

Study of Microcontrollers in Embedded System

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Study of Microcontrollers in Embedded System

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Submitted in partial fulfilment of the requirements

for the degree of

Bachelor of Technology in Computer Science Engineering

By:

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Faculty Guide:

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CERTIFICATE

This is to certify that the Practice School-1 project work entitled "**Study of Microcontrollers in Embedded System**" submitted by **Lakshaya Bathla (2016btechcse151)**, towards the partial fulfilment of the requirements for the degree of **Bachelor of Technology in Computer Science Engineering** of JK Lakshmipat University Jaipur is the record of work carried out by them under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for Practice School-1 examination.



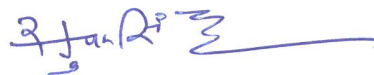
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I would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

Sincerely yours,

Lakshaya Bathla (2016BtechCSE151)



ABSTRACT

The initial part of my training was how to send signals from USB to serial ports I learned about it in brief and then I experimented with it on my own after that I was taught about XCTU which is an application developed to interact with embedded digital devices with different radio frequencies.

After this, I learned about the Atmel Studio and learned about how to install it on my PC and after that, I learned what it is used for and I learned one of our organisation's devices has been programmed on it. I will get to that later after this I was taught about mbed which is a platform used to program microcontrollers which can be connected to the internet and be used remotely and then I had to learn a few terminal commands to access and use the terminal.

During this, I had to learn a text based modem control program named minicom so that I could communicate with the device. Then I learned about mbed programming boards and how I could customise any port to receive or transmit any signal needed.

After this, I learned how to use a programmer to program a device called Kiassanmatic using Atmel and I learned that they used Atmel to program these devices and then I got the job to program them and test them. I was given a hex code which I burned on the microcontroller of the device then I performed a simple test using the master sim to diagnose the device and checked if the device was working properly.

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CHAPTER 1 : INTRODUCTION TO THE COMPANY

1.1 LOCATION

Wavenet Solutions Private LTD. Has got three offices in USA, UK and INDIA. Founded in 2011 with offices in Reston, USA and Gurgaon, India.

1.2 BACKGROUND

Wavenet Solutions Private Limited is an elite provider of Advanced Technology Services and Solutions in Telecom Software, Enterprise Mobility and Embedded Systems to a wide array of companies including OEMs, ODMs, Operators, Enterprises and Utilities across the globe.

The leadership team has an average of 18 years' experience in Telecom Software industry. Track record includes engagement with top-notch global technology names in significant capacities. Prominent ones include AT&T, Verizon, CISCO, Qualcomm, HP, Sprint, Agilent, Marvell, TI, Nokia, Ericsson, NEC, Panasonic, Freescale, Alcatel, Aricent, Ascom and much more.

1.3 STRENGTHS

- 1 Expert Lead Development Model*
- 2 Rapid and Cost-Effective Solutions Design*
- 3 Best-in-Class Product & System Design*
- 4 Innovative Solutions and True Partnership*
- 5 Young & Entrepreneurial Team*

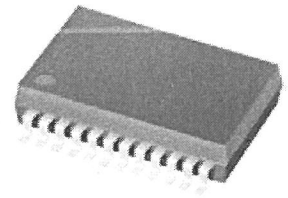
CHAPTER 2 : MICROCONTROLLERS

2.1 WHAT ARE MICROCONTROLLER

A **microcontroller** is a small computer on a single integrated circuit. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general-purpose applications consisting of various discrete chips.

2.2 FEATURES

- Central processing unit
- Volatile memory (RAM)
- Flash memory
- Discrete input and output bits
- Converters
- In-circuit programming/debugging support



2.3 APPLICATIONS

Microcontrollers are just about everywhere today, and that means that you will find a shocking number of applications where the controllers are in use.

- Digital video cameras
- Cell phones
- Digital point and shoot cameras
- Kitchen appliances – microwaves, coffee makers, etc.
- Vehicles

Whenever there is a need in an electronic device for a controller to provide a limited number of functions Microcontrollers are used. The iPhone, for example, has two Microcontrollers that take care of distinct functions.

