SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU-572103
(An Autonomous Institute under Visvesvaraya Technological University, Belagavi)

Industrial Training Report

on

Embedded Systems

submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted by

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CHAPTER 1

INTRODUCTION

1.1 Profile of the Industry

Technosphere is a Marketing and Consulting LLP found in September 2009 by Technocrats, located in Bangalore. It is an experienced management, with over 30 man-years of experience in IT Product Development and Service Industry. Technosphere is built with the vision to enable partnership between Industry and Academics resulting in successful induction of students into Technical Industry. It also has a proven track record of delivering cutting-edge products. Technosphere Labs provides end to end product engineering services and Internet of Things (IOT) connectivity solutions. Technosphere team can execute projects from concept to mass-production, including Architecture, Hardware, Firmware design and Compliance. Technosphere provides end to end product engineering and design services and internet of things (IOT) connectivity solutions, helping clients build smart digital products with multiple sensors and embedded technologies to connect to the cloud.

1.2 Objective of the Training

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires non-standard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

1.3 Nature/Scope of Training

An embedded system is a programmed controlling and operating system with a dedicated function within a larger mechanical or electrical system, often with real time computing constraints. Modern embedded systems are often based on microcontroller (i.e. CPUs with integrated memory or peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations, or even custom designed for the

application at hand. Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Smart waste management system is designed using PIC 18F46K22.

