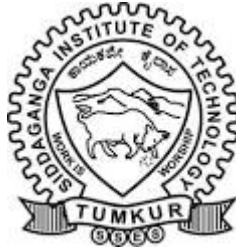**SIDDAGANGA INSTITUTE OF TECHNOLOGY, TUMAKURU-572103**

(An Autonomous Institute under Visvesvaraya Technological University, Belagavi)

Industrial Training Report on

"Internet of things"

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

BACHELOR OF ENGINEERING

in

ELECTRONICS & COMMUNICATION ENGINEERING
Submitted by

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

2021-22

Certificate

Figure 0.1: Certificate

Course Outcomes

CO1: Identify and model a given engineering problem

CO2: Apply prior acquired knowledge and identify an appropriate problem solving methodology

CO3: Implement the methodology and propose a meaningful solution

CO4: Demonstrate the use of modern tools

CO5: Demonstrate individual and team work

CO6: Effectively communicate the solution to problem orally and writing

CO7: Demonstrate life- long learning skills

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1		3										3	3	3
CO-2	3											3	3	3
CO-3			3		3							3	3	3
CO-4			3		3							3	3	3
CO-5									3					3
CO-6	3	2	2		2			2		2		3	3	2
CO-7	3	2	2		2							3	3	3
Average	3	2	3		3			2	3	2		3	3	3

Attainment level: - 1: Slight (low) 2: Moderate (medium) 3: Substantial (high)

POs: PO1: Engineering Knowledge, PO2: Problem analysis, PO3: Design/Development of solutions, PO4: Conduct investigations of complex problems, PO5: Modern tool usage, PO6: Engineer and society, PO7: Environment and sustainability, PO8: Ethics, PO9: Individual and team work, PO10: Communication, PO11: Project management and finance, PO12: Lifelong learning

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Chapter 1

Introduction

1.1 Profile of the Industry

Monkfox is an IIT, IISc Alumni initiative to provide best in class training to Engineering Graduates. [1] They share a common vision, which is to change the look and shape of higher education in the country. They conduct various hands-on technology workshops i.e. Student Training Programs (STPs) and Faculty Development Programs (FDPs). Figure1.1 shows the company logo.

Figure 1.1: Monkfox Logo

Monkfox: To inculcate the practice of hands on practical learning in all the Colleges and Universities.

1.2 Objectives

To expose the students to actual working environment and enhance their knowledge and skill from what they have learned in the college and to instil the good qualities of integrity, responsibility and self-confidence. It is also to help the students learn about the safety practices and regulations followed inside the industry and instils the spirit of teamwork and good relationship between students and employees.

1.3 Scope of the Training

1. Gain knowledge and precious experience in the entire field of IoT including android, python and machine learning.

2. Learn to know the proper way and procedure required to approach a problem statement.

3. Understand the technical competence required from a student as expected by an industry.

4. Hands-on implementation of the modern tools.

Chapter 2

Technical Competency

2.1 Modern tools/Technology/Platform introduced

2.1.1 Anaconda Navigator

Figure 2.1: Anaconda logo

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing, that aims to simplify package management and deployment.Logo of Anaconda Navigator is shown in Figure2.1. Package versions are managed by the package management system conda. Figure2.2 shows Anaconda Navigator pane.
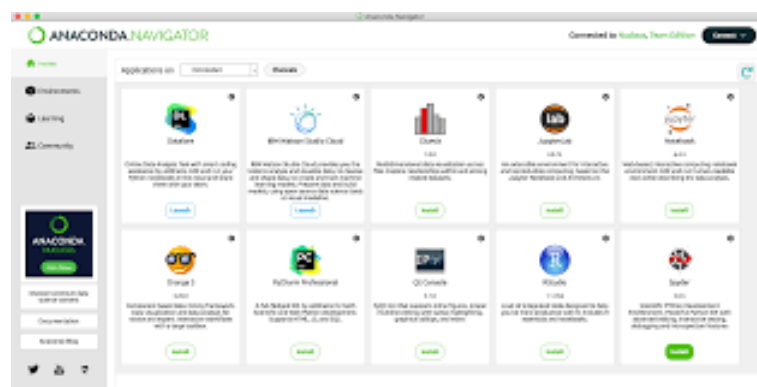

Figure 2.2: Anaconda Navigator

Anaconda Navigator: Anaconda Navigator is a desktop GUI included in anaconda distribution that allows users to launch applications and manage conda packages, envi-

ronment and channels without using command-line commands.

