it may not happen directly. However, if the existing customers are part of the same geography or demographics where you reposition your product or service, they can easily recognise it. The outcomes usually affect the business's top-line, expanding the market, and hence the sales base.

Paradigm

The last one in 4Ps is paradigm innovation. It is quite complicated compared to the other three. And that is because this innovation is about the business's mental model, that is, how your business thinks about why you do what you do and for whom. You can also call it a high-level business model.

It is the hardest to handle because it expresses your understanding, which you want your customers to appreciate. Nonetheless, many companies use it during their brand revival efforts.

Now back to my main argument regarding the significant update to this 4P based thinking. A lot has changed in the last few years, especially in the last two years. And as the change percolates through various aspects of society, it will affect businesses and how they approach innovation in their business.

We often insist on data to make informed decisions. But this is a data abundance economy. Everyone has enough data to prove their point.

It is not about right or wrong data. Every data has some perspective. This puts every business in a strange fix. It compels us to look beyond data, which can be more powerful and useful.

SO, THE PRODUCT, PROCESS, PARADIGM, OR POSITIONING INNOVATIONS ARE NOT HELPFUL. THIS IS THE NEW WORLD. THE 4Ps OF INNOVATION HAVE SERVED WELL IN THE PAST. BUT NOW, THEY ALONE ARE NOT ENOUGH. WE NEED TO UPDATE OUR PERSPECTIVE AND THINK BEYOND THE 4Ps OF INNOVATION.

How can it be done? Let me show you an example to prove my point.

At the beginning of this article, I asked you to think about carbonated drinks and your choice. People were clearly divided between Coca Cola and Pepsi until the last few years. They still are. Both brands have tried their hands at all the 4Ps of innovation successfully. But now, if you combine their 4Ps with available data and look at the bigger picture through a different lens, it will change your perspective significantly.

Allow me to share some data. And this data is coming from a Harvard study. It is called impact weighted accounts initiatives (IWAI). Using sample data and findings from that study, here is how these two brands stack up.

Coca Cola's net revenue during 2018 was approximately $31.8 billion. But to generate this revenue, its total environmental impact cost was about $3.7 billion. We are talking about many things, such as plastic waste produced, drinkable water consumed, drinkable water wasted, etc. And that means, if they were to pay for all the environmental costs, according to Harvard, their real profits would be about -11.6%, a loss!

What about Pepsi? Pepsi's net revenue during 2018 was about $64.7 billion, about twice as much. Pepsi's environmental impact cost was about $1.8 billion to generate this revenue. And it means, if Pepsi were to pay for all the environmental costs, their profits would be down to about -3%, also a loss. And remember, we are talking about a like to like comparison here.

The bottom line is, Coca Cola is four times 'dirtier' than Pepsi. Does that change your preferences? What do you think about it now? Do you see a point favouring one over the other?

I do not see why I would choose one over the other. For me, both do not fit my personal brand promise. Both are not aligned with what I am about as a person. And it is not just about these two brands of carbonated drinks, but also about all the others. They all affect the ecosystem similarly, some more, some less.

So, the product, process, paradigm, or positioning innovations are not helpful. This is the new world. The 4Ps of innovation have served well in the past. But now, they alone are not enough. We need to update our perspective and think beyond the 4Ps of innovation.

What do you think? EFY

PICK AND PLACE MACHINE
Selection Made Easy

If you are planning to purchase a new pick and place machine for your manufacturing unit, here are a few insights from experts that could help you select the best machine for your specific requirement

ABBINAYA KUZHANTHAIVEL

A pick and place (PnP) machine makes use of comprehensive mechanisms to mount small electronic components and SMDs, such as capacitors, resistors, and ICs, onto a printed circuit board (PCB). It ensures that the small components are picked up carefully and placed accurately onto the PCB. The machine can be manual requiring placement by hand, semi-automatic with software assistance for placing, or automatic for typical mass manufacturing units with in-line facilities. Combined with their respective strengths, here are a few parameters to consider before investing in the machine.

The PnP machines have considerably improved recently to achieve speed with accuracy, and flexibility. However, standard requirements for specific parameters, like accuracy rate, component sizes, and board sizes, have not changed much. The future of SMT production is anything but predictable according to experts. With rapidly changing build schedules, there is a proliferation of new materials and advanced components to locate, load, mount, and trace. As these high-mix challenges go mainstream and mid-volume, real productivity and throughput suffer. Several equipment manufacturing firms are trying to solve precisely these challenges.

Yamaha Motor's Z:TA-R YSM40R (Credit: https://global.yamaha-motor.com)

Let us have a look at some of the features and the challenges so that you can select the most appropriate machine for your production house.

Machine construction. When selecting a PnP machine, the most important factor is its construction. It determines the machine's effective components per hour (CPH) number, footprint, and the number of component feeders it can accommodate. The construction may either be all-welded steel or a bolted-together frame.

The most accurate machine may come with a welded structure to provide significant stability for accurate positioning and high-speed movement in X and Y axes. This suits any production environment without need for calibration. Apart from this, careful selection of centering methods and component positioning systems can support optimisation.

Placement speed. CPH is the measure at which the machine will pick up and place components onto the PCB. The speed measured in CPH will have a direct impact on production volume. Many PnP machine manufacturers rate their machines based on the IPC 9850 standard, a general guide for part mix and PCB placement arrays of their machines. It helps determine the throughput after accounting for feeder changes, transfer

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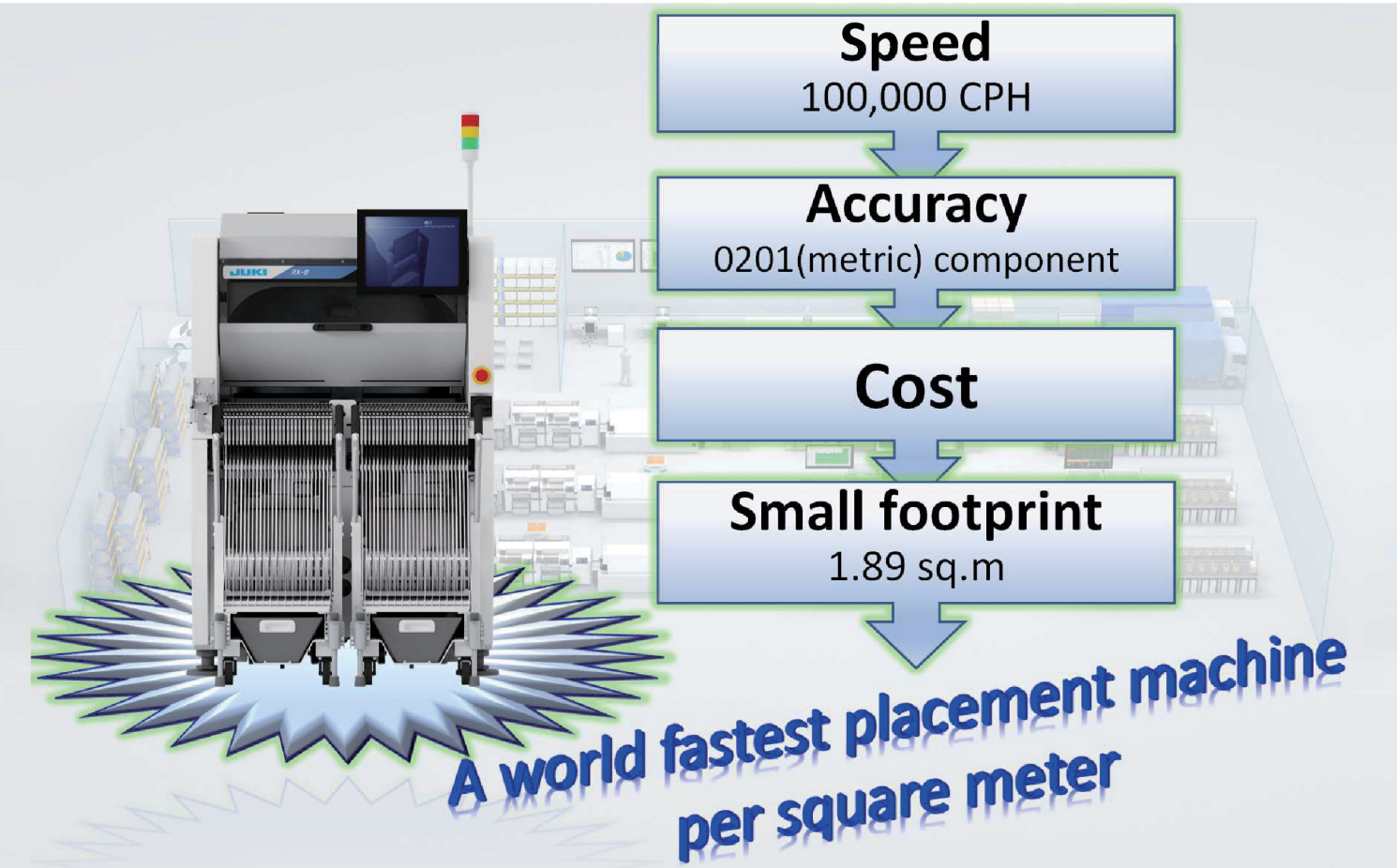

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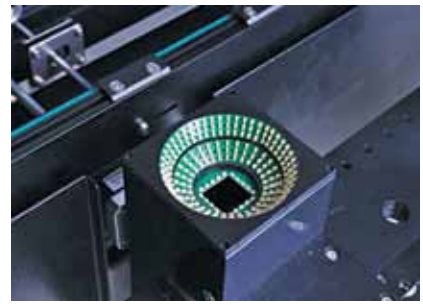
Juki Corp's RX-8 (Credit: https://www.juki.co.jp)

time, and other adjustments along the entire assembly process.

The industry is working towards faster machines every year to match the increased speed demand. Yamaha Motor's ultra-high-speed modular Z:TA-R YSM40R is one of the recent launches claiming to offer 200,000 CPH. The speed is said to be achieved by edge technology, including innovative high-speed rotary heads and linear motors incorporating new, high-speed algorithms, with the machine width of just one metre.

Juki Corp's RX-8 is another recent launch that claims to have the highest placement rate per square metre with CPH up to 100,000. It is compact and modular, featuring 998mm width. The new P20 placement head, designed for placing ultra-small chips and small integrated circuits (ICs), is credited for high-speed picking and placing from the single reel.

Intelligent camera systems. A camera system with high resolution improves the overall speed of the machine. New machines focus on their camera systems, like the one in the Neoden 8 PnP machine. It comes with the HR Flyvision camera



Vision system inside Neoden 8 PnP machine (Credit: https://neodenusa.com)

system for component recognition and Double Mark cameras to reach the extreme end feeders for better calibration.

Component handling. The PnP machines handle the minimum and maximum component dimensions according to the production needs for chip-scale package (CSP), ball-grid array (BGA), and other odd parts. The machines need various alignment methods to handle such a range of components, say, from minimum sizes of 0402, 0201, or 01005. Tiny components smaller than 0402 may require additional nozzles. The machines with single alignment give more precision and speed. An alternative alignment system can handle large component sizes.

However, one should remember, not all machines that can handle large components can also inspect them. Hence, most of the new launches with the latest vision system and software can take on everything from 01005-size flip chips and CSPs to large quad flat packages (QFPs) and ball grid arrays (BGAs). Even tall, odd-shaped and through-hole components can be mounted with ease.

For instance, ASM Assembly Systems has a complete solution from component pickup, image recognition to placement of odd-shaped components. Its Siplace TX models are said to work with up to 48,000 CPH with minimum 0201 (metric) and maximum component size of 8.2mm × 8.2mm × 4mm.

Number of pick up heads. A PnP machine has single or multi-heads to grab different shapes and heavy parts. Equipped with a number of nozzles to grasp the components, the head is movable in different directions simultaneously to ensure high productivity and flexibility.

For instance, the Yamaha YRM20 comes with a rotary RM head that is claimed to achieve 115,000 CPH. It features a one-head solution that can carry components of odd shapes and eliminates the need for head replacements, thus improving the component feed speed.

Similarly, the Neoden 8 model has eight synchronised nozzle heads to give repeatable placement accuracy.

Smart feeders. Recent machines focus also on the feeder capacity.

ASM Assembly Systems machine (Credit: www.asm-smt-tools.com)

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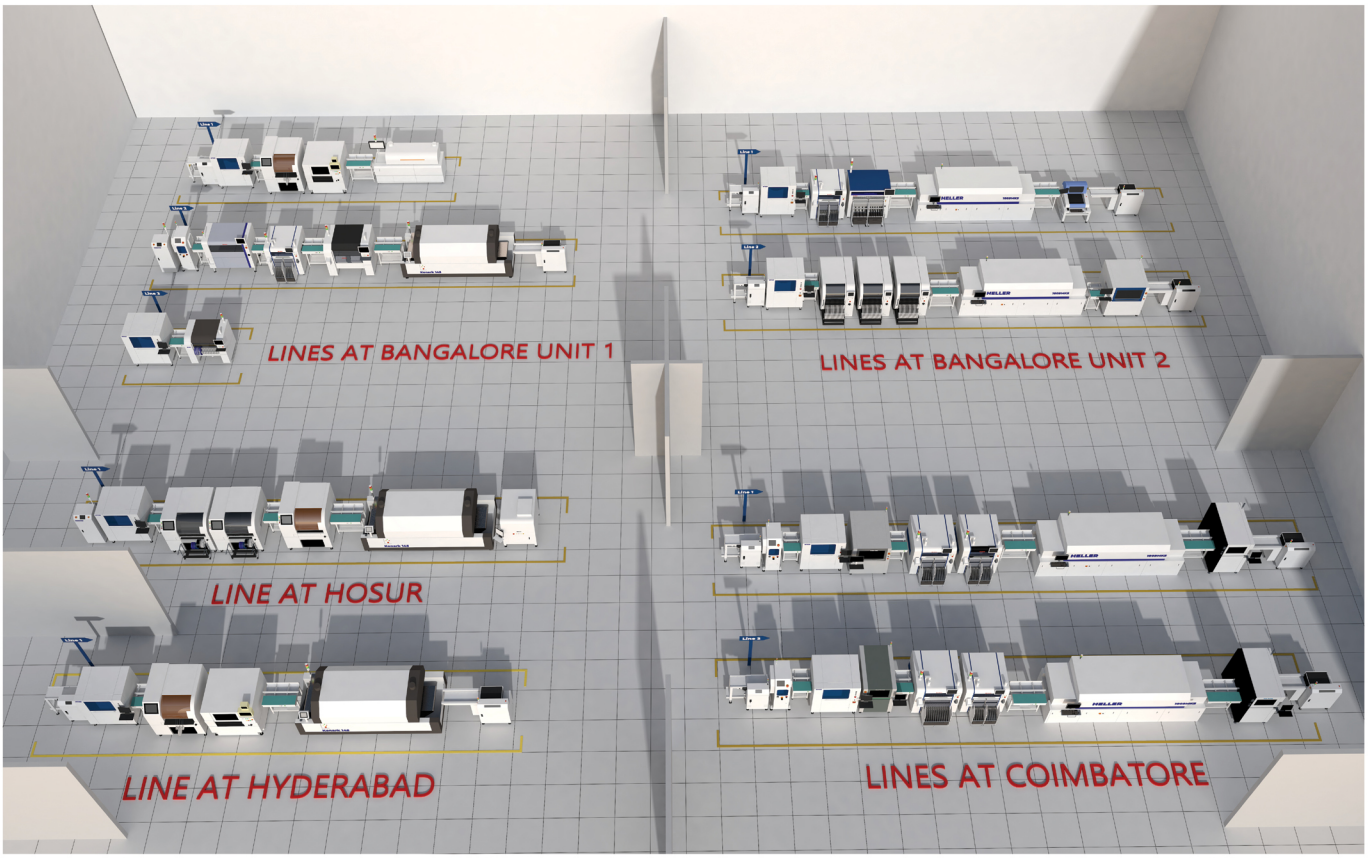

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Yamaha YRM20 (Credit: https://global.yamaha-motor.com)

The larger components may require larger feeders. So, it is advisable to figure out the number of slots needed for larger tape feeder types, say, from 4mm to 56mm.

Mycronic MY300 has an 'intelligent feeder' solution that is claimed to take less than ten seconds of loading time. Agilis tape and stick feeders and tray handling systems in the machine are said to handle a wide range of components to meet the needs of today's SMT manufacturing grounds. The compact 4, 8, 12, and 16mm Agilis tape feeders come with an innovative cover-tape separator on the pen-sized feeder that exposes components for easy picking. The feeders provide quantity and location tracking, operator guidance, simplified data entry, moisture sensitive device (MSD) handling, and on-the-fly changeovers. Fully operator-independent, it ensures higher productivity in a smaller footprint. Its product set-up time is another important feature for quick processing.

With the SMT measuring feeder feature in place, there is no need to measure materials manually, which improves the efficiency and avoids the occurrence of material error. The recent machines feature component verification before placement to ensure the right component is placed at the right location and comes with RCDT (resistor, capacitor, diode, and transistor) measurement tools. Neoden 8 features pneumatic feeders.

Component lead pitch. Industry experts consider 0.012 fine pitch as an unsaid thumb rule for selecting PnP machines. The component lead pitch is the distance between the centres of the leads. However, experts warn buyers to not be moved by motor specifications or accuracy as even machines with great motor accuracy may not pick up, inspect, and place fine-pitch components.

Smart bin system. The most common reason for unplanned downtime in high-mix electronics manufacturing is missing material. A smart bin system helps machine operators minimise downtime by ensuring that all needed material is collected and prepared just-in-time for production. Building on other powerful material handling solutions, the system brings ease-of-use to the kitting and changeover process. The end result is faster changeovers and higher utilisation.

Next-generation precision. The latest pick-and-place solutions combine rigid machine frame, advanced mount head technology, and automatic thermal adaption for the highest levels of precision. The MY300 adds an improved line scan vision system to take this accuracy into the next generation. It combines three programmable light sources with either 2K or 4K resolution to ensure a future-proof solution for the most advanced components down to 0.15mm pitch. Both options provide extremely precise on-the-fly positioning and inspection for any type of miniaturised or specialised component

Accuracy and repeatability. Experts' candid recommendation regarding accuracy for PnP machines is 0.00254mm (0.0001-inch) with a fine pitch lead of 12mil repeatedly. Though such high accuracy is commonly characterised for high-budget machines, one can always find a used PnP machine to attain such results. Besides, remember to buy a machine that comes with software suites to handle the process.

Featuring a single turret head

Eight synchronised nozzle heads of Neoden 8

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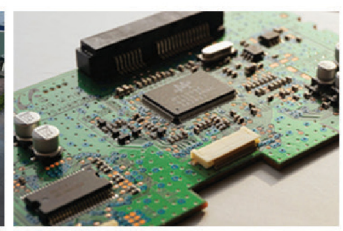

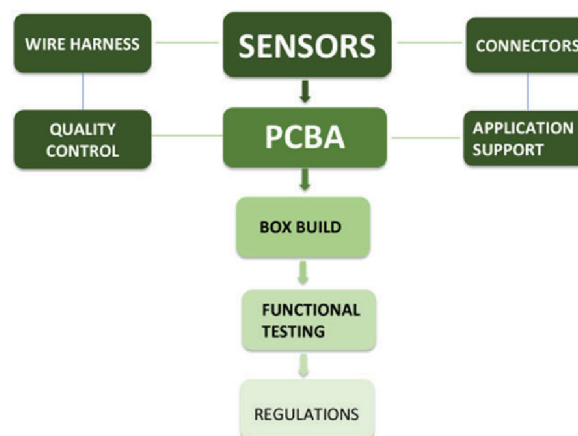

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with eight or twelve nozzles, Europlacer's ii A1 model is said to deliver flexibility in handling a broad range of components with 164 feeder positions and two internal matrix trays, all in a compact footprint. It also features the firm's patented intelligent conveyor with board stops under full software control.

Software suite. If you are considering purchasing automatic machines, how are they programmed and what are the software used should be answered. The software has three primary goals of easy use, flexibility, and optimising performance.

Whatever, remember to check if your model comes with a computer or just the software. This can neither be good nor bad as some users prefer to install the software on their own PCs. A fully integrated system is the best choice to avoid software compatibility issues, however.

Also check if the machine runs on a familiar graphical user interface (GUI), such as Windows, or a proprietary system. Most operators prefer a standard GUI since a proprietary GUI may require a longer learning curve. CAD download, teaching camera, barcode readers, management information system (MIS), and optimisation functions and off-line programming can all make the operator's job easy and efficient. Hence, a strong software suite is important to make the process easy and traceable.

Mycronic MY300 (Credit: www.mycronic.com/en)

For instance, DDM Novastar adds a unique programming software—SMTrue Run Optimise—to the full-scale SMT assembly services it offers. The software is used for making offline programming of automatic SMT machines to derive increased efficiency and throughput.

ASM Assembly System also has IIoT interfaces for integration into line and factory systems (ASM OIB, IPC-Hermes 9852, IPC-CFX) and the cloud (ADAMOS) with advanced workflow solutions for setup processes, material management, factory monitoring, and factory integration.

The new machines are also using a lot of open source software. OpenPnP is an open source SMT pick and place system that includes ready-to-run software and hardware designs that you can build and modify. Index PnP is an open source pick-and-place machine that is among the recent launches designed for mass-production volumes typical of crowdfunding projects.

Europlacer's ii A1 model (Credit: https://europlacer.com)

Other important considerations

Populating more boards and machines that are fit for any intelligent factory, complete with fully automated material flow, faster changeovers and open interface software is the real pursuit of the industry. There is no limit to the minutiae of pick-and-place machine specifications. You may have to select the features as per your needs.

Unlike the rapid placers, precision placers often do not use mounted nozzles. They may rely on gantry-supported moving heads with relatively few pickup nozzles. While the conventional four-head vertical heads were only available in table-top machines, now they have evolved into automated machines.

Some machines may have to optionally be fitted with a dispense head for depositing adhesive on the board. If you require this feature, consider the dispense method, dot size, and dispense speed.

Maximum and minimum PCB or panel size and thickness can be critical requirements for some manufacturers. Fiducial recognition, coordinate correction, and bad mark detection should be standard for any automatic PnP machine.

New machines have a 3D stereo measurement feature for the through-hole device that easily identifies the image of the vertical pin and height of the component lead to detect bending deformation. This tells whether the through-hole components are placed accurately to ensure the correct height after placement, and thus reduces the need for operator's visual inspection. Simi-

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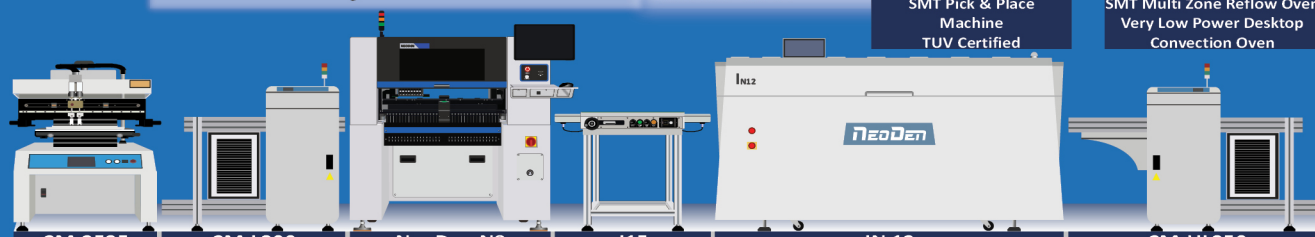

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larly, pattern feature recognition is another aspect intended for special components to recognise irregular placements and ensure accuracy.

Experts also try to find the best acceleration. In many cases, the acceleration of large components is set manually. Recent upgraded machines can automatically detect and accelerate to ensure the quality of placement and maximise the utilisation of equipment.

The next idea catching up is of PCB placement inspection. Before valuable components, such as BGAs and land-grid array (LGAs), are placed, interfering object detection is carried out in the placement area below these components. The foreign material/parts in excess are found in time to avoid placement defects. This can check whether there are any missing components under the shields before they are placed, which may play a good protective role in improving product quality.

The automotive electronics industry is expected to increase the demand for SMT continuously. Considering that automotive products have higher requirements for personal safety, service life, and outdoor use conditions, the reliability and durability needs of automotive electronic products are higher than those of others.

New PnP machines feature technologies like auto-cut sensor and advanced sensor technologies. Auto-cut sensor technology is a human safety feature that temporarily stops the process to avoid serious hazards or machine damage on human intervention. Advanced sensor technology helps a specific set of sensors, like in-sensor, out-sensor, and waiting sensor, in tracking the PCB at every stage in the production process.

Index PnP (Credit: https://github.com/index-machines/index)

Auto-optimisation is another feature to consider as it can suggest feeder and nozzle measurements. There is also a feature called regular automatic detection for nozzles. The closed-loop control of the nozzle ensures that the nozzles on the placement head are always in a normal clean condition, and the contaminated and damaged nozzles are automatically replaced in time.

Choosing the best

The latest generation of the placement machines sets new records in speed, floorspace performance, and accuracy for high-volume production applications. Smart factory solutions are fast becoming a trend in the electronics manufacturing industry to cut down on costs and improve efficiency of production.

However, buyers should pay attention to performance and usability in relevance to their manufacturing needs. Machines are available in various price ranges with a wide range of customer support and maintenance. Keeping in mind the investment on machine is vital to avoid spending a fortune on costly outsourced machines.

While the classic PnP vision systems are difficult to work in areas requiring production tolerances and deviations, Schubert Group—a company developing modular packaging machines—suggests its neuronal networks based on artificial intelligence could be a solution of the future. "The image processing system therefore learns on its own and sorts the products into classes independently in a longer learning process. This means that the parameters are selected by the system and no longer by the programmer. For customers, this means a significant step towards independence—In the future, they could actually use neuronal networks, under certain conditions, to teach their packaging machine to handle a new product on its own," writes Dr Abdelmalek Nasraoui on the company website. EFY

The article has been compiled with key inputs from:

- Jae Won, ASMPT Solutions
- Priyesh S, Chipmax Designs Private Ltd
- Mohamed Tharik Ajee, Enthutech
- Arvind Gopal Joshi, Accurex Solutions
- Suresh Nair, Leaptech Corporation

Abbinaya Kuzhanthaivel is a technophile at EFY with interest to write on electronics, communication networks and open source

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INDIA SEMICONDUCTOR MISSION: India Needs To Do Enough To Sit On The World Table

The government's strong foot forward with regards to the semiconductor space was a much-needed move and, although late, it is expected to herald the golden era of the electronics industry of the country

SIDDHA DHAR

Even kids today are aware that there are things called semiconductors and chips. Some of them even know where these are used thanks to the semiconductor shortage that has been rattling the world since the onset of the Covid-19 pandemic.

But in India, this awareness is not just an outcome of the global chip crisis. The government of India's recent endeavors to make the country self-reliant in the areas of chip manufacturing has a greater part to play in beginning a conversation around hardware manufacturing in every other household, something very few in the country cared about before.

The government has come up with an ambitious ₹760 billion incentive to build the semiconductor industry of the country. Although the roots of it lie in reducing its dependence on China, the move has been long awaited by the industry, and thus, highly lauded. Better late than never, right? However, no matter how ambitious the plan, the industry which has been neglected for the longest time now needs to buckle up and get a few things straightened out before it can dive headlong into the game.

"I think we always talk about three aspects: economic security, cybersecurity, and infrastructure security. The infrastructure in particular needs to be built. It is high time because otherwise we will be in trouble in the future. You need to have a seat on the table," says Dr Satya Gupta, President, VLSI Society of India.

Building the ecosystem: There's more than what meets the eye

"I think that if there is any nation that can emerge as a superpower in chip design, along with China, India has to be there," notes Dr Naveed Sherwani, CEO, Rapid-Silicon. The road to the zenith, however, is a long and risky one, something Indian businesses are yet to be ready for. In our bid to achieve self-reliance, big corporations are

necessary to give our mission the momentum, but the ultimate goal must be reached by homegrown chip companies.

It is a widely known fact that making chips is a precarious business, which needs steep investment. It becomes even more tedious when a new startup wants to enter the space thanks to the high cost of entry. "The first challenge these startups face is the cost of EDA tools which are prohibitively expensive. Almost 25% of the total cost of the entire design chain is attributed to the cost of the EDA tools," says Vivek Khaneja, Executive Director, C-DAC.

And although this is being addressed to some extent by open source tools and open domain companies, which help provide easier access to EDA tools and IPs, the truth is that their standard offering is beyond the reach of a small startup.

Availability of IPs is another major obstacle that prevents chip startups from moving forward. When you are trying to solve a problem, you will create a solution that has some sort of programmability and peripheral IPs. Getting hold of those IPs, which are silicon proven today, is not easy and, most importantly, it is not cheap.

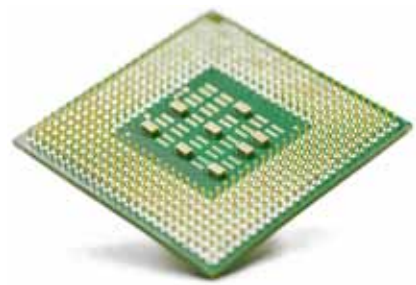
Open source IPs have made life easier but only on the surface. At the crux of it, the quality of such IPs may be subpar and integrating those IPs in the design is a matter of shooting in the dark with the hope of striking Eureka.

Additionally, building a prototype for a chip startup is extremely difficult due to their limited funding and the fact that, typically, foundries refrain from giving them much leverage when it comes to prototyping.

Mike Wishart, CEO, e-Fabless, points out, "You look at what happened in software, by removing all the upfront cost, they took out the 'no' out of innovation. One of the biggest issues you get in silicon is that there are so many things you have to spend money on."

Funding for chip startups

"Based on my experience of raising money for my own company, a big part of getting companies funded and up and running is, in fact, persistence," explains Wishart. Hardware startups are notorious for being incapable of catching the eye of investors due to the high investments that they require along with the even higher risks and marginally lower profits associated with them.



When you come back to the life cycle of funding a company, it is a 'crawl-walk-run' cycle for every company. The crawl part is when you have to get the proof of concept, and then come the walk and run part when you produce it and then scale it up. "The funding difference between software and semiconductor is not that different in the walk and run part but it's the crawl, the getting started part, which is the killer," says Wishart.

The existing semiconductor ecosystem is built and consolidated around creating and making standard product chips for mass markets, where the basic model is to pour tremendous amounts of money into capital equipment and R&D, create a product and sell a lot of them to enable PCs and phones. Industry leaders emerged in areas like EDA, IP, and foundry and they quite understandably protected their investment licenses that must be signed and often paid for upfront. As a result, not only did it get more expensive to start a company, but it also became incredibly time consuming.

The emergence of open source led to a great amount of cost-reduction along with simplification, sharing and faster time to design. Yet, their delivery for chips that are optimised for quality, power, performance, and cost is often not at the level required for startups to be able to scale their product. It gives the required push, but it may not be sufficient to keep the momentum.

Building a company from the ground up is a tedious task. As such, building a chip startup is difficult on its own. Moreover, the chip ecosystem is an extremely rigid one that leaves very little space for newcomers. How do we turn the tide?

"I think the tide will only be turned if there is a demand for locally produced chips," says Sherwani. While the government's efforts to support domestic startups to encourage them to build chips is commendable, there is a need for these chips to come to the forefront, which can only happen when enough demand is created.

Sherwani suggests having provisions that may help incentivise the use of locally-made chips.

"I'm not saying putting a barrier for big players, but indigenous players need to be given more benefits. As part of this overwhelming plan, we must create incentives for startups," Sherwani adds.

Lack of VC infrastructure

The lack of a proper venture capitalist (VC) or venture capital infrastructure is another obstacle in allowing proper funding to flow in the right direction when it comes to hardware startups. A lot of VCs that exist in the country do so only on the surface level. At the core, these are just US based VCs who operate in India, among other places. The need, in this case, is much more precise—India needs Indian VCs—to understand the local demand

The age of AI and future of EDA

While all this chatter is taking place, software companies have also started realising the importance of chips. Marking their own presence, companies like Google have begun making their own chips and even released an AI based floor planning tool.

AI has taken the world by storm, having been incorporated into every little aspect of our life. It is only natural that the chip industry would get the taste sooner or later. Will this change the EDA space? Will AI take over the chip making process, eliminating the need for human intervention forever?

While tools like these are a welcome innovation in the industry, even by staunch hardware guys, the fact remains that removing human intervention completely is yet a far cry. "They will be helpful for simpler chips. For more complex chips, human ingenuity is still needed. A master floor planner is still needed but the iteration we go through can be helped with through AI. AI can be helpful for more productivity," says Sherwani.

But one of the biggest aspects that the entry of AI would change is the access to EDA tools, especially for companies that have limited resources to access world-class tools. "I think this is one thing that EDA companies have resisted to this day. If the tools move to cloud, then hooking it up with the additional tools on the cloud will really help everyone all over the world. But we need to have a wider ecosystem and AI will provide that, I think it could be a good step," adds Sherwani.

and fuel their capital to meet those needs.

With the semiconductor policy in place, there is hope for such an infrastructure to be built. But that needs a lot of push to come from the industry to show how marketable their product is, whether in local or global terms, in order to attract the right set of eyes towards them and let the pendulum of reverse brain drain going.

A common problem that many tech startups face is the lack of business acumen. No doubt intensive technical knowledge is critical, but the lack of decision making collapses a business even before it begins. And the problem is a deep-rooted one.

While a lot of design moved to India, design decisions never moved to India. Big MNCs may have 10,000 people working for them in India but no decision makers are here. The people who are buying chips are mainly in the US and, as such, one key thing that never happened is that chip buyers and people who specify what chips need to be designed and how they need to be designed were ever here in India.

This lack of critical decision making has led to the workforce in India to be unaware of the specific market demands. And when this workforce starts out on its own, it is only natural that their product does not fit market standards. This becomes another hurdle in getting the right funding where the VC's expectations and the product just do not match.

Leveraging the academia

A large part of Silicon Valley's success is attributed to the contributions made to innovation and collaboration of the academia and the industry.

Subhasish Mitra, Professor at Stanford, says, "There are three key aspects in which US universities have made a big mark. They are not all Silicon Valley aspects, which is why I believe we can emulate the same in India because I think the expertise that is needed in each of these areas, India has that."

