SMART PARKING SYSTEM

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF DEGREE
OF

MASTER OF TECHNOLOGY
IN
COMPUTER SCIENCE ENGINEERING

Submitted by:

SHIVANI MALIK

2K17/CSE/17

Under the supervision of

Dr. RAJESH KUMAR YADAV
(Assistant Professor)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
DELHI TECHNOLOGICAL UNIVERSITY
(Formerly Delhi College of Engineering)
Bawana Road, Delhi-110042

JUNE, 2019

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi - 110042

CANDIDATE'S DECLARATION

I, Shivani Malik, Roll No. 2K17/CSE/17 student of M.Tech (Computer Science and Engineering), hereby declare that the project Dissertation titled **"SMART PARKING SYSTEM"** which is submitted by me to the Department of Computer Science & Engineering, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of and Degree, Diploma Associateship, Fellowship or other similar title or recognition.

Place: Delhi Shivani Malik

Date:

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

DELHI TECHNOLOGICAL UNIVERSITY

(Formerly Delhi College of Engineering)

Bawana Road, Delhi - 110042

CERTIFICATE

I hereby certify that the Project Dissertation titled **"SMART PARKING SYSTEM"** which is submitted by Shivani Malik, 2K17/CSE/17 Department of Computer Science & Engineering, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere

Place: Delhi

Date:

Dr. Rajesh Kumar Yadav

SUPERVISOR

Assistant Professor

ACKNOWLEDGEMENT

The success of this project requires the assistance and input of numerous people and the organisation. I am grateful to everyone who helped in shaping the result of the project.

I express my sincere thanks to **Dr. R.K. Yadav**, my project guide, for providing me with the opportunity to undertake this project under his guidance. I was always supported and encouraged by him to realise that the learning process is more important than the final outcome. I am very indebted to the faculties for their guidance, continuous monitoring and motivation during all the progress evaluations to complete my work. They helped me throughout with new ideas, provided information necessary and pushed me to complete the work.

I also thank all my fellow students and my family for their continued support.

ABSTRACT

Internet of Things, this term became popular over the last few years, but its existence was discovered in the early 2000s. IOT consists of mainly two words,Internet which refers to the collection of vast global network of connected servers, computers, and mobiles using the internationally used protocols . With Internet one can send, receive, or communicate the information. Things can have different meaning example a physical object, an action or idea, situation or an activity. In IoT basically there is inter-network of the devices and physical objects.The objects can gather the data at remote locations and communicate to different units. With IoT different things such as wearable, watch, home devices can work smartly and collaborate with sensing, computing.IoT has made advancements in a number of fields such as Transport, Health Care, Smart Parking, Agriculture, Irrigation, Weather monitoring etc.

With continuous growth in the population, there has been an increase in personal and public vehicles.Easy transportation is a basic need in today's world where time is most precious.So it is really necessary that transportation must be carried out smoothly with fast moving lives of people.Traffic congestion is a major problem leading to delay in transportation and increasing pollution. Car Parking plays a major role in traffic congestion and the parking facilities in urban cities are still unable to improve their facility.Car Parking is a regular and frustrating activity for many people in cities around the world. So due to the traffic congestion and cars waiting to park burns about one million barrels of world's oil every day[4]. As the worldwide population continues to

urbanize without a well-planned,convenient parking management of the vehicle, these issues will get worse.Smart Parking could save 2, 20,000 gallons of fuel by 2030 and approx, according to a study. 3,00,000 gallons of fuel if effectively introduced by 2050[4].Other than wastage of time in searching for parking space,the environment is also affected by the emission of damaging and terrible car gases. This emission by combustion of petrol adulterates the atmosphere with CO2 and other gases.So,it has become a necessity to implement Smart parking System atleast in low air quality and densely polluted areas.Therefore in this report a Smart Parking Management system is introduced. People can search for empty parking spaces beforehand using an android application, resulting in the reduction of waiting time, traffic congestion, pollution etc.

CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Internet of Things

Internet is a marvellous thing and it gives us all kinds of advantages, which were previously not possible. Think about your mobile phone before it became a smart phone. Now, you can read every book, look into any movie, listen to all the songs in the hand palm. These are just to name some of your smart phone's incredible stuff. It comes down to the fact that connecting to the Internet has many incredible advantages. In reality, the Internet of Things is a simple concept, it means to take and connect all things in the world with the internet. IoT is a network of millions of devices equipped with some kind of sensors that gather some data and these data are transmitted over the network. The things in IoT refers to any device like sensor present in automobile, a heart monitor carried by a person, cameras getting live feed of animals in forest. These things are then connected to the internet i.e they have been assigned an IP address and the data collected by these devices are then transferred over the network. Based on these data various actions can be performed. With IoT the objects can be controlled remotely over the network making the environment smart. It is currently one of the emerging topics nowadays. All the things that are connected to Internet can be classified into three categories:

- Things that gather and transmit information.

This include sensors like air quality sensor, temperature sensor, IR sensor and many more. These sensors gather information from their environment and send it forward.

Example, farmers can get information regarding soil moisture and can decide accordingly to water right amount of water to crops.

- Things which obtain information and act accordingly.

The sensors receives some information and act accordingly. For example, car receives signal from keys and the door opens, printer receives information and prints. There are numerous examples, but the real IoT emerges when things can perform both above.

- Things that does both.

Taking the farming example, the sensors gather information of soil moisture and tell farmers the amount of water needed to crops. Rather than involving a farmer the system can automatically decide the amount and provide the water itself. Extending it a step further, if the system receives information regarding weather, then it would also know if it's going to rain or not and can decide to water the crops or not.

1.1.1 Applications of IoT

With the increase in demand of IoT, it is predicted the count of the connected devices will reach approx. 24 billion by 2020. Following are some of the areas where IoT is being used to carry out the task efficiently:

1. Smart Home

Living in a home that acts smartly where we can control appliances remotely through smartphone or appliances take actions on their own based on the environment for example turning the lights on/off based on the people present in the room, turning on the air conditioner remotely in a hot summer weather, monitoring of the appliances.

2. Wearables

Wearable devices are equipped with different sensors that collect data and this data is processed to provide user with meaningful information. These wearable generate information mainly related to fitness, entertainment and health.

3. Connected cars

A car connected to the internet where the onboard sensors gather data to provide comfort, optimise operation, maintenance. For example a sensor monitors the pressure in the tyre and it alerts user if pressure below certain threshold.

4. Industrial IoT

The Industrial Internet of Things (IIoT), combines machines, people at work and advanced analytics. It is the network of devices that are connected to each other leading to systems, which like never before can monitor, collect, analyse and provide new outputs. These insights can then assist industrial companies in making beneficial business decisions.

5. Agriculture

IoT is used to detect soil dampness and complements, control the use of water for the development of plants and decide on custom-made compost. The data generated by the farmers are used to improve the profitability of the farmers.

6. Smart retail

Use of IoT in shops would give a chance to retailers improve the experience of consumers for in-store shopping. Retailers can use Beacon technology to interact with smartphones for providing better service to the consumers. They may improve their profit by tracking the users path and modifying the layout of the store accordingly.

7. Medical

IoT in the field of medical aims at providing a healthier life to people by wearing devices connected to internet that collects different data. This data can then be used in the analysis of health and provide strategies to fight illness.

8. Smart Cities

With IoT a smart city can be developed. Few of its examples are smart parking management, effective management of waste materials, monitoring environmental

factors critical for health such as water pollution index, air pollution index, smart street lighting, smart management systems for public transport and safety.

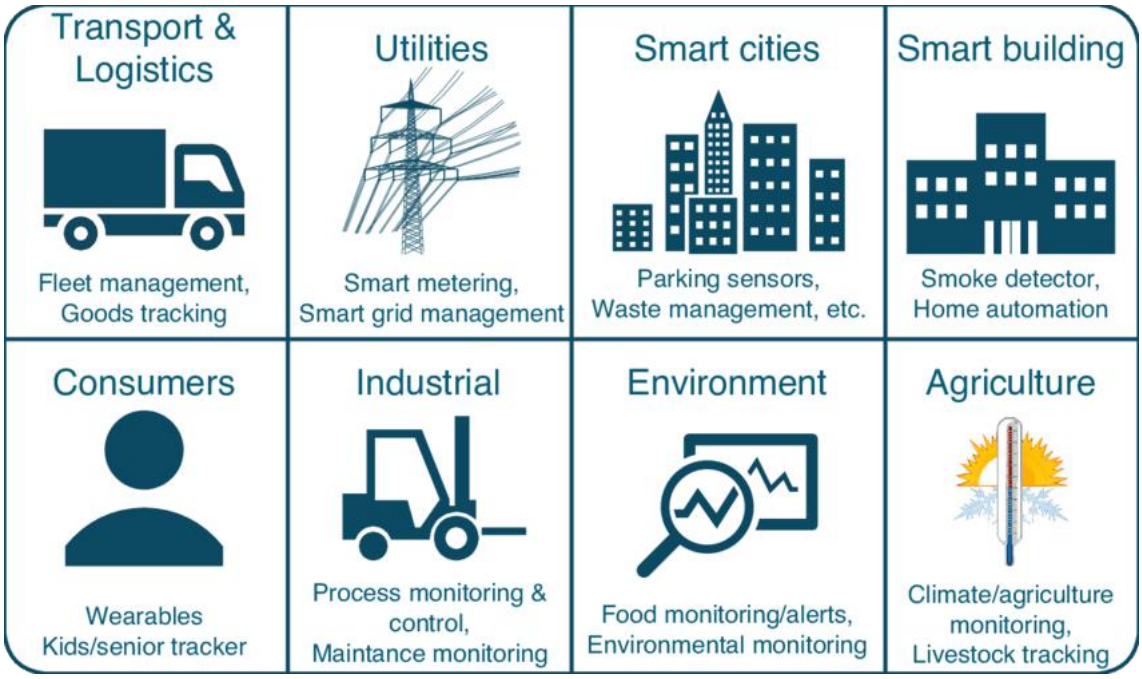

Figure 1.1: Applications of IoT.

1.1.2 Challenges in IoT

IoT is a quite new industry concept and presents them with an enormous chance to flourish in this world of digital transformation. The IoT stands for companies in many ways, but the basic concept stays the same; data collection, data analyzing, and then reengineering processes and benefit realization insights are provided. The challenges to be faced by the IoT industry are:

1. Security

The increased number of connecting devices allows security vulnerabilities and poorly designed devices to be exploited which can expose user data to theft by not providing sufficient protection for data streams and in some cases endangering the safety and health of people (implanted, Internet-enabled medical devices and hacking cars).

2. Privacy

The IoT poses unique privacy challenges which go beyond the existing data protection issues. Much of that is because we integrate devices without us knowingly using them in our environments.