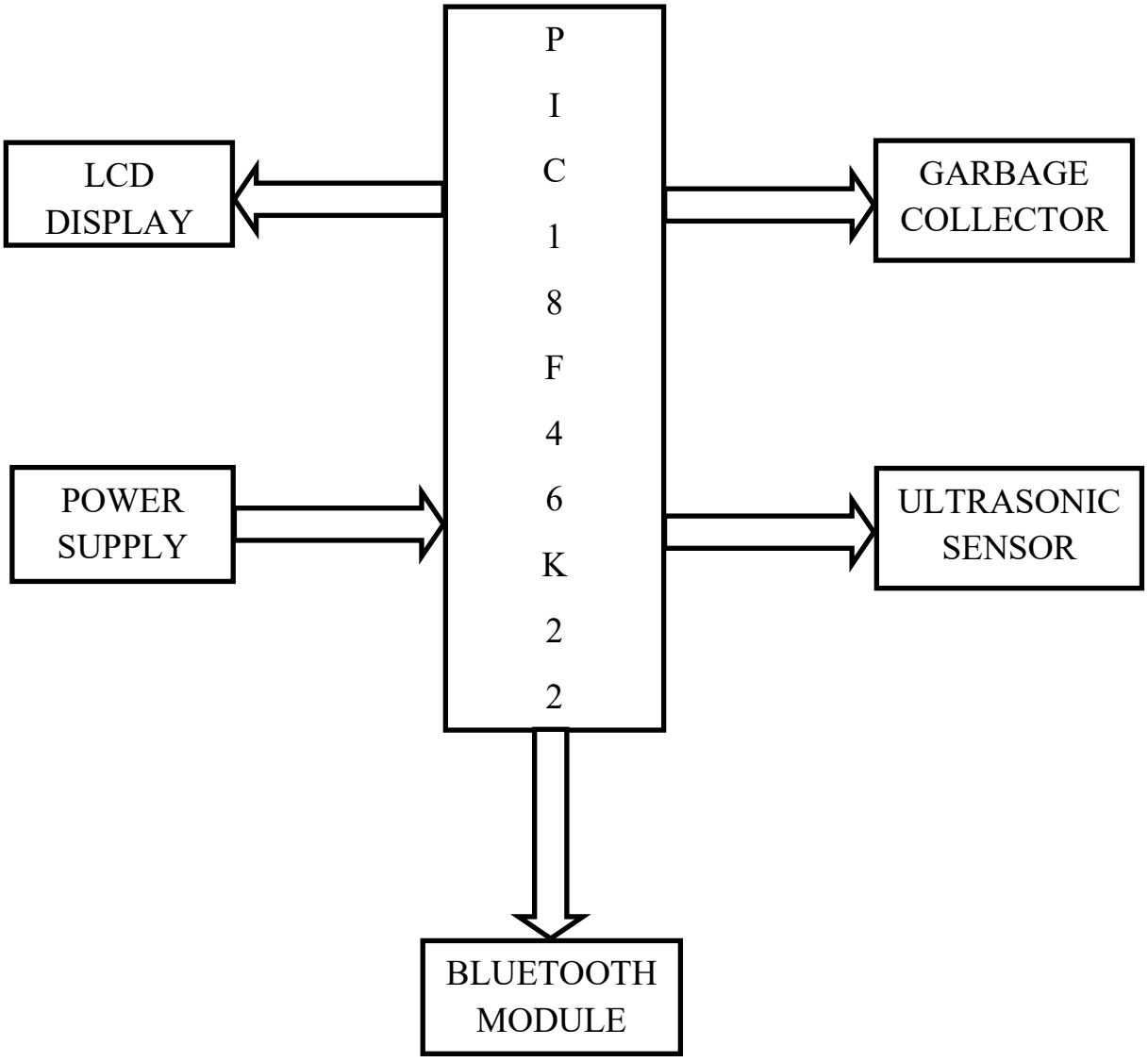

Fig. 1.3. a: Block Diagram of Smart Waste Management System

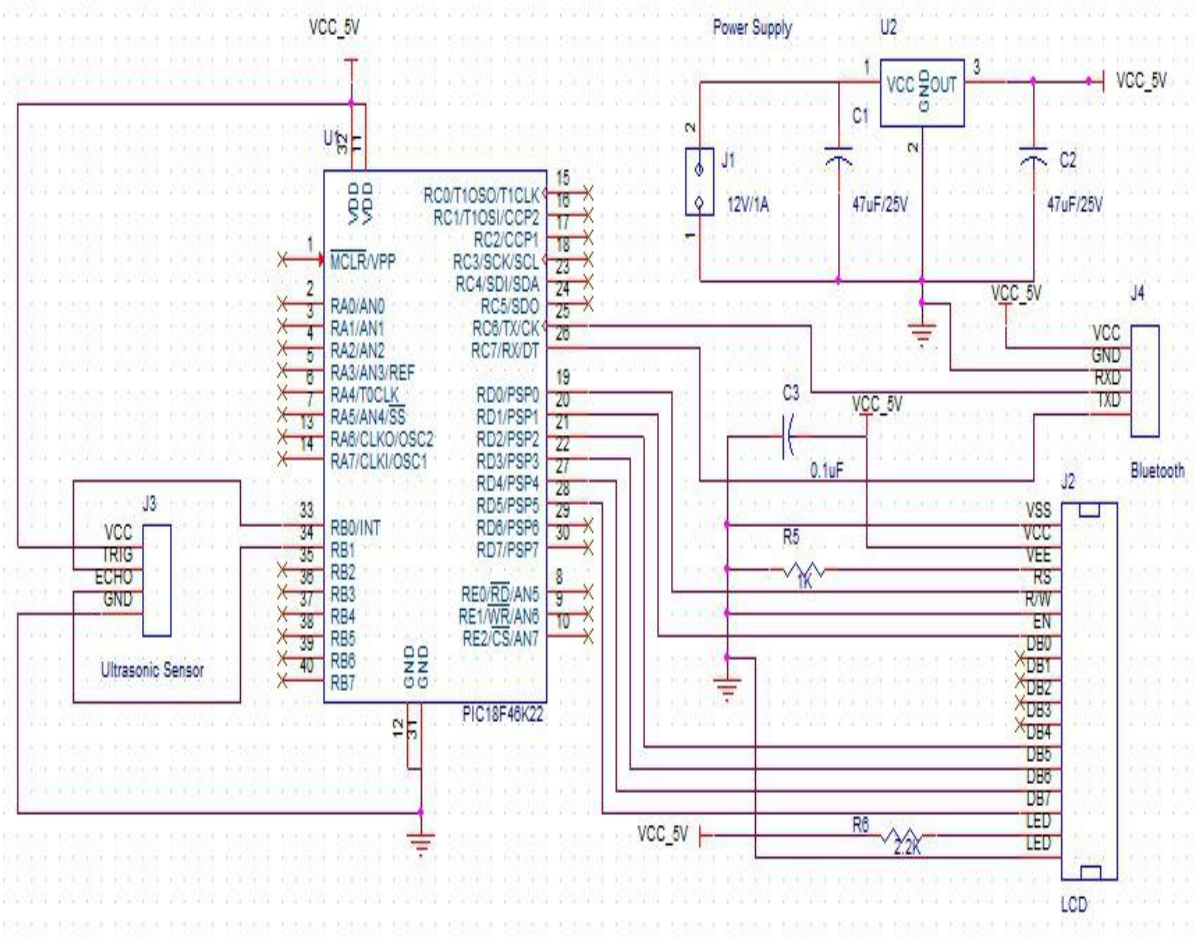

Fig. 1.3. b: Schematic of Smart Waste Management System

Ultrasonic sensor is used to sense the distance i.e. quantity of waste is sensed using this sensor. When the bin is completely filled with wastes the message is sent to authorized authorities through Bluetooth device app which is designed using MIT App Inventor.

Quantity of waste will be displayed in LCD displayed at particular stages as shown in below Fig. 1.3. b.