The first aspect, Mitra reiterates, is the ideas that come out of academia. The way this happens is that they pick a problem that, if solved, would have a big impact.

Second, there needs to be a mindset shift to not just focus on creating specific chips but also create the fundamental technologies to figure out how to create the next technologies that will enable the next generation of chips. Here, too, the formula is the same—you pick a problem that is really important and try to find an end-to-end solution.

Third, it is necessary to give due focus to the electronic design automation (EDA) aspect. The innovation that happened in that aspect was, again, they followed the same formula of problem solving.

Mitra asks, "Why can't India do all of this? Because if you look at the expertise in India, Indians have creativity that is directly connected to chip design and at the same time Indians are very good at math. So, there is no reason why India should not shine there."

But while ideas from academia are long-range and industry changing, they also require heavy investments and have long gestation periods to make them see the light of the day.

"In the US, we have been able to fund these ideas and it may take a company 9-10 years before that product hits the market, but it changes the world. We don't have that kind of patience, which is why I think India needs something different," says Sherwani.

This, suggests Sherwani, can be solved by focusing on building low-cost, high-efficiency chips, for which the country already has existing capabilities and infrastructure.

The problem, however, lies in striking the right balance. While focusing on such chips would help light that fire and kick that ball, there is a danger of that ball being stuck in a local minima. As such, the focus would only be limited to solving a local problem and may never reach global scale.

This is where it becomes imperative to strike the right balance between encouraging and fueling academic research, while also focusing on keeping India on the right track to achieve reliance and sustainability in chip design.

Speakers

Mike Wishart, CEO, e-Fabless

Dr Naveed Sherwani, CEO, Rapid-Silicon

Dr Satya Gupta, President, VLSI Society of India

Subhasish Mitra, Professor at Stanford, the USA

Vivek Khaneja, Executive Director, C-DAC

India first, world second

It is no surprise that the golden period for Indian electronics and semiconductor industry has started to take shape. Sherwani notes, "What we now need is a group of people, Indians who want to make India great. India has a very large number of people with extensive experience in various aspects of chip making. How many nations have that?"

Fostering this ripe talent and providing them avenues to come and build the semiconductor industry is essentially among the best ways to develop the same. Especially since most of these talents have worked closely with companies based in Silicon Valley, they have the knowledge and expertise to emulate the same in India. The product ecosystem in India is already well-developed, what it needs is a little fire to make it shine bright enough for the world to see.

The chip industry is a cutthroat one, and India being in its nascent stage to develop its own niche, needs to be wary of diving headlong into the competition. While the ambition is understandable and lauded, common sense must still prevail if it wishes to make a mark. For that, it needs to turn its head and start looking inward rather than outward. "I think we must start with making simple chips, chips which are relevant to India," says Sherwani.

Microcontrollers, IoT chips, and LED PCBAs are some aspects that India can aim for, simply because their demand in local terms is extremely high, making it easily scalable while also giving the still-growing market a big indigenous push. Gupta suggests taking a thread out of the big-little approach that many MNCs have followed. This would allow Indian companies the option to choose indigenously produced chips to add to their domestically produced products, which would further increase their value addition.

"For instance, India today makes 700 (types of) LED bulbs domestically for domestic consumption. A small tensor chip goes into every small volt LED. It's a simple chip but the volume is humongous. And since the product is also made by Indian companies, they can decide what to use. This could be the little part of the big-little. The big part would automatically proceed once we conquer our local ground," says Gupta.

Additionally, owing to the high investment that chip making requires, not every idea gets elevated. This also means that a lot of great ideas with little marketability, at least initially, have had to go down the drain only because someone decided it would not be worth spending on.

"I think we need to become more open and allow for more people to contribute their ideas in order to see what kind of stars can emerge. It is important to remove the ability of third parties to say 'no' to a project as much as we can," Wishart adds.

Grabbing the seat

The government's strong foot forward with regards to the semiconductor space was a much-needed move and, although late, it is expected to herald the golden era of the electronics industry of the country. What needs to be done is to adopt a problem-centric approach to think of an end-to-end solution, which can be scaled up from a local problem into a global problem. This is where the academia needs to play its part.

"The real question is how we can get real good ideas. The moment we are able to bring compelling ideas, people will be forced to fund them," reiterates Mitra.

While sovereignty is the ultimate goal, India needs to focus on getting a share of the pie, no matter how small it is. In the end, India needs to do enough to sit on the table with other countries, because if we control even 3% of the market, we can sit there. If we are zero, we will not even be invited. EFY

The author, Siddha Dhar, is a technology enthusiast at EFY

1 GalaxEye SATELLITES CONSTELLATION WITH 'DRISHTI'

GalaxEye, an IIT Madras incubated space tech startup, aims to send a constellation of satellites equipped with their proprietary sensor, called Drishti, into space

GalaxEye team with some of their mockups

The founders of GalaxEye have developed and launched the Drishti sensor, a patent-pending technology that is also their USP. "The Drishti sensor enables multi-sensor fusion," says Suyash Singh, Co-Founder and CEO, GalaxEye. In simple words, Drishti sensors are basically a hybrid version of multiple sensors—hence, multi-sensor fusion. There are multiple sensors today that are used on an individual basis, like thermal sensors, radiometers, or radars on a satellite. But GalaxEye's Drishti sensors are able to give comprehensive data that anyone would want from a satellite since they are a combination of many sensors.

The Drishti sensors themselves are not commercially available. They will be deployed on GalaxEye's satellites only. What the company will be making commercially available is the dataset obtained from the sensors. GalaxEye believes that this dataset will be able to serve any sector that requires satellite imagery—insurance, agriculture, utilities, defense, etc.

GalaxEye's mission is to launch a constellation of satellites working in tandem to provide imagery. "We will have a group of such satellites monitoring the Earth on daily basis," explains Singh. This constellation will provide insights both during day/night time and irrespective of weather conditions. However, their short-term goal is to launch their first satellite in some time, probably by the end of 2023.

It is well said that big success does not come without challenges—at times, the volume of the data that needs to be transferred from one point to another is challenging. GalaxEye is solving that challenge by building a dashboard with a map for users to draw a cross-sectional area on. The company will then deliver the data for that particular area.

Dealing with market competition is critical for all companies. Even in the space technology business, there are some global players who are doing satellite imagery using single sensor based imaging. What differentiates GalaxEye from them is the multi-sensor fusion mentioned earlier. It is this differentiation that they bring to the table that's very important for the customers.

GalaxEye, like most startups these days, has a very unique story of how it was launched. In 2020, the company was founded by a team of five students/alumni of IIT Madras, who initially were a part of Team Avishkar Hyperloop—a student competition team. In 2019, the team participated in the SpaceX Hyperloop Competition and that's how GalaxEye came into being. "A few of us from the Hyperloop team were really excited about space technologies in general," recalls Singh.

Singh points out that the Indian government, ISRO, and some universities have been taking steps towards getting students interested in space technology—like launching student space programmes and interdisciplinary courses. He throws light on how students can get started in a niche field like space technology, "Students can start with drones and communication, and then, if interested, they can move forward to taking specialised subjects during the PG."

—Aaryaa Padhyegurjar

2 ZYPP'S UNIQUE SOLUTION FOR EV FLEETS

Many Indian startups have begun dabbling in the electric vehicle (EV) space. While most of them follow the same route with their business, Akash Gupta-led Zypp Electric has gone out of the box and risked a fusion that very few have executed successfully

Whether due to government's mandate, or the intention to reduce their carbon footprint, businesses all over are actively looking to make the shift to EVs. Logistics sector, which is notorious for carbon emissions, urgently needs to make this shift and Zypp Electric has taken note. It leases electric bikes complete with battery infrastructure and maintenance support to such companies so that they need not worry about investing large sums on buying EVs. Their platform helps to keep a check on these e-bikes and also operate them.

(L to R) Tushar Mehta (Co-founder & COO), Rashi Agarwal (Co-founder & CBO), and Akash Gupta (Co-founder & CEO)

Akash Gupta, Co-founder & CEO riding Zypp Electric

Zypp also smartly prevents theft of the e-bikes. Apart from the usual KYC of the driving partners, these e-bikes have been fully tech-enabled. There is no key and the bikes are geo-fenced to always track them. Their custom battery management system ensures that the batteries are utilised properly. "We have proper triggers baked onto the app, which tells the driver the right time to charge the bike," explains Gupta, CEO and Co-founder, Zypp Electric.

But that's not all. Zypp has also

figured out how to fund the acquisition of these bikes for themselves. "All of these bikes are invested by HNIs who like to invest in these assets. It is like an alternate asset/investment earning plan similar to how you invest in an FD or a mutual fund or real estate." Zypp offers 20% pre-tax return to these investors for a 3-year plan, after which it offers to buy them back, essentially turning itself into an EV fintech firm!

In terms of scaling up, Zypp's ambitions are simple. Expansion. Be it expanding the number of bikes they currently deploy (which is pegged to reach 15,000 within 12-18 months), or increasing the number of clean deliveries happening in the country, or expanding their operations from Delhi-NCR and Hyderabad to Bengaluru and Mumbai, Gupta aims to do it all.

This is not easy though; the biggest hurdle in Zypp's plans is the low number of bikes being supplied at present. "The EV ecosystem and OEMs are still in the nascent stage, so none of the OEMs are able to deliver 1000-2000 bikes a month today, even though we are ready to buy those many bikes every month."

Additionally, Gupta wants more robust bikes to be made that are suitable for the Indian terrain. Zypp's outlook is positive, and it believes that with the right nudge, it can propel the country into meeting the clean energy goals it has set.

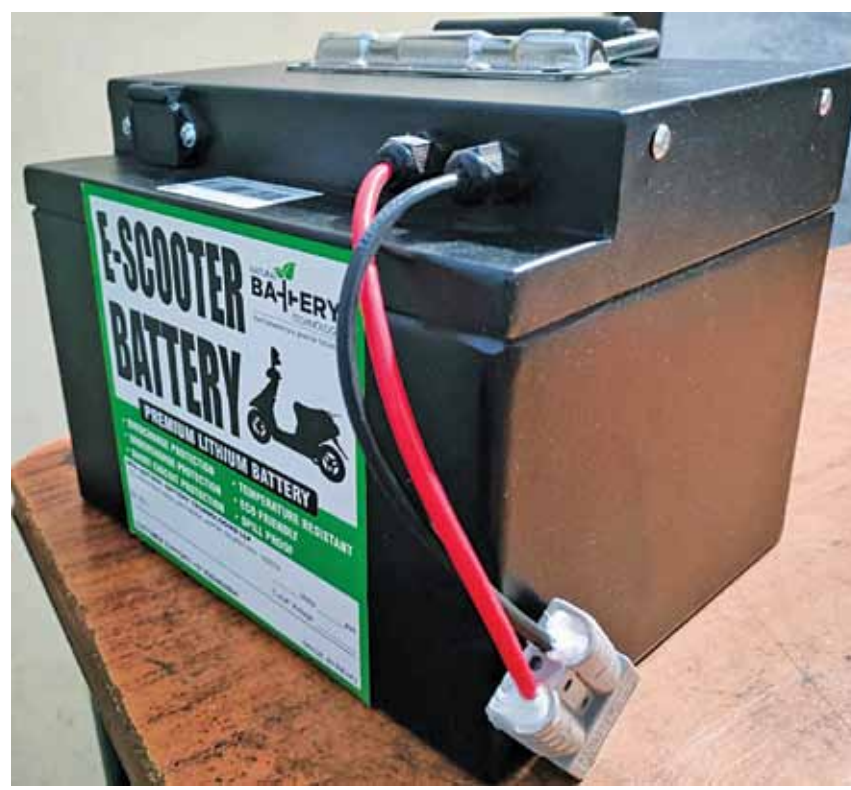
—Siddha Dhar

3 NATURAL BATTERIES: SAFE AND EFFICIENT

While recent incidents of electric vehicle fires have alerted us on battery safety needs, a Jaipur based startup, Natural Battery Tech, is building batteries that it claims can sustain harsh temperatures up to 200°C and still provide optimal efficiency

With the rise in demand for larger battery packs with more safety features, Puneet Jain, CEO, Natural Battery Tech, says they are now designing lithium-ion batteries that can work beyond their rated capacity and also sustain harsh temperatures.

"The lithium cells (NMCs) may get heated and touch up to 55-60 degrees Celsius, leading to thermal runaway. The usual batteries available in the market may use a thermal foam or epoxy sheet that can protect up to 100 or 125 degrees Celsius. By using specialised thermal pads and heat protection devices, we are able to secure the complete pack up to 200 degree Celsius. These materials can also absorb vehicle shocks to safeguard battery internal components," he explains.



For ensuring safety from faulty cells, the firm has introduced fused connection technology, which isolates the faulty cell in the pack from the rest. "A battery pack is a combination of cells. If you are using a simple connection type and if any cell goes bad, it cannot isolate itself from the regular pack. While bigger firms like Tesla go for expensive technologies like ultrasonic bonding to address such issues, we have

come up with a cheaper solution of using fused connections for our battery packs," says Jain.

Jain calls the optimisation feature as their unique selling point. "If a client orders a 50Ah (ampere-hour) battery, we give them a 51.5Ah battery. This is a subtle difference, but it turns out to be a great trust-building factor," he says.

To optimise space and fit more battery capacity in limited vehicle space, the firm uses customised ABS structures to keep the lithium cells in place. The ABS structure has involved careful selection of materials that can enable the battery to be compressed further and allow packing more capacity. A typical battery of 50Ah capacity is housed in a box of 400mm thickness and with the compression structure, it is reduced to 365 ~ 370mm. The space saving (approx. 30mm all-round) can be used for increasing the capacity of the battery further.

While the team had earlier faced difficulties in selecting materials that could provide both thermal and shock protection, and also in designing ABS structures, finding a manufacturer in India was a bigger challenge. "We couldn't find a manufacturer in India and hence we moved to importing from countries like China and Germany. This is also a reason that puts our cost a little higher compared to our competitors," Jain says.

The business was started in 2019 with the leasing of electric rickshaw batteries. It was later shifted to a couple of other financial models, realising the initial heavy investments. "I partnered with electric vehicle manufacturers and sometimes we even did the delivery service by hiring drivers. All those options were not very scalable with the limited funds. Now we currently focus only on building batteries," he adds.

He strongly believes that allowing a free hand to experiment is a great way to innovate. "I have quite some examples in our factory where we had trained our manpower from little technical expertise to adapt successfully in innovating at our factory floors. Those with not so higher education backgrounds have experimented a lot with testing, repairing, tinkering, and are now working out ways of producing efficient results," Jain says.

Puneet Jain, CEO, Natural Battery Tech

Jain expects to soon introduce an effective liquid cooling mechanism. His team is designing the pump and pipe systems for liquid cooling to effectively keep the larger packs cool. Jain aims to develop a great battery ecosystem deploying battery swapping and charging infrastructure in India in the long run. He says, "We are already in talks with some investors. We want to create an infrastructure where the batteries can be easily serviced, recharged and all managed through mobile apps."

The firm is currently planning expansion and looking for sophisticated OEMs to co-design battery packs customised for their vehicles. It is also in process of hiring battery researchers, mechanical engineers, supply chain managers, product development experts, and electrical engineers. EFY

—Abbinaya Kuzhanthaivel

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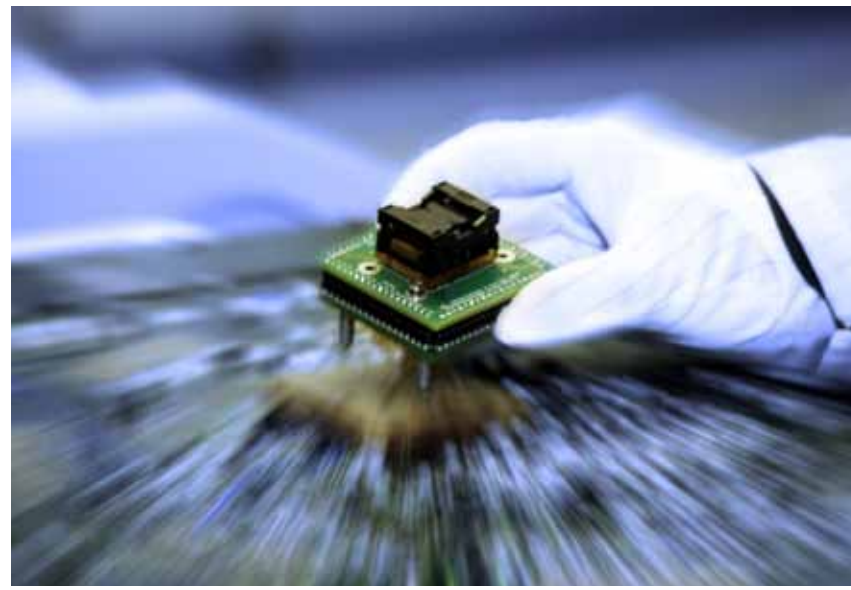
"Branding is what people say about you when you are not in the room."

-Jeff Bezos

MeitY forms 17-member advisory committee to steer Semiconductor Mission

The Ministry of Electronics and Information Technology (MeitY) has announced the formation of a 17-member advisory committee to provide a more solid path to the government's ₹760 billion India Semiconductor Mission. The Minister of Electronics and Information Technology Ashwini Vaishnaw will be the Chairperson of the committee, while Minister of State for Electronics and Information Technology Rajeev Chandrasekhar will be the Vice-Chairperson. The newly minted committee shall provide inputs to the government to enable the building of a resilient supply chain, promote investments and ways of financing the semiconductor sector, research and innovation as well as intellectual property generation.



Representational image

PEOPLE (on the move)

Sumant Sinha takes over as ASSOCHAM President

Sumant Sinha (left), Founder, Chairman & Managing Director of ReNew Power, has taken over as President of the Associated Chambers of Commerce and Industry of India (ASSOCHAM). Ajay Singh (right), Chairman & Managing Director of SpiceJet, India's second-largest airline by fleet size, is the new Senior Vice-President of ASSOCHAM.

Rajan Kapoor appointed NexGen Power Systems' MD for India R&D

NexGen Power Systems has appointed Rajan Kapoor as Managing Director for its India operations. As Managing Director, India, Rajan will be responsible for driving NexGen's India Centre of Excellence to revolutionise the design and development of power conversion systems.

SECI appoints Sanjay Sharma as Director-Solar Division

Sanjay Sharma has been appointed Director of the solar division of Solar Energy Corporation of India. Prior to this appointment, Sharma held the position of Executive Director of the state-run company.

Tushar Mehta appointed Zypp Electric's COO

Electric mobility start-up Zypp Electric has elevated its Business Head, Tushar Mehta, as the company's Co-founder and Chief Operating Officer. Tushar joined Zypp last year as Business Head and has been closely working with the founding team to improve operations and business strategies. In his new role, Tushar will be leading the business and growth at Zypp.

CORPORATE news

Motherson Sumi Group eyeing to foray into semiconductors

Following the likes of Vedanta and Tata, Samvardhana Motherson Sumi Group is also planning to enter the semiconductor manufacturing space. It is looking for a global partner to enter the same. Motherson's Vice-Chairman Laksh Vaaman Sehgal said that the investment to get into semiconductor manufacturing being large, the company will not get into the space on its own and is eyeing a partner.

Tejas Networks to acquire majority stake in chip firm Saankhya Labs

Telecom gear maker Tejas Networks is acquiring 64.4% stake in Bengaluru based semiconductor firm Saankhya Labs Private Ltd in an all-cash deal of ₹2.84 billion. Tejas Networks, upon procuring all necessary consents and approvals, also intends to proceed with acquiring the balance 35.6% shares through a merger process or a secondary acquisition. Saankhya develops system and semiconductor products for cellular wireless, broadcast radios, and satellite communication ground terminals, which are deployed by customers in India and in international markets. It has 73 international patents.

Samsung now eyeing PLI incentives through contracts

Samsung Electronics, which had previously refused to participate in the telecom production-linked incentive (PLI) scheme, is in talks with Indian telecom majors Reliance Jio and Bharti Airtel for 4G expansion and 5G supply contracts. Samsung had in mid-2021 decided not to take part in the initial PLI scheme, reasoning that setting up a plant for network equipment was not viable at that time in India with just one client, Reliance Jio Infocomm.

Made in India iPhones: Pegatron and Foxconn are on the roll

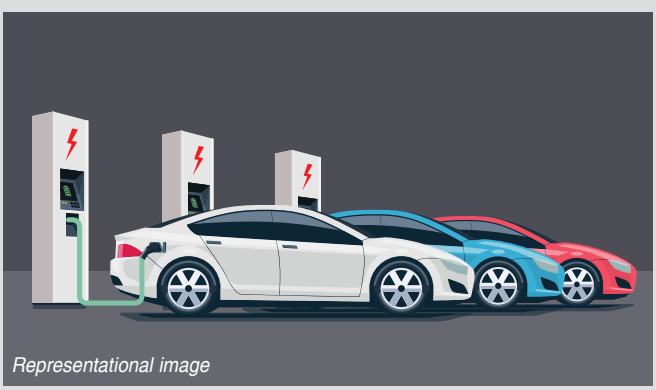
Apple's second largest contract manufacturer Pegatron has local manufacturing of the tech giant's products in India, with a target to produce goods worth more than ₹80 billion in the next fiscal year. It will initially make iPhone 12 devices, followed by the new iPhone 13 series from a new facility in Tamil Nadu. Meanwhile, Foxconn has already started making iPhone 13 in India.

Vikram Solar set to file papers for an IPO

Vikram Solar is looking to go public as it files draft papers for a reported ₹20 billion initial public offering (IPO). It will offer a mix of fresh share sales and stake sales by promoters for the issue, which is likely to be worth ₹1.8 billion. It has roped in JM Financial and Kotak Mahindra Capital as the lead managers for the public issue.

Tata Motors to make massive investment in EV segment

Tata Motors is planning to invest ₹150 billion in the EV segment in the next five years. President for passenger vehicles business of Tata Motors Shailesh Chandra said that the company is also planning to develop around ten more new offerings in the segment.



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SNIPPETS

- One Moto is looking to set up an EV manufacturing facility at Zaheerabad in Telangana with a manufacturing capacity of 25,000 units per month, which will be ramped up to 100,000 units in the next three years.
- Pinnacle Industries has introduced a range of precision EV components for two- and three-wheelers as it looks to become an end-to-end EV components and solutions provider.
- Spacetech start-up Pixxel has raised $25 million in a Series A funding round led by Toronto based Radical Ventures, making it India's largest fundraise by a space technology company to date.
- EV mobility firm Bounce is looking to expand its presence in the EV industry of the country, for which it is eyeing a fundraiser of $100 million.
- Domestic electronics maker Blue Star E&E has opened a new medical diagnostic equipment refurbishment facility at Bhiwandi, Maharashtra.

Suzuki to invest $1.4 billion in Gujarat to build EVs

Gujarat is set to become a hotspot for electric vehicle (EV) manufacturing as Japanese auto major Suzuki Motor Corporation is looking to invest approximately 150 billion yen (₹104 billion) for local manufacturing of EVs and their batteries. The company signed an MOU with the state of Gujarat at India-Japan Economic Forum held in New Delhi, in the presence of Japanese Prime Minister Fumio Kishida and Indian Prime Minister Narendra Modi.

Omega Seiki Mobility to enter African EV market through JV

Looking to expand its reach to the African market, Omega Seiki Mobility (OSM) has joined hands with Egyptian e-commerce last-mile delivery firm Rabbit Express to form a joint venture for the same. OSM will initially export its two- and three-wheelers to the African market and later the two partners will set up a manufacturing facility in capital city Cairo. OSM will hold up to 26% stake in the JV while Rabbit Express will hold the remaining stake.

US based Triton Electric to manufacture EVs in Gujarat

With a total investment of ₹108 billion, US based Triton Electric Vehicle has signed an agreement with the Gujarat government to set up a commercial electric vehicle (EV) manufacturing plant at Bhuj in Kutch district. Triton Electric Vehicle will set up the plant over 645-acre land with an annual production capacity of 50,000 trucks. The state government will assist in providing necessary approvals and registration for the establishment of this plant in accordance with the existing policy.

ITP starts lithium battery manufacture in Gurugram

ITP Energy Systems has set up a 100MWh lithium battery manufacturing plant in Gurugram. In phase 1, the facility will cater to solar segment at first and then focus on battery packs for e-mobility, which are due for launch in Q3 FY22. With multiple EVs catching fire in the past month, the plant at Gurugram has been set up, keeping this in mind, to make batteries that are thoroughly tested and have proper thermal management.

Ola Electric invests in Israeli battery tech firm

Electric vehicle giant Ola Electric has invested in the Israeli battery technology company StoreDot. StoreDot makes batteries with extreme fast charging (XFC) technology. As part of the investment in StoreDot, Ola Electric will have access to the company's XFC battery technology, along with exclusive rights to manufacture batteries integrating StoreDot's fast charge technology in India.

Cygni Energy looking to set up lithium-ion battery plant

Hyderabad based lithium-ion battery pack manufacturing firm Cygni Energy Private Limited is looking to invest about $40 million (over ₹3 billion) to set up a greenfield manufacturing plant near Hyderabad. Their batteries are used for electric vehicles and stationary applications like telecom towers.

Exide building Li-ion cell manufacturing unit in Karnataka

Battery maker Exide Industries has announced it is planning an investment of about ₹60 billion in building a lithium-ion cell manufacturing unit in Karnataka. The company has sought 80 acres of land at Haraluru industrial area near the Bengaluru international airport. This proposal is for one of India's largest giga factories for advanced cell chemistry technology.

Epsilon Carbon signs JV for battery materials plant in India

World's first commercial polymetallic nodule processing plant is coming up as Epsilon Carbon as signed a joint venture agreement with US' Nasdaq-listed The Metals Company Inc to invest ₹12 billion for it in India. The focus of this collaboration will be to produce cathode precursors with the lowest carbon footprint. These cathode precursors will be converted to cathode active materials at the proposed facility.

Simple Energy signs MoU for Li-ion battery cells ecosystem in India

Simple Energy has signed a Memorandum of Understanding (MoU) with US based battery technology firm C4V for setting up lithium-ion cell manufacturing ecosystem in India. In addition to the make in India initiative, this strategic partnership covers cells with industry-leading safety, higher energy density than lithium ferro phosphate batteries, faster charging, and longer life cycle based on C4V's patented technology.

BEL and AAI join hands to develop air-traffic management systems

Bharat Electronics Limited (BEL) and Airports Authority of India (AAI) have entered into an agreement for the joint, indigenous development of systems for air-traffic management and surface movement of aircraft at airports in the country, which were hitherto being imported. BEL and AAI will jointly develop civil air-traffic management system with advanced surface movement guidance and control, a complex ground surveillance system that manages air-traffic at airports and in Indian civil airspace for safe operation of flights from take-off to landing.

Samsung to re-enter India's laptop market after exit in 2014

Sensing a rise in demand in the market, Samsung is all set to re-enter the Indian laptop segment this month as it looks to capture double-digit market share by the year-end. Samsung India General Manager and head of new computing business Sandeep Poswal said that by the end of 2022, Samsung plans to have double-digit market share in the addressable area where it operates.

Nothing India to begin making smartphones

Carl Pei-led Nothing is now looking to make smartphones. It is planning to foray into the business in the third quarter of this year, Nothing India Vice-President and General Manager Manu Sharma revealed. Pei, who is the Co-founder of OnePlus, said that Nothing is developing its own operating system for the phones, which will be built using Qualcomm's Snapdragon mobile platform.

Centre plans to modernise SCL plant for chip manufacture

As part of its effort to begin manufacturing semiconductors, the Semi-Conductor Laboratory (SCL) in Mohali is being modernised by the Central government. The Parliamentary Standing Committee on Communications and Information Technology has submitted a report, which gives a detailed plan for modernising the SCL unit in Mohali. The government had asked the committee for a plan to upgrade the SCL factory. The India Semiconductor Mission (ISM) will be responsible for handling the upgrade.

BATTERY STORAGE PLI APPROVAL FOR INCENTIVES

Name of applicant	Capacity quoted (GWh)	Status	Capacity awarded (GWh)
Rajesh Exports Limited	5	Awarded	5
Hyundai Global Motors Company Limited	20	Awarded	20
Ola Electric Mobility Private Limited	20	Awarded	20
Reliance New Energy Solar Limited	20	Awarded	5
		Waitlisted	15
Mahindra & Mahindra Limited	15	Waitlisted	–
Exide Industries Limited	6	Waitlisted	–
Larsen & Toubro Limited	5	Waitlisted	–
Amara Raja Batteries Limited	12	Waitlisted	–
India Power Corporation Limited	5	Waitlisted	–

Smartphone exports increase 75% in FY21: ICEA

The India Cellular & Electronics Association (ICEA) has released data which suggests that smartphone exports increased by 75% in financial year 2021, reaching over $5.5 billion from $3.16 billion. ICEA attributed the IT hardware production-linked incentive (PLI) scheme as the primary driver of this growth.

Chennai now the best for low-cost electronics R&D

Chennai was ranked as the world's cheapest foreign direct invest-

INTERNATIONAL news

Intel to beef up its investment in Europe for making chips

US chipmaker Intel has revealed that it will invest up to 80 billion euros ($88 billion) across Europe in the next decade, as part of which it plans to build a semiconductor plant in Germany. The chipmaker will allot 17 billion euros to beef up its European production capacity with a semiconductor fab mega-site in Magdeburg, Germany. The site will include two semiconductor factories, or fabs, that will make chips with Intel's advanced technology.

Nvidia interested in using Intel for manufacturing its chips

Following the fallout of its deal to acquire British chip firm ARM Ltd, Nvidia has shown interest in partnering with US chipmaker Intel to make chips. Early last year, Intel decided to expand its business into making chips that others design as well, called the foundry business, and has announced several multibillion-dollar projects for new manufacturing centres in the United States and Europe.

SK Hynix looking to acquire Arm through a consortium

Months after the fallout of the highly-anticipated Nvidia-Arm deal, South Korean chipmaker SK Hynix is looking to form a consortium to acquire British semiconductor company Arm. "We are reviewing possibly forming a consortium, together with strategic partners, to jointly acquire it," Park Jung-ho, Vice Chairman and CEO of SK Hynix, told reporters after the company's annual shareholders meeting. The idea of possible acquisition is, however, at an early stage.

Kioxia and Western Digital to build new flash memory fab

Kioxia Holdings Corp is looking to collaborate with Western Digital Corp to build a new flash memory fab together. The facility is set to be bult at the latter's plant in northern Japan, which may reportedly entail an investment of around $8.3 billion.

Samsung and Western Digital to develop next-gen storage

Samsung Electronics has signed an MoU with Western Digital to co-develop next-generation data placement, processing, and fabrics (D2PF) storage technologies. The companies will initially focus on aligning their efforts and creating a vigorous ecosystem for zoned storage solutions, including zoned name spaces SSDs and shingled magnetic recording HDDs.

SEMIKRON and Danfoss Silicon Power merge to specialise

SEMIKRON and Danfoss Silicon Power announced a merger to create a joint business specialised in power electronics focusing on power semiconductor modules. The newly formed SEMIKRON-Danfoss joint business will be owned by the current owner-families of SEMIKRON and the Danfoss Group, with Danfoss being the majority owner. The new joint business will be managed by one common leadership team, retaining existing production facilities, customer and supplier relationships, and distribution channels.

US chip firm Ampere Computing files for IPO

American server processor startup Ampere Computing has filed for an IPO in the United States. A public listing would give Ampere an infusion of cash and potential access to more investment further down the line via public markets. Oracle has quietly invested $426 million in Ampere, which is run by former Intel president Renée James.

Wacom, STMicroelectronics and CEVA collaborate for digital pens

CEVA, together with STMicroelectronics and Wacom, have announced their collaboration to develop an enhanced digital pen experience with a new, wireless sensor module that extends the digital pen's functionality through advanced gesture, cursor, and motion control. The combined effort leverages the specialised capabilities of the three companies to create an advanced, sensor-enabled digital pen that can be adopted by OEMs to add value to their smartphone, tablet, notebook, PC, interactive whiteboard, or other smart-display products.

Analog Devices and Gridspertise join forces for smart grids

Analog Devices and Gridspertise are collaborating to advance the resiliency and quality of smart grids around the world. The collaboration enables the development of new hardware and software that support distribution grid self-healing and adaptation in response to the significant changes in energy supply and demand as renewable energy sources are brought online.

ment (FDI) location for electronics research and development, as per an assessment conducted using investment location comparison tool called fDi Benchmark. Chennai emerged as the cheapest location in the top hundred electronics FDI destinations, with estimated annual operating costs of $1.24 million for a fifty-person R&D centre. Among the world's competitive locations, Chennai was ranked second, only after Seol, which is home for large campuses of players like Samsung and LG Electronics.

Niti Aayog to roll out battery swapping policy

Keeping in line with the Finance Minister's promise in the Union Budget speech, NITI Aayog is likely to roll out a battery swapping policy by December this year. "The Battery Swapping Policy is likely to be rolled out by December," Sudhendu Jyoti Sinha, adviser (Infrastructure Connectivity-Transport and Electric Mobility), NITI Aayog, informed. Sinha also said that the Aayog is working on a proposal to prod railways to set up electric vehicle charging stations at railway stations in cities whose population is more than one million.

Government begins probe as more e-bikes catch fire

Following recurring incidents of electric bikes catching fire, Road Transport and Highways Secretary Giridhar Aramane told media that independent experts in science and technology space will probe the incidents and submit a report. The government has ordered a probe into the matter.