Applications in Anaconda Navigator: JupyterLab, Jupyter Notebook, QtConsole, Spyder, Glueviz, Orange, Rstudio

Jupyter Notebook: Jupyter Notebook (formerly IPython Notebooks) is a web-based interactive computational environment for creating Jupyter notebook documents. A Jupyter Notebook document is a JSON document, following a versioned schema, and containing an ordered list of input/output cells which can contain code, text, mathematics, plots and rich media, usually ending with the ". ipynb" extension. Jupyter Notebook is a platform where projects on Machine Learning and Artificial Intelligence can be easily implemented and tested the file written can also be used anywhere.

2.1.2   Android Studio

Figure 2.3: Android Studio Logo

Android Studio is the official integrated development environment for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. Logo of Android studeio is shown in Figure2.3. It is available for download on Windows, macOS and Linux based operating systems. Android studio IDE is shown in Figure2.4.

Features:

- Gradle-based build support

- Android-specific refactoring and quick fixes

- Lint tools to catch performance, usability, version compatibility and other problems

- ProGuard integration and app-signing capabilities

- Template-based wizards to create common Android designs and components
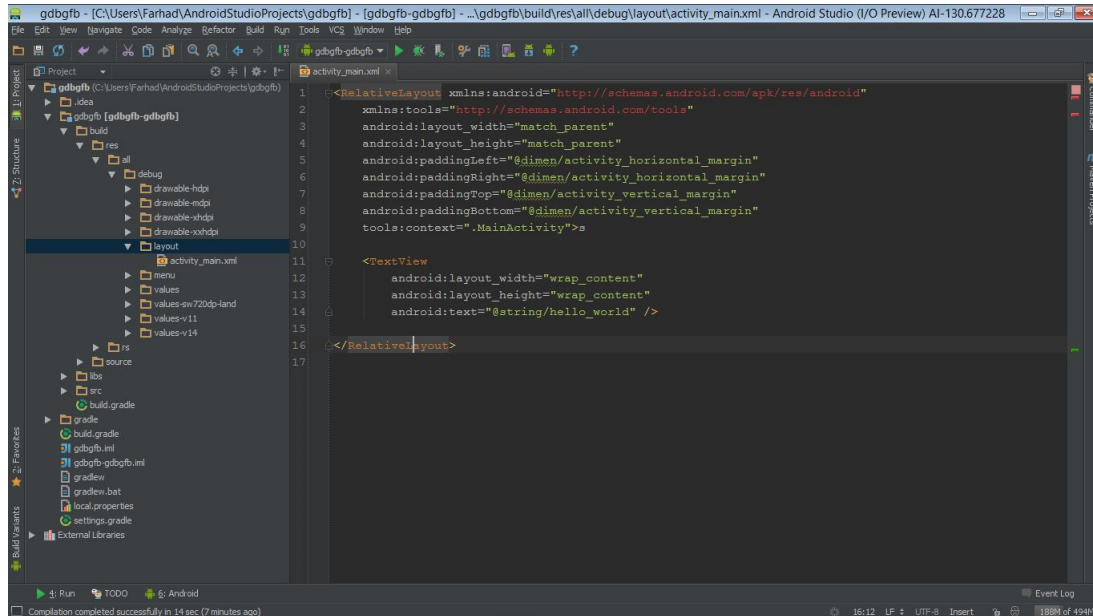
Figure 2.4: Android Studio IDE

- A rich layout editor that allows users to drag-and-drop UI components, option to preview layouts on multiple screen configuration

- Support for building Android Wear apps

- Built-in support for Google Cloud Platform, enabling integration with Firebase Cloud Messaging (Earlier 'Google Cloud Messaging') and Google App Engine

- Android Virtual Device (Emulator) to run and debug apps in the Android studio

Android Studio supports all the same programming languages of IntelliJ e.g. Java, C++and more with extensions. It supports all Java 7 and 8 language features and some features of Java 9.

2.1.3   Arduino Uno

The Arduino Uno is an open-source microcontroller board based on the Microchip AT-mega328P microcontroller and developed by Arduino.cc. Arduino Uno board is shown in Figure2.5. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. [4]

Features:

- It is an easy USB interface. This allows interface with USB as it is a serial device.