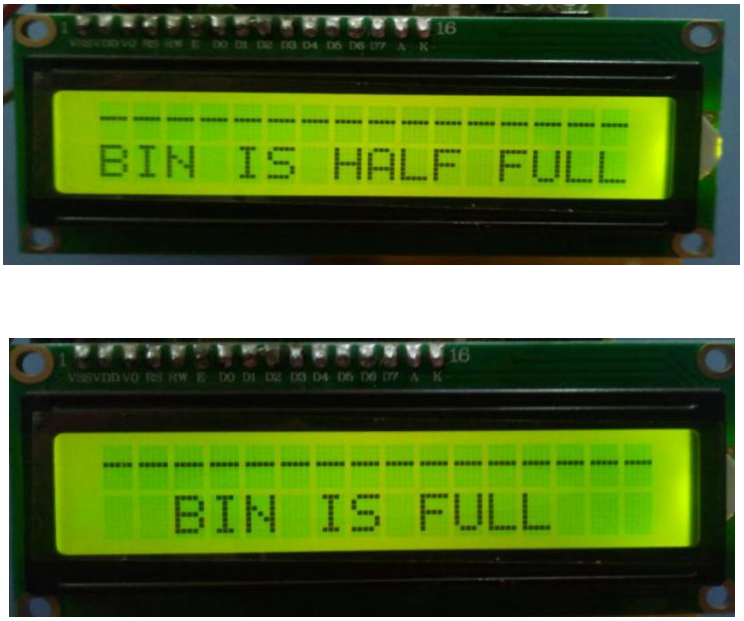

Fig. 1.3. c: LCD Display's related to waste quantity in bin

Message which is sent to authorized person as follows "BIN IS FULL" & "SEND THE TRUCK" as in Fig.1.3. c.

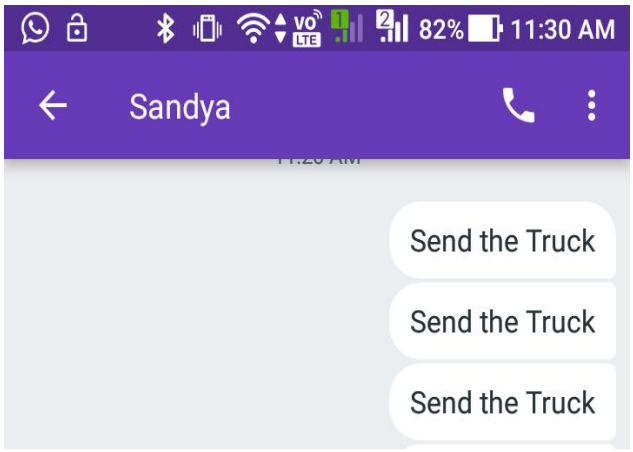

Fig. 1.3. d: Message sent to authorized person

CHAPTER 2
TECHNICAL COMPETENCY

2.1 Modern Tools/ Technology/ Platform included

2.1.1 PIC 18F46K22

PIC is a family of modified Harvard architecture micro-controllers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics division. The name PIC initially referred to “Peripheral Interface Controller” now it is “PIC” only. It is flash microcontroller. It has 10-bit A to D convertor and two PWM modules. PIC18F46K22 is used as smart microcontroller which performs two main functions. It identifies operated data from batteries and Because of its high performance, low power consumption, more efficient, we are going to use PIC18F46K22 microcontroller. PIC and PIC micro are registered trademarks of Microchip Technology. It is generally thought that PIC stands for Peripheral Interface Controller, although General Instruments original acronym for the initial PIC1640 and PIC1650 devices was “Programmable Interface Controller”. The acronym was quickly replaced with “Programmable Intelligent Computer”.

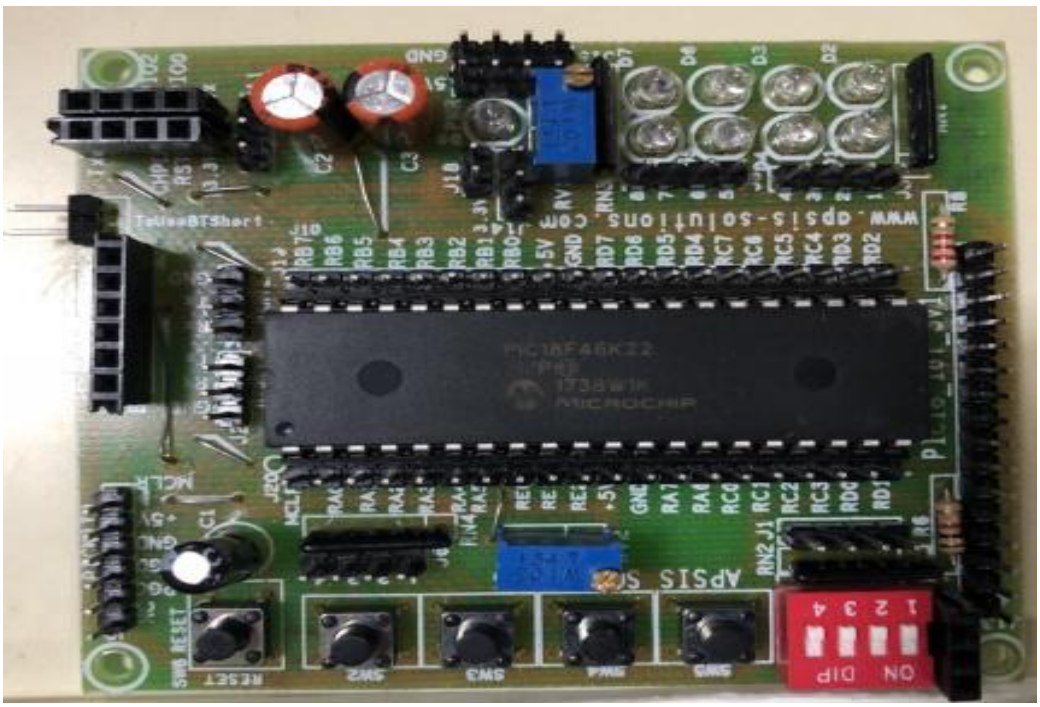

Fig. 2.1. a: PIC18F46K22 board with peripherals

Features of PIC 18F46K22 are:

- High-Performance RISC CPU.
- Flexible Oscillator Structure.
- Extreme Low-Power Management.
- Two Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART) modules.
- Analog-to-Digital Converter (ADC) module and Digital-to-Analog Converter (DAC) module.
- Alternate Run Modes.
- Memory Endurance.
- Self-programmability.
- Extended Instruction Set.
- Enhanced CCP module.
- Extended Watchdog Timer (WDT).

Fig. 2.1.b: PIC Microcontroller

2.1.2 ARM Controller

ARM stands for Advanced RISC Machines refer to a 32-bit RISC (Reduced Instruction Set Architecture) Instruction Set Architecture. About 98 percent of the more than one billion mobile phones sold each year use at least one ARM processor. Till now more than 10 billion ARM powered units have been manufactured. ARM processors are used extensively in

consumer electronics, including PDAs, mobile phones, digital media and music players, hand held game consoles and calculators.

ARM was founded in November 1990 by Spun out of Acorn Computers. They license ARM core designs to semiconductor partners who fabricate and sell them to customers. It does not fabricate silicon itself. ARM licenses processor cores (and other IP) to partners for use in their own products. Also, develop technologies to assist with the design-in of the ARM architecture. Software tools, boards, debug hardware, application software, bus architectures, peripherals, memory, etc

A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 is ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. A blend of serial communications interfaces ranging from a USB 2.0 Full Speed device, multiple UARTs, SPI, SSP to I2Cs, and on-chip SRAM of 8 KB up to 40 KB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low-end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems.

Features of LPC 2148:

- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 KB to 40 KB of on-chip static RAM and 32 KB to 512 KB of on-chip flash memory.
- 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- Full chip erase in 400ms and programming of256 bytes in 1ms.
- USB 2.0 Full-speed compliant device controller with 2 KB of endpoint RAM.
- In addition to LPC2148 provides 8 KB of on-chip RAM accessible to USB by Direct Memory Access (DMA).
- Single 10-bit DAC provides variable analog output (LPC2142/44/46/48 only).
- Two 32-bit timers/external event counters (with four capture and four compare Channels each), Pulse Width Modulation (PWM) unit (six outputs) and watchdog.

- Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input.
- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400kbit/s),
- SPI and SSP with buffering and variable data length capabilities.
- Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses.
- 60MHz maximum CPU clock available from programmable on-chip PLL with settling Time of 100ms.
- On-chip integrated oscillator operates with an external crystal from 1 MHz to 25MHz
- Power saving modes include idle and Power-down.
- Single power supply chip with POR and BOD circuits:
- CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 % for LPC2148) with 5 V tolerant I/O ports.

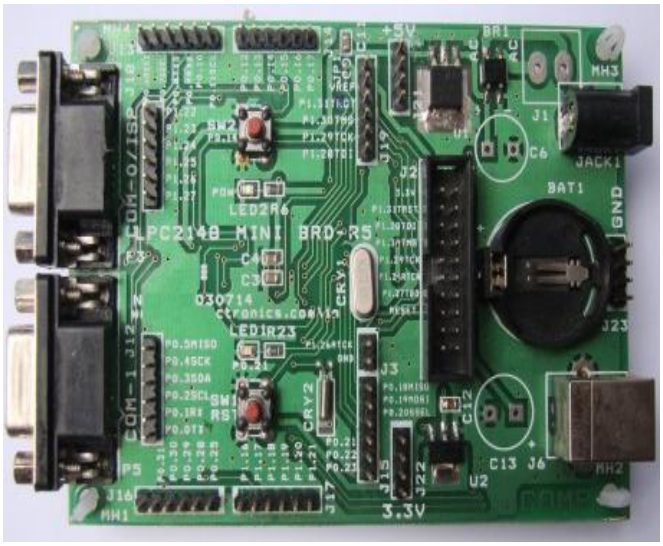

Fig. 2.1.c: ARM Microcontroller

2.1.3 MIT App Inventor

App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It allows new comers to computer programming to create software applications for the Android operating system (OS). It uses a graphical interface, very similar to Scratch and the Star Logo TNG user interface, which allows users to drag-and-drop visual objects to create an application that

can run on Android devices. In creating App Inventor, Google drew upon significant prior research in educational computing, as well as work done within Google on online development environments. App Inventor and the projects on which it is based are informed by constructionist learning theories, which emphasizes that programming can be a vehicle for engaging powerful ideas through active learning.