CHAPTER 3 : **OBJECTIVE OF THE STUDY**

The objective of the training was getting familiar with what happens in an industry. The main reason for our PS1 was getting to know How the industry works seeing how it progresses with our own eyes and to experience what kind of behaviour is expected from us.

In the embedded training, I was learning how to cope up with microcontroller boards and how to program them to receive and send information on their own when they receive a certain kind of information like pressing a certain button would send a certain signal that would trigger the program to produce a certain outcome.

The other objective of my training was to understand what IoT is and how is it so popular these days I understood that by working on Mbed.

IoT is in many things we see in the world. Anything that is connected to the internet and can smartly give responses according to the user's needs is basically using IoT to do so. This includes Self drive cars to wearable smart watches or any such device is an Extension of IoT.

The IoT is a means to make Human life's simpler and more automated it takes the basic human needs and gives responses to make it easier for us to achieve our goals. IoT is the futures best resource as it is highly reliable and can be variably used according to one's need.

CHAPTER 4 : LEARNINGS

There are many things I learned in this training I will start to Present them in as much detail as I can:

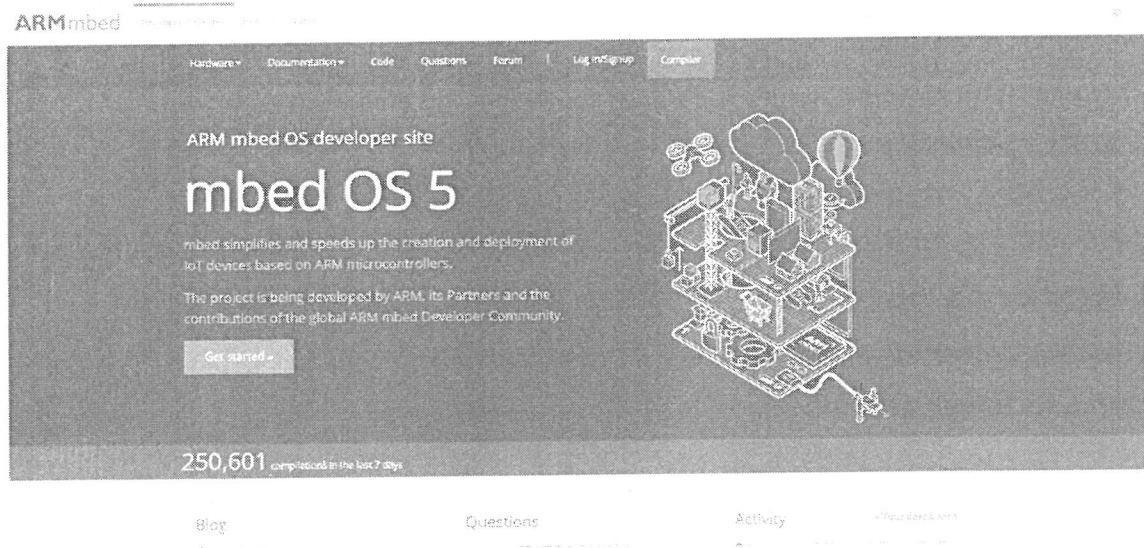


Fig 1.

Firstly, I learned about Mbed which is an IoT platform.

I learned about working on mbed in Linux based Operating systems i.e. Ubuntu. The mbed was installed on my Windows using virtual box and then I just had to the basics of choosing the microcontroller board I wanted to work on the one I was working on was