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- TrioSTAT is bidirectional, grid tied inverter connect at the output of TrioSTAT will feed energy back to grid.
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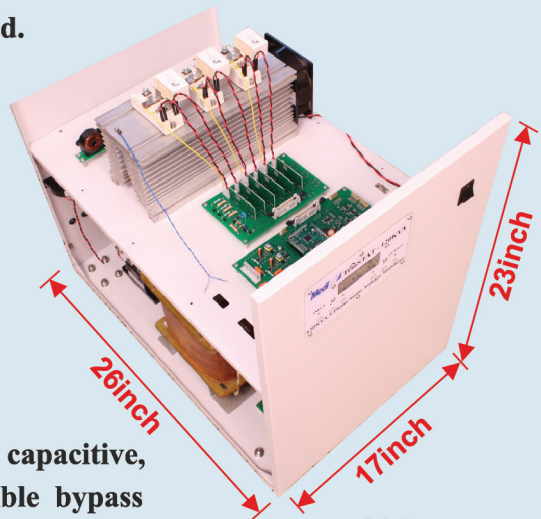

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For video demo of the product, go to Youtube and search "TrioSTAT"

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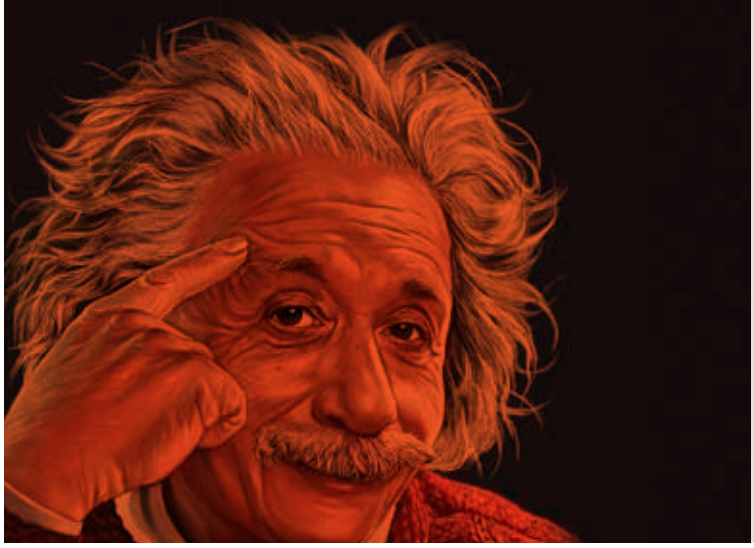
—Albert Einstein



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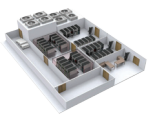

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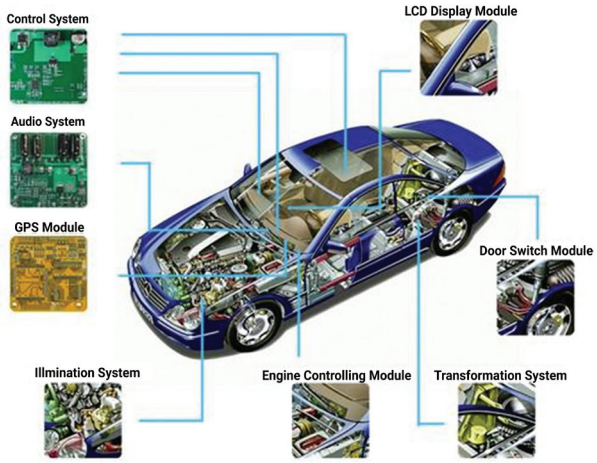

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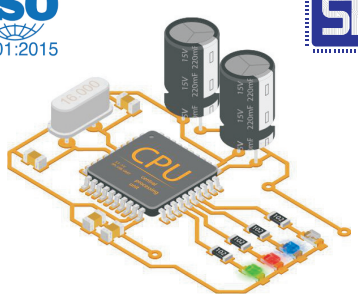

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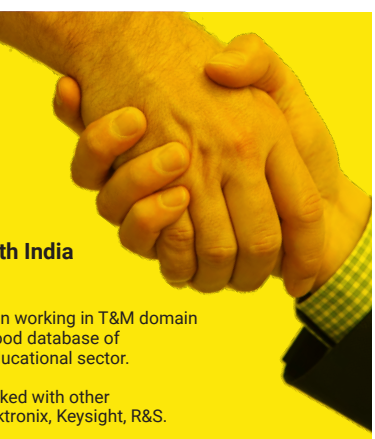

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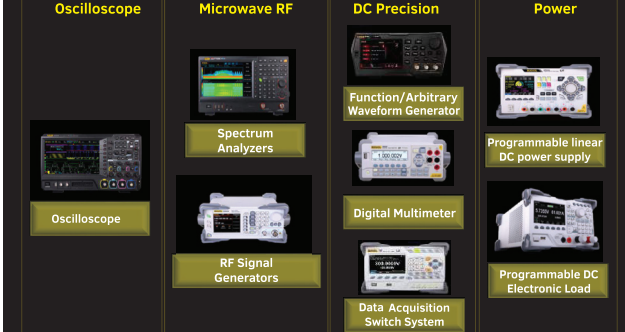

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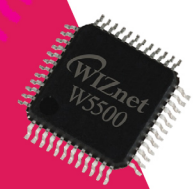

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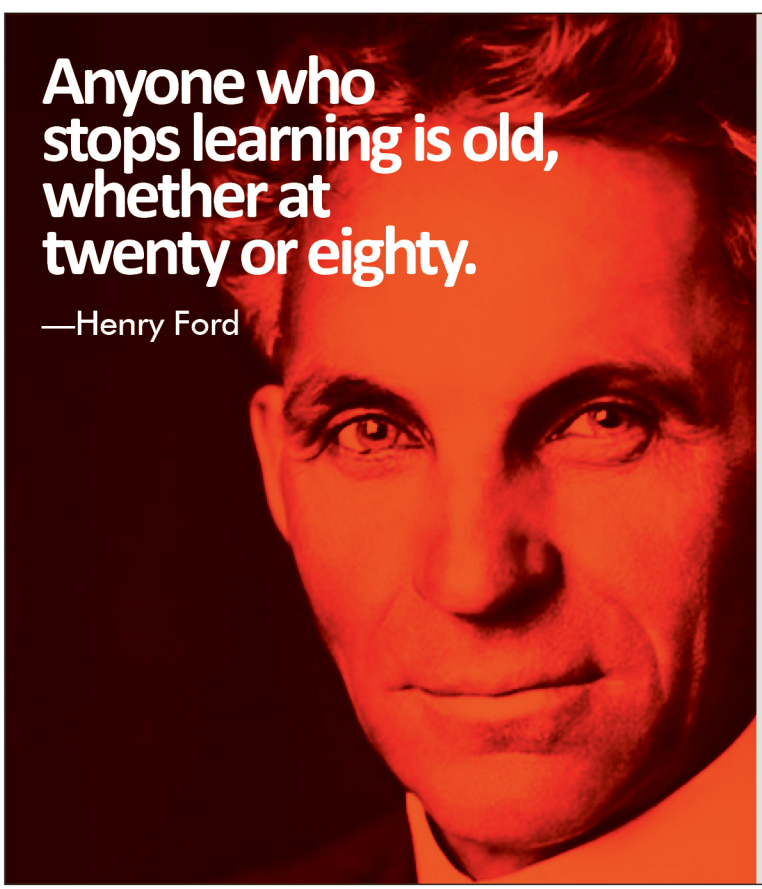

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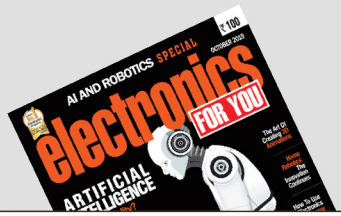

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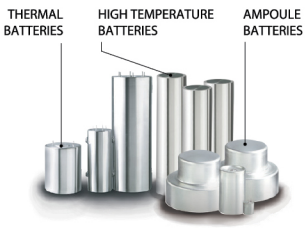

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GALAXYEYE

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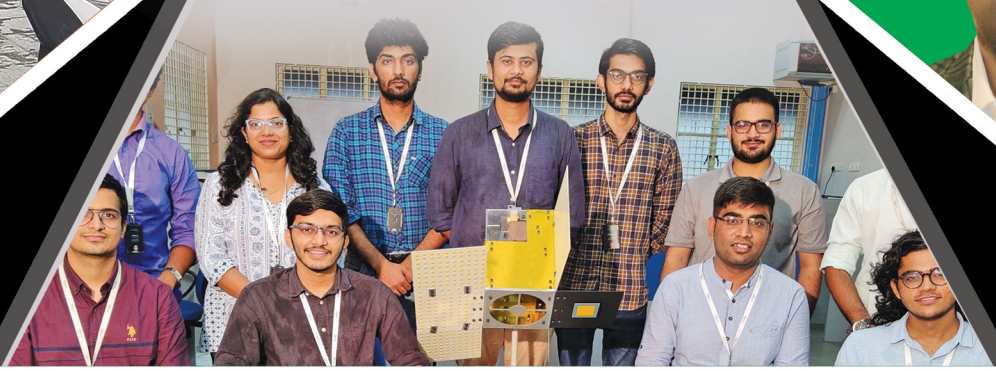

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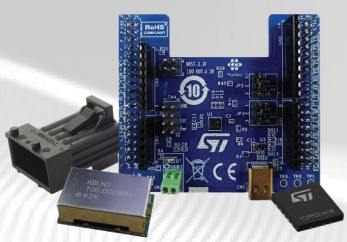

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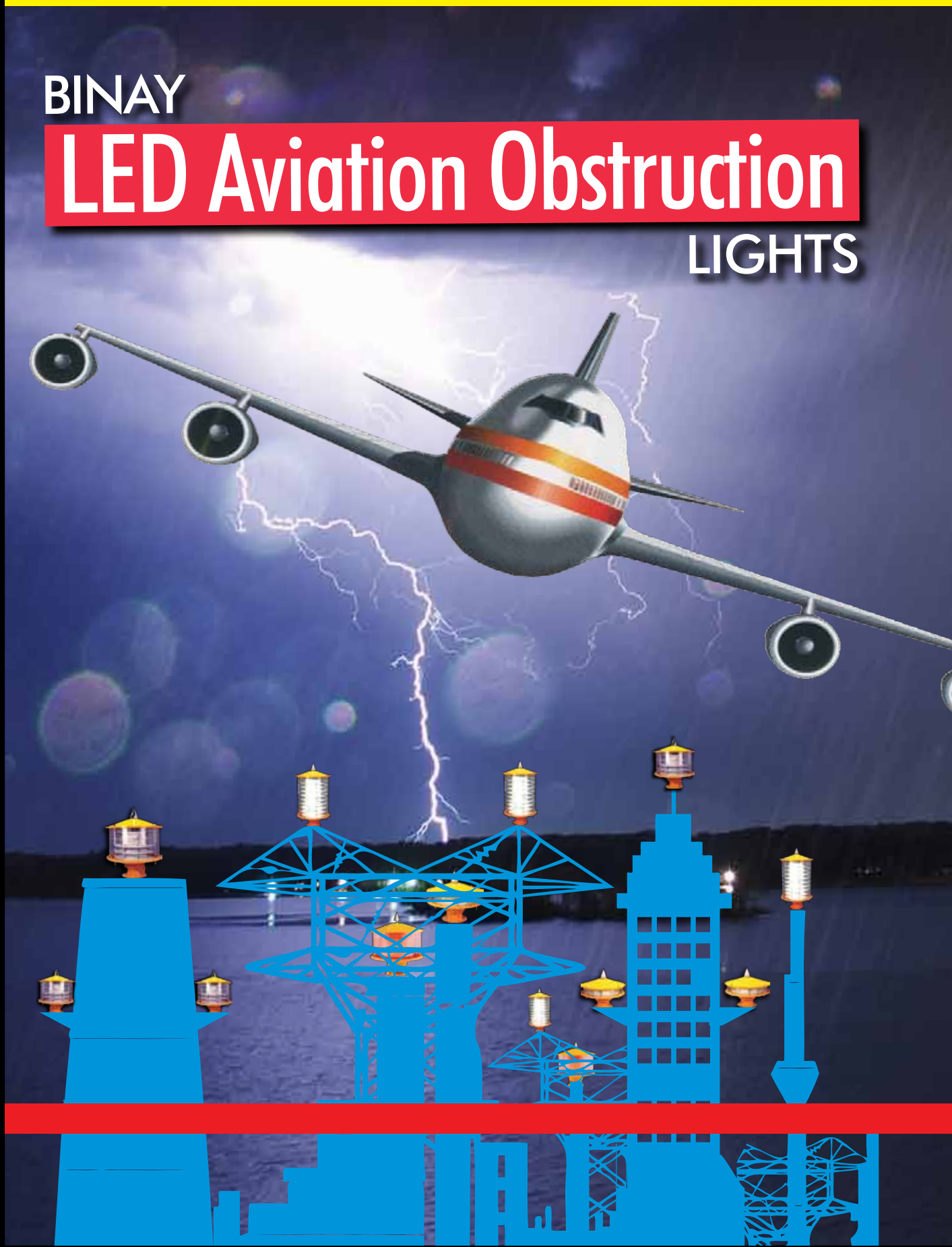

TECHNOLOGIES SINCE 1983

BINAY LED-based HIGH, MEDIUM and LOW Intensity Aviation Obstruction Light Beacons

As per International Civil Aviation Organisation (ICAO) requirements
Available in Low Intensity, Medium Intensity and High Intensity versions (as per International Civil Aviation Organization guidelines), BINAY's patented LED Aviation Lights come with 5-year/3-year warranties

High Intensity
200,000 candela
(Flashing White LEDs)

Medium Intensity
20,000 candela
(Flashing White LEDs)

Medium Intensity
2,000 candela
(Flashing Red OR Fixed Red LEDs)

All BINAY Aviation Lights are based on Non-switching passive type circuitry (NO SMPS)

The circuitry incorporated inside the LED Aviation Obstruction Lights is passive electronic (solid-state) in nature, and does not use internal SMPS driver switching units to control the light unit. Internal LED current control is by non-switching electronic means only. No electrolytic capacitors are used inside the Aviation Obstruction Light unit.

The above is necessary to ensure reliability of the LED Aviation Obstruction Light. This system design effectively eliminates any active components and circuits inside the aviation light itself, and enhances the solid-state passive reliability of the LEDs (mounted in relatively inaccessible locations at the height of tall structures). This drastically reduces the possibility of component failure - and hence possibility of any maintenance requirement – in the LED Aviation Obstruction Lights themselves (which are mounted at extreme heights in the system).

The BINAY LED Aviation Obstruction Light offers the following advantages:

- Fit-and-forget maintenance-free operation
- A long life of 100,000 hours (20 years at 12 hours daily burning)
- Pays for itself within a short period of operation in the form of reduced installation, maintenance and servicing costs
- Quick Installation; Reliable operation 365 days per year
- Shock-proof and vibration-resistant
- Over-Designed Intensity to allow for natural LED intensity degradation over its operating lifetime

LED Obstruction Lighting for:

- Industrial chimneys and smokestacks
- Transmission, microwave and cellular towers
- Radio, TV and similar structural towers
- High-rise buildings and structures
- Airports and airfields

THE BINAY LED OBSTRUCTION LIGHT IS UNDER ACCEPTED PATENT, AND AS SUCH IS A PROPRIETARY PRODUCT

Binay Opto Electronics Pvt. Ltd.
(An ISO 9001:2015 Certified Company)
27, Panditia Terrace, Calcutta 700 029, India

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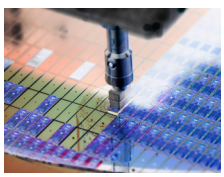

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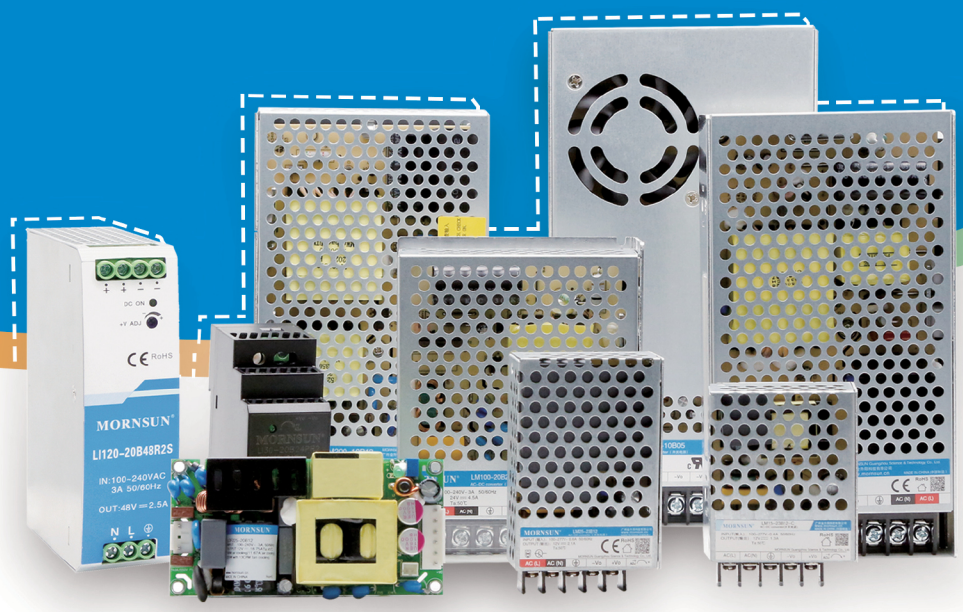

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• • •

IoT PROJECTS

Please let me know some IoT projects published in EFY.

Manish Hosamani

EFY. Following are some IoT projects recently published in EFY:

1. Remotely Control TV With Alexa IoT TV Controller (December 2021)
2. Control Lights Through Thoughts Using EEG Based IoT Controller (November 2021)
3. IoT Based Automated Table Lamp (October 2021)
4. IoT On The Eyes: To Control Home Appliances (October 2021)

• • •

OPTICAL COMMUNICATION

I am interested in optical communication. Please let me know the links or EFY issues in which the topic was covered.

Subhash Arya

EFY. You may please go through the following articles available on our website:

1. An Overview Of Wireless Optical Communication: *https://www.electronicsforu.com/market-verticals/communication/wireless-optical-communication*
2. Optical Networks Create Huge Demand: *https://www.electronicsforu.com/tech-zone/test-measurement-electronics/optical-networks-create-huge-demand*

• • •

UV STERILISATION BOX

This is regarding the 'Make Your Own UV Sterilisation Box' DIY article published in November 2021 issue. Where can I find the chokes required for this UV project? I couldn't find them online. Also, can you please share the video of the UV project?

Ammar

The author Ashok Baijal replies:
I purchased the items online from Amazon, but these should be available in local electrical markets as well. They are commonly used in water filters. I used the Osram brand. Video of the project was not made, but photos are included in the article. It is simple to build. The chokes and tubes are held to the box using zip ties. I am using it without any problem till date for sanitising masks, keys, and phone after every use.

• • •

SEMICONDUCTOR MANUFACTURE

This refers to the article 'Industry 4.0 Can Boost Implementation Of Semiconductor Manufacturing' published in April issue. On the first page, EMS is wrongly mentioned as "environmental management services" while it actually stands for "electronics manufacturing services."

Sunil Banwari (The author)

EFY. Thanks for pointing out the mistake!

• • •

555 TIMER ASTABLE MULTIVIBRATOR

Where can I get the details of 555 timer based astable multivibrator using MATLAB?

Dhanush Shetty

EFY. Please see 'Demo of 555 timer-based astable multivibrator using MATLAB' DIY article available on our website at *https://www.electronicsforu.com/electronics-projects/demo-555-timer-based-astable-multivibrator-using-matlab*

• • •

REPAIRING BOSE STEREO SYSTEM

I have been using a Bose stereo system for about 15 years but now it is not working. I sent it to a Bose service centre, but they could not repair it because some spare parts are not available. I had seen in good old days that local radio repair mechanics used to find the fault and repair within no time. Why it can't be done now? Please let me know if there is solution to this problem.

D.C.S. Gaitonde

EFY. Any audio system running for 15 years must be a good-quality product. However, as the technology evolved, the components used in audio systems and their technology have improved considerably. So, getting the old components now is very challenging. Even the authorised dealers may not have the old parts with them.

In this situation, first identify the exact part number of the faulty components and then check with some local radio mechanics. They may help you get the components either from their old stock or from some other sources. Once the parts are available, the local radio mechanic can fix your stereo, or you can get it done at an authorised service centre.

You can also search for other Bose servicing centres in India on the internet and check whether the parts are available with them.

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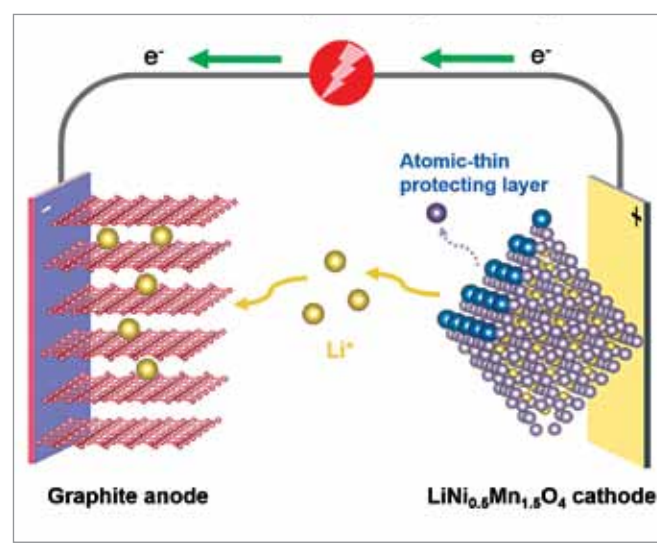
You may soon be able to stretch your TV

Stanford University researchers have developed a proof-of-concept of a re-shapable display made up of a stretchy polymer called 'super yellow' and the synthetic plastic material polyurethane. It has a maximum brightness of at least two times that of a cellphone screen and can be stretched up to twice its original length without tearing. The display can be stuck to your skin, making wearable electronics a valuable market for this technology. "Imagine a display where you can both see and feel the three-dimensional object on the screen," says Stanford University chemical engineer Zhenan Bao.

Zhitao Zhang wears the flexible light-emitting film, featuring a Stanford logo, on the knuckle of their finger. This shows how the film can hold up to flexing and wrinkling (Credit: Zhitao Zhang and Jiancheng Lai of Bao Group Research Lab)

The lifespan of lithium-ion batteries doubled

Researchers at the University of Queensland have developed a technology that more than doubles the lifespan of highly sought-after high-voltage lithium-ion batteries, which achieve higher energy density but last only several hundred cycles. The researchers have demonstrated a battery that remains stable for more than 1000 charge/discharge cycles. They designed a uniquely-grown atomic-thin functional layer on the surface of a high-voltage cathode, which is the source of lithium ions and is a critical aspect that limits the cycle life in a battery. It should be noted that with the industry under increasing pressure to decarbonise, the development of lithium-ion batteries of lower cost, higher energy density, and longer cycle life is vitally important.



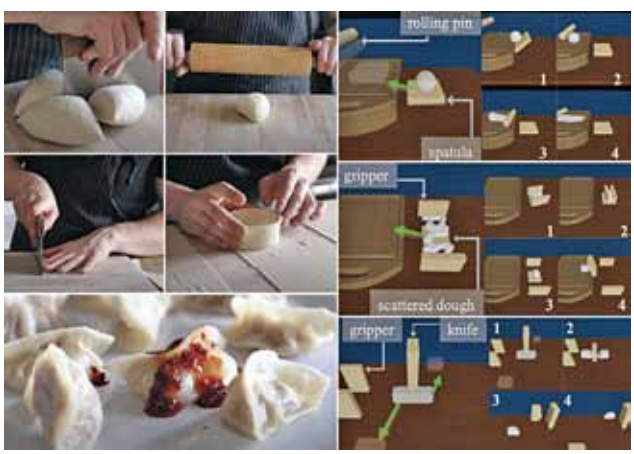
Atomic-thin layer grown on cathode enables long-lasting battery (Credit: https://www.uq.edu.au)

Honey based memristor for neuromorphic computing

Researchers at Washington State University have demonstrated prototype of a memristor made from an unusual material—honey! The memristor is the most crucial component in neuromorphic computing; it is literally a neuron realised on hardware. The researchers created this honey based memristor by turning real, bee-sourced honey into a solid form that was held between two metal electrodes. This design resembles synapses in the brain and how they are kept between pairs of neurons. The researchers anticipate that their findings lay the foundation for biodegradable, long-lasting, organic based computing systems that are much more efficient than traditional computing designs.

This ML framework helps robots make pizzas

Researchers at MIT, Carnegie Mellon University and the University of California, San Diego have developed a framework called DiffSkill for a robotic manipulation system that



Researchers from MIT and elsewhere have created a framework that could enable a robot to effectively complete complex manipulation tasks with deformable objects, like dough or cloth, that require many tools and take a long time to complete (Credit: https://news.mit.edu)

employs a two-stage learning process. This new machine-learning (ML) framework can enable robots to do sophisticated manipulation tasks using deformable objects, such as dough or cloth, over an extended period of time. Each step the robot must take to complete the objective is solved by a 'teacher' algorithm. Then it trains a 'student' ML model, which learns how to perform each skill required during an activity, such as rolling a pin. The researchers discovered that the student neural network could even surpass the teacher algorithm!

Artificial fingertips with e-neurons for soft robotics

Researchers at the University of Bristol have developed an artificial fingertip that emits signals that appear to be similar to those produced by the human touch nerve. The device is essentially a hollow elastomer dome with a thin

Robotic finger tip makes human-like 'nerve' signals (Credit: https://www.electronicsweekly.com)

wall that measures around 25mm wide. Short rigid rods in a contrasting colour are printed through the rubber. They found that their 3D-printed tactile fingertip can produce artificial nerve signals that look like recordings from real, tactile neurons. This is an exciting development in soft robotics—being able to 3D-print tactile skin could create robots that are more dexterous.

Manufacturing as an online service through 3D printers

Hui Wang (left), associate professor of industrial engineering and An-Tsun Wei, a PhD student, are the co-authors of a paper detailing how learning cloud data collected from interconnected 3D printers improves quality control and printing accuracy (Credit: FAMU-FSU Engineering)

FAMU-FSU College of Engineering researchers are working to improve 3D printing technology by teaching machines to learn from one another—a great example of group intelligence. The researchers used a cloud platform to connect different printers, and then had the machines communicate data on accurate processing, reducing the time it took to prepare and calibrate them. They also constructed a mathematical model to better understand the printing process. The technology demonstrates that data generated from multiple production machines can be shared with each in a timely manner, and manufacturing can be done as an online service for meeting diverse market demands.

Smartphone cameras may soon capture 3D images

Stanford University researchers have developed a novel method for ordinary image sensors to sense light in three dimensions using lidar. The research team's lidar system

The lab-based prototype lidar system that the research team built, which successfully captured megapixel-resolution depth maps using a commercially available digital camera (Credit: https://news.stanford.edu)

was able to capture megapixel-resolution depth maps with a commercially accessible digital camera. Simply put, their all-new approach is simple and integrates into everyday cameras like cellphones. With this technology, cameras will be able to estimate the distance between objects, resulting in a three-dimensional image that can be viewed on smartphones. This way, smartphone cameras may be able to capture three-dimensional images (3D).

New gate-oxide tech can produce better transistors

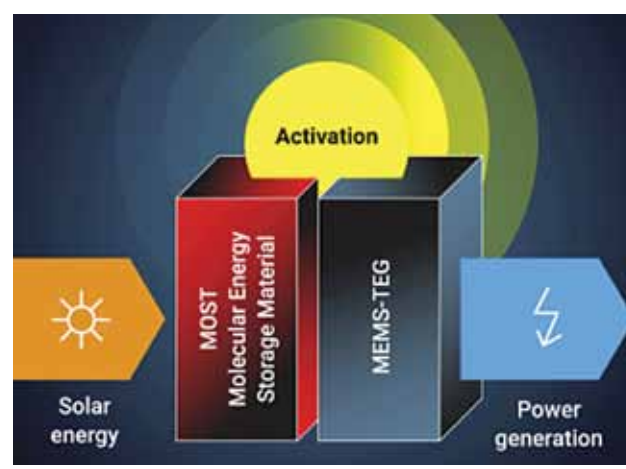
Engineers from the University of California, Berkeley have demonstrated a major breakthrough in the design of gate-oxides of transistors that could significantly reduce their energy consumption without sacrificing speed, size, or performance. They did this by leveraging negative capacitance to make better transistors with the help of engineered crystal structures. The research shows how negative capacitance may be obtained in an engineered crystal made up of a layered stack of hafnium oxide and zirconium oxide that is compatible with modern silicon transistors. They were able to show that their gate-oxide technology is better than commercially available transistors.

Speech tech for information in seven northeastern languages

IIT Guwahati researchers are developing a speech technology tool that will enable retrieval of healthcare related information in seven northeastern languages. This new technology uses spoken keyword spotting (KWS) in northeastern languages. The project's KWS systems will be able to detect a list of predefined terms in a given voice signal in one of the project's target languages. Modeling speech with state-of-the-art deep neural network techniques will be part of the endeavour. People in far-flung parts of Northeast India should be able to obtain healthcare-related information in their own languages as a result of this project.

Electricity on demand from solar energy stored up to 18 years

Researchers at Chalmers University of Technology in Sweden have devised an energy system that can capture solar energy, store it for up to eighteen years, and then release it as needed. By connecting the system to a thermoelectric generator, scientists have now succeeded in making



The concept of MOST (Credit: https://www.sciencedaily.com)

it produce electricity. The new technique is based on the solar energy system called MOST—molecular solar thermal energy. Simply put, the technique works by using a specifically designed molecule that changes shape when exposed to sunlight. Then, a generator can be used to release the energy and transform it into power.

Probe to track soil moisture and density for agriculture

A research team at Cornell University has designed a new form of instrumentation tool called capacitance probe. It uses a number of sensors to track everything from solid

Jin Xu, one of the co-authors of the study, surveys sand dunes (Credit: https://www.azocleantech.com)

concentration to velocity and water content. All of this is done with unparalleled spatial resolution. The probes can reach deep and are small, hence collecting data on a millimetre scale to determine the right quantity of moisture and sand density. The investigation revealed how porous sand is, with a small quantity of air seeping through it. The scientists believe that their probe will be used for a variety of purposes, including studying how soils absorb and drain water in agriculture, and calibrating satellite measurements over deserts.

E-textiles could replace messy adhesive sensors for animals

Purdue University biomedical engineers and veterinarians have created a new remote horse slicker (a sort of coat) that can monitor a horse's cardiac, respiratory, and muscular conditions. It is made using e-textiles technology and uses Bluetooth for communication. They developed a dual regime spray to directly embed a pre-programmed pattern of functional nanomaterials into the slicker's fabrics. Adding e-textile qualities to clothes allows scientists, researchers, and clinicians to take advantage of the

The horse slicker is being tested on a horse running on a treadmill (Credit: Purdue University)

garments' already-existing ergonomic designs to achieve a commercial grade of wearability, comfort, air permeability, and machine washability.

A system that protects solar farms from cyberattacks

A new study from the University of Georgia recommends a novel strategy to protect solar farms, which might be a target of cyberattacks. A team from UGA's College of Engineering proposed a sensor system that monitors a crucial electrical component of solar farms for indicators of cyber-intrusion in real time. They devised a system that can identify anomalies in a power electronic converter's operations in real time, using only one voltage sensor and one current sensor. The system can discern normal conditions, open-circuit faults, short-circuit faults, and cyberattacks using deep learning approaches. Even if the firewall or security software fails to identify an attack, the sensors would detect unusual activity in the device's electrical current. The system can also perform diagnostic tests to discover the nature of the issue.

This 3D printing tech could help in cancer detection

Researchers at the USC's Viterbi School of Engineering have devised a highly specialised 3D printing process that permits microfluidic channels to be built on chips at a microscale previously unattainable. The researchers employed vat photopolymerisation, a sort of 3D printing process that uses light to manipulate the conversion of liquid resin material into its solid state. They were able to print even where the channel height was at 10 micron level and controlled it accurately to an error of plus or minus one micron. The new 3D printing platform's microscale channels enabled various applications, such as particle sorting. This could have a huge impact on cancer detection and research.

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INNOVATION UPDATES

Amongst numerous press releases of new products received by us, these are the ones we found worthy of the title *Truly Innovative Electronics*

Sensor for continuous measurement of liquids

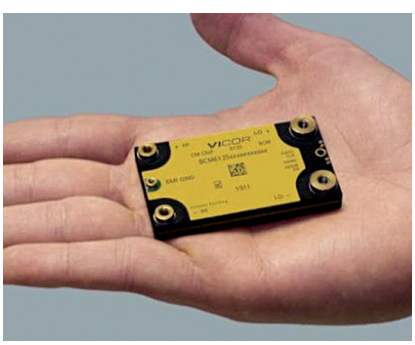
VEGAPULS 6X from Vega is a universal sensor for continuous level measurement of liquids and bulk solids. The sensor is capable of measuring under all process conditions and

offers a self-diagnosis system. It is IEC 62443-4-2 compliant, which ensures secure communication and access control. The non-contact working of the sensor enhances the working life and ensures a maintenance-free operation.

Vega
https://www.vega.com/en-us

High-density power module for automotive applications

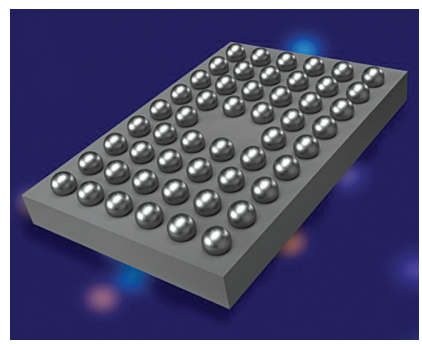
Vicor's BCM6135 is a high-density power module for automotive applications. The 2.5kW module has a small form factor that can easily fit inside the palm of one's hand. The reduced size and weight of the power-dense module provides design flexibility, scalability, and space savings for all kinds of electric vehicle development. According to the company, this module can help reduce automotive power system size, weight, and number of components by up to 70%.



Vicor
https://vicorpower.com

Industry's first Qi v1.3 certified wireless power receiver

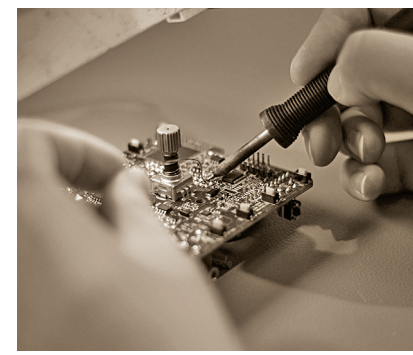
Wireless Power Consortium (WPC) has certified Kinetic Technologies KTE7000 product as the first wireless power receiver to achieve Qi version 1.3 status. The KTE7000 is a single-chip 5W wireless power receiver that conforms to WPC/Qi v1.3 Baseline Power Profile (BPP) standards. The Qi v1.3 specifications provide improved foreign object detection and enables device authentication. The Qi v1.3 can enhance automation of compliance testing, which reduces testing time and decreases potential interoperability problems.