3. Standards

Sometimes developers design products that are operative on the Internet without standards to guide manufacturers, without taking into consideration their impact. If they are not designed and configured properly, such devices can negatively affect their networking resources and the broader Internet.

4. Regulation

Legal issues related to IoT devices cover the transnational flow of data; conflicts between law enforcement and civil rights; policies on the retention of information and destruction; and legal liability for unauthorized use, breaches of security or privacy weaknesses.

5. Development

The wide range of IoT problems will not be exclusive to industrialized countries. The IoT has a major promise in terms of social and economic advantages for the developing and emerging economies.

1.1.3 Architecture of IoT

The architecture of IoT varies, depending on the type of solution we want to build. IoT as a technology consists mainly of four main components, which are structured around an architecture.

Stage 1:

Sensors sense the surrounding or any object, collect the necessary information and can also transform that information.

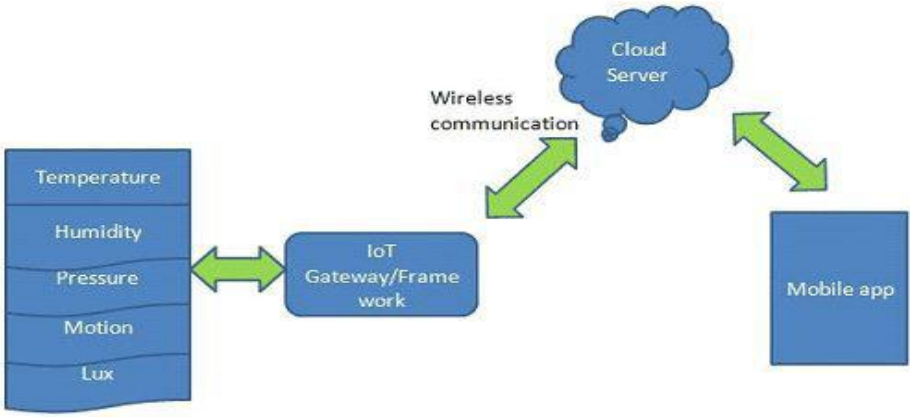

Figure 1.2 : IoT Architecture

Stage 2:

The data generated by the sensors is collected by a device placed at a close proximity to these sensors. This data is processed/digitised for further processing.

Stage 3:

It includes the network layer through which data is transferred to the cloud.

Stage 4:

Stage 3 data is transmitted to a cloud, where more powerful information technology systems can analysis, manage and save data. The final processed data is further used by various applications as needed.

1.2 Smart Parking System

With continuous growth in the population, there has been an increase in personal and public vehicles.Easy transportation is a basic need in today's world where time is most precious.So it is really necessary that transportation must be carried out smoothly with fast moving lives of people.Traffic congestion is a major problem leading to delay in transportation and increasing pollution. Car Parking plays a major role in traffic congestion and the parking facilities in urban cities are still unable to improve their

facility.Car Parking is a regular and quite disturbing thing frustrating activity for many people who used to travel frequently with their own vehicle. A survey carried out elicits that one million units of oil is wasted each day waiting for parking and traffic situation[4]. As there is continuous race towards creating metropolitan cities without a well defined and analyzed plan,convenient parking management of the vehicle, these issues will get worse.Smart Parking could save 2, 20,000 gallons of fuel by 2030 and approx, according to a study. 3,00,000 gallons of fuel if effectively introduced by 2050[4] as shown in figure 1.3. Other than wastage of time in searching for parking space,the environment is also affected by the emission of damaging and terrible car gases. This emission by combustion of petrol adulterates the atmosphere with CO2 and other gases.So,it has become a necessity to implement Smart parking System atleast in low air quality and densely polluted areas.With Smart Parking System, individuals who want to park their car can beforehand check for the availability of parking slots using some application or with the help of some display screens in the parking area.Using the application the individual can know whether there is a vacant space or not without actually entering the parking space,thus saving the time and reducing traffic congestion. People can even book the parking space in advance.

A Smart Parking System concept is shown in Figure 1.4. In this Infrared sensors are deployed at parking slots. A soon as a car enters that space sensors will sense the vehicle and sensors value will be displayed on the screen. Screens will be deployed at entry and exit gates.

1.2.1 Layered architecture of Smart Parking System

A layered architecture is presented for Smart Home in [10]. The system is divided into three layers namely sensing layer after it comes network layer, and finally application layer (Figure 1.5). Sensing layer consist of all the sensing and detecting technologies and is responsible for collecting data from all the parking slots and this data is then sent to the second layer that is network layer.

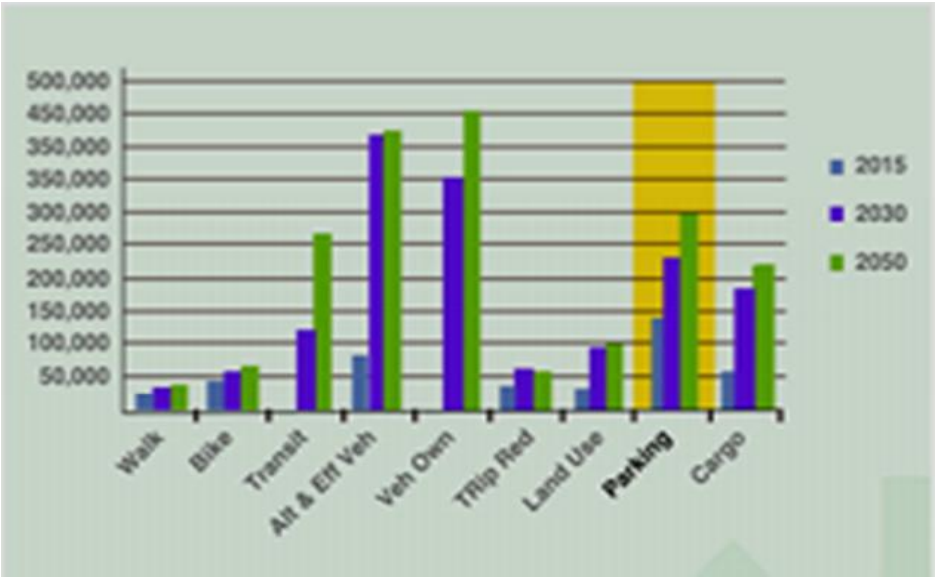

Figure 1.3 : Approximated fuel saved (in gallons)[4].

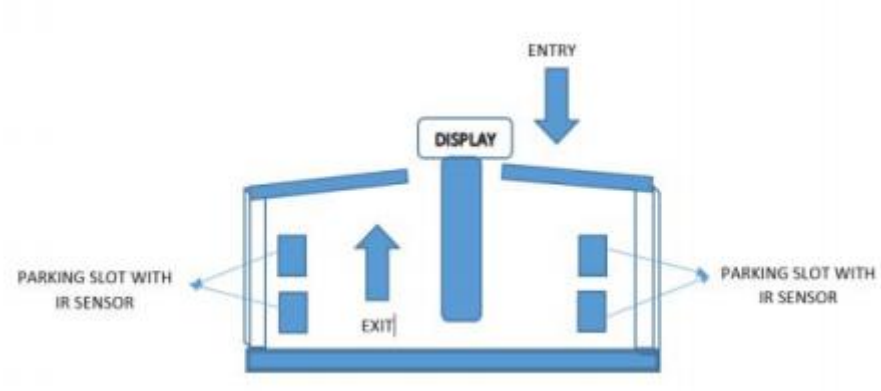

Figure 1.4 : Basic Concept of the system

Network layer depicts the internet through which data from sensing layer is sent to application layer. In application layer there are different applications for different purposes which processes the data according to their needs, for example getting real time parking status directly to our smart home.RFID tags can also be used to authorize the visitors. Visitors will be asked to scan their RFID tags at entry and exit gates. If the visitor is authorized then only the gates will be opened. The concept of smart parking would be a great assistance for time saving and reducing air pollution.

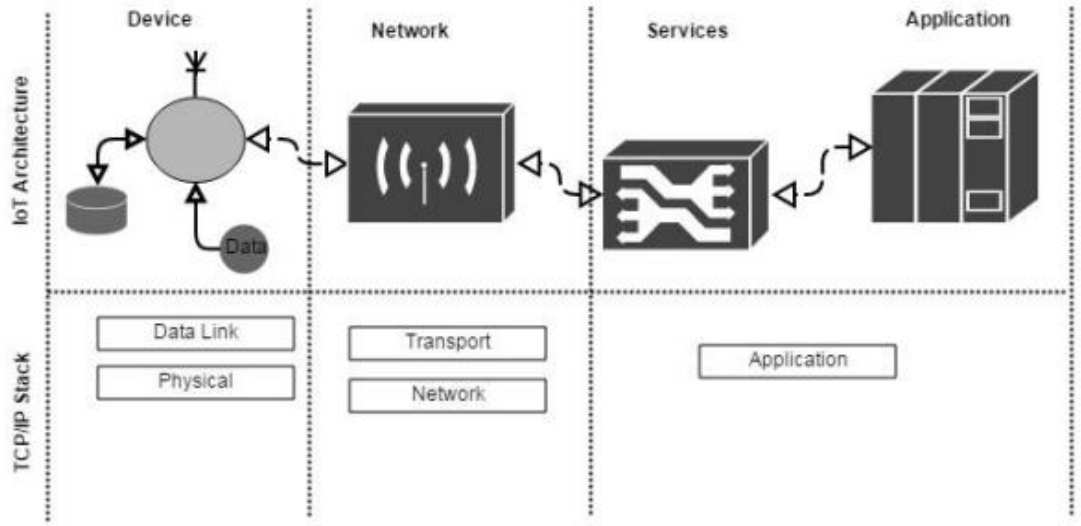

Figure 1.5 : Layered Architecture of Smart Parking[10].

1.2.2 Smart parking System Ecosystem

This ecosystem includes two flows: information and traffic. The traffic situation arises when people search for parking space, shown in the lower blue triangle in Figure 1.6. Drivers can receive availability information, and can reach the desired place to park. There can be a conflict when too many drivers search for the parking slot. Drivers behave differently on the basis of few factors such as the information they have got and for how much time they are wandering for searching.At any time when a vehicle enters or exits the parking space, it is detected by the sensors deployed at the slots and the information is updated to the driver, this flow is known as the information flow, In order to get the real status of parking spaces, sensors are fixed at the parking space. Sensors then create a network and send data storage devices the recent information.