Figure 2.5: Arduino UNO

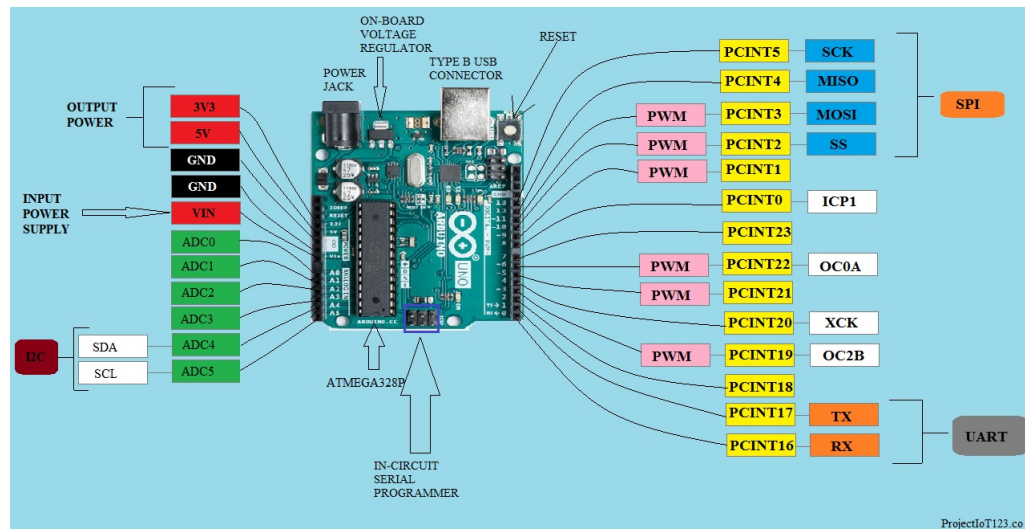- The chip on the board plugs straight into your USB port and supports on your computer as a virtual serial port. The benefit of this setup is that serial communication is an extremely easy protocol which is time-tested and USB makes connection with modern computers and makes it comfortable.

- It is easy-to-find the microcontroller brain which is the ATmega328 chip. It has a greater number of hardware features like timers, external and internal interrupts, PWM pins and multiple sleep modes.

- It is an open source design and there is an advantage of being open source is that it has a large community of people using and troubleshooting it. This makes it easy to help in debugging projects.

- It is a 16 MHz clock which is fast enough for most applications and does not speeds up the microcontroller.

- It is very convenient to manage power inside it and it had a feature of built-in voltage regulation. This can also be powered directly off a USB port without any external power. You can connect an external power source of up to 12v and this regulates it to both 5v and 3.3v.

- 13 digital pins and 6 analog pins. This sort of pins allows you to connect hardware to your Arduino Uno board externally. These pins are used as a key for extending the computing capability of the Arduino Uno into the real world. Simply plug your

electronic devices and sensors into the sockets that correspond to each of these pins and you are good to go.

- This has an ICSP connector for bypassing the USB port and interfacing the Arduino directly as a serial device. This port is necessary to re-bootload your chip if it corrupts and can no longer used to your computer.

- It has a 32 KB of flash memory for storing your code.

- An on-board LED is attached to digital pin 13 to make fast the debugging of code and to make the debug process easy.

- It has a button to reset the program on the chip.