Kinetic Technologies
https://www.kinet-ic.com

World's first image compression DTV SoC

BXE-4-32 GPU from Imagination Technologies has been integrated into Realtek's RTD2885N to optimise image quality and significantly reduce system bandwidth for an ultra-responsive user experience. Imagination's IMGIC technology available in BXE-4-32 provides lossless, frame buffer compression technology. The BXE enables higher resolution capability, lower silicon cost, and reduced bandwidth requirements.



Imagination Technologies
https://www.imaginationtech.com

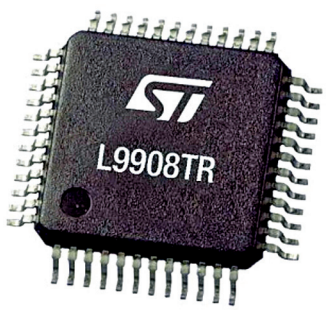
Single-antenna IoT connectivity solution

ELS62 from Thales' is a single-antenna solution that is compliant with

LTE-Cat.1bis standard. It provides a low-cost solution and simplifies design, thereby reducing development cost and time. The ELS62 module integrates security features to protect both the device and data, by ensuring robustness against cyberattacks, with strong device authentication and data encryption. It can be used in applications such as medical wearables, smart meters, and home alarm systems.
Thales
https://www.thalesgroup.com/en

3-phase GDU for 48V automotive applications

ST Microelectronics L9908 is a 3-phase gate driver unit (GDU) developed for 48V automotive applications. The GDU



is capable of controlling 6 N-channel FETs for brushless motors. It has flexible I/O channels and three current sensors. The module is capable of operating in 12V, 24V, and 48V systems. It features a 32-bit SPI interface to offer diagnostic and protection features, such as real-time phase voltage monitoring along with open load detection and a few others.
ST Microelectronics
https://www.st.com

Ultra-sensitive capacitive barometric pressure sensor

The BMP581 is a barometric sensor from Bosh Sensortec that detects fluctuations equivalent to one-thousandth of a mosquito's weight. The energy-efficient sensor is a highly accurate altitude tracking IC that can provide precise location information for applications such as indoor localisation, floor detection, and navigation. The portable size and low power consumption make it suitable for smart wearables, hearables, and IoT applications.
Bosh Sensortec
https://www.bosch-sensortec.com

New-generation 3D touchless user interfaces

TouchNetix has developed fully integrated aXiom touchscreen chips that offer new 3D sensing capabilities by detecting air gestures, allowing

touchless functions in a variety of automotive, industrial, and consumer environments. TouchNetix' single-chip aXiom technology enables proximity sensing 10-15cm above the surface of the screen and provides much higher signal-to-noise ratio (SNR) than the traditional touchscreen controllers available in the market.
TouchNetix
https://www.touchnetix.com

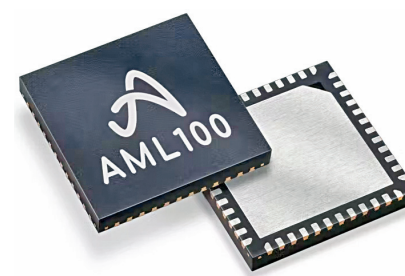
Energy harvesting and power management in same chip

Diatom NH16D3045 is a a high-performance energy harvester with an integrated power managment solution for low-power applications. The IC can be used to charge a variety of energy storage elements, such as

rechargeable batteries or supercapacitors, while it can harvest energy from light or from all types of solar PVs and from other energy sources, including kinetic, thermal, and radio frequencies. It is designed to work in the range of microwatts to a few milliwatts of power suitable for devices like smart wearables, electronic shelf labels, and wireless sensor networks.
Diatom
https://www.nowi-energy.com

World's first fully analogue machine learning chip

Aspinity's AML100 is the first product in Aspinity's AnalogMLfamily that can detect and classify sensor-driven events from raw, analogue sensor data. It allows developers to design significantly lower-power, always-on edge



processing devices. The IC consumes less than 20µA when in always-sensing, thus, enabling a ultra-low power always-on edge-processing solution for voice-first systems, acoustic event monitoring applications, predictive and preventative maintenance for industrial equipment, and biomedical monitoring.
Aspinity
https://www.aspinity.com

NEW PRODUCTS

MAKE IN INDIA

COMPONENTS

Discrete GPU series

Intel Arc-A GPU series, which includes Intel Arc 3, 5, and 7, have been developed specifically for gamers and digital creators. The Arc A-series is based on Intel's new Xe high-performance graphics microarchitecture also called Xe HPG. Intel Arc 3 is a discrete graphics family for laptops, while the Intel Arc 5 and Intel Arc 7 are for desktops and workstations. The series supports DirectX 12 Ultimate and hardware-accelerated ray tracing and Xe Super Sampling (XeSS). The XeSS is Intel's AI based imaging technology that can enhance gaming performance.

Intel
https://www.intel.com

Hardware security modules

TrustFLEX ECC608 and Trust Anchor TA100 from Microchip Technology are Qi 1.3 compatible hardware security modules (HSMs). The TrustFLEX ECC608 is an industrial grade product with a pre-configured key for Qi 1.3 authentication while the TA100 is a crypto-automotive security IC developed for automotive security applications. Both the ICs provide support for secure boot and multiple key management protocols, such as transport layer security (TLS). The secure storage subsystem offers secure key provisioning, including X.509 certificates to cryptographically verify the source and quality of the certified power transmitter.

Microchip Technology
www.microchip.com

Millimetre wave 5G chipset

Analog Devices' new millimetre wave (mmW) 5G front-end chipset is developed with the goal to reduce complexity to produce faster radios. The chipset contains four power-efficient ICs and works on a wide frequency of 24 to 47GHz radio waves. It features two single-channel (1T1R) up/down converters (UDCs) and two 16-channel dual-polarisation beamformer devices. The power-efficient ICs enable reduction of size, weight, power, and cost in mmW phased array designs.

Analog Devices
https://www.analog.com

Energy extracting PMICs

These ICs are optimised for intermittent and pulsed power inputs and are self-configurable with the ability to automatically switch between buck, boost, and buck-boost operations. The PMICs come with selectable and adjustable storage elements and protection mechanisms, which make them suitable for a wide range of applications, such as automation and IoT.

e-Peas
https://e-peas.com

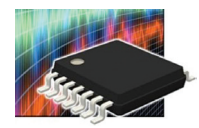
GaN converter

The 50W GaN converter from STMicroelectronics integrates a 650V GaN power transistor and has a very low power standby mode that consumes less than 30mW. It requires minimal additional components for designing an SMPS, thus simplifying the design. The VIPer50GaN also offers good efficiency at all line and load conditions along with multiple protection features.

STMicroelectronics
www.st.com

Digital potentiometers

Omni Pro has released six digital potentiometers featuring direct interface with incremental encoders and an adjustable debounce for mechanical encoder/switch. These three terminal ICs have 64 viper control for adjustment of resistance and are suitable to replace mechanical potentiometers in high vibration, automotive applications. The ICs are available in 20k, 50k, and 100k versions.



Omni Pro
Omni Pro Electronics

HV cartridge fuse

Littlefuse has released the 828 Series of high voltage cartridge fuse that has been designed and tested for use in compact automotive applications. The fuse has a high interrupting rating and provides overcurrent protection. Its small form factor along with the high operating temperature range makes it suitable for applications as a protection device in the power distribution unit and onboard charger of electric vehicles.

Littlefuse
https://www.littelfuse.com

Smart TV chips

Pentonic series of smart TV chips will enable TV manufacturers to offer

Dolby Vision gaming features. The chips can enable the Dolby Vision IQ with precision detail in the 8K and 4K smart TVs. These also allow users to watch multiple media sources in Dolby Vision in several windows at the same time. Besides, Pentonic chips improve latency through the auto low latency mode (ALLM) and variable refresh rate (VRR).

MediaTek
https://www.mediatek.com

BOARDS & MODULES

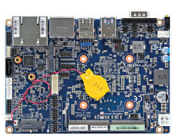
eFPGA module

Flex Logic Technologies' INFERX X1M provides great design flexibility and high performance at relatively low power requirements, making it suitable for edge AI applications. The eFPGA module comes in a compact M.2 form factor and offers an edge logic accelerator. The module is suitable for edge AI applications, such as industrial machine vision, smart wearables, image processing, robotic vision, and analytics.

Flex Logic Technologies
https://flex-logix.com

Embedded single board computer

Avalue Technology Inc. has released an embedded single board computer, ECM-EHL, equipped with the Intel Pentium/Celeron/Atom SoC BGA processor. Compared to its predecessors, it has improved performance, I/O capability, and better security features. It supports Linux as well as Windows 10. The module has extended temperature tolerance from -40°C to +85°C (with 0.5m/s air flow), which is suitable for industrial and outdoor applications under harsh operating conditions.



Avalue Technology Inc.
https://www.avalue.com.tw

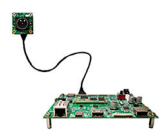
Linear power supply

Silent Angel has released the Forester F2, a linear power supply specifically made for the home Hi-Fi system. It offers four different linear power outputs that are optimised for improving the musical performance in various approaches. The power supply has toroidal transformers and low-noise MOSFETs. Its circuitry is designed to eliminate high-frequency electrical noises, make the transmission steadier, and reduce jitter and latency issues. The power supply is housed in an SECC galvanised steel box for better durability.

Silent Angel
https://www.silent-angel-audio.com

AI vision kit

qSmartAI80_CUQ610 from e-con Systems is a ready-to-deploy AI vision kit. It features a Qualcomm QCS610 SoC based SoM, e-con's 4K MIPI low-light camera module, Sony's STARVIS 4K camera module, IMX415, and a carrier board. This ready-to-deploy kit is designed for running image based machine learning (ML) and deep learning models on the edge.



e-con Systems
https://www.e-consystems.com

1200W power supply

Powerbox OFI1200A, designed for conduction cooling applications in industries, can operate between -40 and +95°C without a fan. The 1200W power supply is suitable for a wide input range between 85 and 305V AC with power factor correction. The module is available in three versions of single-output DC voltage: 12V/84A, 28V/43A, and 48V/25A. Each can provide 'near to zero' to the maximum rated output voltage and current.

Powerbox International AB (PRBX)
https://www.prbx.com

T&M SOLUTIONS

Automated test solutions

The Rohde & Schwarz ZNrun K410 and K411 are capable of automatically analysing the Ethernet cable assembly precisely. The ZNrun K410 software automates the time-intensive manual Ethernet cable testing procedure following the IEEE 802.bj, by, and cd standards while the ZNrun K411 is capable of testing much faster IEEE 802.3ck Ethernet standard.

Rohde & Schwarz
https://www.rohde-schwarz.com

Cable plus network software

Fluke Networks has upgraded its LinkIQ Cable + Network Tester soft-

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ware. The software is suitable for testing and troubleshooting IP networks and testing industrial Ethernet cabling. It provides reports including the expanded network testing and allows users to document their work. The software now supports users in twelve languages and is available in all-new LinkIQ units, It is also available as a free upgrade to the existing customers.

Fluke Networks
https://www.flukenetworks.com

Wi-Fi 6E testing solution

The Microwave Vision Group (MVG) and Anritsu Corporation have jointly developed a solution for testing the new Wi-Fi 6 spectrum extension, Wi-Fi 6E. The new solution combines MVG's multi-probe system and Anritsu's MT8862A wireless connectivity test set. The new product supports an effective, simple, and stable test environment for RF evaluation of the IEEE 802.11ax 6GHz band (Wi-Fi 6E) OTA measurements.

Microwave Vision Group: www.mvg-world.com, Anritsu Corporation: www.anritsu.com

SOFTWARE

EDA tool

The Pulsonix version 12.0 offers a 3D collision detection for both multi-board designs and board folding, and significant speed improvements over previous versions. The software adds around 100 new features compared to its previous version. Pulsonix V12.0 also has a dark mode, which reduces strain on the user's eyes and a simpler interface that reduces complexity for a new user.

Pulsonix
https://pulsonix.com

NEW FEATURES

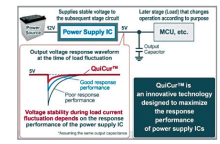
Power loss protection feature

Swissbit has launched a new power loss protection (PLP) feature called 'powersafe,' which is capable of protecting their industrial SSDs in the event of sudden power outages. During sudden power outages, extra power is provided to the SSDs to safely execute the write commands and flush data. This is achieved by using an additional PLP level to secure the data from the DRAM to NAND (cached data) or while the data is being transferred from host to controller (dynamic data). The tantalum capacitor used is one of the key components that makes the powersafe feature possible.

Swissbit
https://www.swissbit.com

Improved response of power supply ICs

ROHM has unveiled QuiCur, a technology developed to improve the response of power supply ICs that are used as DC/DC converter ICs and LDOs. The response performance involves voltage stability and response speed of subsequent stages. This technology is said to simplify the power supply circuit design by providing stable operation even with fewer external components, which will reduce the mounting area and thereby reduce the size of the product.



ROHM Semiconductor
www.rohm.com

ENTERPRISE SOLUTIONS

Dome cameras for surveillance

The Project series dome cameras from Matrix Security Solutions feature 8Mp back-illuminated CMOS sensor developed by Sony and a high MTF lens that enhances video quality in low light conditions. These cameras can support SD cards up to 512Gb and have H.265 compression and motion based frame rate reduction system that reduces the memory requirement by up to 50%. The cameras offer a fixed and motorised varifocal lens that enables options to zoom in and out of the video footage and have an IP67 rating for dust and water resistance.

Matrix Security Solutions
https://matsecurity.in

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Career

"VOLTX.AI Is A Productivity Suite For BATTERY DESIGNERS... A Free Version Is Available"

EFY chanced upon Voltx.ai, a firm that claims to offer an innovative design tool for battery designers, and spoke to Anton Doos, the CEO, to understand the tool better and their revenue strategy

ANTON DOOS
CEO, VOLTX.AI

Can you please explain your product in detail?

Voltx.ai is a productivity suite for battery designers. It has multiple tools along with a dashboard with a materials database where users can search, compare, edit, and add parts.

One of our tools, the Pack Designer, combines parts and generates over 1000 battery pack designs per second. Then it compares all the designs and shows you the best. Doing this manually would be impractical because it would take too long (in mathematics, it is known as a combinatorial explosion problem). So, by using automation tools, engineers can much more quickly gain insight and come up with the best designs.

Another tool, the Configuration Designer, is a digital grid paper for battery designers. We see many businesses relying on MS Paint or Excel to draw their configurations because there are no better alternatives. Our Configuration Designer lets engineers draw and flip cells and connections, change cell models, and in real time simulate short-circuit, current load, and others. These automation features lead to faster and better designs.

How can users access Voltx.ai?

Voltx.ai is still in the alpha stage. A free version is available for users to use and submit feedback.

Any indication of the kind of fee that you are expecting to charge?

We are planning to charge US$500 per month for five users. There is also an early adopters' discount for companies who provide us with feedback.

By when do you plan to turn this into a paid product or service? And are we correct to assume that it will be a software-as-a-service (SaaS) model?

Yes, it is a SaaS model with a freemium account. We are on track to go live with paid accounts before summer (2022). Our intention for the free accounts is that DIY users can get sufficient utility and business users can try out the software before deciding to upgrade.

Since you may add more features to Voltx.ai later based on user feedback, won't that delay industry-readiness of your product?

I believe industry-readiness looks like a sine-wave adoption curve. Our modus operandi to advance adoption is to continuously identify user problems and add solutions as features. It is all under the umbrella of the overall vision of using automation to reduce the time between concept and manufacturing. When enough problems are solved, users will find enough value, and the product will be ready for market.

Through feedback from our early adopters, we believe our next set of features will make our software market-ready. One example of this is, while talking to our users we identified that many wanted to export our designs to CAD to integrate into their existing workflow. Most businesses have standard operating procedures, and almost every engineering team relies on CAD at one point or another in their process.

Our solution created a new Export to FreeCAD button, where within twenty seconds of clicking the button the battery design will open as a CAD model on your computer and can be integrated into any existing workflow.

Why do you consider your product to be a milestone for battery design and production?

The algorithm we invented solves some difficult problems with very accurate results. We have compared the batteries designed manually by professionals with the batteries designed through our software. The results have shown very little difference. There is a considerable

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efficiency gain from this, going from tasks that take hours to tasks that take seconds.

Can you provide examples of some difficult problems solved by your algorithm?

One problem with battery design is that of a combinatorial explosion of possibilities due to the number of different cell models, configurations, and other parts.

Think of it like chess. The first chess computers quickly outperformed humans because they could analyse hundreds of thousands of moves quickly. The way people design battery packs now is like chess—humans use knowledge, experience, and intuition to constrain the total search size. This must lead to less than optimal results since the full search space of potential battery designs has not been created or analysed.

One of the ways we solved this problem is with a highly optimised algorithm that can generate the designs thousands of times per second. A second part is how we analyse and sort the results from most to least useful to present users with the optimal design.

What benefit can battery design engineers receive compared to any other similar product? What is your USP?

Other battery software we have seen focus on simulations, especially for EV packs. We focus on automating the design of any battery pack so that users can start manufacturing as soon as possible.

How is that different from other battery design tools?

From what we have seen, other battery design software are usually a sub-feature of their main software. They have high-cost software for enterprises that are designing electric vehicles and large-format battery packs. These tools focus on simulations, particularly thermal simulations.

Think of a company like Toyota designing a new electric vehicle. Our software is for any business that designs battery packs, everyone ranging from DIY to startups to enterprises. It is lower-cost than competitors, and we are more focused on small and medium format packs, although we can produce large format packs as well. That means robots, drones, home power systems, or anything else you can imagine powering is what can benefit from our software.

Another big difference is our vision and overall focus on automation and Industry 4.0. The tools we provide are intended to speed up the engineering workflow—both to find the optimal design quickly and output the necessary information to begin manufacturing. What we are building today will run tomorrow's smart battery factories while our competitor products are not guided by this vision.

Which companies and institutions are using your software? What kind of products are they developing?

There is a wide range of people using the software. We have seen one company build a battery design for a giant solar yacht. We have seen electric bikes, robots, drones, home solar systems, and many other applications. EFY

www.opensourceforu.com

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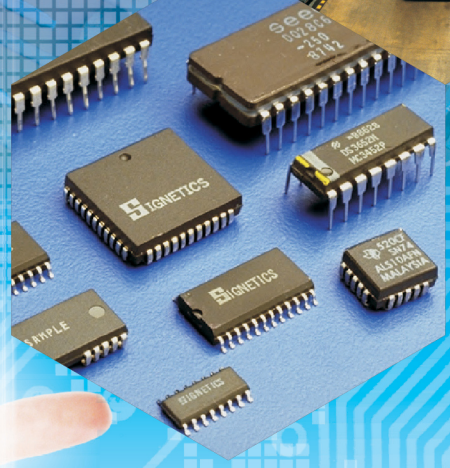

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THE DASHBOARD

Semiconductor Shortage Likely to Ease Significantly in H2 2022

Global semiconductor chip shortages are likely to continue easing during the second half of 2022 as demand-supply gaps decrease across most components. Across PCs and laptops, the supply gap for the most important PC components like power management ICs, Wi-Fi and I/O interface IC have narrowed. Inventory levels of 5G-related chipsets including mainstream application processors, power amplifiers, and RF transceivers have increased significantly.

Component	Shortage Level in H1 2021	Shortage Level in H2 2021	Shortage Level in 2022	Price Increase 2022 (YoY)
AP/SoC - Flagship 5G	●	●	●	Up 5-10%
AP/SoC - Mainstream 5G	●			FLAT
AP/SoC - 4G	●	● ●	● ●	Up +10%
RFIC/FEM	●	● ●		Up 5%
Memory - DRAM/MCP	●	●		Down 10-15%
Memory - Flash				Down 10%
CIS - 64MP and above			●	FLAT
CIS - 12 - 48MP	●			Up 0-5%
CIS - 2/5/8MP	● ●	●		Down 0-5%
DDIC/TDDI	● ● ● ●	● ●	●	Up 5-10%
PMIC	● ● ●	● ● ●	● ●	Up 15-20%
Packaging Substrate	●	● ●		Down 0-5%

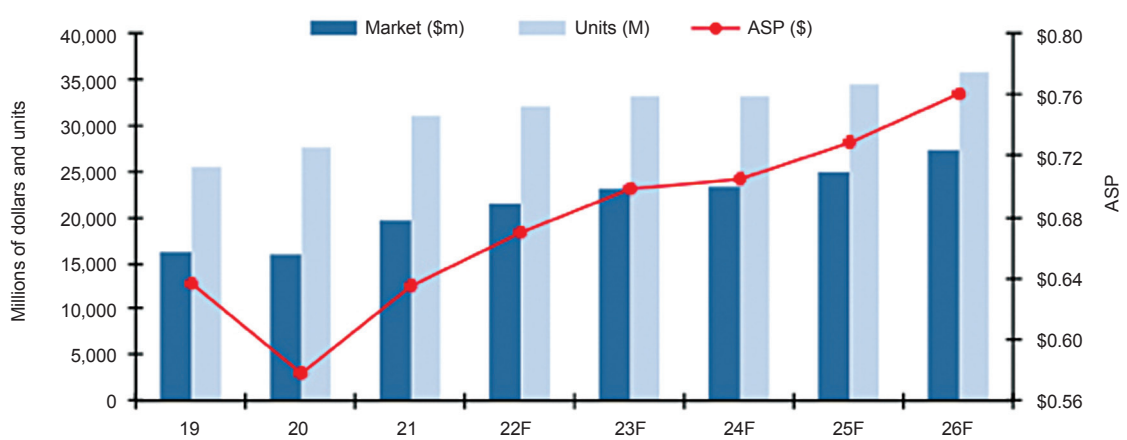
● Demand>Supply by 10%
● ● Demand>Supply by 10%-20%
● ● ● Demand>Supply by 20%-30%
● ● ● ● Demand>Supply by 30%-40%

1. Sufficient supply with price competition in 2022
2. Improving shortage to balance level in 2022
3. Slightly shortage in cetain parts in 2022
4. Remains shortage in 2022

(Source: Counterpoint Research)

Microcontroller Sales Expected to Reach $27 Billion by 2026

Microcontroller (MCU) sales boomeranged back with strong growth in the economic recovery during 2021, when the MCU market climbed 23% to a record-high $19.6 billion. Between 2021 and 2026, total MCU sales are projected to increase by CAGR of 6.7% and reach $27.2 billion in the final year of the forecast. In the next five years, sales of 32-bit MCUs are expected to grow by a CAGR of 9.4% to hit $20.0 billion in 2026.

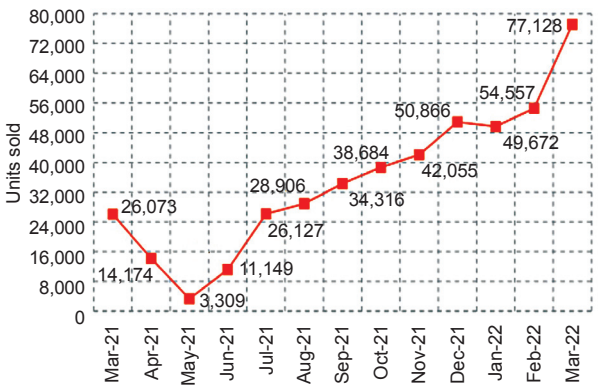


(Source: www.icinsights.com)

At-a-glance view of key industry trends that can shape the future of your business…

India's EV Sales Continue to Grow

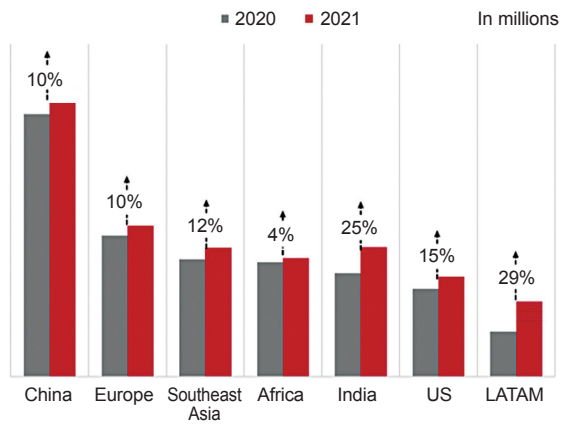
The overall EV sales in India for the month of March 2022 bounced back to its growth trajectory, clocking 77,128 units. This signifies a m-o-m rise of 41.4% and a y-o-y jump of 196%. EV registrations in March 2022 were driven by electric two-wheelers and passenger-type electric three-wheelers, which together accounted for 91.17% of total registrations in the month. The shares of these categories were followed by e-cars (4.62%), cargo-type electric three-wheelers (4.08%), and so on.



(Source: https://jmkresearch.com)

Refurbished Smartphone Market Shows Strong Growth In India In 2021

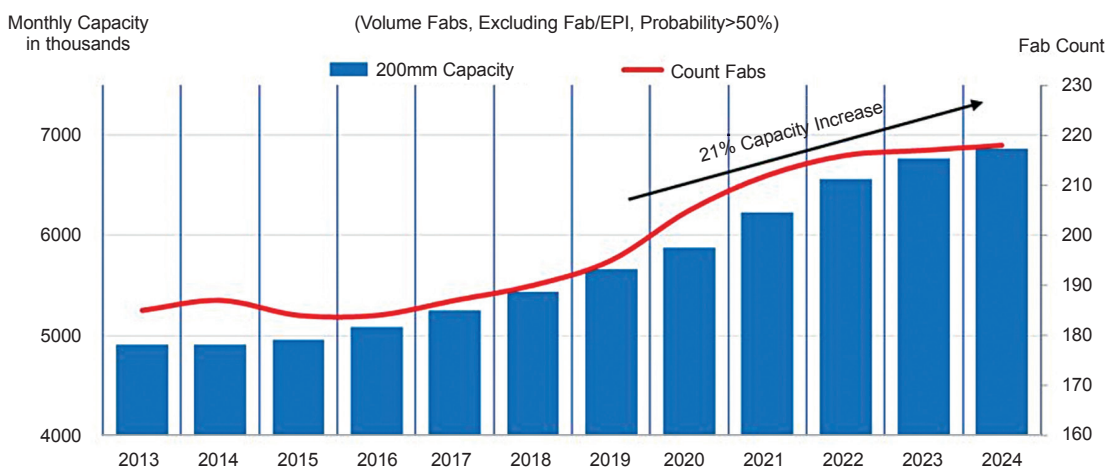
The global secondary smartphone market saw a surge in demand as well as supply in 2021. Even as new smartphone shipments grew 4.5% YoY in 2021, refurbished smartphone volumes witnessed a 15% YoY growth. Latin America and India lead with the highest growth rates, at 29% and 25% respectively. Apple remains the secondary smartphone market leader.



(Source: Counterpoint Research)

200mm Semiconductor Fab Capacity Set to Surge 21% to Mitigate Supply-Demand Imbalance

Semiconductor manufacturers worldwide are on track to boost 200mm fab capacity by 1.2 million wafers, or 21%, from the start of 2020 to the end of 2024, to hit a record high of 6.9 million wafers per month. After climbing to $5.3 billion last year, 200mm fab equipment spending is expected to be $4.9 billion in 2022 as 200mm fab utilisation remains at high levels and the global semiconductor industry works to overcome the chip shortage. Equipment investments are projected to remain above $3 billion in 2023, with the foundry sector accounting for 54%, followed by discrete/power at 20%, and analogue at 19%.



(Source: www.semi.org)

Beyond The 4Ps OF INNOVATION

If you were offered a carbonated drink in a glass, what are the chances that you could easily identify whether it was Coca Cola or Pepsi? Would you even care? Well, hold on to that thought as we talk about several types of innovations first

ANAND TAMBOLI
is a serial entrepreneur, speaker, award-winning author, and an emerging-technology thought leader

People have been talking about the 4Ps of innovation for quite some time. While these lenses have served well in the past, they are becoming outdated now. With the level of chaos that is going on around the world, I would say they are ripe for an update. But before we discuss the update, let us recap what those 4Ps are.

Product or service

The first P in the list of 4Ps is your product or service; the thing that you offer to your customers. So, when someone says innovate your product or service, they want you to create and introduce a new product or service to your customers. Sometimes, it does not have to be a completely new thing as an improved version of previous products or services qualifies. The caveat is, of course, there must be some enhancement in quality or overall performance. There must be some material change.

This type of innovation is mostly driven by technological advancements, outdated product designs, changes in customer requirements, competition, etc. What is peculiar about this type of innovation is that it is clearly visible to customers. Mostly because they are the direct receivers of it.

Process

The second P in 4Ps is the process. It is all about how you create and deliver your product or service. This may include changes in the equipment and technology used in making the product. In addition, there might be an improvement in tools, techniques, and solutions used to help in making and delivering the product or service. It also includes processes you use to maintain your goods, accounting methods, customer service, etc.

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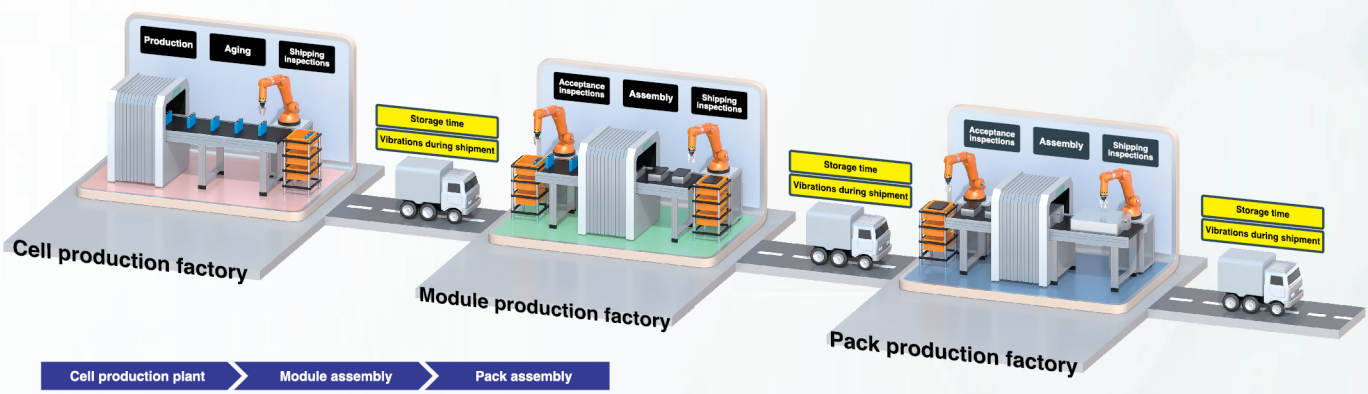

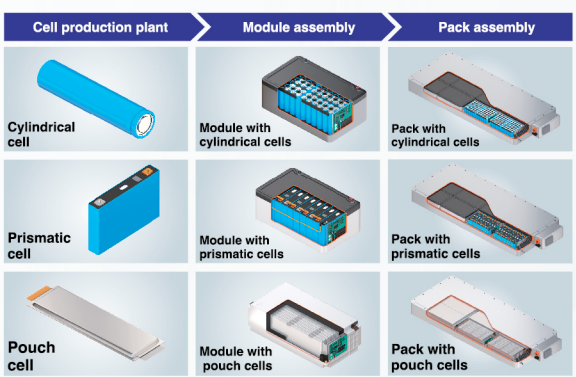

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This change may not always be visible to customers, and they may not even realise it sometimes. But from a business's point of view, process innovation often leads to bottom-line impact.

Position

Third P is about product positioning in the market. It is about who do you offer your product or service to. It is about the story you tell about your product or brand. This helps create a unique position in customers' minds and the market.

Most of the time, positioning-related innovation is geography or demography-specific. Customers do not easily recognise this innovation as it may not happen directly. However, if the existing customers are part of the same geography or demographics where you reposition your product or service, they can easily recognise it. The outcomes usually affect the business's top-line, expanding the market, and hence the sales base.

Paradigm

The last one in 4Ps is paradigm innovation. It is quite complicated compared to the other three. And that is because this innovation is about the business's mental model, that is, how your business thinks about why you do what you do and for whom. You can also call it a high-level business model.

It is the hardest to handle because it expresses your understanding, which you want your customers to appreciate. Nonetheless, many companies use it during their brand revival efforts.

Now back to my main argument regarding the significant update to this 4P based thinking. A lot has changed in the last few years, especially in the last two years. And as the change percolates through various aspects of society, it will affect businesses and how they approach innovation in their business.

We often insist on data to make informed decisions. But this is a data abundance economy. Everyone has enough data to prove their point.

It is not about right or wrong data. Every data has some perspective. This puts every business in a strange fix. It compels us to look beyond data, which can be more powerful and useful.

SO, THE PRODUCT, PROCESS, PARADIGM, OR POSITIONING INNOVATIONS ARE NOT HELPFUL. THIS IS THE NEW WORLD. THE 4Ps OF INNOVATION HAVE SERVED WELL IN THE PAST. BUT NOW, THEY ALONE ARE NOT ENOUGH. WE NEED TO UPDATE OUR PERSPECTIVE AND THINK BEYOND THE 4Ps OF INNOVATION.

How can it be done? Let me show you an example to prove my point.

At the beginning of this article, I asked you to think about carbonated drinks and your choice. People were clearly divided between Coca Cola and Pepsi until the last few years. They still are. Both brands have tried their hands at all the 4Ps of innovation successfully. But now, if you combine their 4Ps with available data and look at the bigger picture through a different lens, it will change your perspective significantly.

Allow me to share some data. And this data is coming from a Harvard study. It is called impact weighted accounts initiatives (IWAI). Using sample data and findings from that study, here is how these two brands stack up.

Coca Cola's net revenue during 2018 was approximately $31.8 billion. But to generate this revenue, its total environmental impact cost was about $3.7 billion. We are talking about many things, such as plastic waste produced, drinkable water consumed, drinkable water wasted, etc. And that means, if they were to pay for all the environmental costs, according to Harvard, their real profits would be about -11.6%, a loss!