Apps can be build by working with

- The App Inventor Designer, where you select the components for your app.
- The App Inventor Blocks Editor, where you assemble program blocks that specify how the components should behave. You assemble programs visually, fitting pieces together like pieces of a puzzle.

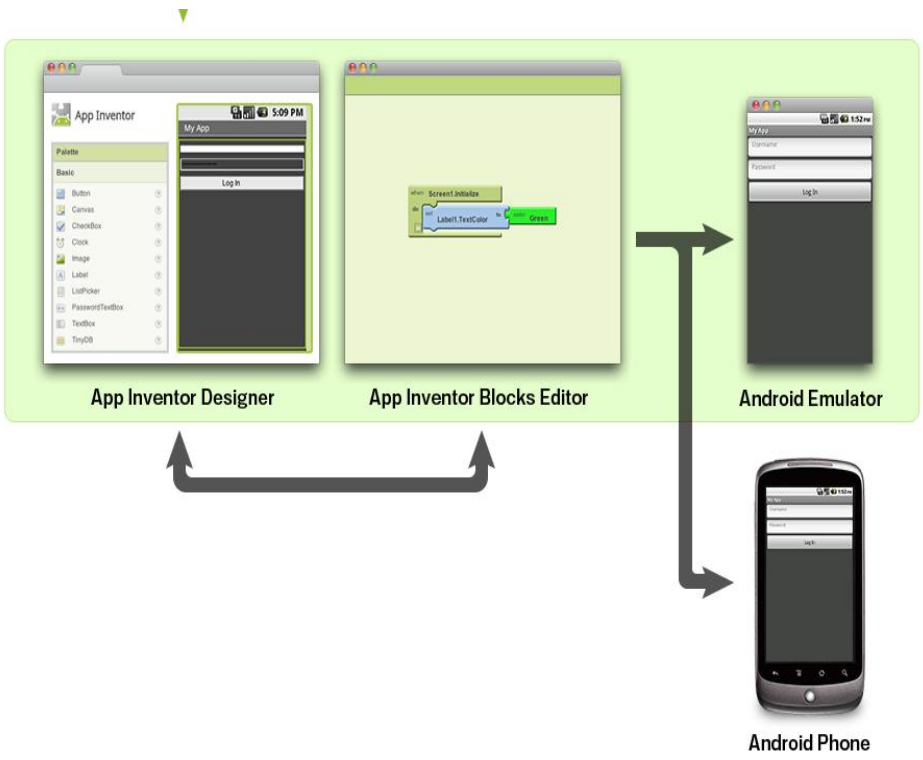

Fig. 2.1.d: Connectivity in MIT App Inventor

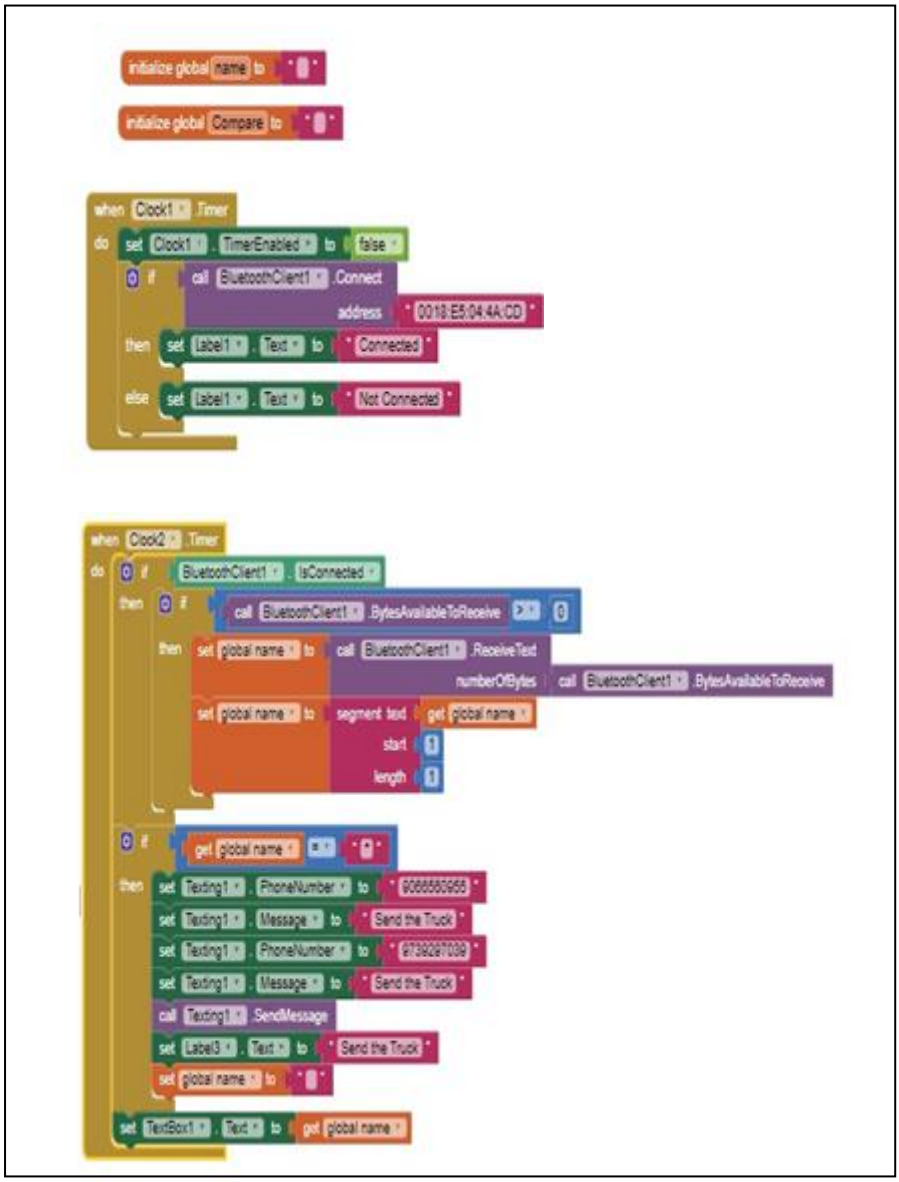

Fig. 2.1.e: Software Designing in MIT app inventor

2.1.4 Internet of Things

The Internet of Things (IOT), also called Internet of Everything or Network of Everything, is the network of physical objects or things embedded with electronics, software, sensors and connectivity to enable objects to exchange data with the production, operator and/or other connected devices based on the infrastructure of International Telecommunication Union's Global Standards Initiative. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems and resulting in improved efficiency, accuracy and economic benefit. The internet of things, or IoT, is a