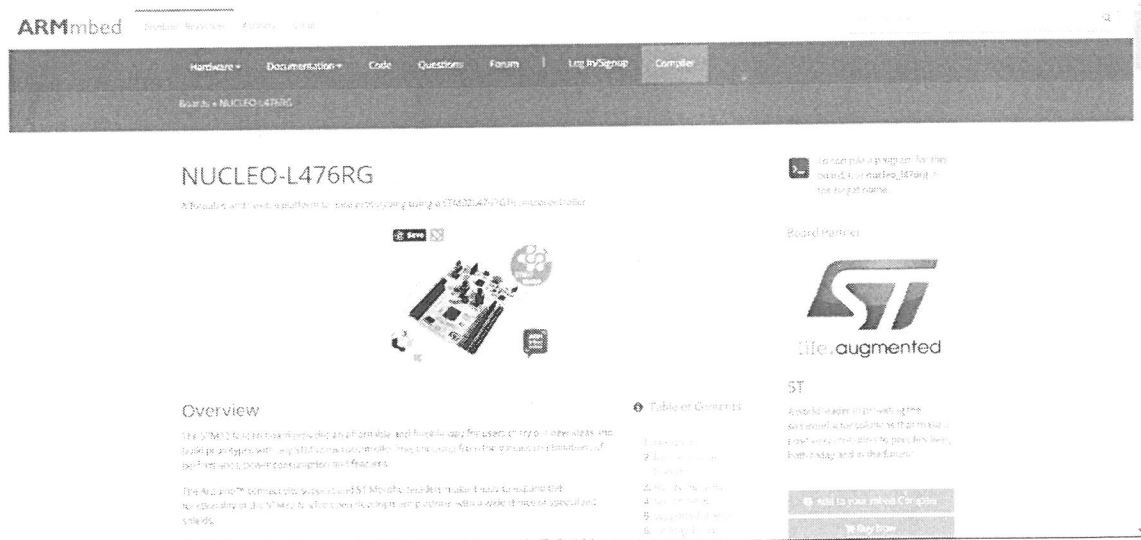


Fig 2.

I had to program this board to do the functions that I required I had to learn about the ports it contains and about the coding of the board and the procedure to use mbed on the device.