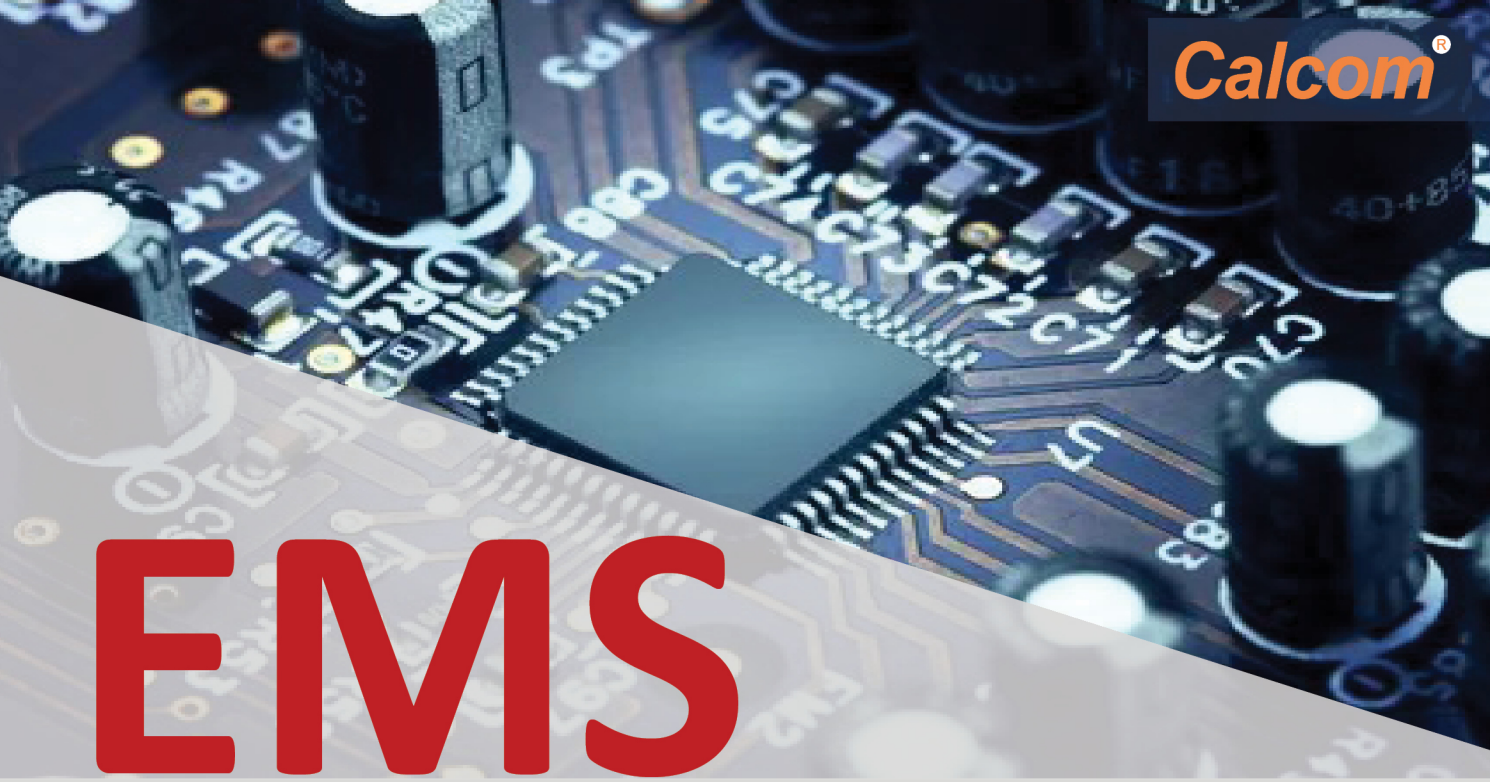
What about Pepsi? Pepsi's net revenue during 2018 was about $64.7 billion, about twice as much. Pepsi's environmental impact cost was about $1.8 billion to generate this revenue. And it means, if Pepsi were to pay for all the environmental costs, their profits would be down to about -3%, also a loss. And remember, we are talking about a like to like comparison here.

The bottom line is, Coca Cola is four times 'dirtier' than Pepsi. Does that change your preferences? What do you think about it now? Do you see a point favouring one over the other?

I do not see why I would choose one over the other. For me, both do not fit my personal brand promise. Both are not aligned with what I am about as a person. And it is not just about these two brands of carbonated drinks, but also about all the others. They all affect the ecosystem similarly, some more, some less.

So, the product, process, paradigm, or positioning innovations are not helpful. This is the new world. The 4Ps of innovation have served well in the past. But now, they alone are not enough. We need to update our perspective and think beyond the 4Ps of innovation.

What do you think? EFY



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PICK AND PLACE MACHINE
Selection Made Easy

If you are planning to purchase a new pick and place machine for your manufacturing unit, here are a few insights from experts that could help you select the best machine for your specific requirement

ABBINAYA KUZHANTHAIVEL

A pick and place (PnP) machine makes use of comprehensive mechanisms to mount small electronic components and SMDs, such as capacitors, resistors, and ICs, onto a printed circuit board (PCB). It ensures that the small components are picked up carefully and placed accurately onto the PCB. The machine can be manual requiring placement by hand, semi-automatic with software assistance for placing, or automatic for typical mass manufacturing units with in-line facilities. Combined with their respective strengths, here are a few parameters to consider before investing in the machine.

The PnP machines have considerably improved recently to achieve speed with accuracy, and flexibility. However, standard requirements for specific parameters, like accuracy rate, component sizes, and board sizes, have not changed much. The future of SMT production is anything but predictable according to experts. With rapidly changing build schedules, there is a proliferation of new materials and advanced components to locate, load, mount, and trace. As these high-mix challenges go mainstream and mid-volume, real productivity and throughput suffer. Several equipment manufacturing firms are trying to solve precisely these challenges.

Yamaha Motor's Z:TA-R YSM40R (Credit: https://global.yamaha-motor.com)

Let us have a look at some of the features and the challenges so that you can select the most appropriate machine for your production house.

Machine construction. When selecting a PnP machine, the most important factor is its construction. It determines the machine's effective components per hour (CPH) number, footprint, and the number of component feeders it can accommodate. The construction may either be all-welded steel or a bolted-together frame.

The most accurate machine may come with a welded structure to provide significant stability for accurate positioning and high-speed movement in X and Y axes. This suits any production environment without need for calibration. Apart from this, careful selection of centering methods and component positioning systems can support optimisation.

Placement speed. CPH is the measure at which the machine will pick up and place components onto the PCB. The speed measured in CPH will have a direct impact on production volume. Many PnP machine manufacturers rate their machines based on the IPC 9850 standard, a general guide for part mix and PCB placement arrays of their machines. It helps determine the throughput after accounting for feeder changes, transfer

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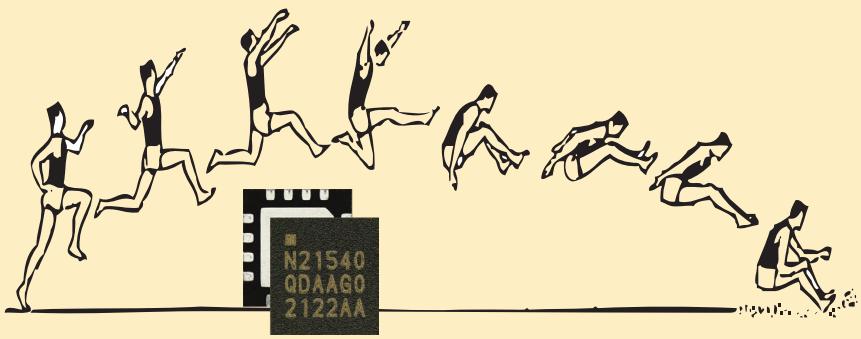
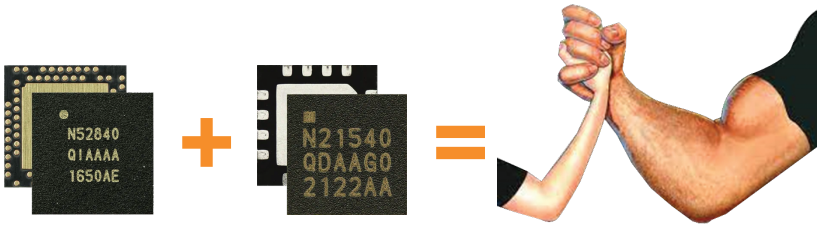
Nordic nRF21540

RF front-end module (FEM) for Bluetooth® Low Energy, Bluetooth® mesh, Thread and Zigbee and 2.4 GHz proprietary range extension



The nRF21540 is a 'plug and play' range extender offering enhanced link robustness with an integrated power amplifier (PA) and low noise amplifier (LNA) for use in our low power short-range wireless solutions. It is a complementary device optimized to boost the link budget of the nRF52 and nRF53 Series advanced multiprotocol wireless SoCs. When combined with an nRF52 or nRF53 Series SoC, the nRF21540 RF FEM's +20 dBm TX output power and 13 dB RX gain ensure a superior link budget for between 16 and 20 dB improvement. This equates to a 6.3 to 10 times theoretical range improvement.



nRF21540 SiP includes below features:

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- 13 dB RX gain with 2.7 dB noise figure
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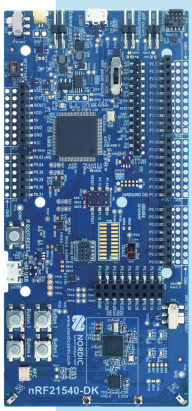
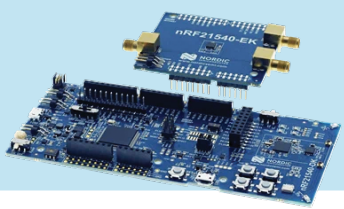


1. nRF52840DK + nRF21540DK
2. nRF52833DK + nRF21540DK
3. nRF5340DK + nRF21540DK



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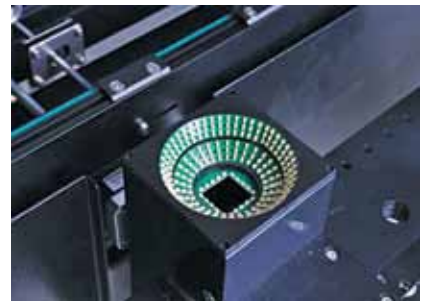
Juki Corp's RX-8 (Credit: https://www.juki.co.jp)

time, and other adjustments along the entire assembly process.

The industry is working towards faster machines every year to match the increased speed demand. Yamaha Motor's ultra-high-speed modular Z:TA-R YSM40R is one of the recent launches claiming to offer 200,000 CPH. The speed is said to be achieved by edge technology, including innovative high-speed rotary heads and linear motors incorporating new, high-speed algorithms, with the machine width of just one metre.

Juki Corp's RX-8 is another recent launch that claims to have the highest placement rate per square metre with CPH up to 100,000. It is compact and modular, featuring 998mm width. The new P20 placement head, designed for placing ultra-small chips and small integrated circuits (ICs), is credited for high-speed picking and placing from the single reel.

Intelligent camera systems. A camera system with high resolution improves the overall speed of the machine. New machines focus on their camera systems, like the one in the Neoden 8 PnP machine. It comes with the HR Flyvision camera



Vision system inside Neoden 8 PnP machine (Credit: https://neodenusa.com)

system for component recognition and Double Mark cameras to reach the extreme end feeders for better calibration.

Component handling. The PnP machines handle the minimum and maximum component dimensions according to the production needs for chip-scale package (CSP), ball-grid array (BGA), and other odd parts. The machines need various alignment methods to handle such a range of components, say, from minimum sizes of 0402, 0201, or 01005. Tiny components smaller than 0402 may require additional nozzles. The machines with single alignment give more precision and speed. An alternative alignment system can handle large component sizes.

However, one should remember, not all machines that can handle large components can also inspect them. Hence, most of the new launches with the latest vision system and software can take on everything from 01005-size flip chips and CSPs to large quad flat packages (QFPs) and ball grid arrays (BGAs). Even tall, odd-shaped and through-hole components can be mounted with ease.

For instance, ASM Assembly Systems has a complete solution from component pickup, image recognition to placement of odd-shaped components. Its Siplace TX models are said to work with up to 48,000 CPH with minimum 0201 (metric) and maximum component size of 8.2mm × 8.2mm × 4mm.

Number of pick up heads. A PnP machine has single or multi-heads to grab different shapes and heavy parts. Equipped with a number of nozzles to grasp the components, the head is movable in different directions simultaneously to ensure high productivity and flexibility.

For instance, the Yamaha YRM20 comes with a rotary RM head that is claimed to achieve 115,000 CPH. It features a one-head solution that can carry components of odd shapes and eliminates the need for head replacements, thus improving the component feed speed.

Similarly, the Neoden 8 model has eight synchronised nozzle heads to give repeatable placement accuracy.

Smart feeders. Recent machines focus also on the feeder capacity.

ASM Assembly Systems machine (Credit: www.asm-smt-tools.com)

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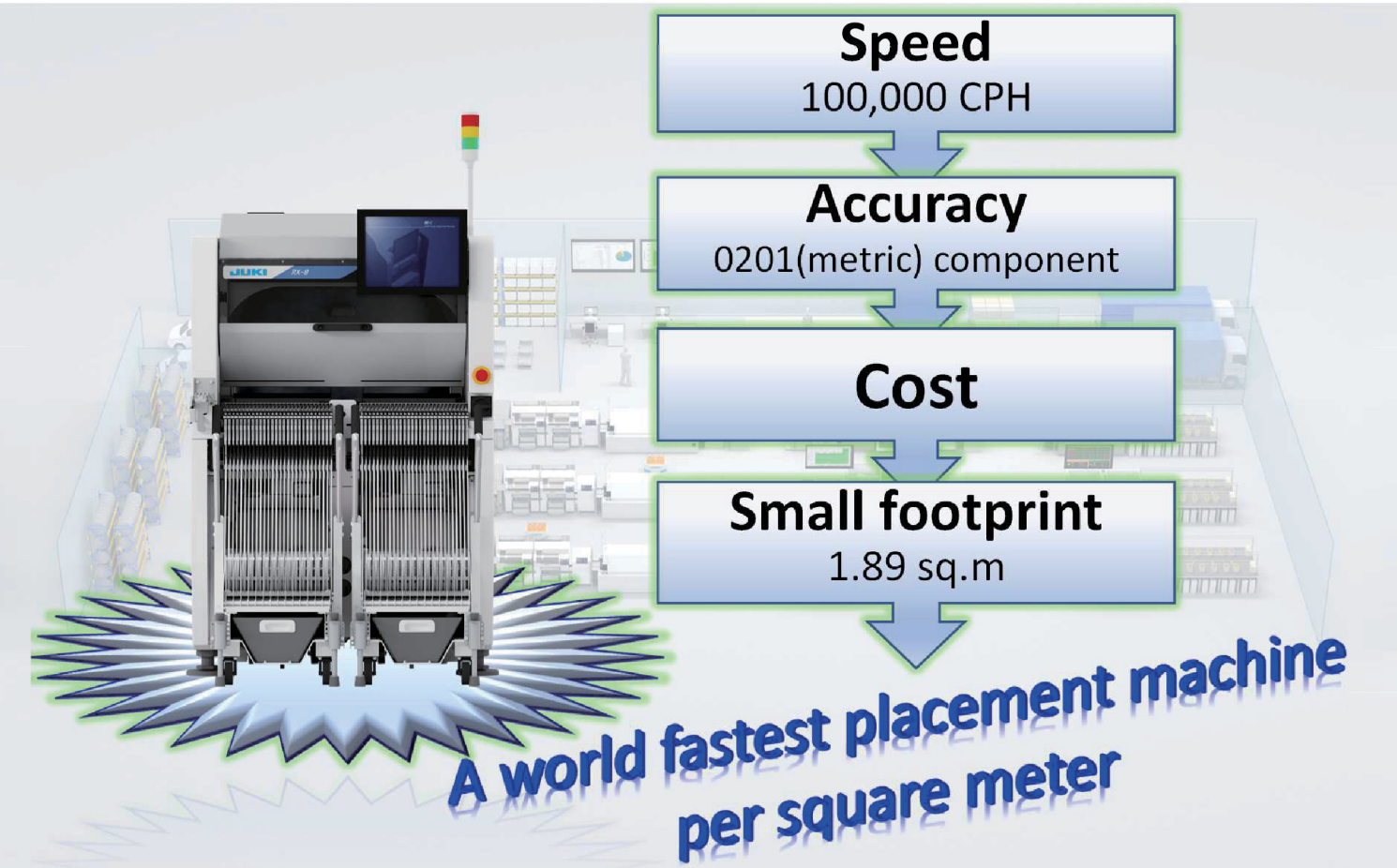
RX-8

A new high speed placement solution from JUKI



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Yamaha YRM20 (Credit: https://global.yamaha-motor.com)

The larger components may require larger feeders. So, it is advisable to figure out the number of slots needed for larger tape feeder types, say, from 4mm to 56mm.

Mycronic MY300 has an 'intelligent feeder' solution that is claimed to take less than ten seconds of loading time. Agilis tape and stick feeders and tray handling systems in the machine are said to handle a wide range of components to meet the needs of today's SMT manufacturing grounds. The compact 4, 8, 12, and 16mm Agilis tape feeders come with an innovative cover-tape separator on the pen-sized feeder that exposes components for easy picking. The feeders provide quantity and location tracking, operator guidance, simplified data entry, moisture sensitive device (MSD) handling, and on-the-fly changeovers. Fully operator-independent, it ensures higher productivity in a smaller footprint. Its product set-up time is another important feature for quick processing.

With the SMT measuring feeder feature in place, there is no need to measure materials manually, which improves the efficiency and avoids the occurrence of material error. The recent machines feature component verification before placement to ensure the right component is placed at the right location and comes with RCDT (resistor, capacitor, diode, and transistor) measurement tools. Neoden 8 features pneumatic feeders.

Component lead pitch. Industry experts consider 0.012 fine pitch as an unsaid thumb rule for selecting PnP machines. The component lead pitch is the distance between the centres of the leads. However, experts warn buyers to not be moved by motor specifications or accuracy as even machines with great motor accuracy may not pick up, inspect, and place fine-pitch components.

Smart bin system. The most common reason for unplanned downtime in high-mix electronics manufacturing is missing material. A smart bin system helps machine operators minimise downtime by ensuring that all needed material is collected and prepared just-in-time for production. Building on other powerful material handling solutions, the system brings ease-of-use to the kitting and changeover process. The end result is faster changeovers and higher utilisation.

Next-generation precision. The latest pick-and-place solutions combine rigid machine frame, advanced mount head technology, and automatic thermal adaption for the highest levels of precision. The MY300 adds an improved line scan vision system to take this accuracy into the next generation. It combines three programmable light sources with either 2K or 4K resolution to ensure a future-proof solution for the most advanced components down to 0.15mm pitch. Both options provide extremely precise on-the-fly positioning and inspection for any type of miniaturised or specialised component

Accuracy and repeatability. Experts' candid recommendation regarding accuracy for PnP machines is 0.00254mm (0.0001-inch) with a fine pitch lead of 12mil repeatedly. Though such high accuracy is commonly characterised for high-budget machines, one can always find a used PnP machine to attain such results. Besides, remember to buy a machine that comes with software suites to handle the process.

Featuring a single turret head

Eight synchronised nozzle heads of Neoden 8

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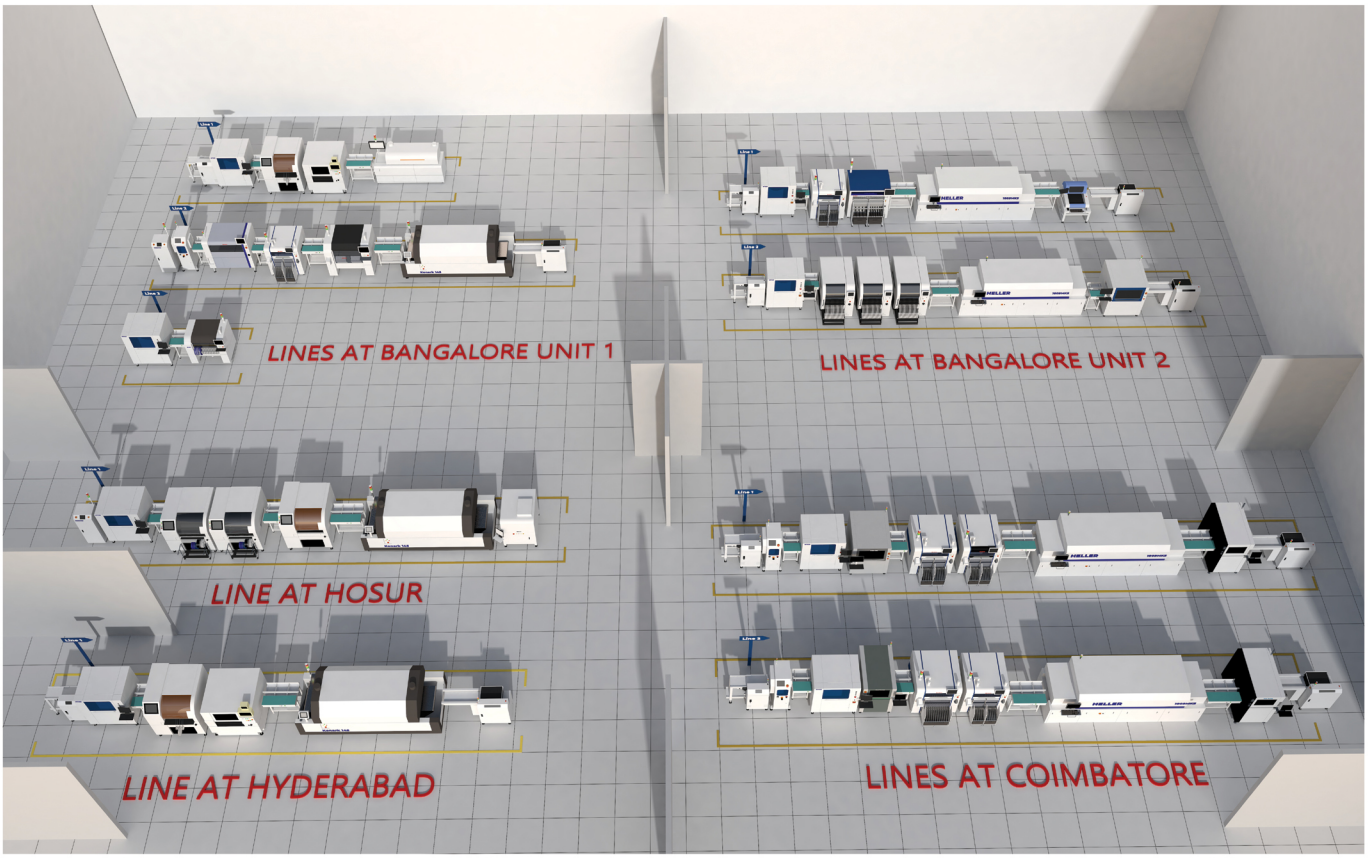

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with eight or twelve nozzles, Europlacer's ii A1 model is said to deliver flexibility in handling a broad range of components with 164 feeder positions and two internal matrix trays, all in a compact footprint. It also features the firm's patented intelligent conveyor with board stops under full software control.

Software suite. If you are considering purchasing automatic machines, how are they programmed and what are the software used should be answered. The software has three primary goals of easy use, flexibility, and optimising performance.

Whatever, remember to check if your model comes with a computer or just the software. This can neither be good nor bad as some users prefer to install the software on their own PCs. A fully integrated system is the best choice to avoid software compatibility issues, however.

Also check if the machine runs on a familiar graphical user interface (GUI), such as Windows, or a proprietary system. Most operators prefer a standard GUI since a proprietary GUI may require a longer learning curve. CAD download, teaching camera, barcode readers, management information system (MIS), and optimisation functions and off-line programming can all make the operator's job easy and efficient. Hence, a strong software suite is important to make the process easy and traceable.

Mycronic MY300 (Credit: www.mycronic.com/en)

For instance, DDM Novastar adds a unique programming software—SMTrue Run Optimise—to the full-scale SMT assembly services it offers. The software is used for making offline programming of automatic SMT machines to derive increased efficiency and throughput.

ASM Assembly System also has IIoT interfaces for integration into line and factory systems (ASM OIB, IPC-Hermes 9852, IPC-CFX) and the cloud (ADAMOS) with advanced workflow solutions for setup processes, material management, factory monitoring, and factory integration.

The new machines are also using a lot of open source software. OpenPnP is an open source SMT pick and place system that includes ready-to-run software and hardware designs that you can build and modify. Index PnP is an open source pick-and-place machine that is among the recent launches designed for mass-production volumes typical of crowdfunding projects.

Europlacer's ii A1 model (Credit: https://europlacer.com)

Other important considerations

Populating more boards and machines that are fit for any intelligent factory, complete with fully automated material flow, faster changeovers and open interface software is the real pursuit of the industry. There is no limit to the minutiae of pick-and-place machine specifications. You may have to select the features as per your needs.

Unlike the rapid placers, precision placers often do not use mounted nozzles. They may rely on gantry-supported moving heads with relatively few pickup nozzles. While the conventional four-head vertical heads were only available in table-top machines, now they have evolved into automated machines.

Some machines may have to optionally be fitted with a dispense head for depositing adhesive on the board. If you require this feature, consider the dispense method, dot size, and dispense speed.

Maximum and minimum PCB or panel size and thickness can be critical requirements for some manufacturers. Fiducial recognition, coordinate correction, and bad mark detection should be standard for any automatic PnP machine.

New machines have a 3D stereo measurement feature for the through-hole device that easily identifies the image of the vertical pin and height of the component lead to detect bending deformation. This tells whether the through-hole components are placed accurately to ensure the correct height after placement, and thus reduces the need for operator's visual inspection. Simi-

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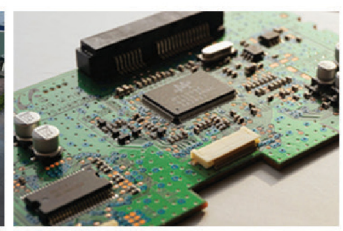

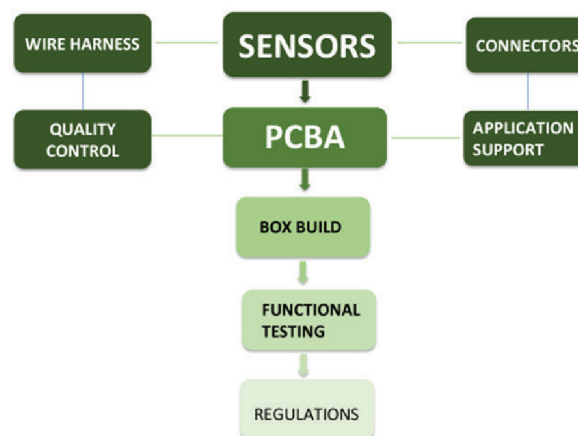

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larly, pattern feature recognition is another aspect intended for special components to recognise irregular placements and ensure accuracy.

Experts also try to find the best acceleration. In many cases, the acceleration of large components is set manually. Recent upgraded machines can automatically detect and accelerate to ensure the quality of placement and maximise the utilisation of equipment.

The next idea catching up is of PCB placement inspection. Before valuable components, such as BGAs and land-grid array (LGAs), are placed, interfering object detection is carried out in the placement area below these components. The foreign material/parts in excess are found in time to avoid placement defects. This can check whether there are any missing components under the shields before they are placed, which may play a good protective role in improving product quality.

The automotive electronics industry is expected to increase the demand for SMT continuously. Considering that automotive products have higher requirements for personal safety, service life, and outdoor use conditions, the reliability and durability needs of automotive electronic products are higher than those of others.

New PnP machines feature technologies like auto-cut sensor and advanced sensor technologies. Auto-cut sensor technology is a human safety feature that temporarily stops the process to avoid serious hazards or machine damage on human intervention. Advanced sensor technology helps a specific set of sensors, like in-sensor, out-sensor, and waiting sensor, in tracking the PCB at every stage in the production process.

Index PnP (Credit: https://github.com/index-machines/index)

Auto-optimisation is another feature to consider as it can suggest feeder and nozzle measurements. There is also a feature called regular automatic detection for nozzles. The closed-loop control of the nozzle ensures that the nozzles on the placement head are always in a normal clean condition, and the contaminated and damaged nozzles are automatically replaced in time.

Choosing the best

The latest generation of the placement machines sets new records in speed, floorspace performance, and accuracy for high-volume production applications. Smart factory solutions are fast becoming a trend in the electronics manufacturing industry to cut down on costs and improve efficiency of production.

However, buyers should pay attention to performance and usability in relevance to their manufacturing needs. Machines are available in various price ranges with a wide range of customer support and maintenance. Keeping in mind the investment on machine is vital to avoid spending a fortune on costly outsourced machines.

While the classic PnP vision systems are difficult to work in areas requiring production tolerances and deviations, Schubert Group—a company developing modular packaging machines—suggests its neuronal networks based on artificial intelligence could be a solution of the future. "The image processing system therefore learns on its own and sorts the products into classes independently in a longer learning process. This means that the parameters are selected by the system and no longer by the programmer. For customers, this means a significant step towards independence—In the future, they could actually use neuronal networks, under certain conditions, to teach their packaging machine to handle a new product on its own," writes Dr Abdelmalek Nasraoui on the company website. EFY

The article has been compiled with key inputs from:

- Jae Won, ASMPT Solutions
- Priyesh S, Chipmax Designs Private Ltd
- Mohamed Tharik Ajee, Enthutech
- Arvind Gopal Joshi, Accurex Solutions
- Suresh Nair, Leaptech Corporation

Abbinaya Kuzhanthaivel is a technophile at EFY with interest to write on electronics, communication networks and open source

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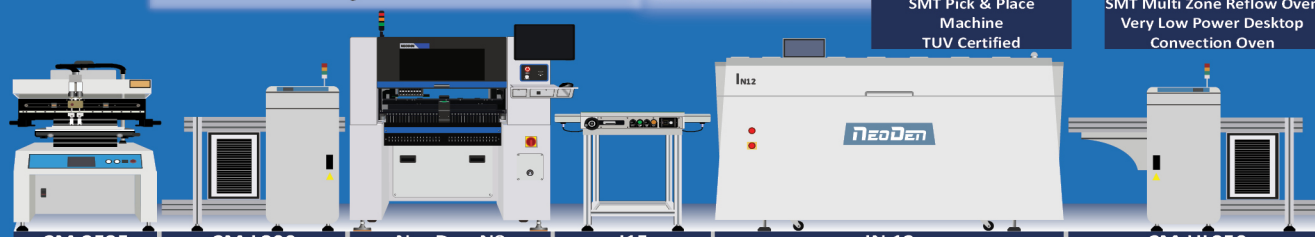

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INDIA SEMICONDUCTOR MISSION: India Needs To Do Enough To Sit On The World Table

The government's strong foot forward with regards to the semiconductor space was a much-needed move and, although late, it is expected to herald the golden era of the electronics industry of the country

SIDDHA DHAR

Even kids today are aware that there are things called semiconductors and chips. Some of them even know where these are used thanks to the semiconductor shortage that has been rattling the world since the onset of the Covid-19 pandemic.

But in India, this awareness is not just an outcome of the global chip crisis. The government of India's recent endeavors to make the country self-reliant in the areas of chip manufacturing has a greater part to play in beginning a conversation around hardware manufacturing in every other household, something very few in the country cared about before.

The government has come up with an ambitious ₹760 billion incentive to build the semiconductor industry of the country. Although the roots of it lie in reducing its dependence on China, the move has been long awaited by the industry, and thus, highly lauded. Better late than never, right? However, no matter how ambitious the plan, the industry which has been neglected for the longest time now needs to buckle up and get a few things straightened out before it can dive headlong into the game.

"I think we always talk about three aspects: economic security, cybersecurity, and infrastructure security. The infrastructure in particular needs to be built. It is high time because otherwise we will be in trouble in the future. You need to have a seat on the table," says Dr Satya Gupta, President, VLSI Society of India.

Building the ecosystem: There's more than what meets the eye

"I think that if there is any nation that can emerge as a superpower in chip design, along with China, India has to be there," notes Dr Naveed Sherwani, CEO, Rapid-Silicon. The road to the zenith, however, is a long and risky one, something Indian businesses are yet to be ready for. In our bid to achieve self-reliance, big corporations are

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necessary to give our mission the momentum, but the ultimate goal must be reached by homegrown chip companies.

It is a widely known fact that making chips is a precarious business, which needs steep investment. It becomes even more tedious when a new startup wants to enter the space thanks to the high cost of entry. "The first challenge these startups face is the cost of EDA tools which are prohibitively expensive. Almost 25% of the total cost of the entire design chain is attributed to the cost of the EDA tools," says Vivek Khaneja, Executive Director, C-DAC.

And although this is being addressed to some extent by open source tools and open domain companies, which help provide easier access to EDA tools and IPs, the truth is that their standard offering is beyond the reach of a small startup.

Availability of IPs is another major obstacle that prevents chip startups from moving forward. When you are trying to solve a problem, you will create a solution that has some sort of programmability and peripheral IPs. Getting hold of those IPs, which are silicon proven today, is not easy and, most importantly, it is not cheap.

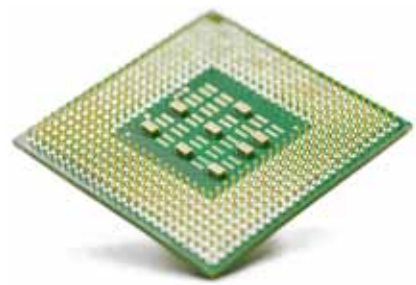
Open source IPs have made life easier but only on the surface. At the crux of it, the quality of such IPs may be subpar and integrating those IPs in the design is a matter of shooting in the dark with the hope of striking Eureka.

Additionally, building a prototype for a chip startup is extremely difficult due to their limited funding and the fact that, typically, foundries refrain from giving them much leverage when it comes to prototyping.