system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

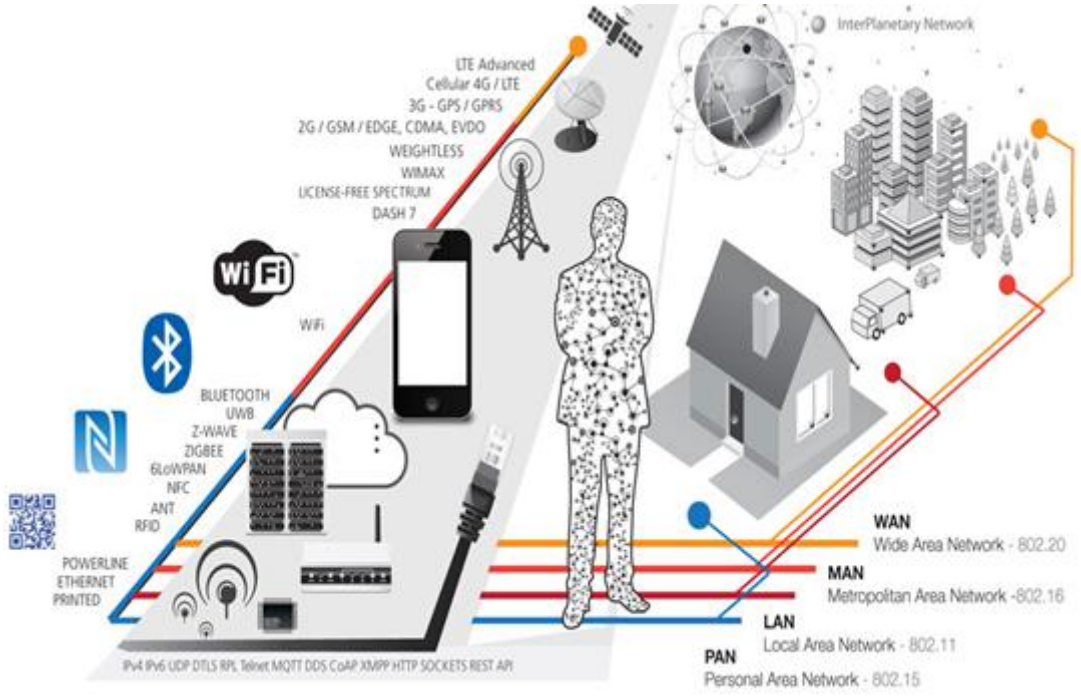

Fig.2.1. f: Overview of IOT system

The internet of things offers a number of benefits to organizations, enabling them to:

- monitor their overall business processes
- save time and money
- enhance employee productivity.
- integrate and adapt business models.
- make better business decisions and
- generate more revenue.

IoT encourages companies to rethink the ways they approach their businesses, industries and markets and gives them the tools to improve their business strategies. In healthcare, IoT offers many benefits, including the ability to monitor patients more closely to use the data

that's generated and analyse it. Hospitals often use IoT systems to complete tasks such as inventory management, for both pharmaceuticals and medical instruments.