2.1.4   Raspberry Pi

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries [3]. Raspberry Pi 3 Model B board is shown in Figure2.6.
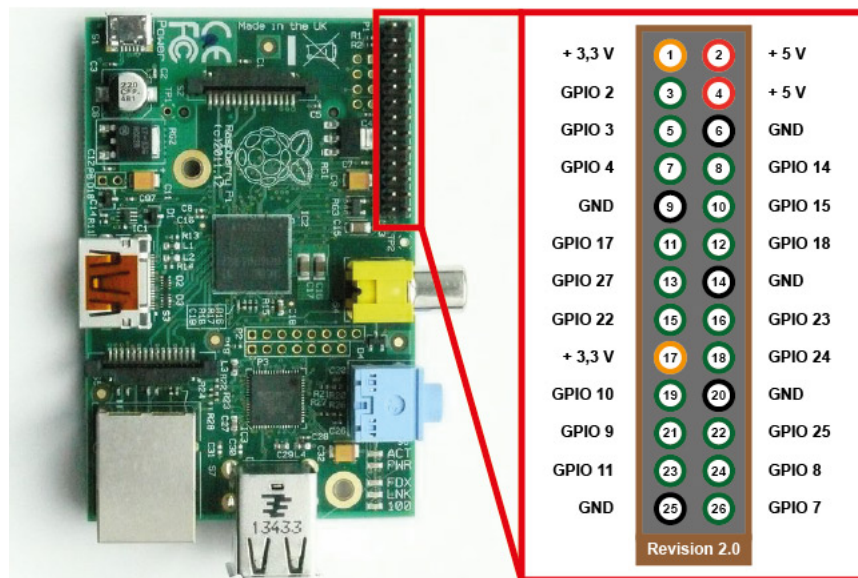
Hardware Specifications:

Figure 2.6: Raspberry PI 3 Model B

1. **Memory:** The raspberry pi model Aboard is designed with 256MB of SDRAM and model B is designed with 51MB.Raspberry pi is a small size PC compare with other

PCs. The normal PCs RAM memory is available in gigabytes. But in raspberry pi board, the RAM memory is available more than 256MB or 512MB.

2. **CPU (Central Processing Unit):** The Central processing unit is the brain of the raspberry pi board and that is responsible for carrying out the instructions of the computer through logical and mathematical operations. The raspberry pi uses ARM11 series processor.

3. **GPU (Graphics Processing Unit):** The GPU is a specialized chip in the raspberry pi board and that is designed to speed up the operation of image calculations. This board designed with a Broadcom video core IV and it supports OpenGL.

4. **Ethernet Port:** The Ethernet port of the raspberry pi is the main gateway for communicating with additional devices. The raspberry pi Ethernet port is used to plug your home router to access the internet.

5. **GPIO Pins:** The general-purpose input output pins are used in the raspberry pi to associate with the other electronic boards. These pins can accept input output commands based on programming raspberry pi. The raspberry pi affords digital GPIO pins. These pins are used to connect other electronic components. For example, you can connect it to the temperature sensor to transmit digital data.

6. **XBee Socket:** The XBee socket is used in raspberry pi board for the wireless communication purpose.

7. **Power Source Connector:** The power source cable is a small switch, which is placed on side of the shield. The main purpose of the power source connector is to enable an external power source.

8. **UART:** The Universal Asynchronous Receiver/ Transmitter is a serial input output port. That can be used to transfer the serial data in the form of text and it is useful for converting the debugging code.

Features of Raspberry Pi Model 3:

- 512 MB SDRAM memory

- Broadcom BCM2835 SoC full high definition multimedia processor

- Dual Core Video Core IV Multimedia coprocessor

- Single 2.0 USB connector

- HDMI (rev 1.3 and 1.4) Composite RCA (PAL NTSC) Video Out

- 3.5 MM Jack, HDMI Audio Out

- MMC, SD, SDIO Card slot on board storage

- Linux Operating system

- Dimensions are 8.6cm*5.4cm*1.7cm

- On board 10/100 Ethernet RJ45 jack.

Some of the applications: Media streamer, Arcade machine, Tablet computer, Home automation, Carputer, Internet radio, controlling robots, Cosmic Computer, Hunting for meteorites etc.

2.1.5 MQTT

MQTT is a lightweight, publish-subscribe network protocol that transports messages between devices. [2] The protocol usually runs over TCP/IP, however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT. It is designed for connections with remote locations where a resource constraints exist or the network bandwidth is limited. The protocol is an open OASIS standard and an ISO recommendation (ISO/IEC 20922).

The MQTT protocol defines two types of network entities: a message broker and a number of clients. An MQTT broker is a server that receives all messages from the clients and then routes the messages to the appropriate destination clients. An MQTT client is any device (from a micro controller up to a fully-fledged server) that runs an MQTT library and connects to an MQTT broker over a network.

MQTT Broker: The MQTT broker is software running on a computer (running on-premises or in the cloud), and could be self-built or hosted by a third party. It is available in both open source and proprietary implementations.