Mike Wishart, CEO, e-Fabless, points out, "You look at what happened in software, by removing all the upfront cost, they took out the 'no' out of innovation. One of the biggest issues you get in silicon is that there are so many things you have to spend money on."

Funding for chip startups

"Based on my experience of raising money for my own company, a big part of getting companies funded and up and running is, in fact, persistence," explains Wishart. Hardware startups are notorious for being incapable of catching the eye of investors due to the high investments that they require along with the even higher risks and marginally lower profits associated with them.



When you come back to the life cycle of funding a company, it is a 'crawl-walk-run' cycle for every company. The crawl part is when you have to get the proof of concept, and then come the walk and run part when you produce it and then scale it up. "The funding difference between software and semiconductor is not that different in the walk and run part but it's the crawl, the getting started part, which is the killer," says Wishart.

The existing semiconductor ecosystem is built and consolidated around creating and making standard product chips for mass markets, where the basic model is to pour tremendous amounts of money into capital equipment and R&D, create a product and sell a lot of them to enable PCs and phones. Industry leaders emerged in areas like EDA, IP, and foundry and they quite understandably protected their investment licenses that must be signed and often paid for upfront. As a result, not only did it get more expensive to start a company, but it also became incredibly time consuming.

The emergence of open source led to a great amount of cost-reduction along with simplification, sharing and faster time to design. Yet, their delivery for chips that are optimised for quality, power, performance, and cost is often not at the level required for startups to be able to scale their product. It gives the required push, but it may not be sufficient to keep the momentum.

Building a company from the ground up is a tedious task. As such, building a chip startup is difficult on its own. Moreover, the chip ecosystem is an extremely rigid one that leaves very little space for newcomers. How do we turn the tide?

"I think the tide will only be turned if there is a demand for locally produced chips," says Sherwani. While the government's efforts to support domestic startups to encourage them to build chips is commendable, there is a need for these chips to come to the forefront, which can only happen when enough demand is created.

Sherwani suggests having provisions that may help incentivise the use of locally-made chips.

"I'm not saying putting a barrier for big players, but indigenous players need to be given more benefits. As part of this overwhelming plan, we must create incentives for startups," Sherwani adds.

Lack of VC infrastructure

The lack of a proper venture capitalist (VC) or venture capital infrastructure is another obstacle in allowing proper funding to flow in the right direction when it comes to hardware startups. A lot of VCs that exist in the country do so only on the surface level. At the core, these are just US based VCs who operate in India, among other places. The need, in this case, is much more precise—India needs Indian VCs—to understand the local demand

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—Authors: *Asher Vinod along with inputs from Prashant Kalalabandi, El Camino Technologies Pvt. Ltd.*

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The age of AI and future of EDA

While all this chatter is taking place, software companies have also started realising the importance of chips. Marking their own presence, companies like Google have begun making their own chips and even released an AI based floor planning tool.

AI has taken the world by storm, having been incorporated into every little aspect of our life. It is only natural that the chip industry would get the taste sooner or later. Will this change the EDA space? Will AI take over the chip making process, eliminating the need for human intervention forever?

While tools like these are a welcome innovation in the industry, even by staunch hardware guys, the fact remains that removing human intervention completely is yet a far cry. "They will be helpful for simpler chips. For more complex chips, human ingenuity is still needed. A master floor planner is still needed but the iteration we go through can be helped with through AI. AI can be helpful for more productivity," says Sherwani.

But one of the biggest aspects that the entry of AI would change is the access to EDA tools, especially for companies that have limited resources to access world-class tools. "I think this is one thing that EDA companies have resisted to this day. If the tools move to cloud, then hooking it up with the additional tools on the cloud will really help everyone all over the world. But we need to have a wider ecosystem and AI will provide that, I think it could be a good step," adds Sherwani.

and fuel their capital to meet those needs.

With the semiconductor policy in place, there is hope for such an infrastructure to be built. But that needs a lot of push to come from the industry to show how marketable their product is, whether in local or global terms, in order to attract the right set of eyes towards them and let the pendulum of reverse brain drain going.

A common problem that many tech startups face is the lack of business acumen. No doubt intensive technical knowledge is critical, but the lack of decision making collapses a business even before it begins. And the problem is a deep-rooted one.

While a lot of design moved to India, design decisions never moved to India. Big MNCs may have 10,000 people working for them in India but no decision makers are here. The people who are buying chips are mainly in the US and, as such, one key thing that never happened is that chip buyers and people who specify what chips need to be designed and how they need to be designed were ever here in India.

This lack of critical decision making has led to the workforce in India to be unaware of the specific market demands. And when this workforce starts out on its own, it is only natural that their product does not fit market standards. This becomes another hurdle in getting the right funding where the VC's expectations and the product just do not match.

Leveraging the academia

A large part of Silicon Valley's success is attributed to the contributions made to innovation and collaboration of the academia and the industry.

Subhasish Mitra, Professor at Stanford, says, "There are three key aspects in which US universities have made a big mark. They are not all Silicon Valley aspects, which is why I believe we can emulate the same in India because I think the expertise that is needed in each of these areas, India has that."

The first aspect, Mitra reiterates, is the ideas that come out of academia. The way this happens is that they pick a problem that, if solved, would have a big impact.

Second, there needs to be a mindset shift to not just focus on creating specific chips but also create the fundamental technologies to figure out how to create the next technologies that will enable the next generation of chips. Here, too, the formula is the same—you pick a problem that is really important and try to find an end-to-end solution.

Third, it is necessary to give due focus to the electronic design automation (EDA) aspect. The innovation that happened in that aspect was, again, they followed the same formula of problem solving.

Mitra asks, "Why can't India do all of this? Because if you look at the expertise in India, Indians have creativity that is directly connected to chip design and at the same time Indians are very good at math. So, there is no reason why India should not shine there."

But while ideas from academia are long-range and industry changing, they also require heavy investments and have long gestation periods to make them see the light of the day.

"In the US, we have been able to fund these ideas and it may take a company 9-10 years before that product hits the market, but it changes the world. We don't have that kind of patience, which is why I think India needs something different," says Sherwani.

This, suggests Sherwani, can be solved by focusing on building low-cost, high-efficiency chips, for which the country already has existing capabilities and infrastructure.

The problem, however, lies in striking the right balance. While focusing on such chips would help light that fire and kick that ball, there is a danger of that ball being stuck in a local minima. As such, the focus would only be limited to solving a local problem and may never reach global scale.

This is where it becomes imperative to strike the right balance between encouraging and fueling academic research, while also focusing on keeping India on the right track to achieve reliance and sustainability in chip design.

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Dr Satya Gupta, President, VLSI Society of India

Subhasish Mitra, Professor at Stanford, the USA

Vivek Khaneja, Executive Director, C-DAC

India first, world second

It is no surprise that the golden period for Indian electronics and semiconductor industry has started to take shape. Sherwani notes, "What we now need is a group of people, Indians who want to make India great. India has a very large number of people with extensive experience in various aspects of chip making. How many nations have that?"

Fostering this ripe talent and providing them avenues to come and build the semiconductor industry is essentially among the best ways to develop the same. Especially since most of these talents have worked closely with companies based in Silicon Valley, they have the knowledge and expertise to emulate the same in India. The product ecosystem in India is already well-developed, what it needs is a little fire to make it shine bright enough for the world to see.

The chip industry is a cutthroat one, and India being in its nascent stage to develop its own niche, needs to be wary of diving headlong into the competition. While the ambition is understandable and lauded, common sense must still prevail if it wishes to make a mark. For that, it needs to turn its head and start looking inward rather than outward. "I think we must start with making simple chips, chips which are relevant to India," says Sherwani.

Microcontrollers, IoT chips, and LED PCBAs are some aspects that India can aim for, simply because their demand in local terms is extremely high, making it easily scalable while also giving the still-growing market a big indigenous push. Gupta suggests taking a thread out of the big-little approach that many MNCs have followed. This would allow Indian companies the option to choose indigenously produced chips to add to their domestically produced products, which would further increase their value addition.

"For instance, India today makes 700 (types of) LED bulbs domestically for domestic consumption. A small tensor chip goes into every small volt LED. It's a simple chip but the volume is humongous. And since the product is also made by Indian companies, they can decide what to use. This could be the little part of the big-little. The big part would automatically proceed once we conquer our local ground," says Gupta.

Additionally, owing to the high investment that chip making requires, not every idea gets elevated. This also means that a lot of great ideas with little marketability, at least initially, have had to go down the drain only because someone decided it would not be worth spending on.

"I think we need to become more open and allow for more people to contribute their ideas in order to see what kind of stars can emerge. It is important to remove the ability of third parties to say 'no' to a project as much as we can," Wishart adds.

Grabbing the seat

The government's strong foot forward with regards to the semiconductor space was a much-needed move and, although late, it is expected to herald the golden era of the electronics industry of the country. What needs to be done is to adopt a problem-centric approach to think of an end-to-end solution, which can be scaled up from a local problem into a global problem. This is where the academia needs to play its part.

"The real question is how we can get real good ideas. The moment we are able to bring compelling ideas, people will be forced to fund them," reiterates Mitra.

While sovereignty is the ultimate goal, India needs to focus on getting a share of the pie, no matter how small it is. In the end, India needs to do enough to sit on the table with other countries, because if we control even 3% of the market, we can sit there. If we are zero, we will not even be invited. EFY

The author, Siddha Dhar, is a technology enthusiast at EFY

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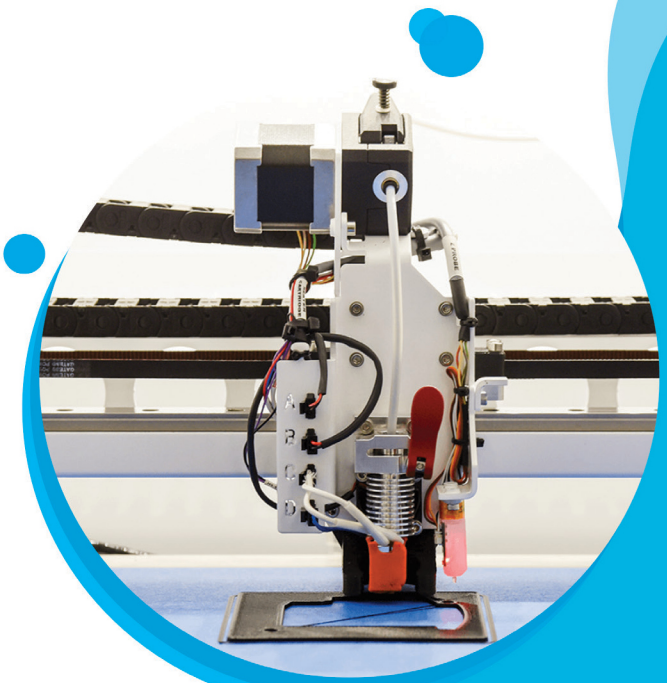

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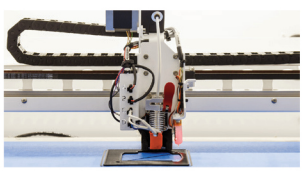
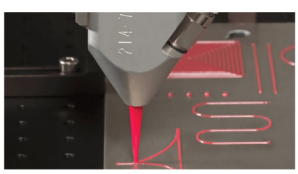
DISPENSING, COATING, AND CUSTOM AUTOMATION

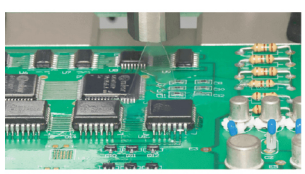
APPLICATIONS



3D Printing

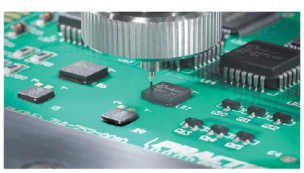


Bonding

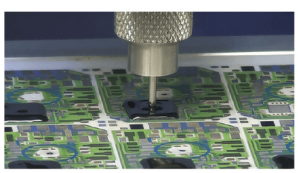


Conformal Coating

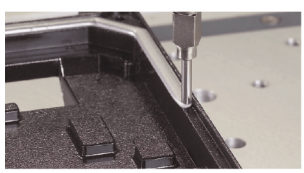
Dam & Fill



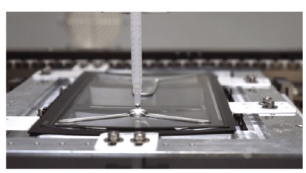
Dispensing



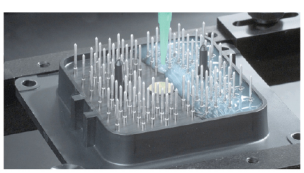
Encapsulation & Glob Top



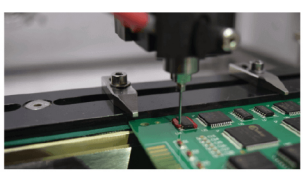
Gasketing



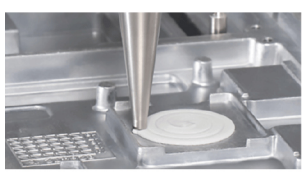
Optical Bonding



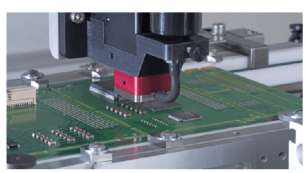
Potting



Surface Mount Adhesive / Solder Paste



Thermal Interface Materials



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1 GalaxEye SATELLITES CONSTELLATION WITH 'DRISHTI'

GalaxEye, an IIT Madras incubated space tech startup, aims to send a constellation of satellites equipped with their proprietary sensor, called Drishti, into space

GalaxEye team with some of their mockups

The founders of GalaxEye have developed and launched the Drishti sensor, a patent-pending technology that is also their USP. "The Drishti sensor enables multi-sensor fusion," says Suyash Singh, Co-Founder and CEO, GalaxEye. In simple words, Drishti sensors are basically a hybrid version of multiple sensors—hence, multi-sensor fusion. There are multiple sensors today that are used on an individual basis, like thermal sensors, radiometers, or radars on a satellite. But GalaxEye's Drishti sensors are able to give comprehensive data that anyone would want from a satellite since they are a combination of many sensors.

The Drishti sensors themselves are not commercially available. They will be deployed on GalaxEye's satellites only. What the company will be making commercially available is the dataset obtained from the sensors. GalaxEye believes that this dataset will be able to serve any sector that requires satellite imagery—insurance, agriculture, utilities, defense, etc.

GalaxEye's mission is to launch a constellation of satellites working in tandem to provide imagery. "We will have a group of such satellites monitoring the Earth on daily basis," explains Singh. This constellation will provide insights both during day/night time and irrespective of weather conditions. However, their short-term goal is to launch their first satellite in some time, probably by the end of 2023.

It is well said that big success does not come without challenges—at times, the volume of the data that needs to be transferred from one point to another is challenging. GalaxEye is solving that challenge by building a dashboard with a map for users to draw a cross-sectional area on. The company will then deliver the data for that particular area.

Dealing with market competition is critical for all companies. Even in the space technology business, there are some global players who are doing satellite imagery using single sensor based imaging. What differentiates GalaxEye from them is the multi-sensor fusion mentioned earlier. It is this differentiation that they bring to the table that's very important for the customers.

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GalaxEye, like most startups these days, has a very unique story of how it was launched. In 2020, the company was founded by a team of five students/alumni of IIT Madras, who initially were a part of Team Avishkar Hyperloop—a student competition team. In 2019, the team participated in the SpaceX Hyperloop Competition and that's how GalaxEye came into being. "A few of us from the Hyperloop team were really excited about space technologies in general," recalls Singh.

Singh points out that the Indian government, ISRO, and some universities have been taking steps towards getting students interested in space technology—like launching student space programmes and interdisciplinary courses. He throws light on how students can get started in a niche field like space technology, "Students can start with drones and communication, and then, if interested, they can move forward to taking specialised subjects during the PG."

—Aaryaa Padhyegurjar

2 ZYPP'S UNIQUE SOLUTION FOR EV FLEETS

Many Indian startups have begun dabbling in the electric vehicle (EV) space. While most of them follow the same route with their business, Akash Gupta-led Zypp Electric has gone out of the box and risked a fusion that very few have executed successfully

Whether due to government's mandate, or the intention to reduce their carbon footprint, businesses all over are actively looking to make the shift to EVs. Logistics sector, which is notorious for carbon emissions, urgently needs to make this shift and Zypp Electric has taken note. It leases electric bikes complete with battery infrastructure and maintenance support to such companies so that they need not worry about investing large sums on buying EVs. Their platform helps to keep a check on these e-bikes and also operate them.

(L to R) Tushar Mehta (Co-founder & COO), Rashi Agarwal (Co-founder & CBO), and Akash Gupta (Co-founder & CEO)

Akash Gupta, Co-founder & CEO riding Zypp Electric

Zypp also smartly prevents theft of the e-bikes. Apart from the usual KYC of the driving partners, these e-bikes have been fully tech-enabled. There is no key and the bikes are geo-fenced to always track them. Their custom battery management system ensures that the batteries are utilised properly. "We have proper triggers baked onto the app, which tells the driver the right time to charge the bike," explains Gupta, CEO and Co-founder, Zypp Electric.

But that's not all. Zypp has also

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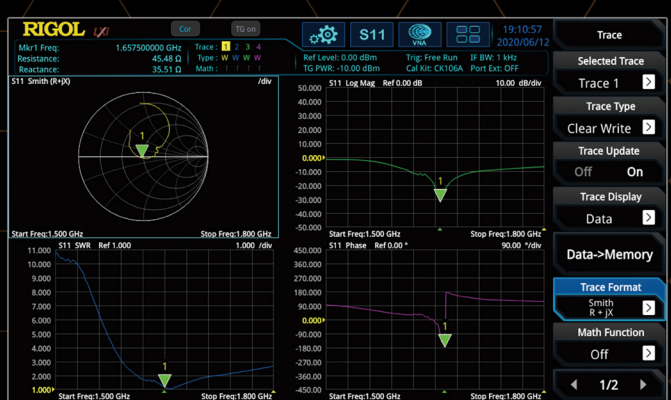


VNA mode S11

figured out how to fund the acquisition of these bikes for themselves. "All of these bikes are invested by HNIs who like to invest in these assets. It is like an alternate asset/investment earning plan similar to how you invest in an FD or a mutual fund or real estate." Zypp offers 20% pre-tax return to these investors for a 3-year plan, after which it offers to buy them back, essentially turning itself into an EV fintech firm!

In terms of scaling up, Zypp's ambitions are simple. Expansion. Be it expanding the number of bikes they currently deploy (which is pegged to reach 15,000 within 12-18 months), or increasing the number of clean deliveries happening in the country, or expanding their operations from Delhi-NCR and Hyderabad to Bengaluru and Mumbai, Gupta aims to do it all.

This is not easy though; the biggest hurdle in Zypp's plans is the low number of bikes being supplied at present. "The EV ecosystem and OEMs are still in the nascent stage, so none of the OEMs are able to deliver 1000-2000 bikes a month today, even though we are ready to buy those many bikes every month."

Additionally, Gupta wants more robust bikes to be made that are suitable for the Indian terrain. Zypp's outlook is positive, and it believes that with the right nudge, it can propel the country into meeting the clean energy goals it has set.

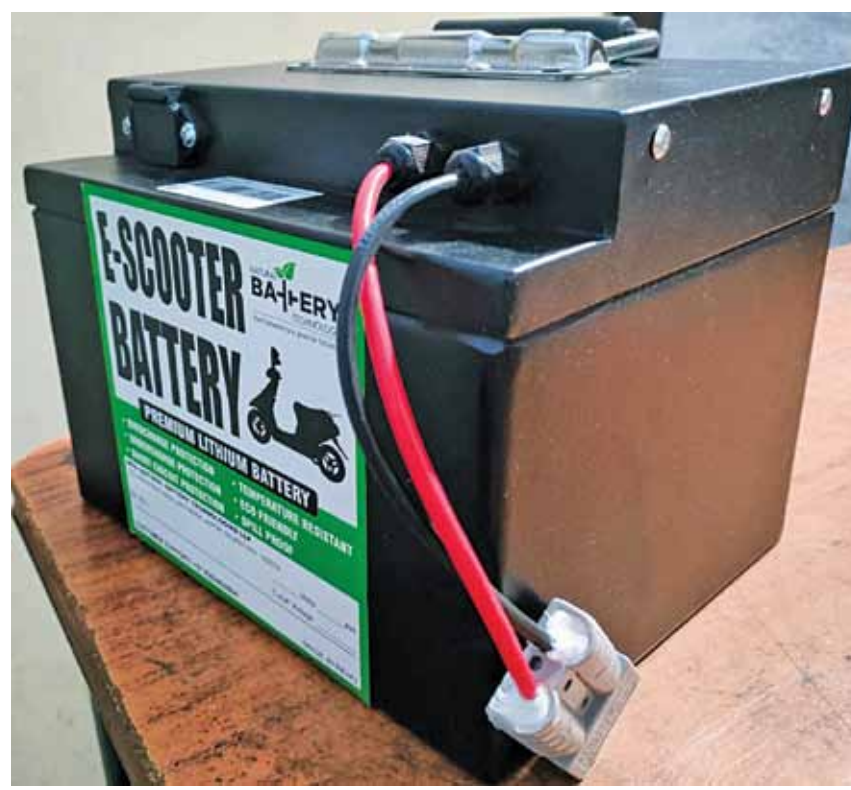
—Siddha Dhar

3 NATURAL BATTERIES: SAFE AND EFFICIENT

While recent incidents of electric vehicle fires have alerted us on battery safety needs, a Jaipur based startup, Natural Battery Tech, is building batteries that it claims can sustain harsh temperatures up to 200°C and still provide optimal efficiency

With the rise in demand for larger battery packs with more safety features, Puneet Jain, CEO, Natural Battery Tech, says they are now designing lithium-ion batteries that can work beyond their rated capacity and also sustain harsh temperatures.

"The lithium cells (NMCs) may get heated and touch up to 55-60 degrees Celsius, leading to thermal runaway. The usual batteries available in the market may use a thermal foam or epoxy sheet that can protect up to 100 or 125 degrees Celsius. By using specialised thermal pads and heat protection devices, we are able to secure the complete pack up to 200 degree Celsius. These materials can also absorb vehicle shocks to safeguard battery internal components," he explains.



For ensuring safety from faulty cells, the firm has introduced fused connection technology, which isolates the faulty cell in the pack from the rest. "A battery pack is a combination of cells. If you are using a simple connection type and if any cell goes bad, it cannot isolate itself from the regular pack. While bigger firms like Tesla go for expensive technologies like ultrasonic bonding to address such issues, we have

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-Jeff Bezos

come up with a cheaper solution of using fused connections for our battery packs,” says Jain.

Jain calls the optimisation feature as their unique selling point. “If a client orders a 50Ah (ampere-hour) battery, we give them a 51.5Ah battery. This is a subtle difference, but it turns out to be a great trust-building factor,” he says.

To optimise space and fit more battery capacity in limited vehicle space, the firm uses customised ABS structures to keep the lithium cells in place. The ABS structure has involved careful selection of materials that can enable the battery to be compressed further and allow packing more capacity. A typical battery of 50Ah capacity is housed in a box of 400mm thickness and with the compression structure, it is reduced to 365 ~ 370mm. The space saving (approx. 30mm all-round) can be used for increasing the capacity of the battery further.

While the team had earlier faced difficulties in selecting materials that could provide both thermal and shock protection, and also in designing ABS structures, finding a manufacturer in India was a bigger challenge. “We couldn’t find a manufacturer in India and hence we moved to importing from countries like China and Germany. This is also a reason that puts our cost a little higher compared to our competitors,” Jain says.

The business was started in 2019 with the leasing of electric rickshaw batteries. It was later shifted to a couple of other financial models, realising the initial heavy investments. “I partnered with electric vehicle manufacturers and sometimes we even did the delivery service by hiring drivers. All those options were not very scalable with the limited funds. Now we currently focus only on building batteries,” he adds.

He strongly believes that allowing a free hand to experiment is a great way to innovate. “I have quite some examples in our factory where we had trained our manpower from little technical expertise to adapt successfully in innovating at our factory floors. Those with not so higher education backgrounds have experimented a lot with testing, repairing, tinkering, and are now working out ways of producing efficient results,” Jain says.

Puneet Jain, CEO, Natural Battery Tech

Jain expects to soon introduce an effective liquid cooling mechanism. His team is designing the pump and pipe systems for liquid cooling to effectively keep the larger packs cool. Jain aims to develop a great battery ecosystem deploying battery swapping and charging infrastructure in India in the long run. He says, “We are already in talks with some investors. We want to create an infrastructure where the batteries can be easily serviced, recharged and all managed through mobile apps.”

The firm is currently planning expansion and looking for sophisticated OEMs to co-design battery packs customised for their vehicles. It is also in process of hiring battery researchers, mechanical engineers, supply chain managers, product development experts, and electrical engineers. EFY

—Abbinaya Kuzhanthaivel

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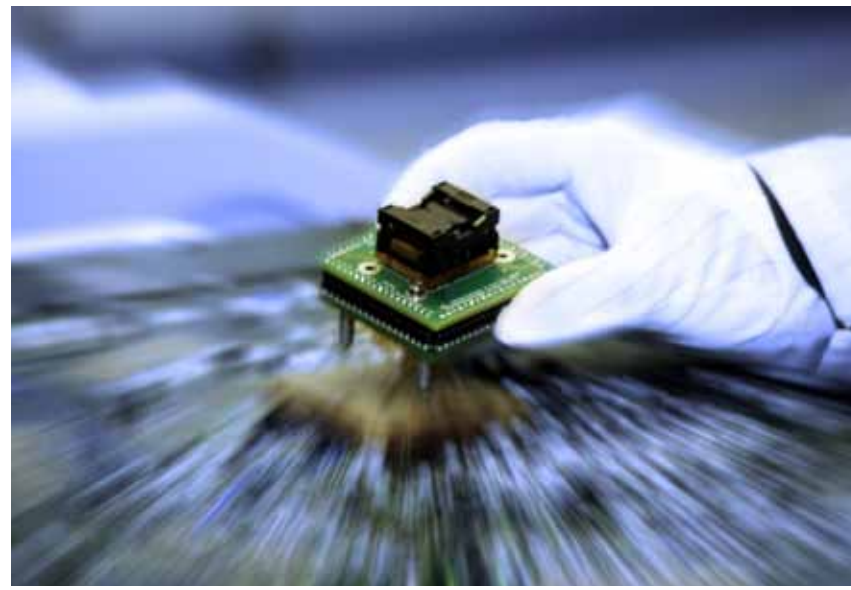
MeitY forms 17-member advisory committee to steer Semiconductor Mission

The Ministry of Electronics and Information Technology (MeitY) has announced the formation of a 17-member advisory committee to provide a more solid path to the government's ₹760 billion India Semiconductor Mission. The Minister of Electronics and Information Technology Ashwini Vaishnaw will be the Chairperson of the committee, while Minister of State for Electronics and Information Technology Rajeev Chandrasekhar will be the Vice-Chairperson. The newly minted committee shall provide inputs to the government to enable the building of a resilient supply chain, promote investments and ways of financing the semiconductor sector, research and innovation as well as intellectual property generation.



Representational image

PEOPLE (on the move)

Sumant Sinha takes over as ASSOCHAM President

Sumant Sinha (left), Founder, Chairman & Managing Director of ReNew Power, has taken over as President of the Associated Chambers of Commerce and Industry of India (ASSOCHAM). Ajay Singh (right), Chairman & Managing Director of SpiceJet, India's second-largest airline by fleet size, is the new Senior Vice-President of ASSOCHAM.

Rajan Kapoor appointed NexGen Power Systems' MD for India R&D

NexGen Power Systems has appointed Rajan Kapoor as Managing Director for its India operations. As Managing Director, India, Rajan will be responsible for driving NexGen's India Centre of Excellence to revolutionise the design and development of power conversion systems.

SECI appoints Sanjay Sharma as Director-Solar Division

Sanjay Sharma has been appointed Director of the solar division of Solar Energy Corporation of India. Prior to this appointment, Sharma held the position of Executive Director of the state-run company.

Tushar Mehta appointed Zypp Electric's COO

Electric mobility start-up Zypp Electric has elevated its Business Head, Tushar Mehta, as the company's Co-founder and Chief Operating Officer. Tushar joined Zypp last year as Business Head and has been closely working with the founding team to improve operations and business strategies. In his new role, Tushar will be leading the business and growth at Zypp.

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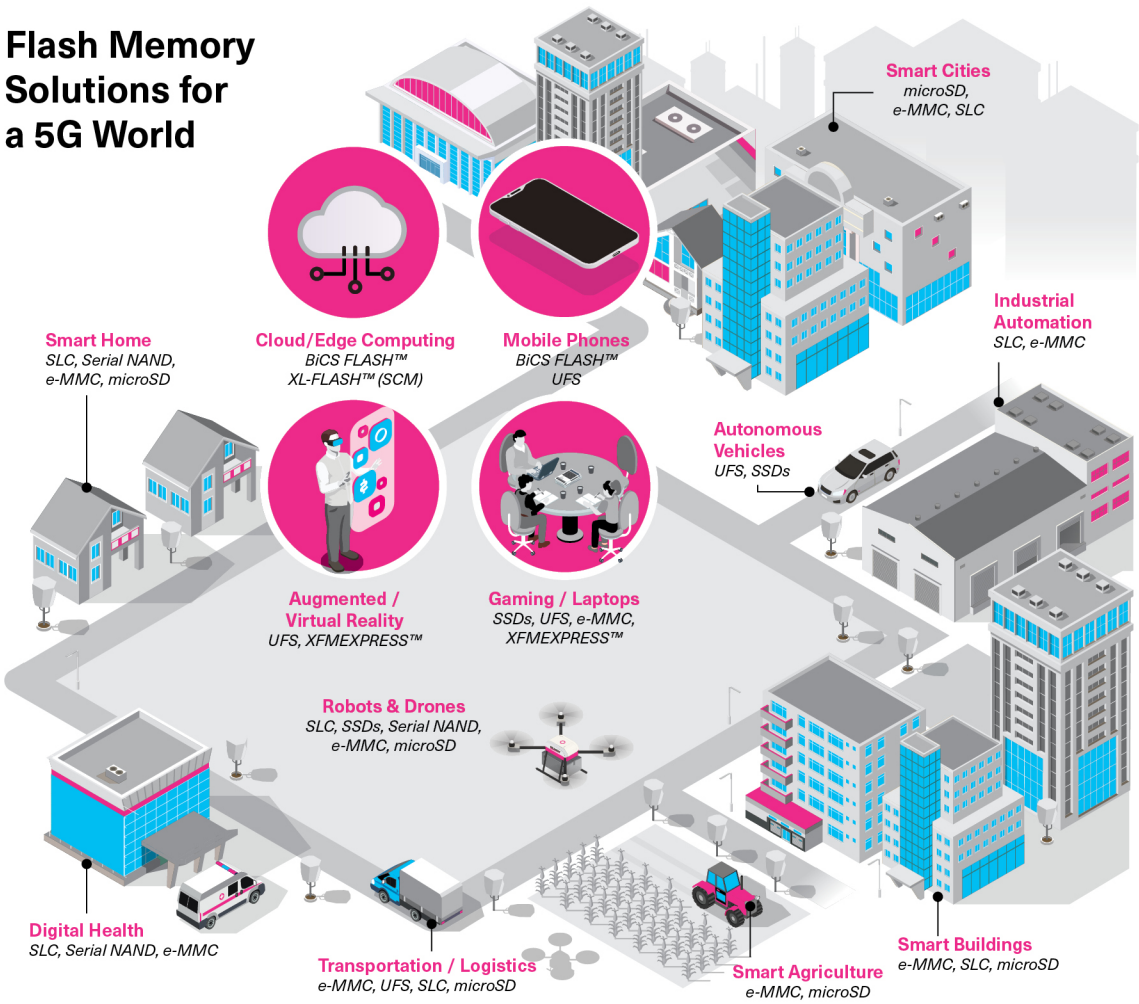

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CORPORATE news

Motherson Sumi Group eyeing to foray into semiconductors

Following the likes of Vedanta and Tata, Samvardhana Motherson Sumi Group is also planning to enter the semiconductor manufacturing space. It is looking for a global partner to enter the same. Motherson's Vice-Chairman Laksh Vaaman Sehgal said that the investment to get into semiconductor manufacturing being large, the company will not get into the space on its own and is eyeing a partner.

Tejas Networks to acquire majority stake in chip firm Saankhya Labs

Telecom gear maker Tejas Networks is acquiring 64.4% stake in Bengaluru based semiconductor firm Saankhya Labs Private Ltd in an all-cash deal of ₹2.84 billion. Tejas Networks, upon procuring all necessary consents and approvals, also intends to proceed with acquiring the balance 35.6% shares through a merger process or a secondary acquisition. Saankhya develops system and semiconductor products for cellular wireless, broadcast radios, and satellite communication ground terminals, which are deployed by customers in India and in international markets. It has 73 international patents.

Samsung now eyeing PLI incentives through contracts

Samsung Electronics, which had previously refused to participate in the telecom production-linked incentive (PLI) scheme, is in talks with Indian telecom majors Reliance Jio and Bharti Airtel for 4G expansion and 5G supply contracts. Samsung had in mid-2021 decided not to take part in the initial PLI scheme, reasoning that setting up a plant for network equipment was not viable at that time in India with just one client, Reliance Jio Infocomm.

Made in India iPhones: Pegatron and Foxconn are on the roll

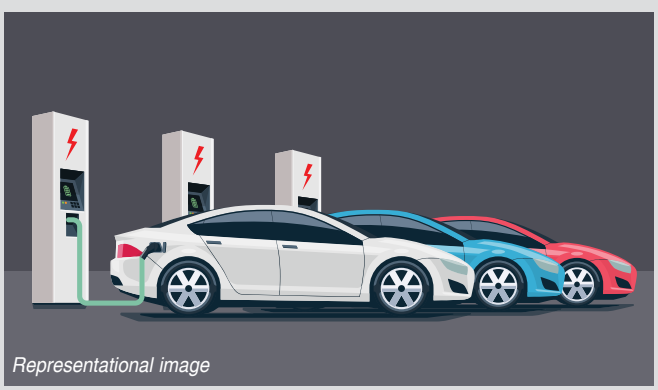
Apple's second largest contract manufacturer Pegatron has local manufacturing of the tech giant's products in India, with a target to produce goods worth more than ₹80 billion in the next fiscal year. It will initially make iPhone 12 devices, followed by the new iPhone 13 series from a new facility in Tamil Nadu. Meanwhile, Foxconn has already started making iPhone 13 in India.