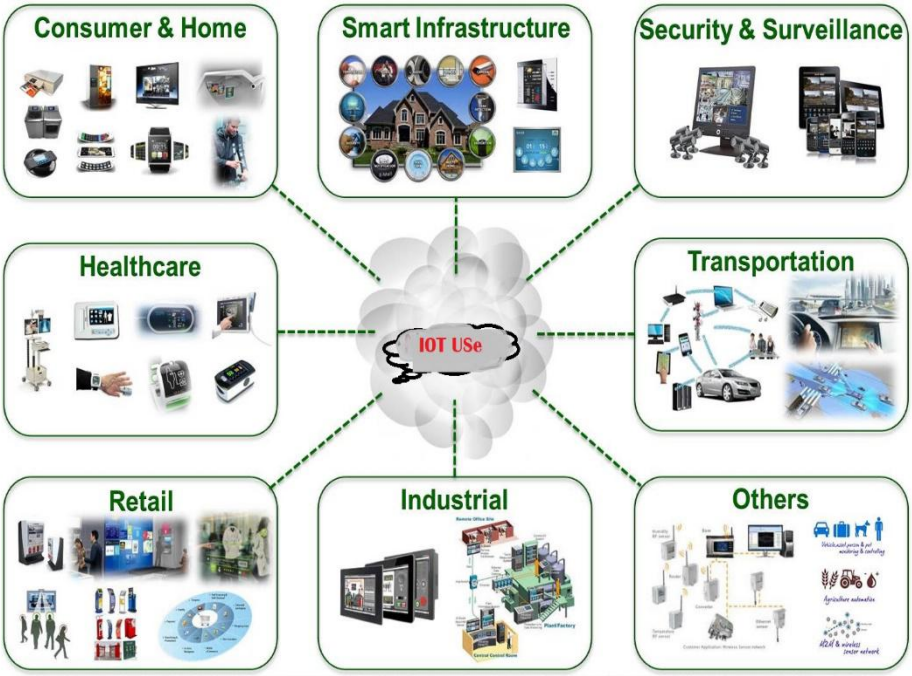

Fig. 2.1.g: IOT applications

2.1.5 Python Scripting

Python is one of those rare languages which can claim to be both simple and powerful. It is a simple and minimalistic language. Reading a good Python program feels almost like reading English, although very strict English. This pseudo-code nature of Python is one of its greatest strengths. It allows user to concentrate on the solution to the problem rather than the language itself. Python is extremely easy to get started with. Python has an extraordinarily simple syntax, as already mentioned. Python is a High-level Language, user need to bother about the low-level details such as managing the memory used by the program, etc. Portable, due to its open-source nature. All Python programs can work on any of the platforms without requiring any changes at all. Python is a general-purpose programming language created in the late 1980s, and named after Monty Python, that's used by thousands of people to do things from testing microchips at Intel, to powering Instagram, to building video games with the PyGame library. Python can be more user-friendly than Java, as it has a more intuitive coding style, both languages do have their unique advantages for developers and end users. However, if

you are just beginning your path towards a programming career, you might want to start by learning Python, as it is less complex.

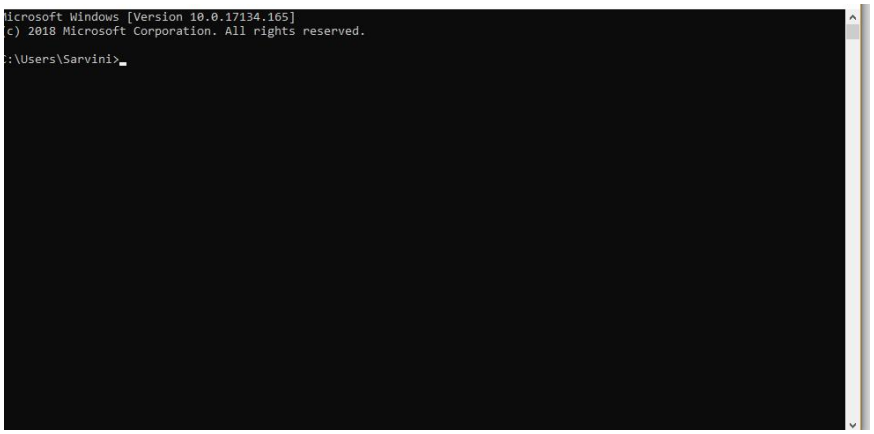

Fig.2.1.h: Command prompt of Python

Applications of python:

- Web Frameworks and Web Applications: Python has been used to create a variety of web-frameworks including CherryPy, Django, TurboGears, Bottle, Flask etc. ...
- Enterprise and Business Applications: ...
- Operating Systems: ...
- Language Development: ...
- Prototyping: ...
- 5 Strategies for Mobile App Development Success.

2.2 DESIGN, IMPLEMENTATION, TESTING AND TROUBLE SHOOTING TECHNIQUES PRACTICED

2.2.1 Hexapod

A hexapod robot is a mechanical vehicle that walks on six legs. Since a robot can be statically stable on three or more legs, a hexapod robot has a great deal of flexibility in how it can move. If legs become disabled, the robot may still be able to walk.