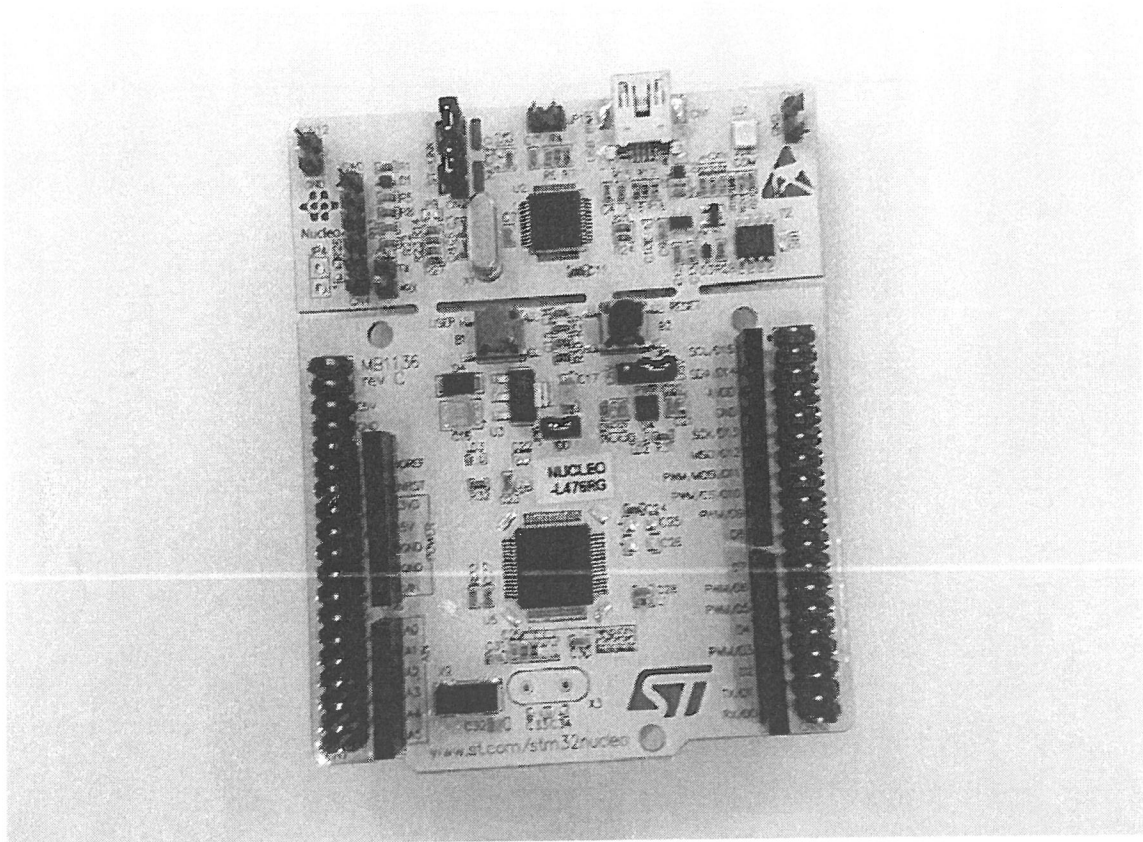


Fig 3.

Before presenting the code, I will show how the mbed used which commands to set the targeted directory on which we had to work so

```
laksh@laksh-VirtualBox:~/Nucleo_blink_led$ ls
BUILD main.cpp mbed mbed.bld mbed_settings.py mbed_settings.pyc
laksh@laksh-VirtualBox:~/Nucleo_blink_led$ mbed target NUCLEO_L476RG
[mbed] NUCLEO_L476RG now set as default target in program "Nucleo_blink_led"
laksh@laksh-VirtualBox:~/Nucleo_blink_led$ mbed toolchain GCC_ARM
[mbed] GCC_ARM now set as default toolchain in program "Nucleo_blink_led"
```

that it can use GCC_ARM which is a toolchain for compiling for Advanced RISC Machine (ARM).

After this, I had to edit the main file to make a program that does what I require it to do. The program that is used to edit any file in Linux is

Visual Interactive (vi) it is the command which opens the file and makes it understandable to us and then we can edit the file using the key I and we can edit the program as we see fit. But to reach there I had to use another command `cd` (change directory). Then I inserted the board and choose its directory as to apply the code Based on that board by using “**MBED TARGET**” command. Then I had to Set the toolchain Which was **GCC ARM**. The next step was Creating the program

CREATING THE PROGRAM

The creating of the programs for mbed is done using simple C or C++ coding they are quite easy to create. The commands for using the board for a specific function was given in some example programs which were given on the official website of mbed and on the board's window.

- ARM® 32-bit Cortex®-M4 CPU
- Adaptive real-time acceleration (ART Accelerator™), allowing Dwait state execution from Flash memory
- 80 MHz max CPU frequency
- VDD from 1.71 V to 3.6 V
- 1 MB Flash
- 128 KB SRAM
- Random generator (TRNG for HW entropy)
- Quad SPI (1)
- Timers General Purpose (7)
- Timers Advanced-Control (2)
- Timers Basic (2)
- Timers LowPower (2)
- SysTick
- Watchdog (2)
- SPI (3)
- I2C (3)
- USART (3)
- UART (2)
- LPUART (1)
- USB OTG Full Speed
- CAN (1)
- SAI (2)
- SDMMC
- SWPMI
- LCD 8x28 or 4x32
- GPIO (51) with external interrupt capability
- Capacitive sensing with 12 channels

Example programs

🔗 [Nucleo_read_analog_value](#)
Read an analog value using ADC. 🔗 [Nucleo_read_analog_value](#)
🔗 [Nucleo_read_analog_value](#)

Last updated: 27 Jun 2012

🔗 [Nucleo_ticker](#)
Basic example of how to blink a led using the Ticker object. 🔗 [Nucleo_ticker](#)
🔗 [Nucleo_ticker](#)

Last updated: 27 Jun 2012

🔗 [Nucleo_blink_led](#)
Blinky LED test for the ST Nucleo Boards. 🔗 [Nucleo_blink_led](#)
🔗 [Nucleo_blink_led](#)

Last updated: 29 May 2012

🔗 [Nucleo_printf](#)
Display a message on PC using UART. 🔗 [Nucleo_printf](#)
🔗 [Nucleo_printf](#)

Fig 4.