The main advantages of MQTT broker are:

1. Eliminates vulnerable and insecure client connections

2. Can easily scale from a single device to thousands

3. Manages and tracks all client connection states, including security credentials and certificates

4. Reduced network strain without compromising the security (cellular or satellite network)
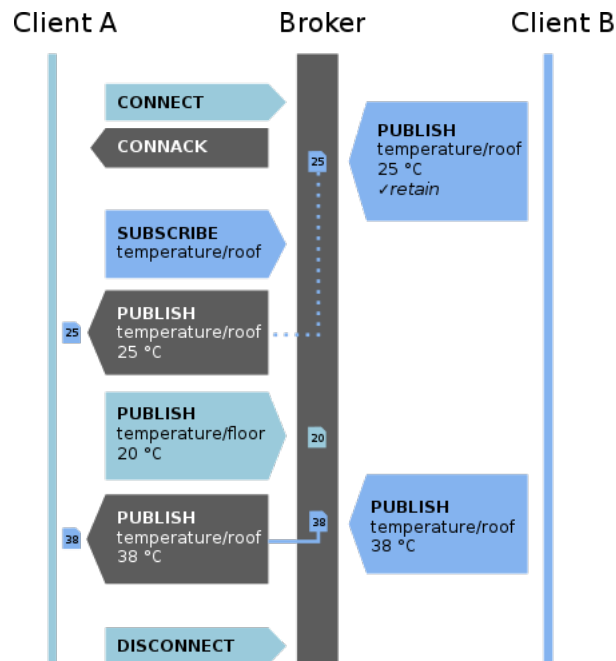
Figure 2.7: MQTT protocol

Message Type:

1. **Connect:** Waits for a connection to be established with the server and creates a link between the nodes.

2. **Disconnect:** Waits for the MQTT client to finish any work it must do, and for the TCP/IP session to disconnect.

3. **Publish:** Returns immediately to the application thread after passing the request to the MQTT client.

2.1.6   Internet of Things (IoT):

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 be-tween the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. Each thing is uniquely identifiable through its embedded com-putting.

Things, in the IOT, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, or field operation devices that assist fire-fighters in search and rescue. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include smart thermostat systems and washer/dryers that utilize Wi-Fi for remote monitoring.

Application: As per a recent survey and study done by Pew Research Internet Project, a large majority of the technology experts and engaged Internet users who responded 83 percent agreed with the notion that the Internet/Cloud of Things, embedded and wearable computing will have widespread and beneficial effects by 2025.

It is as such clear that the IOT will consist of a very large number of devices being connected to the Internet. Integration with the Internet implies that devices will utilize an IP address as a unique identifier.

IOT systems could also be responsible for performing actions, not just sensing things. Intelligent shopping systems, for example, could monitor specific users' purchasing habits in a store by tracking their specific mobile phones. These users could then be provided with special offers on their favourite products, or even location of items that they need, which their fridge has automatically conveyed to the phone.

Additional examples of sensing and actuating are reflected in applications that deal with heat, electricity and energy management, as well as cruise-assisting transportation systems.

2.1.7 Machine Learning:

The most hearing buzz words at present and most of the people are interested to work and do projects on is Machine Learning and Artificial Intelligence which are used in each and every part in industries.

Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop a conventional algorithm for effectively performing the task.

Types of Learning Algorithms:

1. **Supervised Learning:** Supervised learning algorithms build a mathematical model of a set of data that contains both the inputs and the desired outputs. The data is known as training data, and consists of a set of training examples. Each training example has one or more inputs and a desired output, also known as a supervisory signal. In the mathematical model, each training example is represented by an array or vector, sometimes called a feature vector, and the training data is represented by a matrix. Through iterative optimization of an objective function, supervised learning algorithms learn a function that can be used to predict the output associated with new inputs. An optimal function will allow the algorithm to correctly determine the output for inputs that were not a part of the training data. Supervised learning algorithms include classification and regression. Classification algorithms are used when the outputs are restricted to a limited set of values, and regression algorithms are used when the outputs may have any numerical value within a range.