Vikram Solar set to file papers for an IPO

Vikram Solar is looking to go public as it files draft papers for a reported ₹20 billion initial public offering (IPO). It will offer a mix of fresh share sales and stake sales by promoters for the issue, which is likely to be worth ₹1.8 billion. It has roped in JM Financial and Kotak Mahindra Capital as the lead managers for the public issue.

Tata Motors to make massive investment in EV segment

Tata Motors is planning to invest ₹150 billion in the EV segment in the next five years. President for passenger vehicles business of Tata Motors Shailesh Chandra said that the company is also planning to develop around ten more new offerings in the segment.



Representational image

SNIPPETS

- One Moto is looking to set up an EV manufacturing facility at Zaheerabad in Telangana with a manufacturing capacity of 25,000 units per month, which will be ramped up to 100,000 units in the next three years.
- Pinnacle Industries has introduced a range of precision EV components for two- and three-wheelers as it looks to become an end-to-end EV components and solutions provider.
- Spacetech start-up Pixxel has raised $25 million in a Series A funding round led by Toronto based Radical Ventures, making it India's largest fundraise by a space technology company to date.
- EV mobility firm Bounce is looking to expand its presence in the EV industry of the country, for which it is eyeing a fundraiser of $100 million.
- Domestic electronics maker Blue Star E&E has opened a new medical diagnostic equipment refurbishment facility at Bhiwandi, Maharashtra.

Suzuki to invest $1.4 billion in Gujarat to build EVs

Gujarat is set to become a hotspot for electric vehicle (EV) manufacturing as Japanese auto major Suzuki Motor Corporation is looking to invest approximately 150 billion yen (₹104 billion) for local manufacturing of EVs and their batteries. The company signed an MOU with the state of Gujarat at India-Japan Economic Forum held in New Delhi, in the presence of Japanese Prime Minister Fumio Kishida and Indian Prime Minister Narendra Modi.

Omega Seiki Mobility to enter African EV market through JV

Looking to expand its reach to the African market, Omega Seiki Mobility (OSM) has joined hands with Egyptian e-commerce last-mile delivery firm Rabbit Express to form a joint venture for the same. OSM will initially export its two- and three-wheelers to the African market and later the two partners will set up a manufacturing facility in capital city Cairo. OSM will hold up to 26% stake in the JV while Rabbit Express will hold the remaining stake.

US based Triton Electric to manufacture EVs in Gujarat

With a total investment of ₹108 billion, US based Triton Electric Vehicle has signed an agreement with the Gujarat government to set up a commercial electric vehicle (EV) manufacturing plant at Bhuj in Kutch district. Triton Electric Vehicle will set up the plant over 645-acre land with an annual production capacity of 50,000 trucks. The state government will assist in providing necessary approvals and registration for the establishment of this plant in accordance with the existing policy.

ITP starts lithium battery manufacture in Gurugram

ITP Energy Systems has set up a 100MWh lithium battery manufacturing plant in Gurugram. In phase 1, the facility will cater to solar segment at first and then focus on battery packs for e-mobility, which are due for launch in Q3 FY22. With multiple EVs catching fire in the past month, the plant at Gurugram has been set up, keeping this in mind, to make batteries that are thoroughly tested and have proper thermal management.

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Ola Electric invests in Israeli battery tech firm

Electric vehicle giant Ola Electric has invested in the Israeli battery technology company StoreDot. StoreDot makes batteries with extreme fast charging (XFC) technology. As part of the investment in StoreDot, Ola Electric will have access to the company's XFC battery technology, along with exclusive rights to manufacture batteries integrating StoreDot's fast charge technology in India.

Cygni Energy looking to set up lithium-ion battery plant

Hyderabad based lithium-ion battery pack manufacturing firm Cygni Energy Private Limited is looking to invest about $40 million (over ₹3 billion) to set up a greenfield manufacturing plant near Hyderabad. Their batteries are used for electric vehicles and stationary applications like telecom towers.

Exide building Li-ion cell manufacturing unit in Karnataka

Battery maker Exide Industries has announced it is planning an investment of about ₹60 billion in building a lithium-ion cell manufacturing unit in Karnataka. The company has sought 80 acres of land at Haraluru industrial area near the Bengaluru international airport. This proposal is for one of India's largest giga factories for advanced cell chemistry technology.

Epsilon Carbon signs JV for battery materials plant in India

World's first commercial polymetallic nodule processing plant is coming up as Epsilon Carbon as signed a joint venture agreement with US' Nasdaq-listed The Metals Company Inc to invest ₹12 billion for it in India. The focus of this collaboration will be to produce cathode precursors with the lowest carbon footprint. These cathode precursors will be converted to cathode active materials at the proposed facility.

Simple Energy signs MoU for Li-ion battery cells ecosystem in India

Simple Energy has signed a Memorandum of Understanding (MoU) with US based battery technology firm C4V for setting up lithium-ion cell manufacturing ecosystem in India. In addition to the make in India initiative, this strategic partnership covers cells with industry-leading safety, higher energy density than lithium ferro phosphate batteries, faster charging, and longer life cycle based on C4V's patented technology.

BEL and AAI join hands to develop air-traffic management systems

Bharat Electronics Limited (BEL) and Airports Authority of India (AAI) have entered into an agreement for the joint, indigenous development of systems for air-traffic management and surface movement of aircraft at airports in the country, which were hitherto being imported. BEL and AAI will jointly develop civil air-traffic management system with advanced surface movement guidance and control, a complex ground surveillance system that manages air-traffic at airports and in Indian civil airspace for safe operation of flights from take-off to landing.

Samsung to re-enter India's laptop market after exit in 2014

Sensing a rise in demand in the market, Samsung is all set to re-enter the Indian laptop segment this month as it looks to capture double-digit market share by the year-end. Samsung India General Manager and head of new computing business Sandeep Poswal said that by the end of 2022, Samsung plans to have double-digit market share in the addressable area where it operates.

Nothing India to begin making smartphones

Carl Pei-led Nothing is now looking to make smartphones. It is planning to foray into the business in the third quarter of this year, Nothing India Vice-President and General Manager Manu Sharma revealed. Pei, who is the Co-founder of OnePlus, said that Nothing is developing its own operating system for the phones, which will be built using Qualcomm's Snapdragon mobile platform.

Centre plans to modernise SCL plant for chip manufacture

As part of its effort to begin manufacturing semiconductors, the Semi-Conductor Laboratory (SCL) in Mohali is being modernised by the Central government. The Parliamentary Standing Committee on Communications and Information Technology has submitted a report, which gives a detailed plan for modernising the SCL unit in Mohali. The government had asked the committee for a plan to upgrade the SCL factory. The India Semiconductor Mission (ISM) will be responsible for handling the upgrade.

BATTERY STORAGE PLI APPROVAL FOR INCENTIVES

Name of applicant	Capacity quoted (GWh)	Status	Capacity awarded (GWh)
Rajesh Exports Limited	5	Awarded	5
Hyundai Global Motors Company Limited	20	Awarded	20
Ola Electric Mobility Private Limited	20	Awarded	20
Reliance New Energy Solar Limited	20	Awarded	5
		Waitlisted	15
Mahindra & Mahindra Limited	15	Waitlisted	–
Exide Industries Limited	6	Waitlisted	–
Larsen & Toubro Limited	5	Waitlisted	–
Amara Raja Batteries Limited	12	Waitlisted	–
India Power Corporation Limited	5	Waitlisted	–

Smartphone exports increase 75% in FY21: ICEA

The India Cellular & Electronics Association (ICEA) has released data which suggests that smartphone exports increased by 75% in financial year 2021, reaching over $5.5 billion from $3.16 billion. ICEA attributed the IT hardware production-linked incentive (PLI) scheme as the primary driver of this growth.

Chennai now the best for low-cost electronics R&D

Chennai was ranked as the world's cheapest foreign direct invest-

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INTERNATIONAL news

Intel to beef up its investment in Europe for making chips

US chipmaker Intel has revealed that it will invest up to 80 billion euros ($88 billion) across Europe in the next decade, as part of which it plans to build a semiconductor plant in Germany. The chipmaker will allot 17 billion euros to beef up its European production capacity with a semiconductor fab mega-site in Magdeburg, Germany. The site will include two semiconductor factories, or fabs, that will make chips with Intel's advanced technology.

Nvidia interested in using Intel for manufacturing its chips

Following the fallout of its deal to acquire British chip firm ARM Ltd, Nvidia has shown interest in partnering with US chipmaker Intel to make chips. Early last year, Intel decided to expand its business into making chips that others design as well, called the foundry business, and has announced several multibillion-dollar projects for new manufacturing centres in the United States and Europe.

SK Hynix looking to acquire Arm through a consortium

Months after the fallout of the highly-anticipated Nvidia-Arm deal, South Korean chipmaker SK Hynix is looking to form a consortium to acquire British semiconductor company Arm. "We are reviewing possibly forming a consortium, together with strategic partners, to jointly acquire it," Park Jung-ho, Vice Chairman and CEO of SK Hynix, told reporters after the company's annual shareholders meeting. The idea of possible acquisition is, however, at an early stage.

Kioxia and Western Digital to build new flash memory fab

Kioxia Holdings Corp is looking to collaborate with Western Digital Corp to build a new flash memory fab together. The facility is set to be bult at the latter's plant in northern Japan, which may reportedly entail an investment of around $8.3 billion.

Samsung and Western Digital to develop next-gen storage

Samsung Electronics has signed an MoU with Western Digital to co-develop next-generation data placement, processing, and fabrics (D2PF) storage technologies. The companies will initially focus on aligning their efforts and creating a vigorous ecosystem for zoned storage solutions, including zoned name spaces SSDs and shingled magnetic recording HDDs.

SEMIKRON and Danfoss Silicon Power merge to specialise

SEMIKRON and Danfoss Silicon Power announced a merger to create a joint business specialised in power electronics focusing on power semiconductor modules. The newly formed SEMIKRON-Danfoss joint business will be owned by the current owner-families of SEMIKRON and the Danfoss Group, with Danfoss being the majority owner. The new joint business will be managed by one common leadership team, retaining existing production facilities, customer and supplier relationships, and distribution channels.

US chip firm Ampere Computing files for IPO

American server processor startup Ampere Computing has filed for an IPO in the United States. A public listing would give Ampere an infusion of cash and potential access to more investment further down the line via public markets. Oracle has quietly invested $426 million in Ampere, which is run by former Intel president Renée James.

Wacom, STMicroelectronics and CEVA collaborate for digital pens

CEVA, together with STMicroelectronics and Wacom, have announced their collaboration to develop an enhanced digital pen experience with a new, wireless sensor module that extends the digital pen's functionality through advanced gesture, cursor, and motion control. The combined effort leverages the specialised capabilities of the three companies to create an advanced, sensor-enabled digital pen that can be adopted by OEMs to add value to their smartphone, tablet, notebook, PC, interactive whiteboard, or other smart-display products.

Analog Devices and Gridspertise join forces for smart grids

Analog Devices and Gridspertise are collaborating to advance the resiliency and quality of smart grids around the world. The collaboration enables the development of new hardware and software that support distribution grid self-healing and adaptation in response to the significant changes in energy supply and demand as renewable energy sources are brought online.

ment (FDI) location for electronics research and development, as per an assessment conducted using investment location comparison tool called fDi Benchmark. Chennai emerged as the cheapest location in the top hundred electronics FDI destinations, with estimated annual operating costs of $1.24 million for a fifty-person R&D centre. Among the world's competitive locations, Chennai was ranked second, only after Seol, which is home for large campuses of players like Samsung and LG Electronics.

Niti Aayog to roll out battery swapping policy

Keeping in line with the Finance Minister's promise in the Union Budget speech, NITI Aayog is likely to roll out a battery swapping policy by December this year. "The Battery Swapping Policy is likely to be rolled out by December," Sudhendu Jyoti Sinha, adviser (Infrastructure Connectivity-Transport and Electric Mobility), NITI Aayog, informed. Sinha also said that the Aayog is working on a proposal to prod railways to set up electric vehicle charging stations at railway stations in cities whose population is more than one million.

Government begins probe as more e-bikes catch fire

Following recurring incidents of electric bikes catching fire, Road Transport and Highways Secretary Giridhar Aramane told media that independent experts in science and technology space will probe the incidents and submit a report. The government has ordered a probe into the matter.

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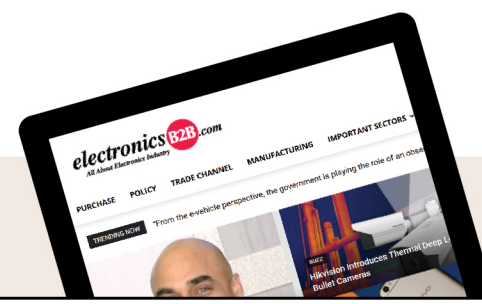

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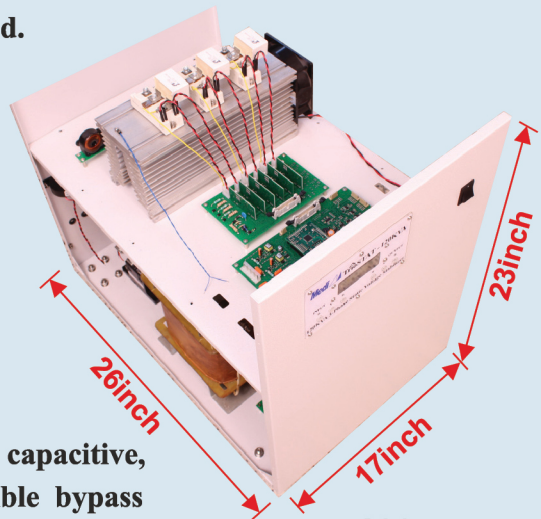

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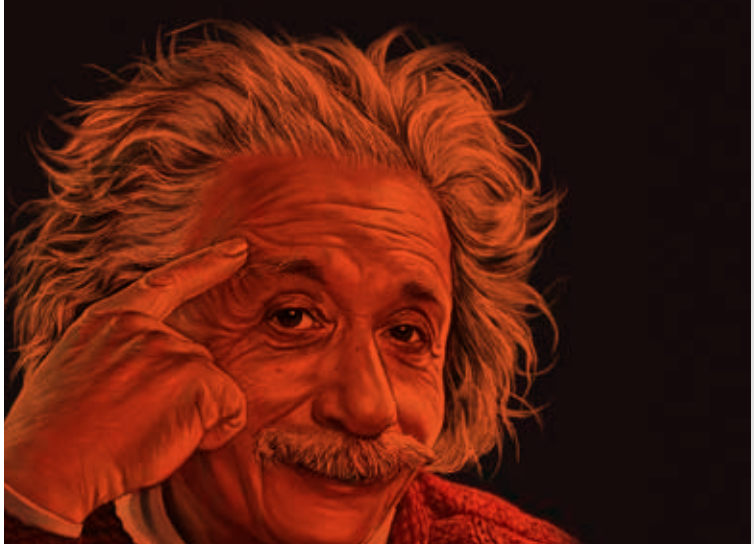

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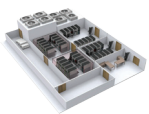

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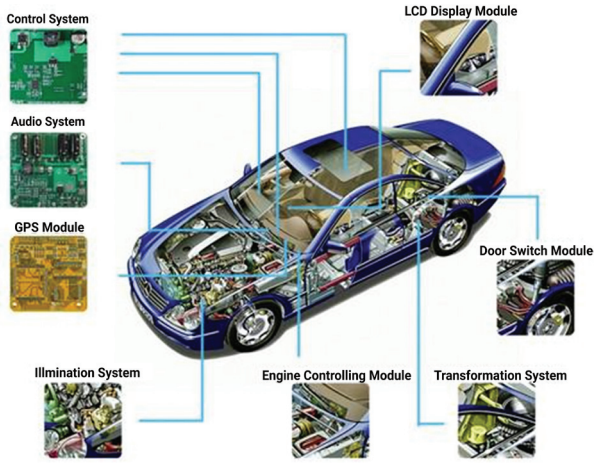

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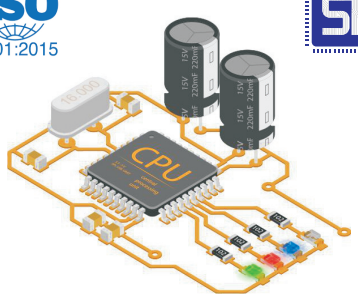

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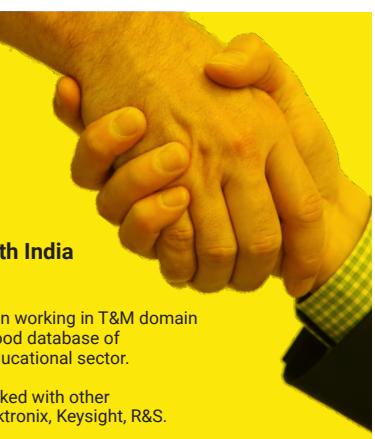

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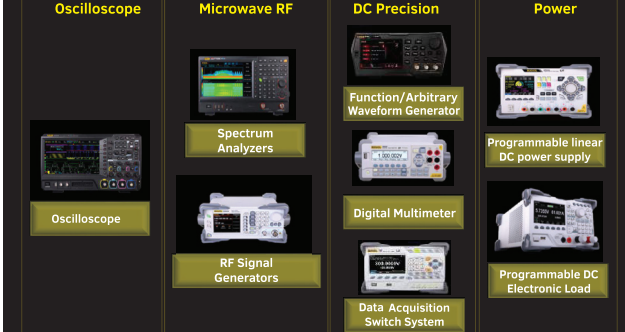

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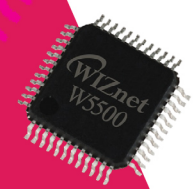

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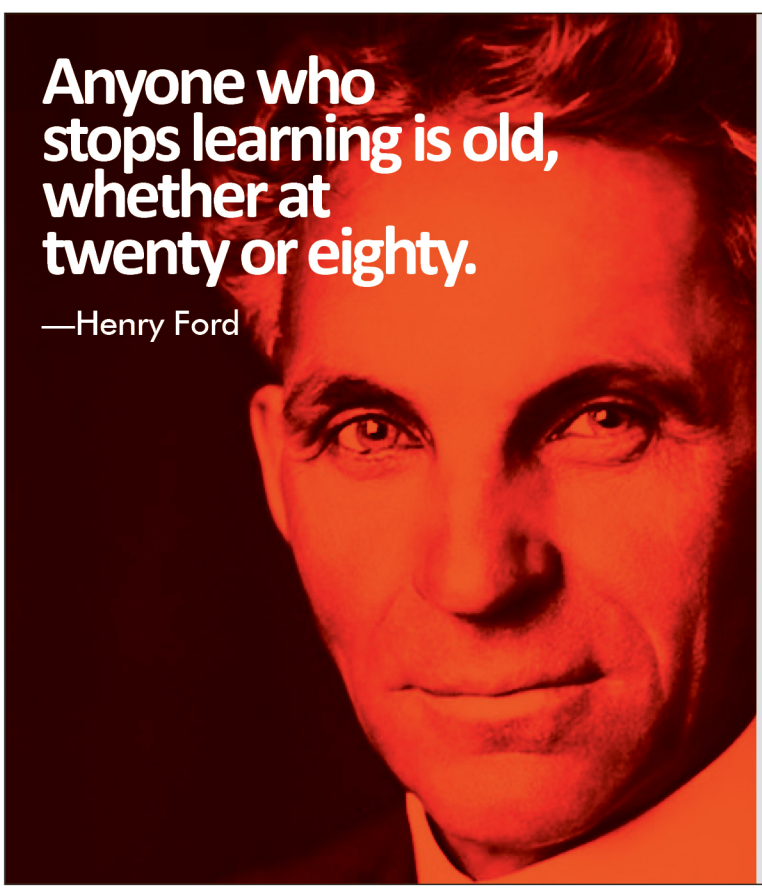

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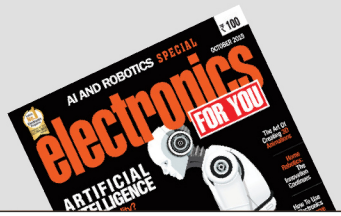

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AI HARDWARE That's Tailored For COMPUTER VISION

Neural networks, AI, ML, and neuromorphic computing are technologies that are actually ways to make machines behave more like humans! Similarly, computer vision focuses on imitating the complex human vision system and leveraging it in applications

AARYAA PADHYEGURJAR

Computer vision is a type of artificial intelligence (AI). The aim is to make computers visualise and understand images or videos as humans do. The field has grown a lot over the last decade, especially due to the new hardware and algorithms that came into the picture. Not just that, this type of computation has become faster and more accessible since the amount of data that is generated has also increased. Thanks to improved training models, deep learning, and better hardware, we are able to identify objects more accurately today.

Computer vision works by recognising patterns in images and videos. You feed the computer with an image of a particular object and then make the computer analyse it using algorithms—the borders, colours, shades, and shapes. We are essentially training a computer to understand and interpret the world.

Computer Vision at Work!

For the 2018 Masters Golf event, IBM employed computer vision to produce My Moments. IBM Watson was given hundreds of hours of film, after which it was able to recognise the sights (and sounds) of key scenes. These pivotal moments were chosen and distributed to viewers as individual highlight clips!

Drone Skygrid, an airspace management system built on AI and blockchain, uses computer vision for near real-time object detection through a drone's live video stream (Credit: Skygrid)

Computer vision: Then and now

In his whitepaper titled 'Everything You Ever Wanted To Know About Computer Vision,' Ilija Mihajlovic, an iOS developer who is passionate about machine learning (ML), explains how ML and deep learning have simplified computer vision. Before deep learning came into the picture, computer vision did not have as much scope as it does today, mainly because a lot of manual coding was required, such as creating a database, annotating images, capturing new images, etc.

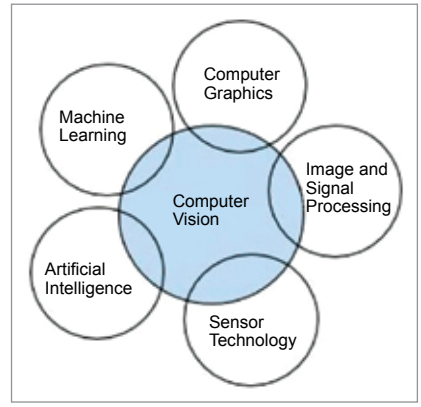
"With machine learning, developers no longer needed to manually code every single rule into their vision applications. Instead, they program features or smaller applications that could detect specific patterns in images," writes Mihajlovic. Today, we use deep learning for computer vision, and all of the work is done by neural networks. When we provide neural networks with lots and lots of labeled images of a particular object, they are able to identify patterns in them.

Hardware for computer vision

Capturing data is an important aspect of computer vision applications, and hardware platforms play a major role here. The main components required for computer vision applications are cameras and image sensors for capturing images, I/Os, a communication interface, and a processing unit. Imaging sensors present in cameras are characterised by their resolution (number of pixels), speed (frames per second), and number of colours.

Depending on the type of computer vision application, the processing unit might vary from CPUs to embedded boards. Here are a few examples:

- CPUs
- GPUs
- Heterogenous systems (CPUs + GPUs + others)
- FPGAs
- ASICs
- Microcontroller boards
- Embedded systems (smart cameras)



Fields that drive computer vision (Credit: IFA)

So where do development boards stand?

Traditional computer vision systems used a camera connected to a general-purpose computer, which used to run the application. In a smart camera though, the whole system can be integrated, right from capturing the image to processing to the final application. Today, the distinction between smart cameras and development boards has slowly started to fade, since many development boards have inbuilt cameras and are tailored for computer vision applications.

With more and more applications being deployed on edge, it

Components of Computer Vision

Hardware: Cameras/Imaging sensors

Software: Machine learning models for processing the images

Hardware: Processing units or conditional logic to automate application-specific use cases

COMPARISON OF SOME COMPUTER VISION BOARDS

	Arduino Nicla Vision	OpenMV Cam H7	Huskylens	VC Picosmart	iVS-AWV3-AR0521
Processor	STM32H757AII6 Dual Arm Cortex M7/M4	ARM 32-bit Cortex-M7 CPU	Kendryte K21 (AI Chip with 64bit RISC-V dual core CPU)	FPGA module, High-end FPU processor	Allwinner V3 system on module
Camera/ image sensor	GC2145 (2MP colour camera)	OV7725 image sensor (can be interfaced with other sensors too)	HuskyLens – OV2640 (2MP camera), Husky-Lens PRO – OV5640 (5MP camera)	1-Megapixel CMOS sensor	ON Semiconductor AR0521 sensor module
Notable characteris-tics and features	MP34DT06JTR digital MEMS microphone, LSM6DSOXTR 6-axis IMU, NXP SE050C2 Crypto chip	Double-precision floating point unit (FPU), Hardware JPEG encoding	It can be used as a stand-alone product or as a peripheral for a microcontroller or microcomputer	VC realtime-OS for real-time image processing	H.264, 1080p60 video codec, integrated ISP supports up to 8MP with auto image function
Connecti-vity and communic-ation	Bluetooth, Wi-Fi, SPI, I2C, UART	Wi-Fi, BLE, SPI, I2C, UART, CAN	UART, I2C	FPC connector	Multiple wireless connec-tivity options available
Supported battery/ power source	Li-ion/LiPo single cell, 3.7V	3.7V LiPo battery	Two power pins on the 4-pin JST connector, micro USB connector	N/A	N/A
Suitable for	Asset tracking, object recognition, predictive maintenance	Object detection, line detection, video recording, QR code detection/deco-ding, eye tracking, colour tracking, frame differencing	Face recognition, object tracking, object recognition, line tracking, colour recognition, tag recognition	Object recognition, position control, barcode reading, Web edge and level control	Autonomous vehicle and aftermarket home auto-mation camera systems
Compatibi-lity/ integrations	Arduino IDE, Arduino CLI, Arduino IoT Cloud, OpenMV IDE	Edge impulse CLI, OpenMV IDE.	Mind+Editor, Arduino IDE	N/A	N/A
Primary programm-ing language	C/C++	Python	C/C++	N/A	N/A
Edge capability	Yes	Yes	Yes	Yes	Yes
Industry-ready?	Yes	Yes	More suited to prototyp-ing	Yes	Yes
Dimensions in mm (l x w x h)	22.86 x 22.86	45 x 36 x 30	52 x 44.5	22 x 23.5	N/A
Weight	2gm	19gm	N/A	N/A	N/A
MSRP	$115.00	$65.00	$54.90	Quote based	Quote based
Datasheet	https://docs.arduino.cc/static/592480018567f53345d4f2b18199cd67/ABX00051-datasheet.pdf	https://cdn.shopify.com/s/files/1/0803/9211/files/OpenMV-H7.pdf?10726770933929369108	https://wiki.dfrobot.com/HUSKYLENS_V1.0_SKU_SEN0305_SEN0336	https://www.vision-components.com/en/products/oem/arm-linux/board-cameras/vc-picosmart/	https://www.ienso.com/product/ivs-awv3-ar0521/

makes more sense to deploy such devices on development boards. Here are some critical features that you need to consider while selecting a development board for your computer vision application:

- High processing speed
- Edge processing ability
- Faster access to memory
- Low power consumption
- Portable
- Inexpensive

While there are embedded platforms specifically for AI like NVIDIA Jetson and Raspberry Pi Compute, AI accelerators like Google TPU, SOMs/SBCs containing high-quality imaging sensors, we will focus on a few boards that were designed for computer vision and compare some of their features.

Current trends in computer vision

Computer vision on edge. To successfully deploy computer vision on edge, neural network design must be integrated into embedded platforms. Then, there are also difficult design decisions to be made around power consumption, cost, accuracy, and flexibility. Overall, for bandwidth, speed, and security reasons, edge computing is critical to computer vision processes. Still, hackers could take advantage of emerging security flaws in artificial intelligence. Designers must take this into consideration too.

However, there are some challenges when it comes to vision AI on edge, such as involving all edge endpoints can lead to complex device architectures. This makes device management and edge computing implementation harder. Edge computing differs from cloud architecture as it is spread out rather than centered around a single cloud. For large enterprises, it may be assumed that such an infrastructure

will have higher maintenance costs than one centered upon the cloud.

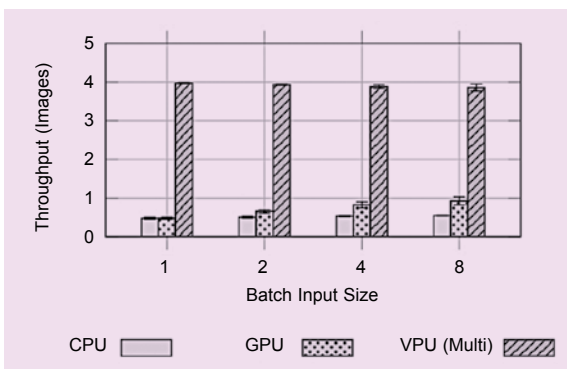
Embedded vision and IoT embedded vision. Embedded vision is when we combine cameras with the processing unit, like smart cameras mentioned before. Many companies, like Lattice Semiconductor and Blaser AG, provide embedded vision solutions. For example, Basler's AI Vision Solution Kit comes with cloud connectivity and contains a dart MIPI camera module, an NVIDIA Jetson Nano development board, lens, and cable. It allows developers to test AI based IoT applications on an optimised vision system and to access cloud services.

But we are about to enter the next stage of the Internet of Things. So far, the focus was on connecting devices, accumulating data, and creating big data platforms. Now, our focus will move to making the 'things' smarter using technologies like computer vision and deep learning on edge. This way, the things will be able to make informed decisions about their surroundings. That's IoT embedded vision.

Blaser's AI Vision Kit (Credit: Blaser AG)

Vision processing units (VPUs). A VPU is a specific type of AI accelerator designed for computer vision tasks. It is well suited for parallel processing. A very popular edge AI accelerator is the Intel Neural Compute Stick 2, which is built on the Myriad X VPU. It offers an easy-to-use USB interface.

Pre-trained convolutional network (CNN) models are used in the VPU chips to execute inference tasks. Studies have shown that VPUs are superior to CPUs and GPUs in terms of performance as well as power consumption. Moreover, a combination of multiple VPU chips can even reduce the thermal-design power (TDP) by up to eight times.



Throughput performance comparison per watt using the CPU, GPU, and multi-VPU configurations (Credit: https://arxiv.org)

Software 2.0 and computer vision. As we move towards Industry 4.0, software development is also moving towards Software 2.0. Software 1.0—the technology stack that includes languages like C/C++, python, etc—is the one that we are familiar with. It needs a coder. On the other hand, Software 2.0 literally writes itself when we feed enough data to a neural network that knows how to code.

This is yet another reason why the computer vision market will continue to grow exponentially. It will drive Software 2.0. Andrej Karpathy, Director of AI at Tesla, is a big proponent of Software 2.0. He notes that with Software 2.0, the computer vision library (for example, OpenCV) could even be auto-tuned on our specific data! EFY

The author, Aaryaa Padhyegurjar, is an Industry 4.0 enthusiast at EFY with a keen interest in innovation and research.

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MULTI-USER CALL BELL
For Up To Nine Persons

S.C. DWIVEDI

This unique but simple call bell can be used to call an office boy or a help at home from up to nine different places. Besides ringing, it shows the number of caller's room or place from where the call is being made.

The author's prototype is shown in Fig. 1 while its block diagram is shown in Fig. 2. The call bell is built around LM7805 voltage regulator IC1, ICs 74LS147, 74LS04, and 74LS247 (IC2-IC4), NE555 timer IC5, BC547 transistors T1 and T2, and 1N4148 signal diodes D1-D4.

IC1 provides 5V regulated power supply to the circuit except piezo buzzer PZ1, which is connected to the 9V battery directly.

IC2 is 10-line to 4-line priority encoder. It encodes nine data lines to four-line BCD. Zero condition requires no input, as zero is encoded when all nine data lines are at a high logic level.

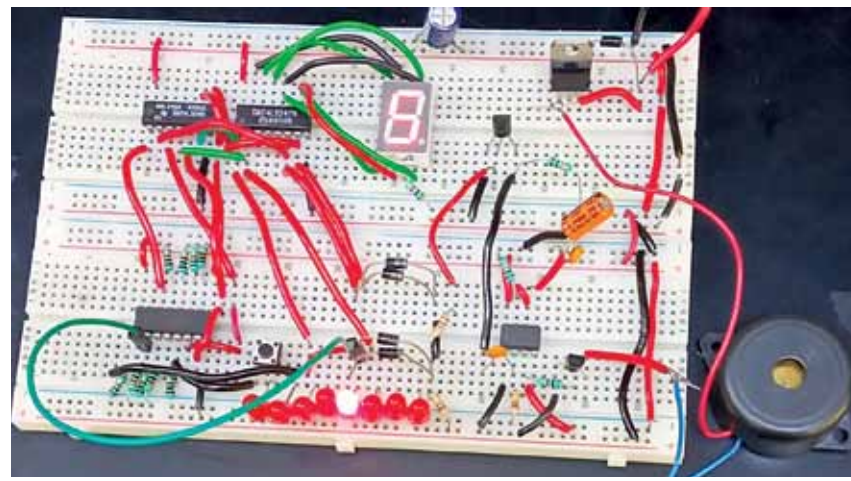

Fig. 1: Author's prototype

IC3 is hex inverter, which inverts output of 74LS147. Only gates IC3(A) through IC3(D) are used to invert the four-line BCD. The inverted outputs of IC3 are given to IC4 and the four diodes.

IC4 is a BCD-to-seven-segment decoder/driver. It has active-low outputs to directly drive the signal diodes. Output of IC4 is given to the common anode display LTS-6960HR/LTS542 (DIS1), which is used to display the caller's room number.