The way to compile a mbed program is by using the command:

```
laksh@laksh-VirtualBox:~/Nucleo_blink_led$ mbed compile
Building project Nucleo_blink_led (NUCLEO_L476RG, GCC_ARM)
Scan: .
Scan: mbed
Scan: env
Compile [100.0%]: main.cpp
Link: Nucleo_blink_led
Elf2Bin: Nucleo_blink_led
+-----+-----+-----+-----+
| Module | .text | .data | .bss |
+-----+-----+-----+-----+
| Fill   | 145   | 0      | 6     |
| Misc   | 62191 | 2500   | 1870  |
| Subtotals | 62336 | 2500   | 1876  |
+-----+-----+-----+-----+
Allocated Heap: unknown
Allocated Stack: unknown
Total Static RAM memory (data + bss): 4376 bytes
Total RAM memory (data + bss + heap + stack): 4376 bytes
Total Flash memory (text + data + misc): 64836 bytes
Image: ./BUILD/NUCLEO_L476RG/GCC_ARM/Nucleo_blink_led.bin
laksh@laksh-VirtualBox:~/Nucleo_blink_led$ cp ./BUILD/NUCLEO_L476RG/GCC_ARM/Nucleo_blink_led.bin /media/laksh/NODE_L476RG/
```

The whole compilation will execute and if any error is reported then it will report to the user in which area the error is caused and which kind of error it is so that the user can fix the error.

The next step is to copy the compiled bin file's image to the board that is done using the "cp" command to the location of the board. After learning about the basic functions to control and use the commands I was asked to make a basic program to turn just the Led on the board from "off" Condition to "on" or vice versa. Then When it got to as complex parts I Was taught how to use serial outputs to send transmit and Receive the signals back and forth from the micro-controller to any device on which data can be accepted and transmitted using a male to female wires.

THE PROGRAM:

```
#include "mbed.h"
DigitalIn mybutton(USER_BUTTON);
Serial pc(SERIAL_TX, SERIAL_RX);
Serial device(USB4_TX, USB4_RX);
DigitalOut myled(LED1);
int main()
{
    myled=1;
    char value[10];
    while(1){
        if (mybutton == 0) { // Button is pressed
            myled = !myled; // Toggle the LED state
            wait(0.2); // 200 ms
            device.printf("ATE0\r"); // "ATE0" Command is sent to the device
            pc.printf("AT by me\n\r"); // "AT by ME" is printed by me on the minicons screen
            {
                device.scanf("%s",&value); // Devices buffer is being checked for any data returned
            }
            pc.printf(value); // The data received is being printed on the screen by minicom
            pc.printf(" by sim\n\r");
        }
    }
}
```

The serial PC in this program denotes the signals that were being sent by me to the device connected which in this case was a sim900a module which is a device that accepts AT commands and can be used to call and message other devices using any sim.

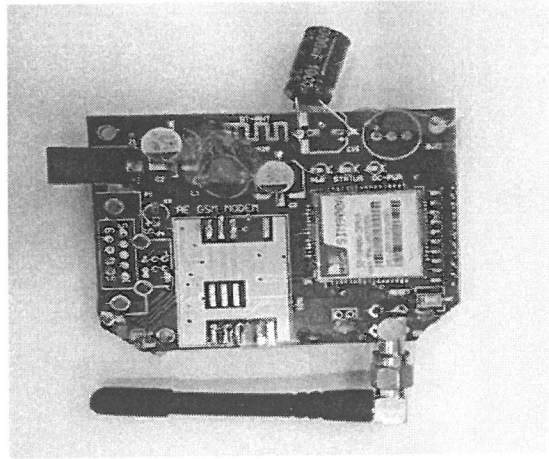


Fig 5. SIM900a

The whole setup after connections looked like this:

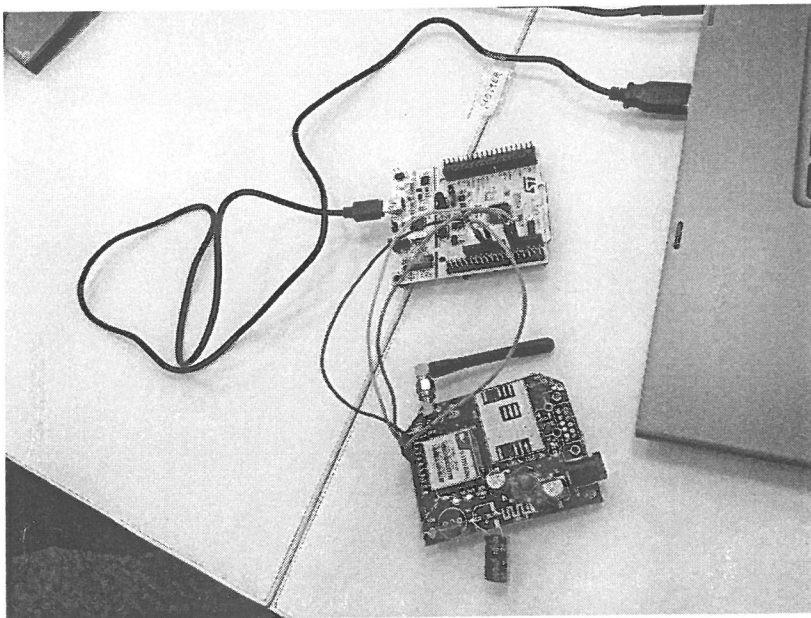


Fig 6. THE WHOLE SETUP

This simple program is used to send the device an ATE0 command which it accepts and sends a response to the minicom. Minicom is a text-based modem control and terminal emulation program for Unix-like operating systems. To use the minicom in terminal a simple command is used: `laksh@laksh-VirtualBox:~/Nucleo_blink_led$ sudo minicom`

When minicom opens the application in the terminal it appears like:

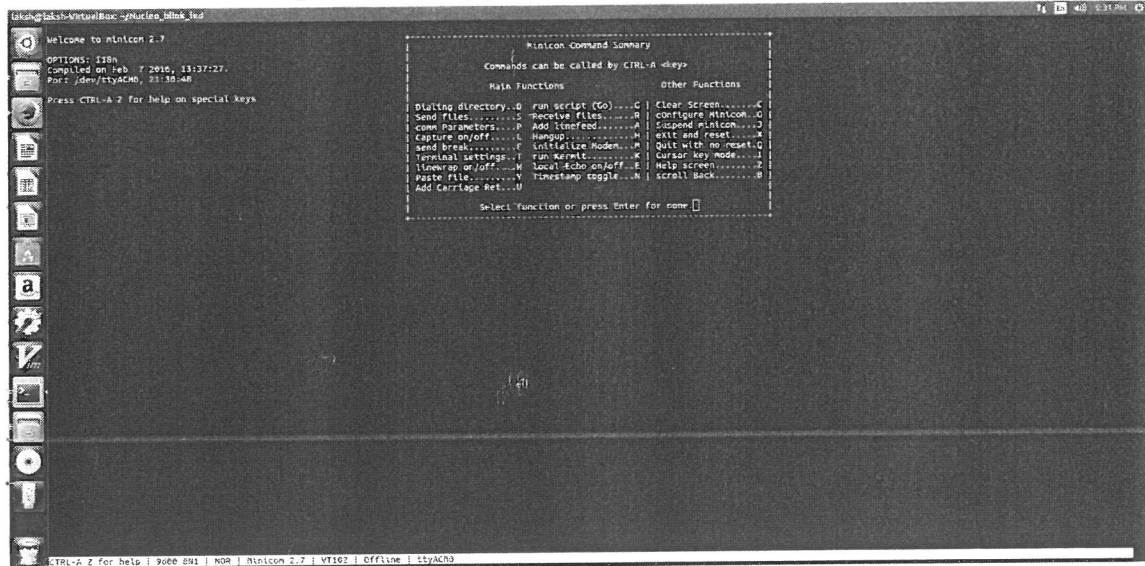


Fig 7.