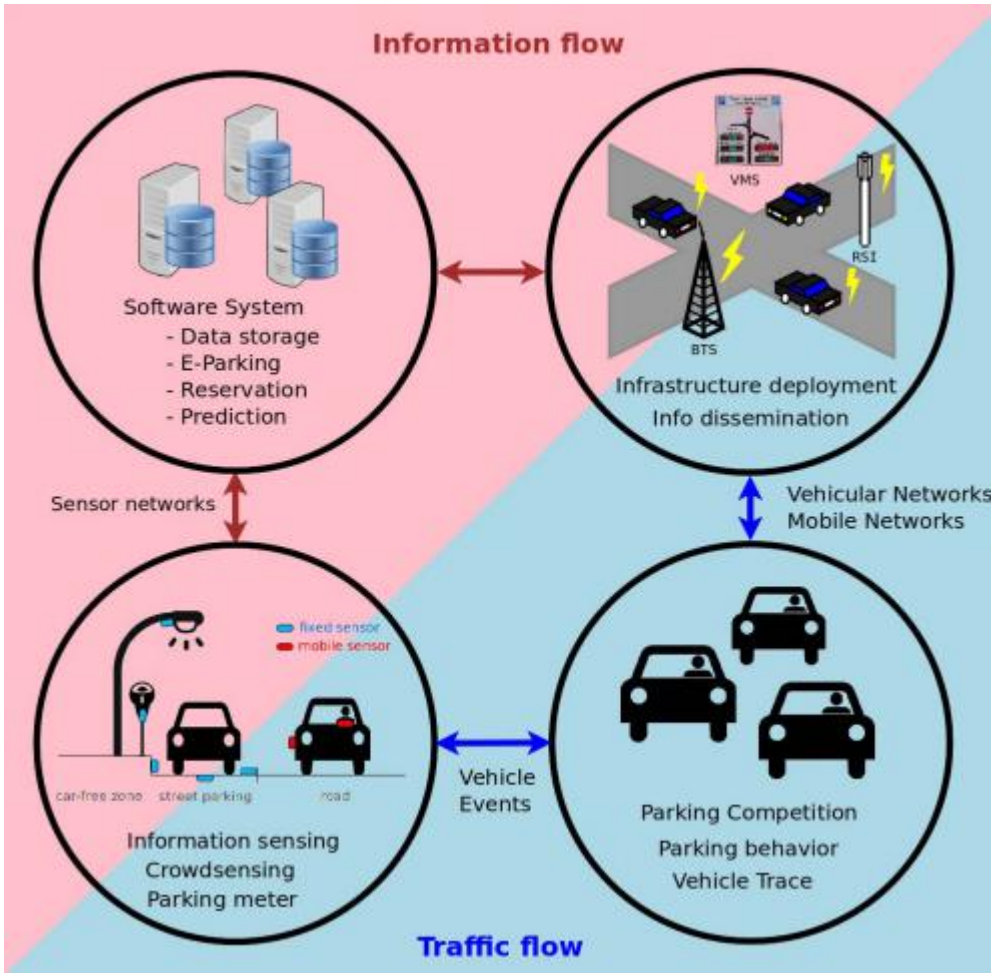

Figure 1.6 : Smart Parking System Ecosystem

CHAPTER 2

LITERATURE REVIEW

2.1 Related Work

The IoT (Internet of Things) is an integration of various technologies that enable social services to be improved utilizing smart sensors and smart objects. Smart devices can be accessed and operated at any moment and from any location via IP (Internet Protocol) connectivity[11].Smart Parking is also a result of IoT . Different types of systems can be designed for parking for example: every visitor is given a tag and it will be authorized before entering the parking space ensuring the security measures. There can be a display for the number of vacant slots at the entry and exit gates. There can be an advanced system where user can beforehand book the slot and payment also be done by some application. In this way many approaches can be used to design Smart Parking system based on our requirements.As IoT is a continuously growing technology, a lot of research has been done in this field.

An Advanced car parking system is proposed in [1], in this the very first requirement is the authorization of the user which is ensured by RFID card.Sensors are installed at slots and as soon as a vehicle enters or exits the slot,information is immediately updated on the displayed screens placed both at the entry and exit gates.These gates will only be opened if authorized RFID card is used despite the presence of free parking slots.

In [2] cloud based approach is suggested where ultrasonic or infrared sensors will detect any vehicle or obstacle. Users can check the availability of parking space using an android application,they can also book the slots and make payments, their entry and exit

time will be noted and when the user have parked the vehicle they should confirm their occupancy using the application.They have proposed a mathematical model.

In [3] they have proposed solutions for smart toll tax collection,smart traffic congestion control and parking system.There will be a central monitoring system which can monitor several parking places in the city.System will have knowledge of availability of different parking spaces. End user will search for free parking space, this system knows the location of end user using GPS(Global Positioning System) and will provide the shortest route to the parking area using Dijkstra's Algorithm.

In [4] they have designed a system consisting of server, database, user friendly application and parking space. They have provided an Android application to user. Users will have to register with some unique ID(ADHAR CARD). This information and parking slots information is feed in the database.User can choose to book specific parking spot at desired space,and a QR code is generated by the sever and send to the user. Users will access the slot using this QR code. In [5] there is a similar type of system consisting of mobile application, cloud server and arduino. Users will book the slot using application and can make payments from that application.

In [6] they have also designed an application for booking the parking slot and bill generation etc but the difference lies in detection technology. They have designed their own sensors. Pressure Sensors are made using two pressure pads which are made using aluminium foil. These pads are separated by a foam layer in the middle. Pressure pads are connected to the NodeMCU microcontroller.

In [7] they have used passive radio Frequency Identification(RFID) technology.A RPM algorithm is proposed for collectively choosing a communication path between the source-destination set of RFID readers and determining the minimum transmission energy required by the RFID reader to ensure communication route connectivity.

In [8] the user who wishes the car to be parked is linked through the password to the Wi-Fi network of that specific parking lot. The IR sensors send the status of the information processing to the micro controller. The micro controller uses IOT to send user information about the slot status to the web page. This makes it easy for the user to find a parking space without congestion.

In [9] they have laid emphasis on the advantage of Cloud integration with IoT and made a comparison between public, private and hybrid clouds. They have used private cloud.

In [12] they have used Raspberry Pi along with Arduino, Amazon Web Service Elastic Compute Cloud, ultrasonic sensors, RFID, Mongo DB. Cloud Application reads and stores the information sent to the MongoDB by the Raspberry Pi application. As a customer sends a request to find the closest accessible parking space, he finds the closest parking space relative to the present place of the user and checks the records to find out if this parking space has any free parking spaces, he does the same until he discovers a parking space accessible and sends the reply back. This application also logs entry, exit time of user and billing information.

The elevated level of development in fresh car registration globally, with significant boom from regional economies such as Asia Pacific (APAC), will provide tremendous parking management company possibilities. With all the upcoming and ongoing smart city projects by the government there will be a surge rise in the demand of Smart parking systems.From 2014 to 2019, the global parking management industry is expected to develop at a Compound Annual Growth Rate (CAGR) of 11.4%. It is projected that the parking management industry will reach $5,025.9 million in 2014[13].

In this system several devices have been used. For obstacle detection, infrared sensors are used, for processing Arduino microcontroller and NodeMCU is used and to connect with the internet Ethernet Shield and ESP8266 have been used.

2.2 Background Work

2.2.1 Arduino Uno

This is a micro controller board which is open source based on ATMega32 (ATMega328 is a microchip), developed by Arduino.cc. Experts are trying to replace large setup devices with microchips that will perform the same function but will be cheap,flexible and compact contrast to their predecessors which were costly and occupy more space. Microcontrollers have made the task easy and are used at a large scale in embedded systems.

Arduino Uno is a very precious addition of USB interface, 14 digital I / O pins, 6 analog pins, and Atmega328 microcontroller in the electronics. It also uses Tx and Rx pins to support serial communication. Arduino Uno is the most common version. Arduino Uno is simple, efficient and cheap option for projects involving digital electronics, embedded system, or IoT.

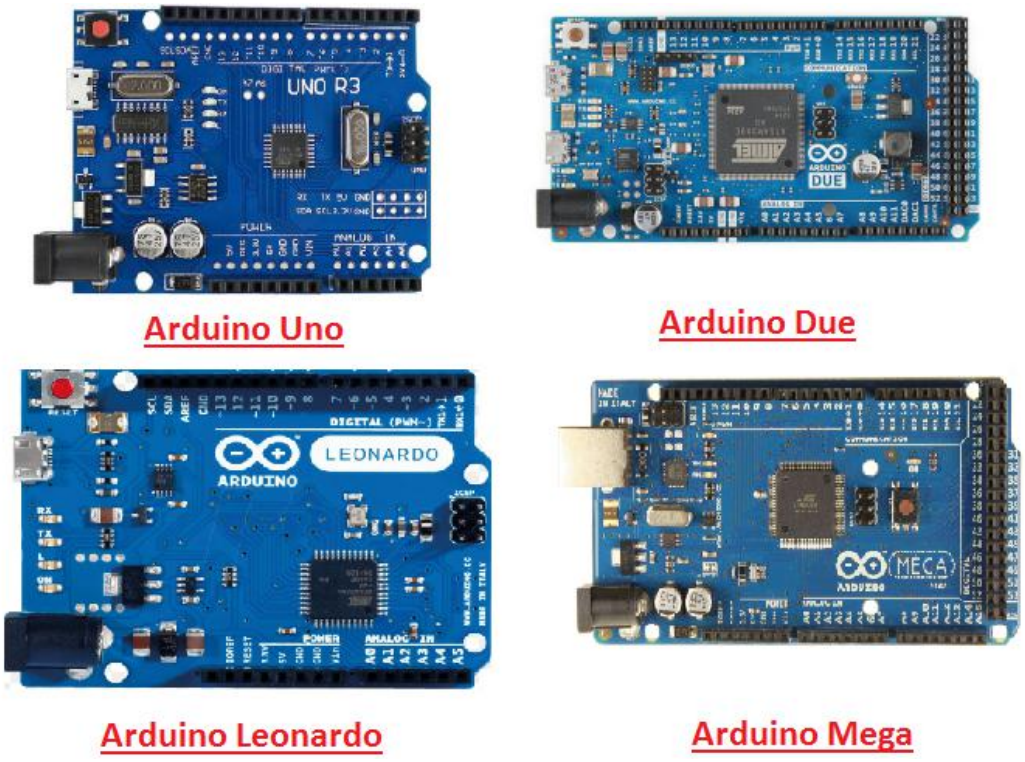

Figure 2.1 Different versions of Arduino Uno[14].

Since Arduino is an open source platform, the boards and software can be modified by anyone. There is a software used for Arduino devices called IDE (Integrated Development Environment). We can use that software for free and anyone with basic skills can learn it. C and C++ language can be used for programming. Usually people have confusion between Microcontroller and Arduino. The first one is a 40 pin chip which has a built in microprocessor whereas arduino has the microcontroller in the base of the board, bootloader and provides access to input-output pins.