2. **Unsupervised Learning:** Unsupervised learning algorithms take a set of data that contains only inputs, and find structure in the data, like grouping or clustering of data points. The algorithms therefore learn from test data that has not been labelled, classified or categorized. Instead of responding to feedback, unsuper-

vised learning algorithms identify commonalities in the data and react based on the presence or absence of such commonalities in each new piece of data. A central application of unsupervised learning is in the field of density estimation in statistics, though unsupervised learning encompasses other domains involving summarizing and explaining data features. Cluster analysis is the assignment of a set of observations into subsets (called clusters) so that observations within the same cluster are similar according to one or more predesignated criteria, while observations drawn from different clusters are dissimilar. Different clustering techniques make different assumptions on the structure of the data, often defined by some similarity metric and evaluated, for example, by internal compactness, or the similarity between members of the same cluster, and separation, the difference between clusters.

Some of the applications of Machine Learning in day to day life:

- Virtual Personal Assistants (Alexa, Google)

- Social Media Services

- Videos Surveillance

- Email spam and Malware filtering

- Online customer support and Online Fraud detection

- Search Engine result refining

- Product Recommendation

2.2   Design, Implementation, Testing, Trouble shooting techniques practiced

The course was designed to balance the needs of the students and the industry standards. Major topics related to IoT like Android development, python, machine learning and the hardware implementation of Raspberry Pi 3B was introduced.

The course was implemented in modules starting with android development using Android Studio, followed by python programming in the command line interface. Machine learning was implemented in python language in Anaconda software. Raspberry Pi 3B

board was programmed in python and the final project was implemented as a combination of all the above mentioned topics.

Testing of the code was done on the teams (comprising of 4 students) respective laptops and circuit boards with the help of trainers and all the materials required were provided by the trainer.

Basic errors occurring while programming was taught through the course and if any errors persisted then the trainer personally debugged the code and enlightened others about the error to avoid others making the same.

2.3 Car Parking System

Smart car parking system aims at providing a confusion free and easy parking. Currently, the common method of finding a parking space today is manual where the driver usually finds a space either by luck or by experience. This process takes time and effort.The challenges and difficulties that are there in conventional car parking can be overcome with the help of smart parking system. It saves us the time and effort that we put into this task and wastage of fuel can be reduced.

Smart car parking system will bring a revolutionary change in the city life, which is

SENSOR → **CLOUD** → **WEBSITE**

THE SENSOR TRANSMITS DATA TO THE CLOUD THAT INDICATES WHETHER A PARKING SPACE IS OCCUPIED OR NOT.

THE CLOUD RECEIVES THE DATA THAT THE SENSOR SENDS OUT AND THEN SENDS IT TO THE SMART PARKING APP.

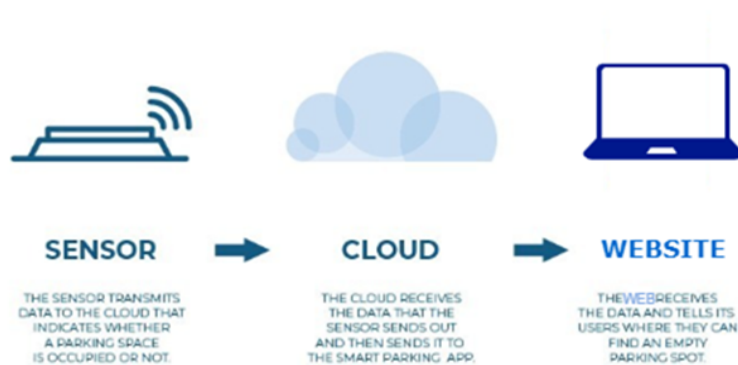THE WEB RECEIVES THE DATA AND TELLS ITS USERS WHERE THEY CAN FIND AN EMPTY PARKING SPOT.

Figure 2.8: Our Approch

filled up with automobiles and make it simple and easy. This project helps the car drivers to park their vehicles with minimum wastage of time and fuel. This system is designed under ARDUINO UNO which uses IR sensor to detect the empty space. As soon as car

fills up the space a signal is sent over to the Arduino board which in turn would make the LED glow depicting that the site is filled and immediately a message on serial monitor would be displayed.