Fig.2.2. a: Example for Hexapod

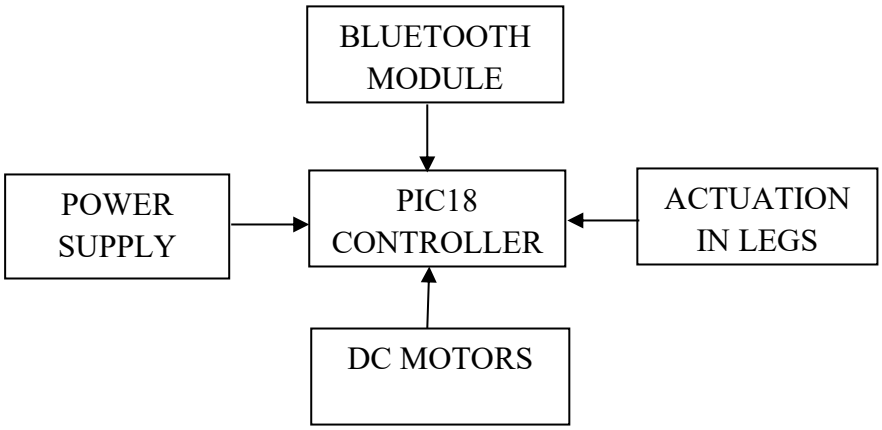

Fig. 2.2. b: Block Diagram of Hexapod

PIC18: The Microcontroller used to control the DC motors to move Hexapod and which movement should be done by it.

Bluetooth module: A Bluetooth module is interfaced with PIC18 which receives the signal via Bluetooth from an android phone.

DC Motor: It is used to move the legs of hexapod. By using few combinations of motors among 12 DC motors, different actions are performed.
An android phone with an android app installed to send signal to PIC18 by which decides the action to be performed.

Applications:

- Traditional robots are fast, can handle heavy loads, but lack positioning accuracy.
- Precision laser welding can also be improved with the help of hexapods.
- Also serve in other fields such as education, entertainment, cleaning, security, tour guiding, and environmental exploration.

CHAPTER 3

SOFT SKILLS AND BEST PRACTICES

3.1 Soft Skills Acquired

Soft skills are a cluster of productive personality traits that characterize one's relationships in a milieu. These skills can include social graces, communication abilities, language skills, personal habits, cognitive or emotional empathy, time management, teamwork and leadership traits. A definition based on review literature explains soft skills as an umbrella term for skills under three key functional elements: people skills, social skills, and personal career attributes. Technosphere deems soft skills as critical for being industrious in today's workplace. Soft skills complement hard skills also known as technical skills, for productive workplace performance and everyday life competencies. Hard skills were the only skills necessary for career employment and were generally quantifiable and measurable from educational background, work experience or through interview.

3.2 Practices followed in Industry

Society offers turnkey development services and would like to realize an embedded product. It will review the requirements and arrive at the optimum architecture and design approach within the set parameters of size, cost and quality requirements. The Architecture and System Design phase of development is most rigorous where society evaluates various platforms and approaches to arrive at the appropriate solution for the specific application. Technosphere will translate an agreed requirement document to a mass-production product which is reliable and cost-effective. Technosphere also designs products to meet required compliance such as statutory (EMI/UL) and domain specific (USB, EMV) certifications. Technosphere has a committed team which is extremely passionate about technology. It is driven to use the potential of the latest technology to design cutting edge products which help new and innovative ideas come to life. Technosphere offers training to students and technical professionals in embedded systems, Advanced Microcontrollers, New technologies such as RFID, Smartcard and Mobile Technology.

The topics covered during the training course are:

* Embedded C Programming
* Advanced Microcontroller
* Internet of Things
* Python scripting
* Hardware development
* Manufacturing technology

CHAPTER 4

CONCLUSION

4.1 Outcome of the Training

The Technosphere has the core competence in offering Product and Service organizations realize their solutions with speed and efficiency. Technosphere provides consulting in new emerging technologies. Its main vision is to enable and support world-class products from concept to deployment by partnering with specialists and deliver tangible value to customers. It has successfully developed solutions in Industrial, Agricultural, Building, Banking and Home Automation. To the academic world, Technosphere helps students realize their ambition of becoming good engineers for the industry, in their final years of education. It provides the right tools, training and hands-on project to enable the students to be “industry ready”. In the Industrial training program, various topics like embedded C programming, brief lectures on advanced microcontrollers like PIC 18 and ARM 7, etc are covered.

Technosphere also offers career opportunities in various embedded hardware-software fields. Selected candidates will be involved in development of next generation products in Industrial, Medical, Enterprise and Home automation involving state-of-art Microcontrollers, display systems, wireless and wired communication, analog and digital interfaces.

BIBLIOGRAPHY

[1] Available: https://www.wikiforu.com/2012/10/microcontroller-8051-introduction

[2] Available: http://appinventor.mit.edu/explore/ai2/tutorials.html

[3] Available: https://en.wikipedia.org/wiki/Internet-of-things

[4] Available: http://www.microchip.com/wwwproducts/en/PIC18F46K22

[5] Y. Daniel Liang, Introduction to Programming Using Python, Pearson Education,2012.