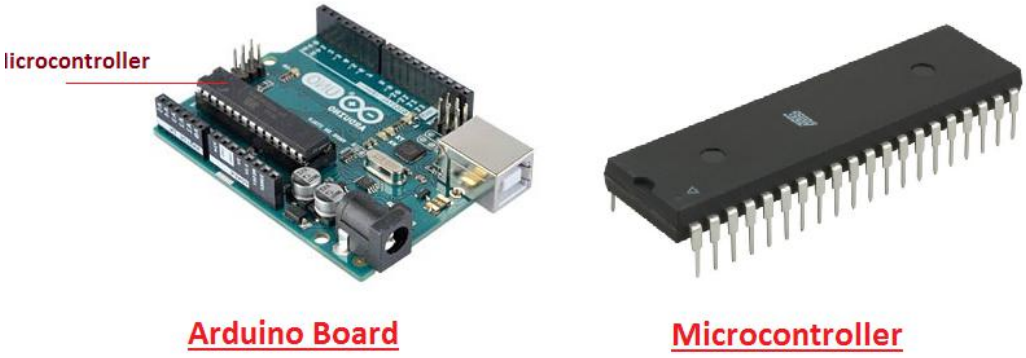

Figure 2.2 Arduino board and Microcontroller[14].

People can easily work with arduino without having much knowledge about it(using tutorials) while learning microcontroller needs some abilities and knowledge.

Introduction to Arduino

David Cuartielles and Massimo Banzi started First Arduino project which was carried out in Interaction Design Institute Ivrea in 2003 so that students and professors can control devices in a cost effective and efficient manner.It can help in controlling and sensing the external electronic devices.This board possess all the features that are necessary to run the controller. We can directly connect it to the computer via USB cable through which code can be transferred to the controller using IDE (Integrated Development Environment) software. There are other ways to power the board by battery or AC to DC adapter. Its RAM memory is 32KB but wecan always use Micro SD card to store more information.

The board functions at 5V consists of 14 I/O digital pins and 6 analog pins which can operate between 20mA to 40mA. In order to make sure the current does not exceeds the given operating conditions pull up resistors are used. If the current exceeds this limit devices may damage.

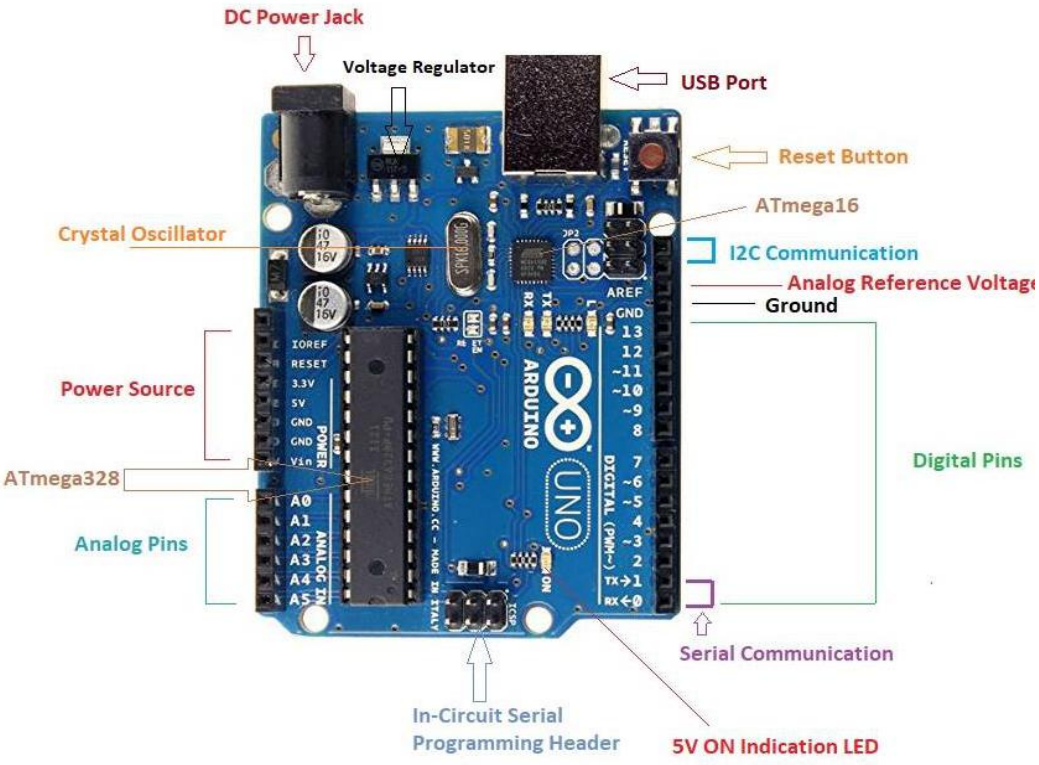

Figure 2.3: Arduino Uno[14].

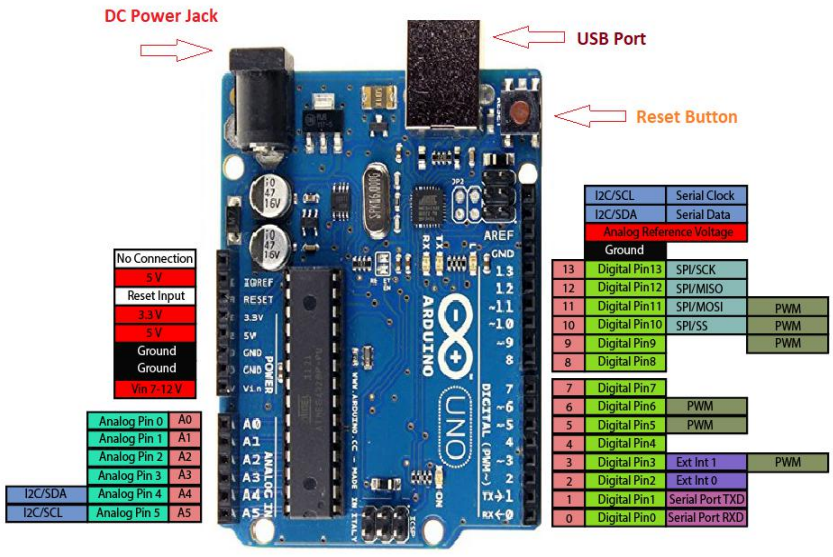

Figure 2.4: Arduino Pinout[14].

There is a built in LED with the board connected through Pin 13.Vin is the input voltage to the Arduino Board which is not 5V. Voltage can be provided by power jack using this pin.5V pin can be used to supply output regulated voltage.

Several ground pins GND are available on the board which can be used according to the need. In case you want to reset the program that will be running on the board, reset pin is used. IOREF is used as voltage reference to the board. 3,5,6,9,10,11 pins provide PWM output.

Serial Peripheral Interface(SPI) communication is carried by pins 10,11,12,13 with the help of SPI library.Analog inputs receive reference voltage by AREF pin.

Pin 0 (Rx) and Pin 1 (Tx) are used for serial communication.Data is received through Rx and transmitted through Tx. External interrupts are thrown with the help of pin 2 and pin 3.

Working with Arduino Uno

We can easily do programming using Arduino IDE in C,C++ language. It can be downloaded from https://www.arduino.cc/en/Main/Software.On the home page you can see Software column,choose Downloads from it as shown in the figure.

Figure 2.5 : Installation of Arduino IDE[15].

You can choose different files according to your operating system.

Figure 2.6: Installation of Arduino IDE[15].

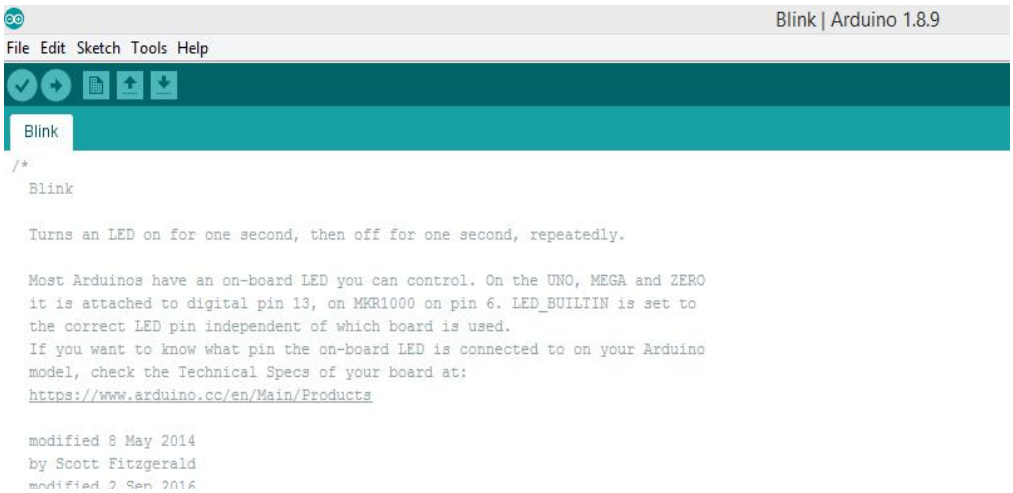

Figure 2.7: Arduino IDE[16].