After the minicom has been opened and the setting has been set to display the output from the device the next step is to press the button so that it sends the command to the sim900a and displays output when executed the result is something is like this:

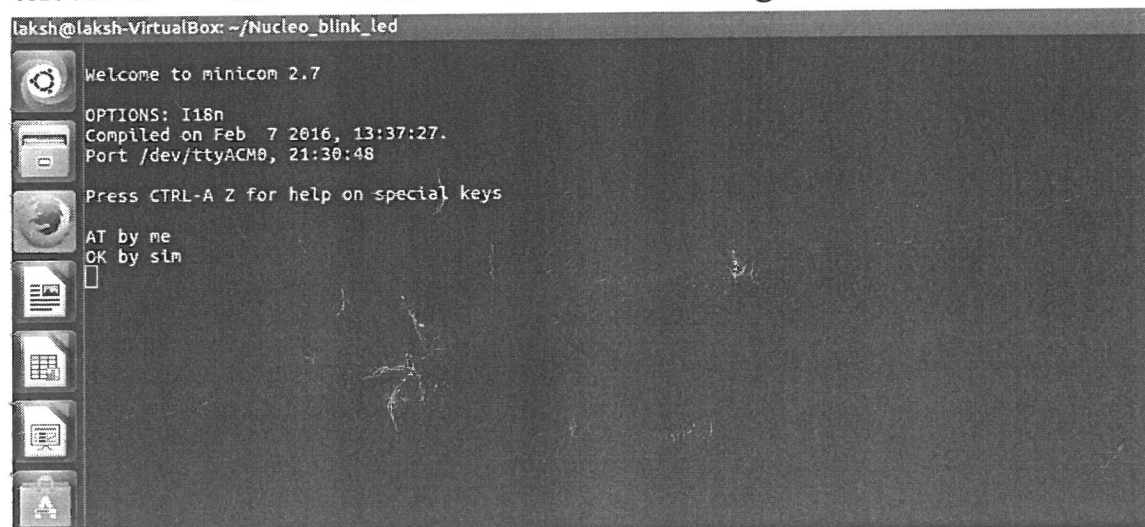


Fig 8.

Then I experimented with my program to call and text and to do repetitive functions e.g. call a number and if it is rejected then call back until the person accepts but 10 seconds after picking up the call hang up and then repeat I also had to test it for other scenarios and remove all the bugs.

Programming the 3-phase KissanMatic

KissanMatic was my company's product in the field of IoT it is a device that can be used to turn the 3-phase supply of power from the main line "ON" Or "OFF" using simple texts like "ACTIVATE" and it will send the status of the device which includes every information about the device including the information if the supply is ON etc.

Programming the KissanMatic was done with the help of a programmer. A programmer is a device that can forward the data of a bin file and load it into the device's flash. The software used for this purpose of using the programmer was ATMEL studio it is a great programming software for professional purposes.

I was given the task of flashing around a hundred of these devices and mark them with their IMEI no. while testing for any malfunctions that may be present in the hardware.

After the KissanMatic was flashed the next step was to test if it was responding and doing what it was supposed to and to check if there were any bugs.