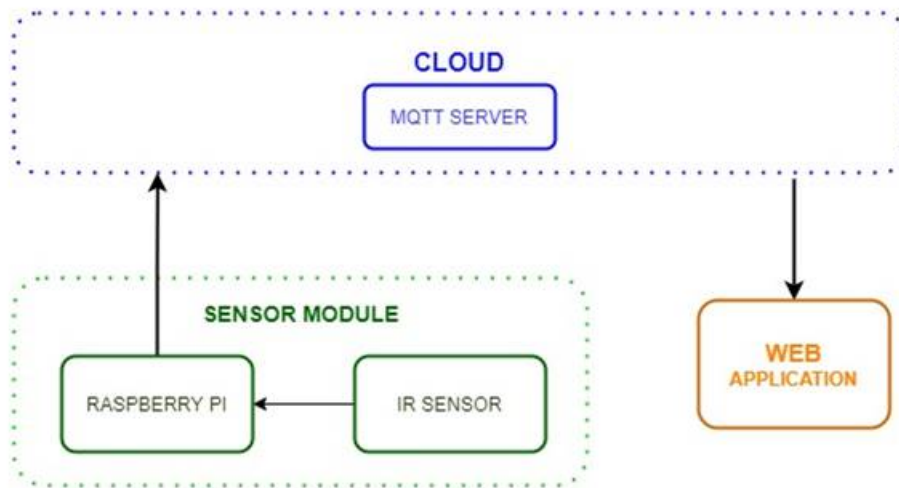The proposed project is a smart parking system that delivers information to people find-

Figure 2.9: Block Diagram

ing a parking space through a web based application.The users have to register themselves in the web appliaction to get the empty slot. The sensors used to detect the empty space transmits data to the cloud.The cloud receives the data from the sensor and it sends this data to web application. The web application receives the data and tells users where they can find an empty parking spot. The web application tells information about number of empty slots and gives status of each slot.

2.4   Result and Conclusion

This car parking system can be implemented in:

- Shopping malls

- Restaurants

- Theatres

- Offices

- Airports

Figure 2.10: Webpage

The system is made more efficient as vehicle travel time and search time are significantly reduced due to the information provided by the parking system. With the information provided, drivers are able to avoid car park that are fully occupied and locate vacant parking spaces with ease elsewhere.

2.4.1   Future Scope

1. Advancement of website which estimates the parking charges on the basis of duration of car is parked.

2. Assigning unique token number to each entry for more safety.

3. An app can be introduced with registration for the frequent users.

Chapter 3

Soft Skills and Best Practices

3.1 Soft Skills acquired

1. **Team work:** Co-operation between those who are working on a task. Teamwork is generally understood as the willingness of a group of people to work together to achieve a common aim.

2. **Project Management:** Project Skills: Project managers have developed many tools and techniques over the years. A basic understanding of typical PM skills such as schedule management and scope management will help you organize and control your project effectively.

    Interpersonal Skills: Projects involve many stakeholders, from project team members to external clients. Interpersonal skills such as leadership and communication are critical for effective interaction with these stakeholders to ensure your project's success.

3. **Financial Management:** Project Financial Management is a process which brings together planning budgeting,accounting, financial reporting, internal control, auditing, procurement, disbursement and the physical performance of the project with the aim of managing project resources properly and achieving the project's objectives.

4. **Ethics:** Project management is driven by decisions, often dozens or more per day. Some decisions are small and barely noticed while others are prominent. Some require deep thought because they involve people, resources and the environment. And sometimes these factors are in conflict, creating a dilemma and perhaps significant risks. While project managers normally know what to do, how to do it can become a puzzle especially when stakeholder interests conflict. Like all leaders, project managers build trust by the way they make decisions. Here again, the how to do it can be puzzling yet is instrumentally important. Ethics is the discipline of how to do it best.

3.2   Practices followed in industry related to society, health, and safety issues

3.2.1   Monkfox follows 6-D process i.e.

1. Discover: In Discovery stage the company compare current and future Job requirements with the current education in the colleges.

2. Define: In Define Stage the company draws up multiple plans on how to fill up the skill gap of the students.

3. Design: In the Design stage the main aim is to come up with solutions for persisting and future problems.

4. Develop: In the Development stage, the company interacts with numerous Industry professionals and trainers to give the program its shape, structure and content based on the industry and job standards and requirement. This helps students to take up advanced technological jobs in any industry.

5. Deploy: In the Deployment stage, the company tries to find out different channels to deliver the program like classroom, online, audio/ video recording etc.

6. Deliver: In the Delivery stage, the company selects only those trainers and professionals who are Subject Matter Experts in their field and have experience in training and skill development.