In the above figure there are five menu options File,Edit,Sketch,Tools and Help. File menu have several commands. New creates a new editor file, Open is used to open an already existing sketch from the computer, Save and Save as are used to save the file with .ino extension. In the Edit menu there are commands for Undo/Redo, that are used to go back or forward one or two steps, cut and copy work as usual, Find can be used to search for a specific word in the sketch. Same are the functions of FindNext and FindPrevious. Copy for forum will copy the text in such a form that is suitable for

forum and Copy as Html will copy the text in such a form that is suitable for Html. In the Sketch menu there are commands for Verify/compile which will check the code for errors, Upload use the settings port to compile and load the binary file to the configured board. Include library can be used for including the library by #include statement at the beginning of code. In the Tools menu Autoformat command formats the sketch, align it nicely. Using Serial Monitor command the serial monitor window is opened and data is exchanged with the connected board on the selected port. Board allows you to select the board that is being used. In case you have a ATMega micro controller which does not have a bootloader then Burn Bootloader command can be used to burn bootloader on the Arduino Board. Help command is also there to help the beginners or guide them.

```
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

Figure 2.8: Example code of Arduino.

Above is an example of basic code for LED built in the Arduino on and off after a specified delay time. Any global variables are declared in the beginning before setup and loop functions and those variables can be accessed from anywhere in the code. Setup function runs once when you press restart or power the board. The loop function runs over and over again forever.So the code inside loop function runs again and again. The first line in the loop function will turn on the LED , it will wait for 1 sec and turn off the LED, again wait for a sec and turn on the LED. This process will go on continuously.

2.2.2 Connecting Arduino to Internet

There are several devices available which can help to connect arduino to the internet. You can choose anyone of them according to your needs.

Arduino Ethernet Shield

Using this device arduino can be easily connected to the internet, transmit and receive data making few changes in the configuration. Tutorials are available on youtube, so one can easily learn from there. Ethernet shield can be used to act as Client and server. The device possess the features of the W51000 chip, comes with an internal 16K buffer. It can offer connection speed of up to 10/100Mb. There's also a micro SD slot present on board that allows you to store alot of information and use your Arduino to serve entire websites. Connect the shield slot into the router or laptop for direct connection. To determine your board's IP address open the DhcpAddressPrinter sketch. It will be found in File, then choose examples then Ethernet and at last DhcpAddressPrinter.

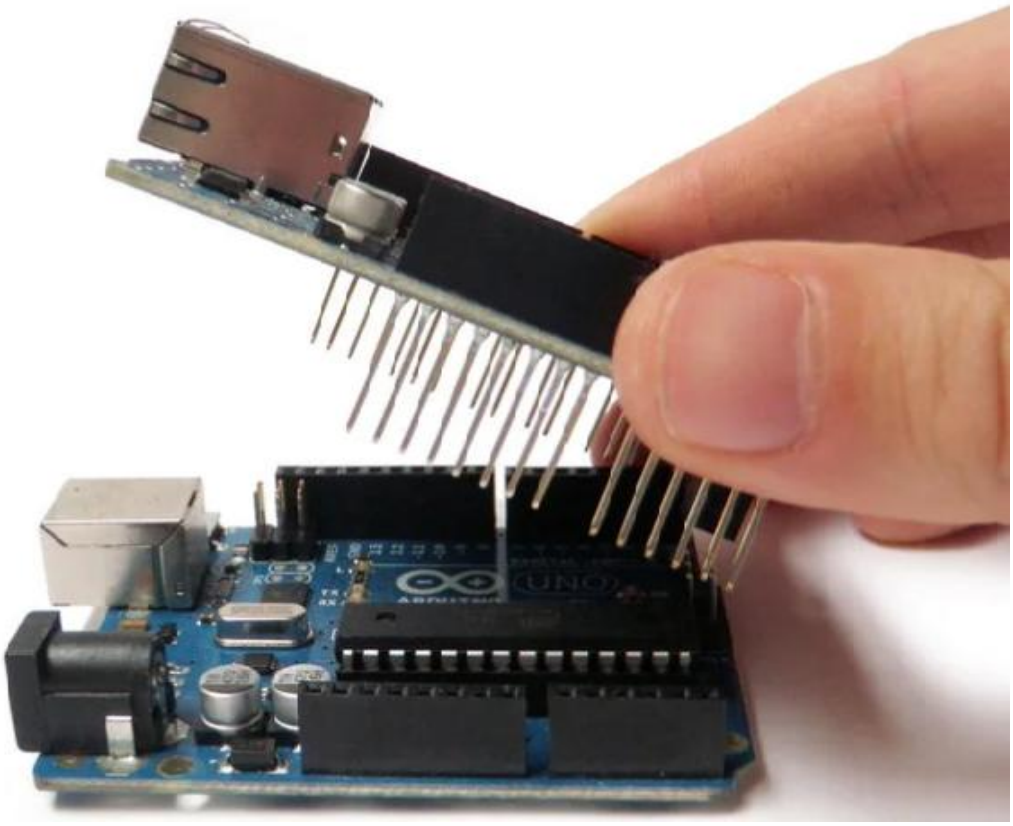

Figure 2.9: Ethernet Shield.

ESP8266

The ESP8266 came into existence in August 2004. Using this, microcontrollers can connect easily to the wifi network and can establish TCP/IP connections. It is quite cheap wifi microchip that comes with 1 MiB built-in flash. Initially its documentation was written in Chinese language but due to its being low cost and compact, the documentation was translated in English Language.

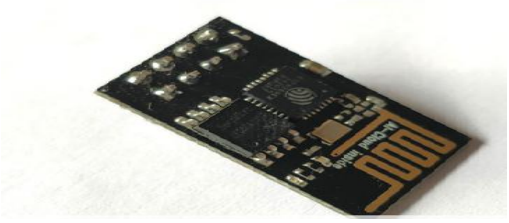

Figure 2.10: ESP8266 chip

ESP8266 Pin Configuration

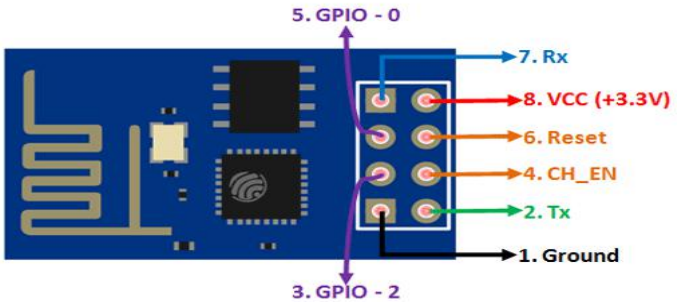

Figure 2.11: Pin Configuration of ESP8266

NodeMCU

It is an open source firmware(hardware manufacturers use integrated firmware to regulate the operations of different hardware devices and systems.)that includes Development kit with wifi enabled ESP8266 chip[17]. It can be connected to serial devices using serial communication protocols such as UART, SPI, I2C etc.

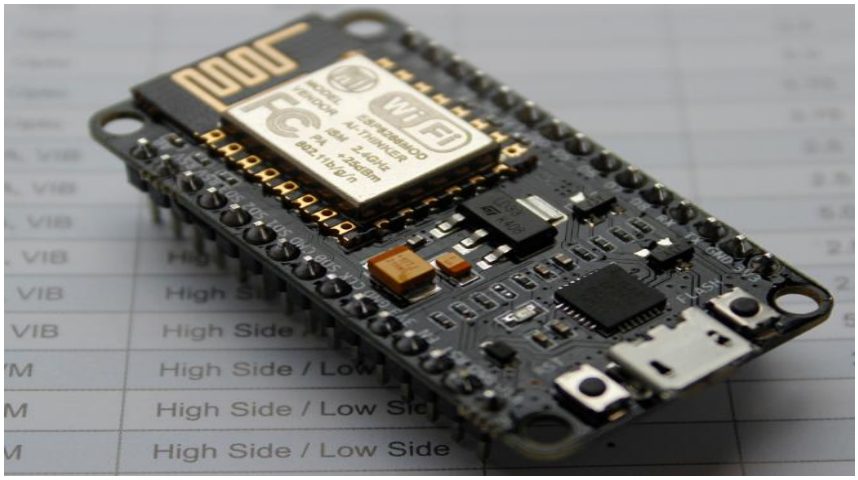

Figure 2.12: NodeMCU[17].

NodeMCU Pin Configuration

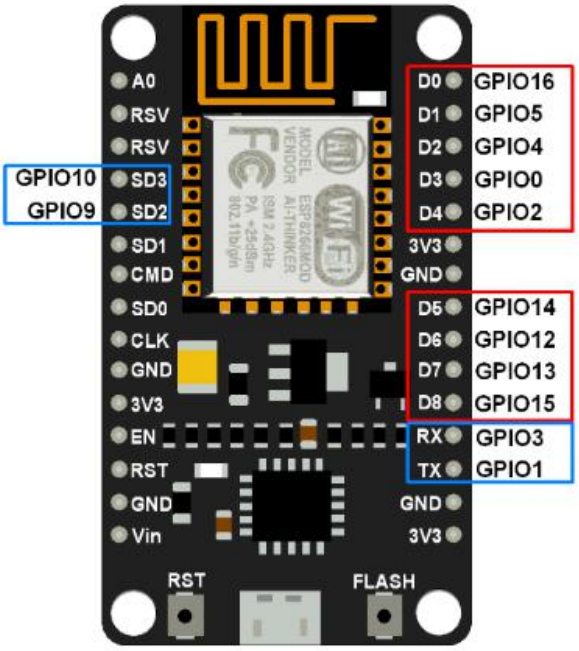

Figure 2.13:Pin Configuration of NodeMCU[17].

NodeMCU Development board pins should be numbered in some different way than internal GPIO notations of ESP8266 as shown in figure. ESP8266 chip has provided 16 GPIO pins but in NodeMCU 11 GPIO pins are avilable out of which two are used for Rx And Tx so pins from D0 to D8 are used for general input/output. Pins 1,3,9,10 are not used for general input/output.

Below is an example how to use digital pins for blinking LED which is connected to pin D4 of NodeMCU[17]..

```
uint8_t LED_Pin = D4;       // declare LED pin on NodeMCU Dev Kit

void setup() {
pinMode(LED_Pin, OUTPUT);   // Initialize the LED pin as an output
}