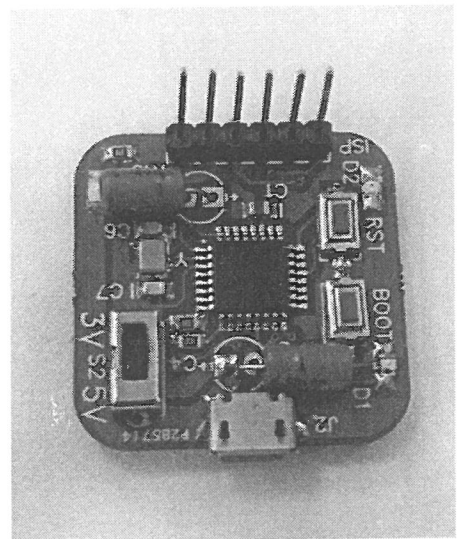


Fig 9. PROGRAMMER

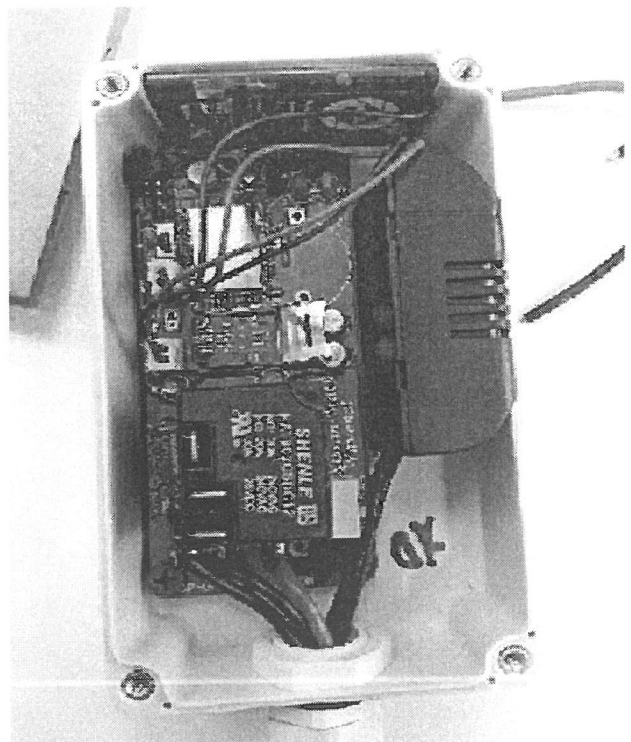
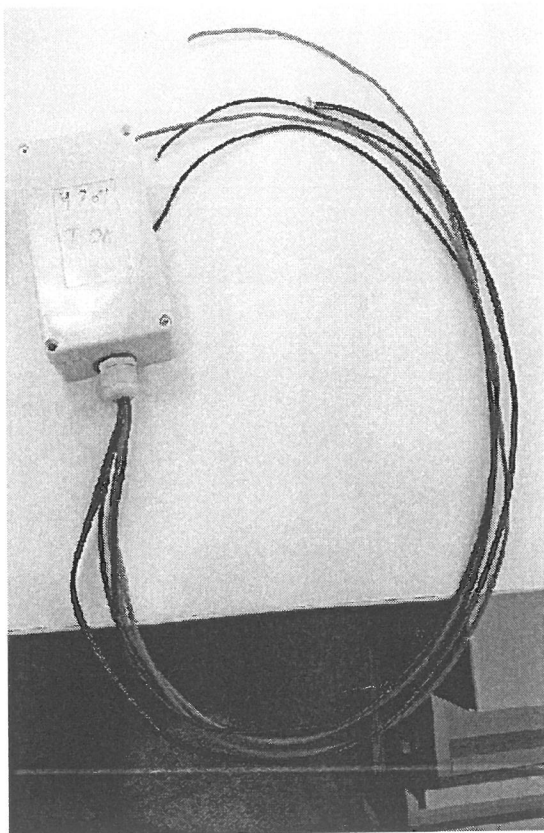


Fig 10. And 11.

KISSANMATIC

This was done by inserting a sim in the KissanMatic and sending this text to the device "Device Test". This forced the device to test the hardware configuration of the device and send the response to the sim with detailed status. This is one of the text runs I did:

Sent: Device test

Received: AC ok

Charger ok

BL: 25%

SL: 41%

IMEI=867567021283884

Not Act

Abbreviations: - BL battery level

SL Signal level

CHAPTER 5 : CONCLUSION

The PS1 enhanced my understanding of the industry and how the industry is progressing these days. I also got a chance to learn work ethics under the supervision of my company supervisor, I learned how to work hard efficiently. I got to learn about IoT and the way to use all the resources you have. I had to Use my skills in programming and my knowledge of circuits I had learnt in digital electronics and my skills in C acquired during my studies.

Through my training I understood the working of serial devices and how can they be programmed to get the desired results. I also learned about microcontroller boards and how they work and how I could program microcontrollers. I also learned the importance of team work and coordination.

BIBLIOGRAPHY

ATMEL STUDIO: <http://www.microchip.com/development-tools/atmel-studio-7>

MBED WEBSITE: <https://developer.mbed.org/>

XCTU: <https://www.digi.com/products/xbee-rf-solutions/xctu-software/xctu>

VIRTUAL BOX: <https://www.virtualbox.org/>

HOW TO INSTALL KISSANMATIC: <https://www.youtube.com/watch?v=85P-YDv6opk>