3.2.2   Safety issues addressed during training:

Raspberry Pi need to be installed with the supported OS, either Raspbian or NOOBS and care should be taken while installing OS into Raspberry Pi Module and not to touch the processors on the Raspberry Pi. Running more number of application in parallel causes the processor to throttle and sometimes causing the OS to freeze. While creating android application, frequently checked the application step by step to avoid crash. Before using sensors, they should be properly calibrated to avoid erroneous output. While soldering the circuit components, distance was maintained to prevent inhalation of toxic lead and proper precautionary measures were taken to avoid burns.

Chapter 4

Conclusion

Industrial Training on Internet of Things completed successfully. This training takes through all phases of designing an Android application, Web application, provides knowledge about Machine learning and helps to solve problems with real data sets, programming skills such as problem decomposition and data type design using Python, and Internet of Things (IOT) based application.

4.1 Outcomes of the Training

1. A unique and in-depth study method to strengthen our conceptual and practical knowledge during our engineering phase.

2. Improve understanding of concepts of industry standards under expert guidance.

3. A flipped classroom concept running parallel with the university with a complete hands-on training in IoT and Machine Learning from Grass root Level.

4. Development of technical skills required in Industry.

Bibliography

[1] https://monkfox.com/

[2] https://en.wikipedia.org/wiki/MQTT

[3] https://www.alliedelec.com/m/d/4252b1ecd92888dbb9d8a39b536e7bf2.pdf

[4] https://datasheet.octopart.com/A000066-Arduino-datasheet-38879526.pdf

Appendices

Appendix A

Data Sheet of Raspberry Pi 3 Model B+

Overview The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT. The dual-band wireless LAN comes with modular compliance certication, allowing the board to be designed into end products with signicantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and theRaspberry Pi 3 Model B.
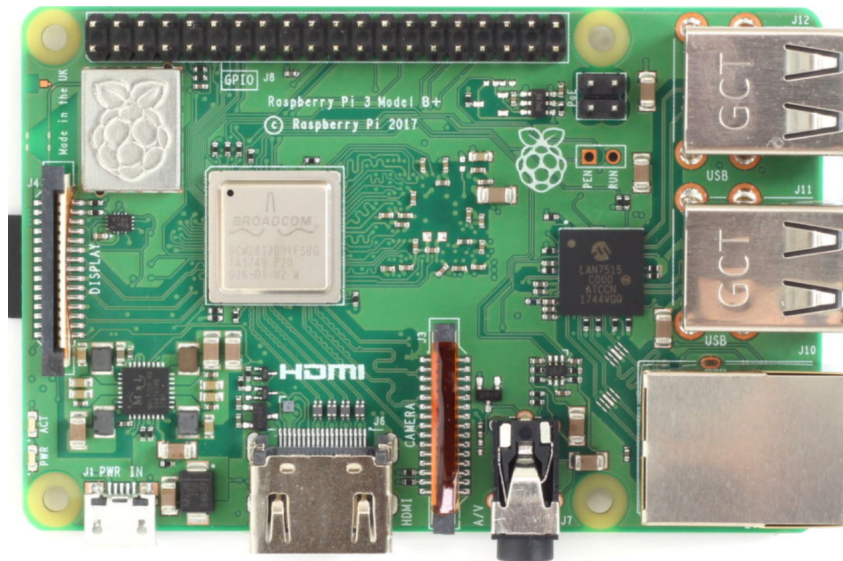

Figure A.1: Raspberry PI

Specification:

Table 1.1: Specification of Raspberry PI

Processor	*Broadcom BCM2837B0, Cortex-A53 64-bit Soc @ 1.4GHz*
Memory	*1GB LPDDR2 SDRAM*
Connectivity	*2.4 GHz and 5 GHz IEEE 802.11 b/g/n/ac wireless LAN, Gigabit Ethernet*
Access	*Extended 40-pin GPIO header*
Vedio & Sound	*1 × full size HDMI, MIPI DSI display port, MIPI CSI camera port*
Multimedia	*H.264, MPEG-4 decode (1080p30), H.264 encode(1080p30)*
SD card support	*Micro SD format for loading operating system and data storage*
Input power	*5V/2.5A DC via micro USB connector, 5V DC via GPIO header*
Environment	*Operating temperature, 0-50°C*

Figure A.2: Physical Specification Raspberry PI