void loop() {
digitalWrite(LED_Pin, LOW); // Turn the LED on
delay(1000);                // Wait for a second
digitalWrite(LED_Pin, HIGH);// Turn the LED off
delay(1000);                // Wait for a second
}
```

Figure 2.14: Example of NodeMCU[17].

CHAPTER 3

PROPOSED SOLUTION

3.1 Problem Statement

There is a lot of wastage of resources while waiting for parking in urban cities. Due to waiting, it can lead to traffic congestion which will result in air pollution. Specially with areas of poor air quality index this is a serious problem. There is a tremendous increase in the use of vehicles. Going offices, home etc is a routine activity and people find it difficult to park their vehicles efficiently and there is wastage of time. So, a smart parking system that will help users to check about empty slots has been proposed.

3.2 Proposed Solution

A solution that is easy to use and reliable for the users needs to be developed. Obstacle detection is used as the principal technology for developing such system. Smart parking is currently one of the promising field of research because of its demand in everyday life. Technology leaders have made great advancement with high accuracy in this field. There are many already existing systems for parking as mentioned in Chapter 2 of this report. The basic flow of the proposed system is shown in figure 3.1

The below figure gives us a basic idea what are we trying to design here. There will be an android application. It can be built by android studio or there is website named MIT App inventor which is used for making android apps or we can use already existing apps on Google Playstore such as Blynk. This report includes how to proceed with both the options.

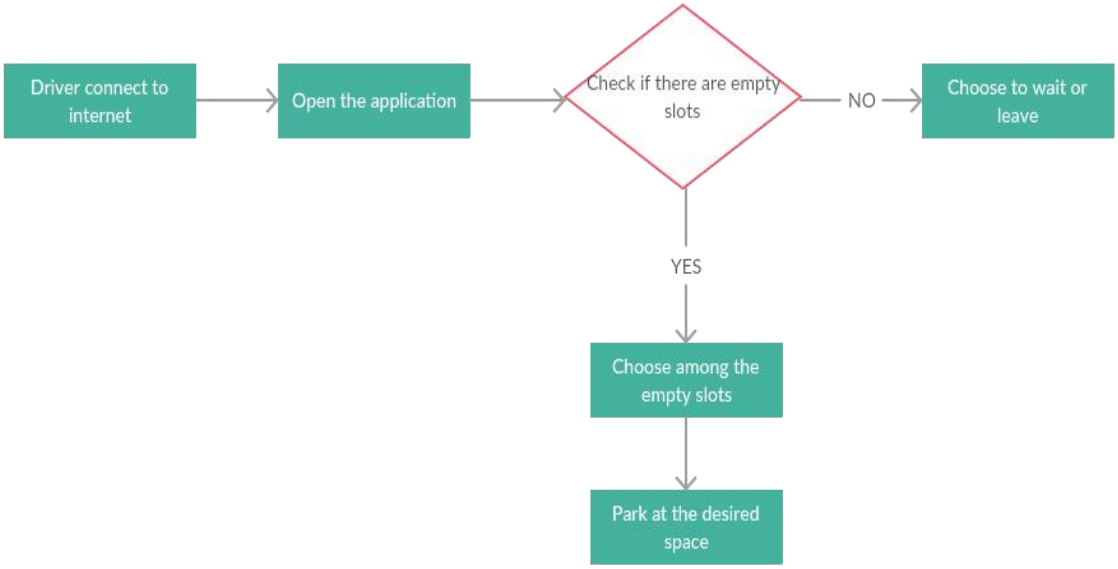

Figure 3.1: System Flow of Smart Parking.

Step 1: The user needs to download application on their android phone.

Step 2: Connect to the wifi of parking area.

Step 3: Check if there are any slots available to park.

Step 4: Now the driver can choose from the available options and go park at the desired location.

This will be the scenario at user's end. Now coming to the details, the parking area will be installed with infrared sensors which will sense any object(vehicles in this case) and send this data to the microcontroller. Microcontroller will send this data to the android application or cloud from where user can see the data. Things will become more clear with the following figure 3.2.

This report includes different approaches towards developing a smart parking system using different devices and scenarios which will be discussed in detail in the coming chapters. All the devices used are easily available on the internet, affordable and easy to

use. Since obstacle detection is an important technology associated with the proposed solution it has been discussed in detail.

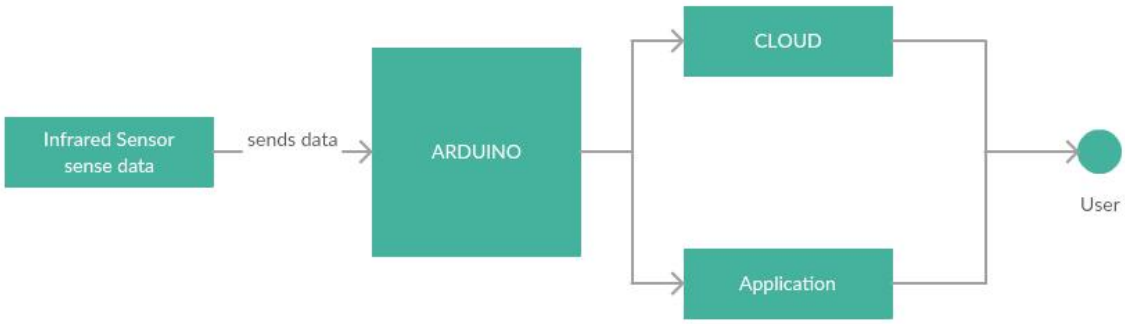

Figure 3.2: System Design.

3.2.1 Obstacle Detection

Infrared technology can be used with wireless applications. The infrared part is divided into three areas in electromagnetic range namely near, mid and far-off infrared region[18]. These regions have different wavelengths. Near infrared region operates at 700-1400 nm, mid infrared region operates at 1400-3000 nm and far-off infrared region operates at 300 nm to 1mm[18]. Microwave frequency is lesser than infrared but visible light frequency is greater than infrared frequency.

In order to sense for obstacles and surroundings, IR sensors are tasked with emitting and detecting infrared radiation. The basis for the working of IR sensors lies within three laws. The fundamental idea of an infrared sensor used in case of Obstacle detection is to transmit an infrared signal, this signal bounces or gets reflected from an object's surface,which is then obtained by the infrared receiver.

Types of IR sensors

There can be two types of infrared sensors passive and active. Passive IR sensors work as infrared detectors. Infrared source is not used in it and any energy coming from obstacles is detected by it. Quantum and thermal, these are the two types of passive

infrared sensors. Active sensors constitute two parts: infrared source and infrared detectors. LED or Infrared laser diode is used in infrared source and photodiodes/ photo transistors are used in IR detectors. An object reflects the power emitted by the infrared source and falls on the infrared detector.

Working of IR sensor

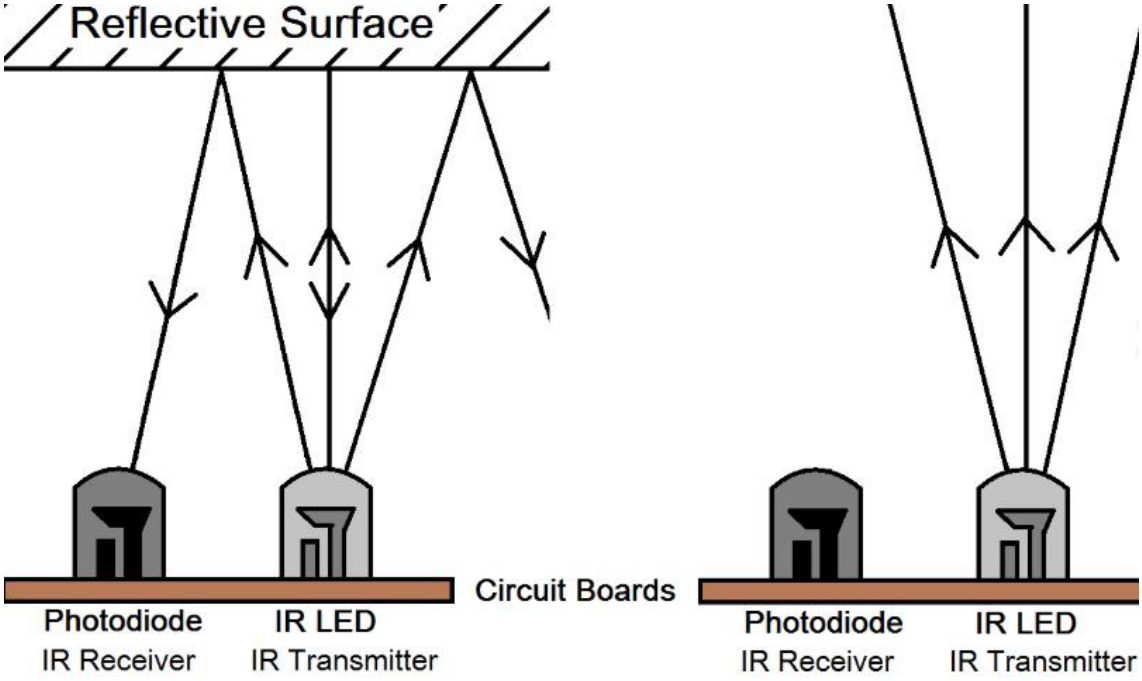

Figure 3.3: Working of IR sensor[19].

IR transmitter or source uses LED. Radiation is emitted by LED that isn't visible to naked eye as its frequency range is within infrared. IR LED working is very simple which uses 3V DC and 20mA current consumption. The IR receiver is just like LED but it will appear in black color on the external.IR transmitter will emit IR signal ,so the radiation that will be reflected by the surface(eg white color) will go in several directions including the IR receiver's direction which is capable of detecting signal from IR source will capture it and hence can detect the object. But if the surface of object is black, nothing will be reflected from the surface and IR receiver will not be able to detect the object despite its presence[19].

FC51 Sensor

I have used FC51 sensor which is easily available over the internet(Amazon, Flipkart) at cheap prices.

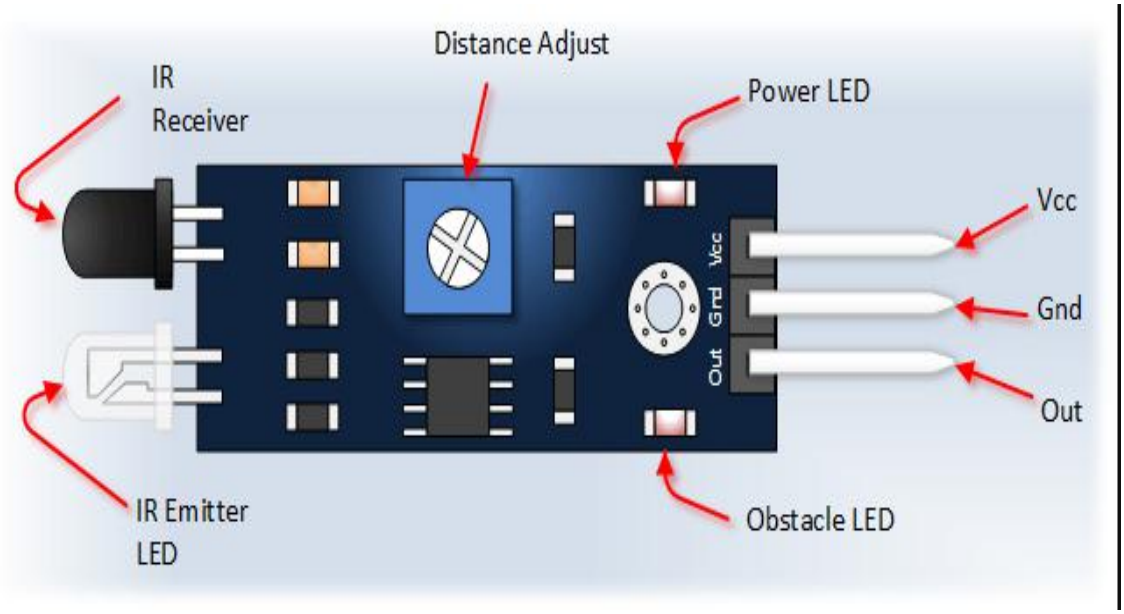

Figure 3.4: Pin Configuration of FC51[19].

It has basically 3 pins. Vcc is connected to 3-5V DC. Gnd is connected to ground and Out is for output signal. Output of D0 is high if there is no object and low if an object is present. It can work up to a range of 2cm to 30 cm[19]. Below is the figure depicting the schematics of IR sensor FC51. Here, LM393 is voltage comparator which gets a threshold value set by potentiometer and the other input is from IC but with a resistor. If the value from resistor series is more in magnitude than that of threshold value, the output of voltage comparator will be high and LED will glow[18].

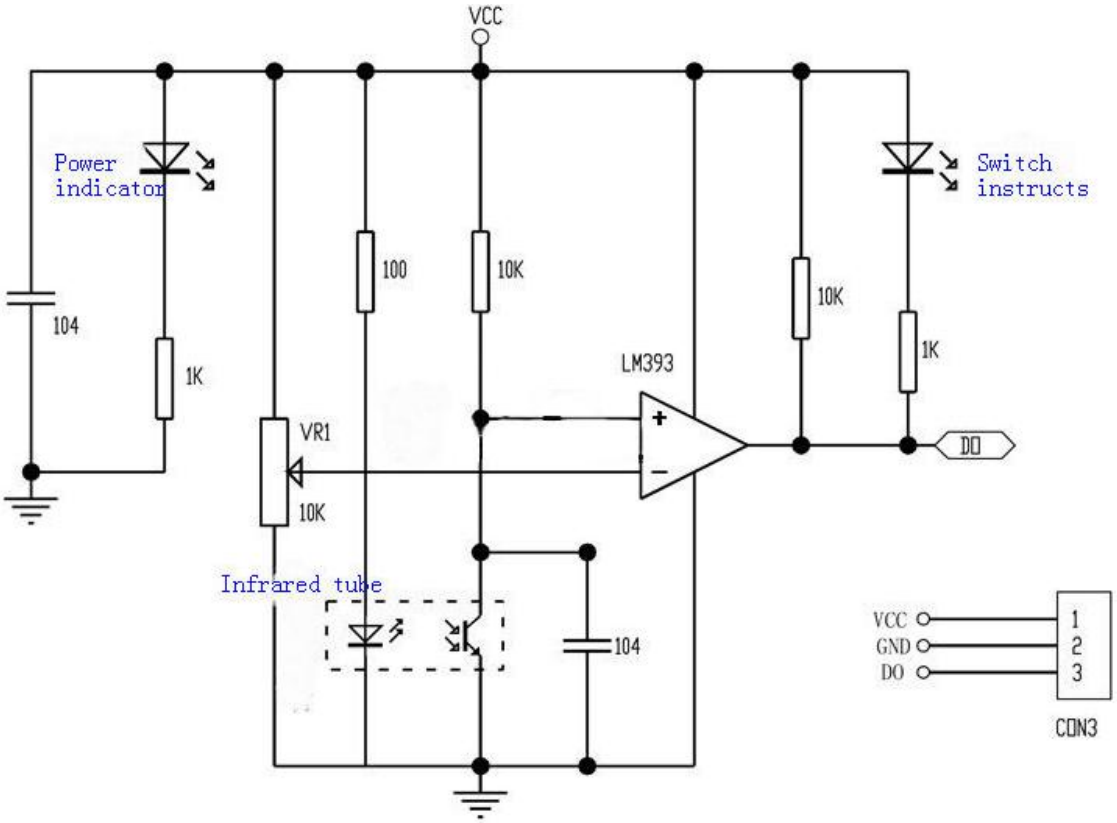

Figure 3.5: Schematic of FC51[19].

Below is an example of how IR sensor FC51 work with Arduino. The digital pin of Arduino is connected to the output pin of sensor. Code is shown in figure 3.6