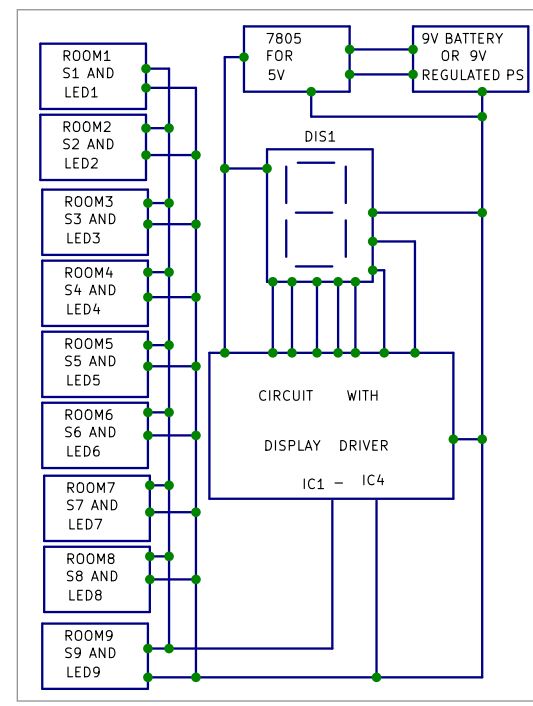

Fig. 2: Block diagram

The input switches (S1 through S9) are used to trigger timer IC5 through four signal diodes (D1 through D4). IC5 drives the piezo buzzer for a pre-set time. Output of IC5 is decided by resistor R13 and capacitor C1.

The nine switches (S1 through

PARTS LIST

Semiconductors:

IC1	- LM7805, 5V voltage regulator
IC2	- 74LS147 10-line to 4-line priority encoder
IC3	- 74LS04 hex inverter
IC4	- 74LS247 7-segment decoder driver
IC5	- NE555 timer
T1, T2	- BC547 NPN transistor
D1-D4	- 1N4148 signal diode
LED1-LED9	- 5mm LED
DIS1	- 7-segment display LTS-6960HR/LTS542

Resistors (all 1/4-watt, ±5% carbon):

R1-R9, R11, R14	- 1-kilo-ohm
R10, R12, R13, R16	- 10-kilo-ohm
R15	- 2.2-kilo-ohm

Capacitors:

C1	- 220µF, 35V electrolytic
C2	- 0.01µF ceramic disk
C3	- 0.1µF ceramic disk

Miscellaneous:

S1-S10	- On/off switch
PZ1	- Piezo buzzer
BATT.1	- 9V battery/regulated power supply

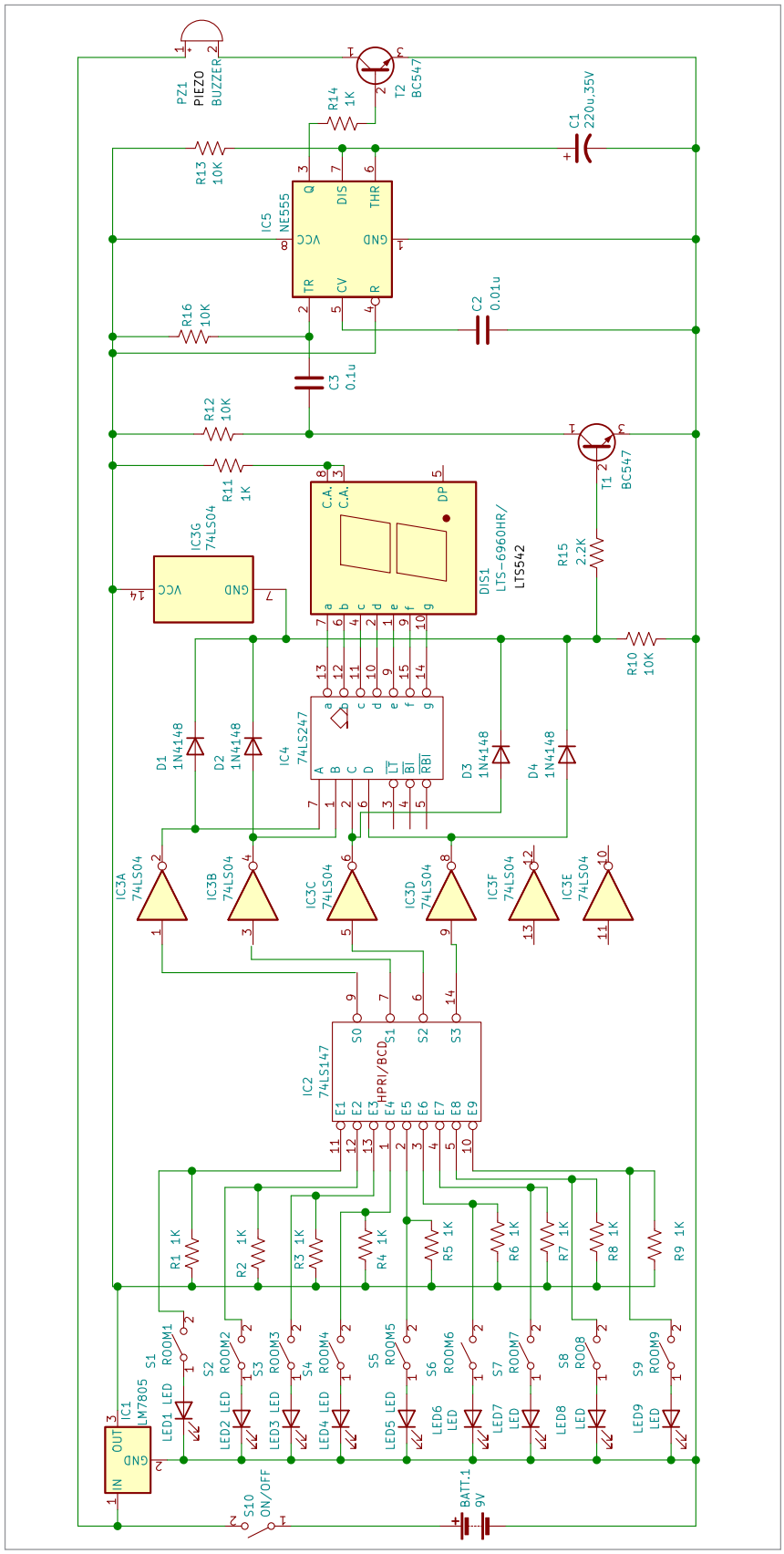

Fig. 3: Circuit diagram

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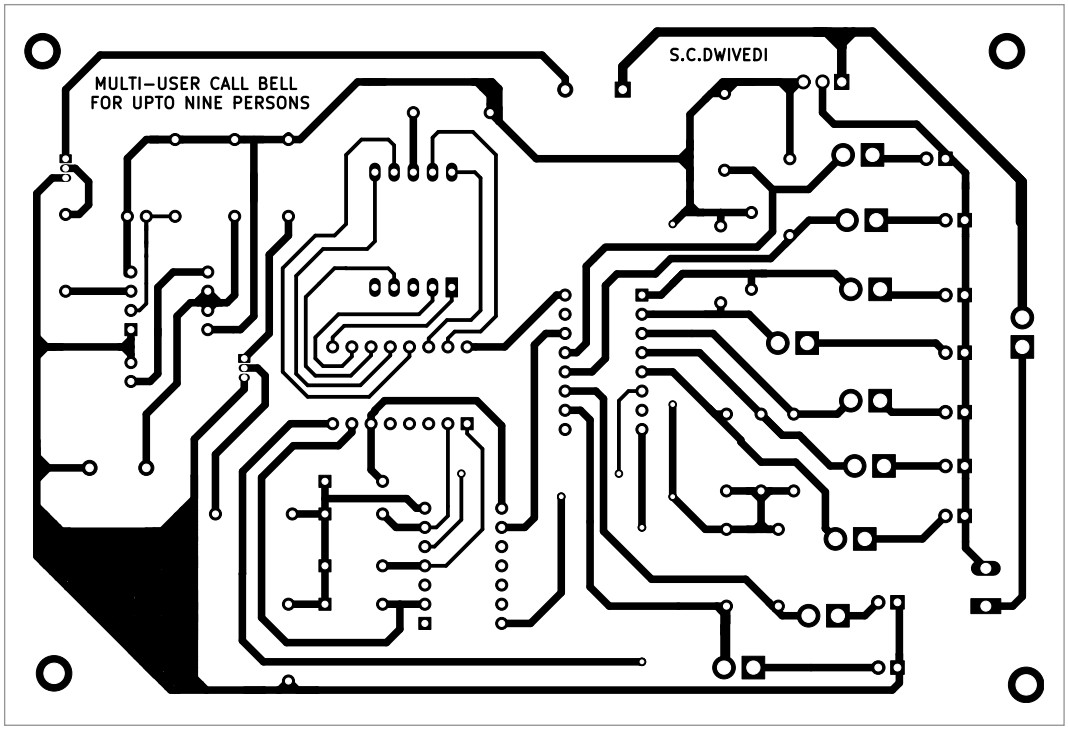

Fig. 4: Actual-size PCB

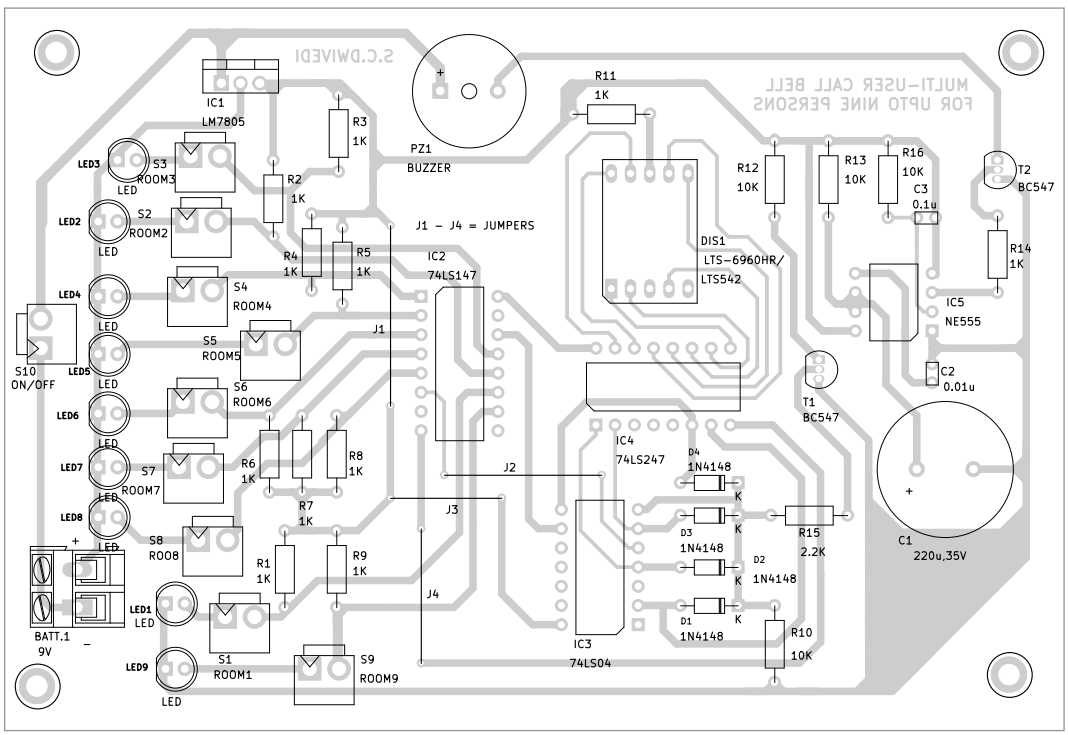

Fig. 5: Component layout of the PCB

S9) are installed at nine different places or rooms along with their corresponding LEDs (LED1 through LED9) for caller indications. IC2 encodes nine data lines into four BCD outputs.

When switches S1 through S9 are open and no LED is glowing, the seven-segment display DIS1 shows 0. If any of the switches is closed, the BCD output goes low and is inverted by IC3(A) through IC3(D). Then that room number LED glows, and at the same time the seven-segment display DIS1 shows that room number.

Working of the circuit is simple. When, say, room number 1's switch S1 is turned on, its LED1 glows and DIS1 displays 1 besides sounding an alarm through piezo buzzer PZ1. The caller should switch off S1 after the call has been attended so that the system is ready to receive the next call.

An actual-size, single-side PCB layout for the call bell is shown in Fig. 3 and its component layout in Fig. 4. After assembling the circuit on PCB, enclose it in a suitable box. Install switches S1 through S9 along with their respective LEDs (LED1 through LED9) in nine different rooms or locations. The assembled PCB, including DIS1 and speaker, should be placed where the attendant is stationed. EFY

S.C. Dwivedi is an electronics enthusiast and circuit designer at EFY

EFY TESTED Ashwini K. Sinha

First Ever Finger-Size FULL-TOUCH E-INK PHONE

ASHWINI KUMAR SINHA

Phones are getting smarter and complex with many functions that most of us find difficult to use. The modern smartphone uses either backlight display or an OLED display that can harm our eyes on prolonged use.

You may have wondered how phones are designed and whether you could make your own smartphone. So, here is how you can make your own smartphone having an impressive E-ink technology. This full-touch, finger sized phone uses UI-powered Linux operating system (OS) that can be accessed using any OS and VNC HDMI. It can perform all the basic functions of a phone.

Fig. 1: Author's prototype

The author's prototype is shown in Fig. 1 and the prototype with its calling screen is shown in Fig. 2. It is so small (see Fig. 3) that it can be strapped to your little finger.

E-ink technology saves power due to absence of backlit display and is good for those who want to avoid the glare of OLED and backlit displays. E-Ink display, like the printed paper, remains visible even when power is cut off, until you refresh it.

However, this is not all. We are going to develop the E-Ink phone,

Fig. 2: Author's prototype with calling screen

Fig. 3: E-ink phone size compared to a finger

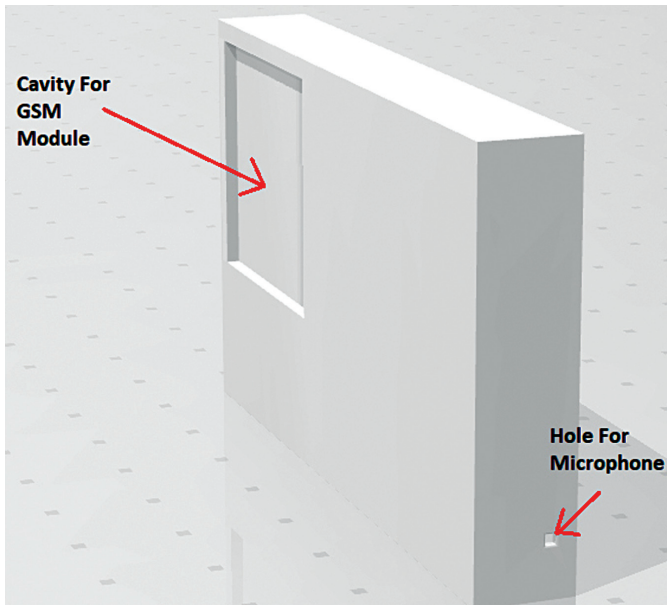

Fig. 4: Body design

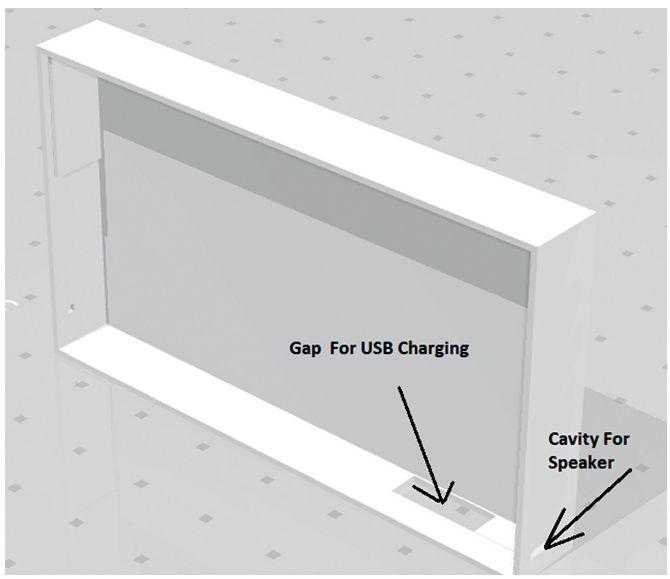

Fig. 5: Holes made in the phone's body

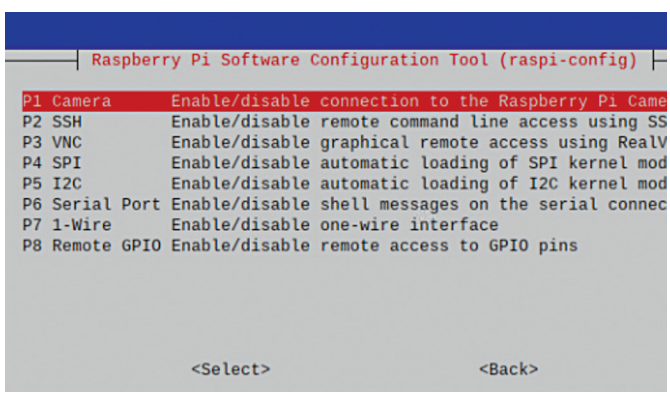

Fig. 6: Software configuration

MATERIAL REQUIRED

Component	Quantity	Description
Raspberry Pi Zero	1	Microcontroller
SIM800L	1	GSM module
Mini speaker	1	8-ohm,0.5W (mini)
Microphone	1	Micro sized mic
Battery and charger	1	3.3V rechargeable battery and charger
5.4cm E-ink touch display	1	Touch E-ink display
3D printed case	1	3D printed PLA case

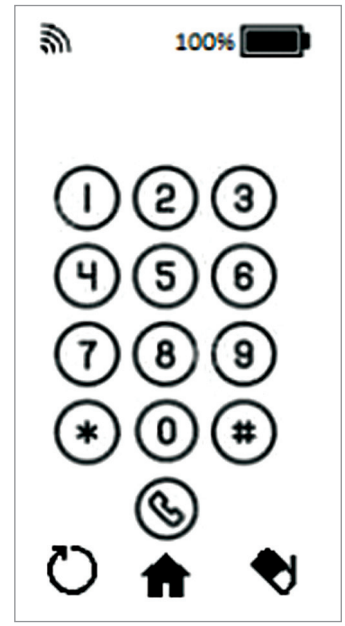

Fig. 7: UI for dialing screen

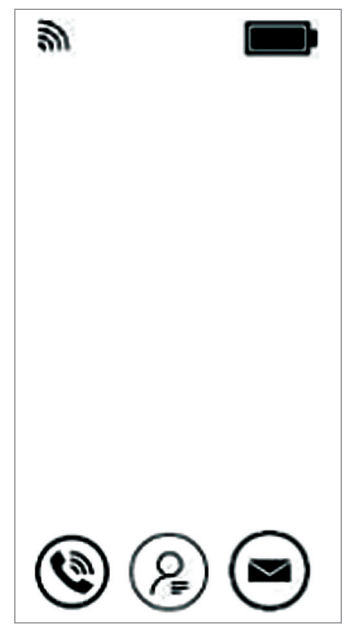

Fig. 8: UI for main screen

and, without any extra cost, you will get a full Linux based portable finger-sized computer as well! So, let us start collecting the required components, which are listed in the table above.

Designing

Though it is a totally home-made DIY phone, we can design it to look slim and attractive. So, for the phone, make its body the same size as the E-ink touch display. Then make space, as shown in Fig. 4, for embedding the GSM module inside the phone body.

Next make a tiny hole where the speaker is to be placed, so that you can hear the sound (see Fig. 5). Similarly, make holes for the mic and power input. Now, after designing the phone body, 3D print it.

Prepare the Raspberry Pi with its latest OS and then enable the SPI and I2C and serial ports of the Raspberry Pi. To do that, run the following command in

Llinux terminal and enable software configuration one by one, as shown in Fig. 6.

```
sudo raspi-config
```

Next, install driver for the E-ink touch display and the Python modules to use the display. To do that, open the Linux terminal and run the following commands:

```
wget http://www.airspayce.com/mikem/
bcm2835/bcm2835-1.68.tar.gz
tar zxvf bcm2835-1.68.tar.gz
cd bcm2835-1.68/
sudo ./configure && sudo make && sudo make
check && sudo make install

sudo apt-get install wiringpi

#For Pi 4, you need to update it:
wget https://project-downloads.drogon.
net/wiringpi-latest.deb
sudo dpkg -i wiringpi-latest.deb
gpio -v
#You will get 2.52 information if you
install it correctly
sudo apt-get update
sudo apt-get install python3-pip
sudo apt-get install python3-pil
sudo apt-get install python3-numpy
sudo pip3 install RPi.GPIO
sudo pip3 install spidev

cd ~
git clone https://github.com/waveshare/
Touch_e-Paper_HAT
```

Creating UI

We need to create the user-interface (UI) for the phone so that it looks beautiful. You can choose any icon and design a custom UI of your choice. For the prototype, round icons were used, as shown in Fig. 7. For UI, we must have the basic design to perform the basic functions. So, here is the list of UI pages for the basic phone functions:

- Main screen
- Dialing screen
- Contacts screen
- Messages
- Incoming call
- Calling screen

For every screen UI we need to

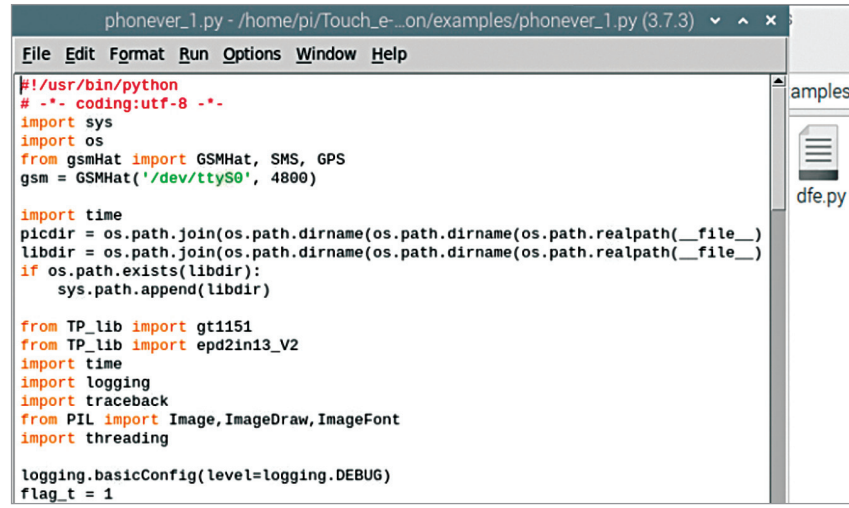

Fig. 9: Python code

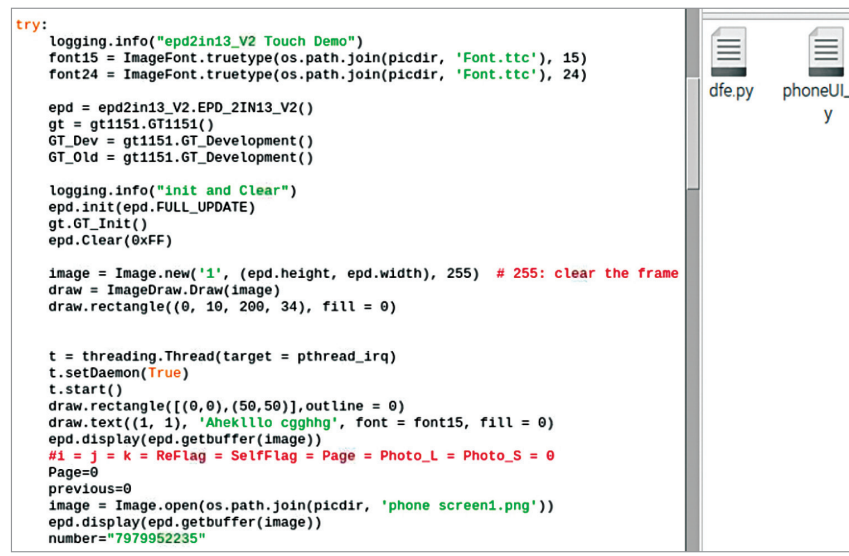

Fig. 10: Home screen

```
while(1):
    gt.GT_Scan(GT_Dev, GT_Old)
    if(GT_Old.X[0] == GT_Dev.X[0] and GT_Old.Y[0] == GT_Dev.Y[0] and GT_Old.S[0] == GT_Dev.S[0]):
        continue
    if (Page==0):
        image = Image.open(os.path.join(picdir, 'phone screen1.png'))
        epd.display(epd.getbuffer(image))
        if(GT_Dev.X[0] > 0 and GT_Dev.X[0] <15 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("h")
            Page=1
        if(GT_Dev.X[0] > 30 and GT_Dev.X[0] <60 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("contact")
            Page=2
        if(GT_Dev.X[0] > 80 and GT_Dev.X[0] <130 and GT_Dev.Y[0] > 200 and GT_Dev.Y[0] < 248):
            print("h")
            Page=3

    if(Page == 1):
        print (number)
        if(previous!=Page):
            image = Image.open(os.path.join(picdir, 'dialing screen.png'))
            epd.display(epd.getbuffer(image))
            previous=Page
        if(GT_Dev.X[0] > 0 and GT_Dev.X[0] < 20 and GT_Dev.Y[0] > 79 and GT_Dev.Y[0] < 88):
            print("1")
            number+= "1"
            print (number)
            draw.text((20, 20),"vhgvjhj", font = font15, fill = 0)
            epd.display(epd.getbuffer(image))
```

Fig. 11: Call function

get the icon, resize, and place it such that it fits inside the actual size of the phone's display (5.4cm size in prototype). For the main screen UI, battery icon is used for getting power information, tour icon for getting the signal info, and dial icon for dialing screen, contacts, and messaging screens. In the middle, it is kept blank to display time, date, etc.

Create the dialing screen UI for the numbers and other icons. Dial a number and go to home screen, or erase and refresh the screen. Similarly, make UIs for the remaining phone functions and screen.

```
    elif(GT_Dev.X[0] > 40 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 190 and GT_Dev.Y[0] < 220):
        print("call")
        gsm.Call(number)        # This call hangs up automatically after 15 seconds
        Page = 4


    if(GT_Dev.X[0] > 30 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 225 and GT_Dev.Y[0] < 250):
        print("home")
        image = Image.open(os.path.join(picdir, 'phone screen1.png'))
        epd.display(epd.getbuffer(image))
        Page=0


if(Page == 2):
    print("cintact")
    image = Image.open(os.path.join(picdir, 'contactsscreen.png'))
    epd.display(epd.getbuffer(image))

    if(GT_Dev.X[0] > 30 and GT_Dev.X[0] < 60 and GT_Dev.Y[0] > 225 and GT_Dev.Y[0] < 250):
        print("home")
        Page=0
if(Page == 3):
    print("Message")

    image = Image.open(os.path.join(picdir, 'contactsscreen.png'))
    epd.display(epd.getbuffer(image))
    print("message c=screen")
    newSMS = gsm.SMS_read()
```

Fig. 12: Message function

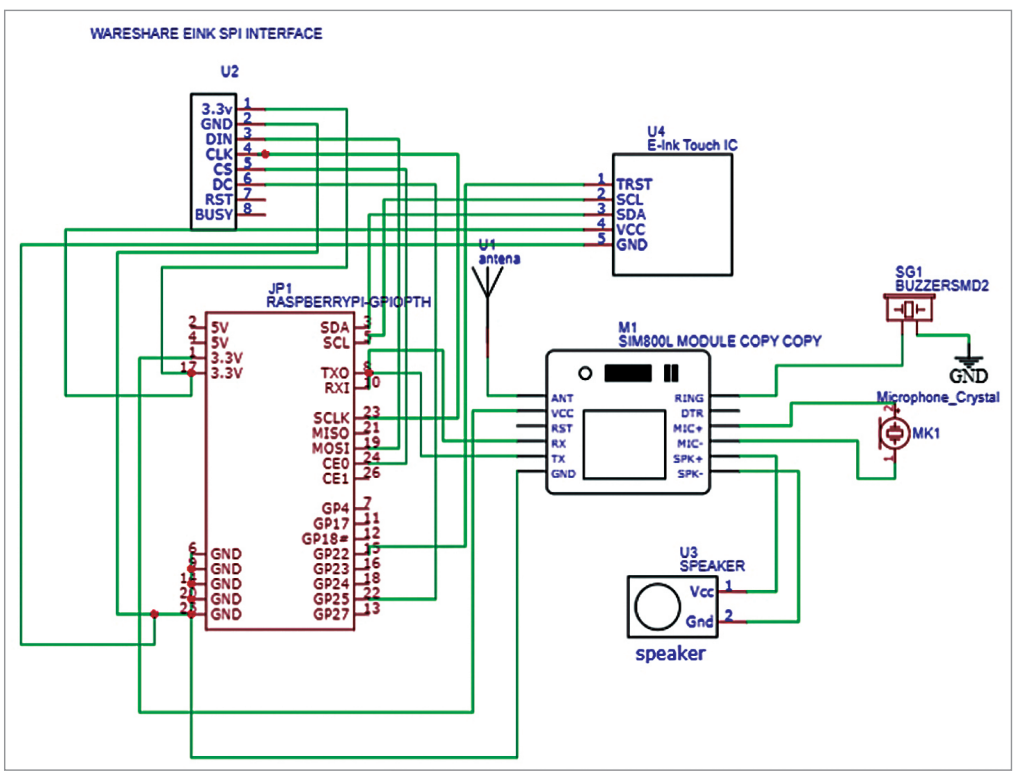

Fig. 13: Circuit diagram

Save the images from the UIs in the pic folder of the Python library that was cloned earlier. Open the code for displaying.

Coding phone OS

To create the code for OS for the phone, import the modules and library for interfacing the E-ink touch display. Then import the Python modules for using SIM 800L GSM module. Next, set the path where you keep the UI images for the phone and create the while loop to check the screen. The page to display is similar to previous, but new if its previous one has new page number. Update the display with UI pic.

For the (first) home page, check the touch points for the icons like dial icon, contact icon, or message icon. Also check the incoming call by checking the ring pin. Then create an 'if' condition where you check the touch points to match the range of icons on the UI. If you touch the phone icon, the touch point should match with the touch point corresponding to the phone.

Set the function in if condition to change the page number to next (No. 2). That is, in the UI image of dialing screen, update the phone screen and set the page number to 2. Now the phone moves to dialing screen with buttons of numbers. Create the if conditions for checking the numbers and icons.

Touch the dial pad screen if touch point range of number is one or two, or other number button. Update an empty string named number, add that number to the string. If touch point matches with the call icon, it sends the com-

EFY Note
The source code of this project is available for free download at *www.electronicsforu.com*

Fig. 14: E-ink header-to-header pins on Raspberry Pi

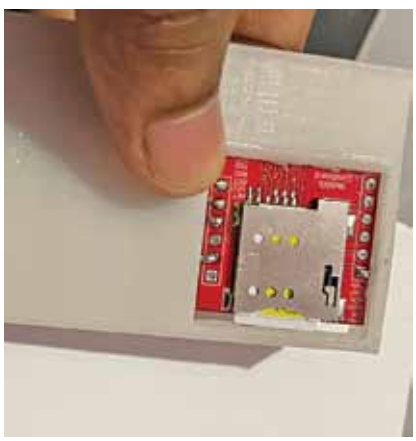

Fig. 15: GSM module fixed in the enclosure

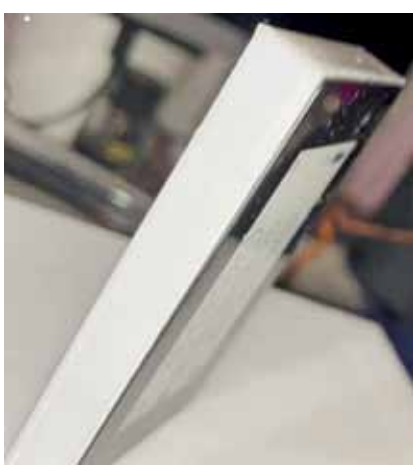

Fig. 16: Phone screen fixed on the base phone cover

mand to GSM module to call that number. It also sets the page number to the calling screen and updates the display with calling screen.

In the calling screen, check the touch points for Call Hang icon. If your touch point matches with the range of call-hang icon, touch point will send the command to SIM800L GSM module to cut the call and hang up. It will also change the page number to 0 and update the display with home screen UI.

Similarly, check the touch points and incoming call and then change the page number and update the display screen with UI for the message, contact, or ringing screen. Then in that screen, check the touch point for the button icon, touch point range, and set the function for those buttons—like hanging phone, home, main screen, calling, and other functions for the button icons. The Python code for achieving the above-mentioned actions are shown in Fig. 9 through Fig. 12.

Connection

After coding, connect the components as per the diagram shown in Fig. 13. Place the Raspberry Pi and SIM 800L module inside in the enclosure/body that has been designed. Fix the speaker and microphone against the holes made in the enclosure for them.

Fix the battery and charging unit in between the display and Raspberry Pi. Then mount the display on the enclosure with the pins matching the E-ink female header-to-header on Raspberry Pi, as shown in Fig. 14. Fix the GSM module on the slot, as shown in Fig. 15, and the phone screen on the base phone cover, as shown in Fig. 16.

Fig. 17: E-ink phone after assembly

Testing

The E-ink phone is now ready to show its magic. Insert the SIM in GSM module and run the OS code, and you are ready to use it.

Tap on on the Call icon and you get the dialing screen. Key in a phone number and touch on Call icon to make the call. Touch the Home icon to get the home screen and touch Contacts to see the contact numbers.

Next, try making a call from some other phone to your E-ink phone. When connected, the buzzer starts ringing and it takes you to the ringing screen. Here, touch the Call Attend icon to attend the call and Call Hang icon to hang up the call.

The final assembled E-ink phone is shown in Fig. 17. Enjoy! EFY

Note. This is the first version of the phone. The author keeps adding new features and improvements on *www.electronicsforu.com*

Ashwini Kumar Sinha is a technology enthusiast at EFY

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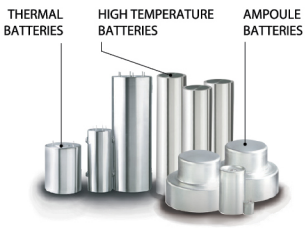
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