```
#define IR 2
int detection = HIGH;     // no obstacle
void setup() {
  Serial.begin(9600);
  pinMode(IR, INPUT);
}
void loop() {
  detection = digitalRead(IR);
  if(detection == LOW){
    Serial.print("There is an obstacle!\n");
  }
  else{
    Serial.print("No obstacle!\n");
  }
  delay(500);     // in ms
}
```

Figure 3.6 : IR sensor code[18].

3.2.2 Smart Parking System using Arduino Uno and Ethernet shield

I have introduced several approaches in this report to design a smart parking system. So the basic need is that whenever a vehicle enters or exit the parking space it should be reflected in the application that can be viewed by the user. So the application we are going to use here is Blynk.

Blynk Application

Blynk is a platform that helps to build an android app very easily by just clicking few buttons. That android app can be used to retrieve some values from micro controller or send some commands to the micro controller. Blynk support various hardware platforms such as different versions of Arduino, Raspberry-pi etc. It also support connection types such as Ethernet, Wifi, Bluetooth, Serial and Cellular. It consists of three components, **Blynk app builder** provide features to build apps that can be used in our project. **Blynk server** is responsible for the communication between the application on our phone and hardware of the project. We can use Blynk cloud or private cloud. **Blynk libraries** helps in communication with server and all the incoming and outgoing commands from the hardware are interpreted by it. These parts interact with each other to create a fully functional IoT application that can be governed by a pre configured form of connectivity from anywhere. From the Blynk app operating on your mobile device, you can regulate your hardware through the Blynk Cloud or the private server of Blynk and similarly sending data from hardware to the application.

Detailed process

To begin with the system, first make connections as discussed in the later chapter. The user need to download Blynk app on their phone. Create a new project using the widgets and functions provided by Blynk. The app will contain simple features. There will be a number of slots corresponding to number of parking spaces. If the LED is on then that slot is occupied by some vehicle, if the LED is off then the slot is empty and the driver can park their vehicle at that position. So when the drivers arrives at the parking area they can open this application and get the information how many slots are available for parking. This approach will largely save their time as they will not have to travel the entire space and can decide at the entrance only.

3.2.3 Smart Parking System using NodeMCU

In above case due to Ethernet shield the user should access same network as of the parking space for the app to work properly. This issue can be resolved by using WiFi network with the help of NodeMCU. NodeMCU is already discussed in detail in the previous chapters. So the functions of the system remain same but this time in place of Arduino, NodeMCU will send data to the Blynk application as it has both the features of microcontroller and WiFi chip. Blynk application features are also discussed in detail above.

Connections are very easy. NodeMCU is easy to use. In this approach user will enter the parking space, connect to the internet. It can connect to any network available. The user will open Blynk application and search for empty parking slots.

Here, the infrared sensors are connected to the digital pins available in NodeMCU for sending data. NodeMCU will read data from sensors,connect to wifi of the parking area and send it to Blynk application. Again Blynk application needs to be configured according to the project specifications.

CHAPTER 4

IMPLEMENTATION

4.1 Implementation using Arduino and Ethernet shield with Blynk

The implementation of the proposed work is done with the help of Arduino uno microcontroller, Ethernet shield, Blynk application, infrared sensors, breadboard and jumper wires. Arduino uno is used for reading sensor data and send it to the Blynk server. Arduino IDE is used for uploading code in C language. Blynk application is used to provide an iterface to the user for monitoring the parking area and availability. Ethernet shield is used to connect Arduino to the internet and send data to the Blynk application.

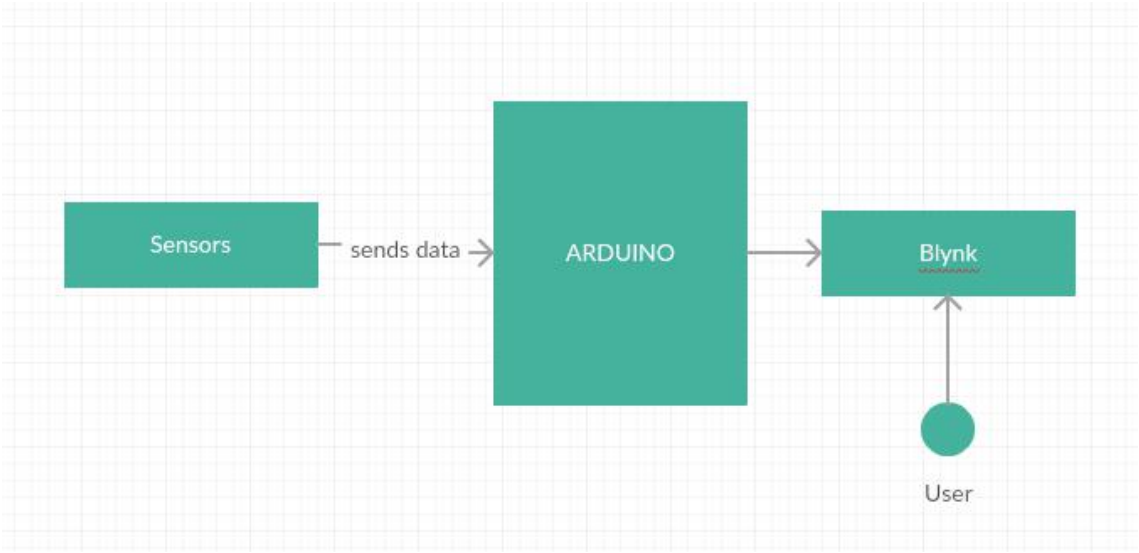

Figure 4.1 Overview of System.

4.1.1 Connecting Arduino with sensors and Ethernet Shield

As shown in the figure 4.2 Arduino ethernet shield is mounted over Arduino. It will connect Arduino to the internet and send data to Blynk application. To mount Ethernet shield is very easy, there are pins provided at the bottom of the ethernet shield, you just need to place it correctly over the pins of Arduino.

Now, here I have used two infrared sensors that will detect any vehicle coming or going out of the slot. We can use a number of sensors that can be connected to the digital pins available in the Arduino board. The output pin of first sensor is connected to the 2nd digital pin of arduino and outpin pin of second sensor is connected to the 3rd digital pin of arduino. Ground pins of both the sensors are connected to GND pin of Arduino. Vcc pin of both the sensors are connected to 5V pin of Arduino. Now Arduino will read the sensor data from these digital pins and send it to Blynk application with the help of Ethernet shield. Arduino will be powered using USB cable connected to laptop.Connect ethernet shield using ethernet cable. For checking if it's working open DhcpAddressPrinter example already built in the Arduino. Open the serial monitor, IP address will be printed. The board is set to Arduino/Genuino Uno. Port is selected to COM5. Following are the connections.

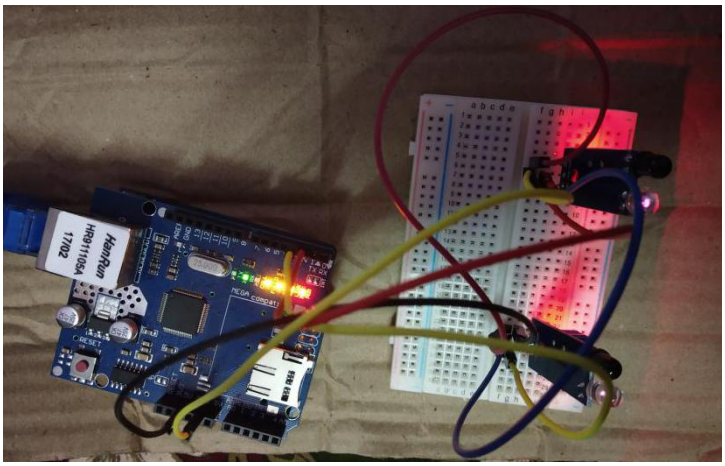

Figure 4.2 Connections.

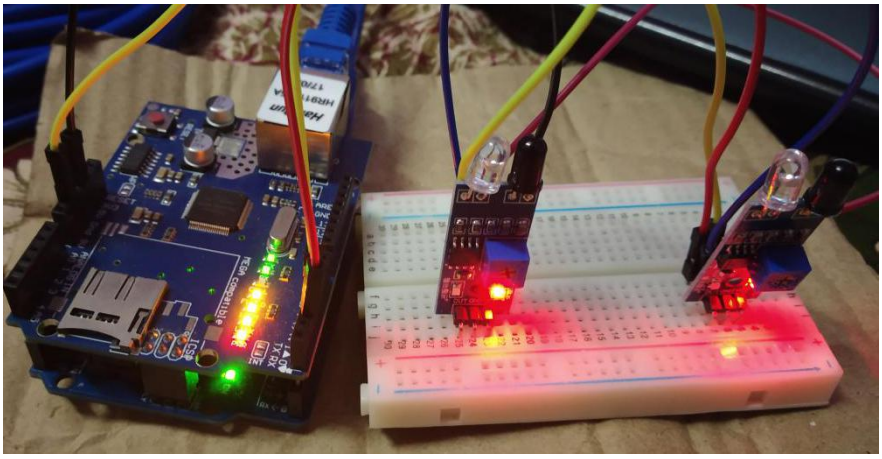

Figure 4.3 Connections.

4.1.2 Blynk

Following are the steps for designing interface for the user.

- Create a new project.
- Enter project name and set the connection to Ethernet.
- Click on create, an authentication code will be sent to the gmail id.
- Click the + button and add two LEDs from widget section.
- Set virtual pin V1 and V2 for LED1 and LED2 respectively.

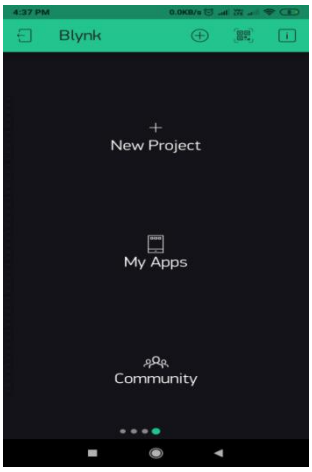

Figure 4.4 Creating Project.

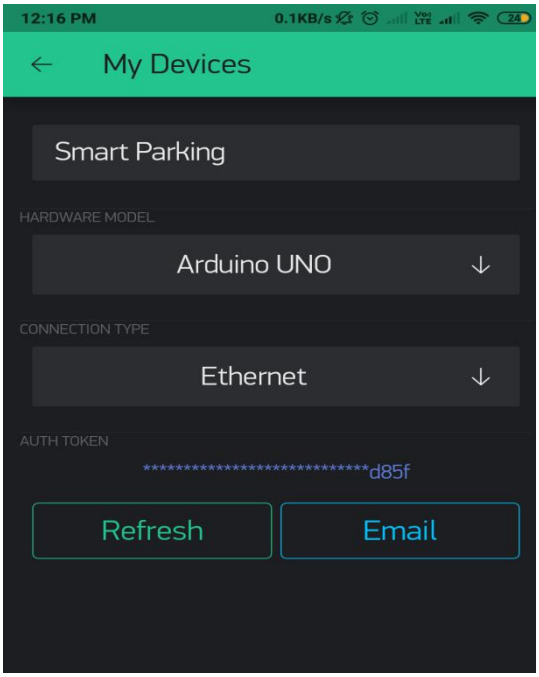

Figure 4.5 Project details.

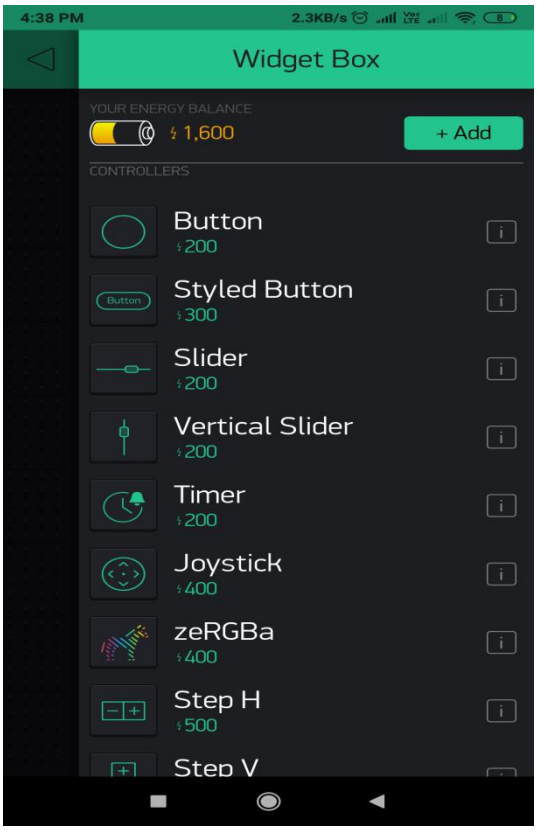

Figure 4.6 Widget Box.

4.2 Implementation using NodeMCU with Blynk

Now, here I have used two infrared sensors that will detect any vehicle coming or going out of the slot. We can use a number of sensors that can be connected to the digital pins available in the NodeMCU board. There is a connection between output pin of first sensor and D1 digital pin of NodeMCU. There is another connection between output pin of second sensor and D2 digital pin of NodeMCU. Ground pins of both the sensors are connected to GND pin of NodeMCU. Vcc pin of both the sensors are connected to 3.3V pin of the chip. Now NodeMCU will read the sensor data from these digital pins and send it to Blynk application. NodeMCU will be powered using USB cable connected to laptop. The board is set to NodeMCU 1.0 (ESP-12E Module). Port is selected to COM6. Set the upload speed to 115200. Check for the same in serial monitor baud rate A custom application can also be designed instead of using Blynk. Following are the connections.

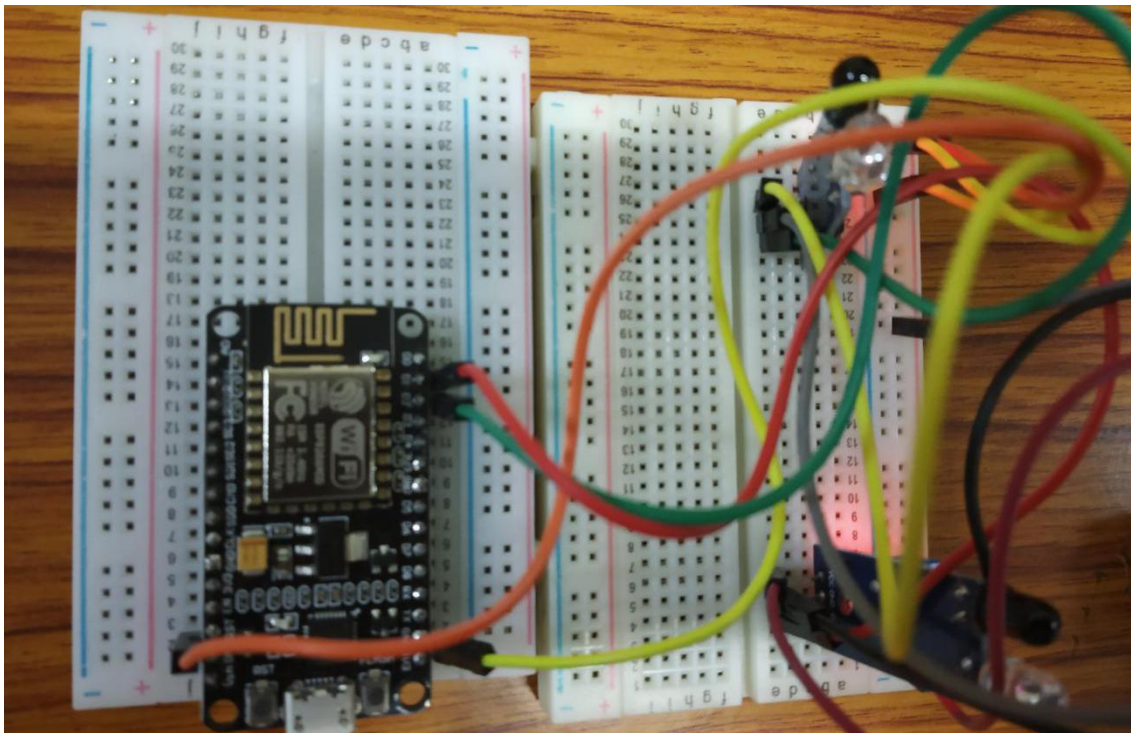

Figure 4.7 :Connections.

```
WidgetLED led1(V1);
WidgetLED led2(V2);
int a,b;
String p="BLOOK",q="CLOOK";
//bool Connected2Blynk = false;
void setup(){
Serial.begin(115200);
 WiFi.mode(WIFI_AP); // workaround
 WiFi.mode(WIFI_AP_STA);
WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }

Serial.print("ggg");
pinMode(D1,INPUT);
pinMode(D2,INPUT);
Blynk.begin(auth,ssid,pass);
```

Figure 4.8 :Setup Code.

```
}
void loop(){
//Blynk.run();
a=digitalRead(D1);
b=digitalRead(D2);
//Serial.print("hello");
String data=String("D1 DATA:")+String(a)+String("| | | | | | | |")+String("D2 DATA:")+String(b);
Serial.print(data);
Serial.print("\n");
if(a==1){led1.off();}
if(a==0){led1.on();}
if(b==1){led2.off();}
if(b==0){led2.on();}
String str=String("Left:")+String(p)+String("| | | | | | | |")+String("Right:")+String(q);
Serial.print(str);
Serial.print("\n");
delay(500);
}
```

Figure 4.9 Loop Code.

CHAPTER 5

RESULTS

5.1 Results for Arduino connected to Blynk

After uploading the code to Arduino open the Blynk application. Three scenarios are shown in the following figures.

- When slot1 is occupied, LED1 will be on and LED2 will be off.

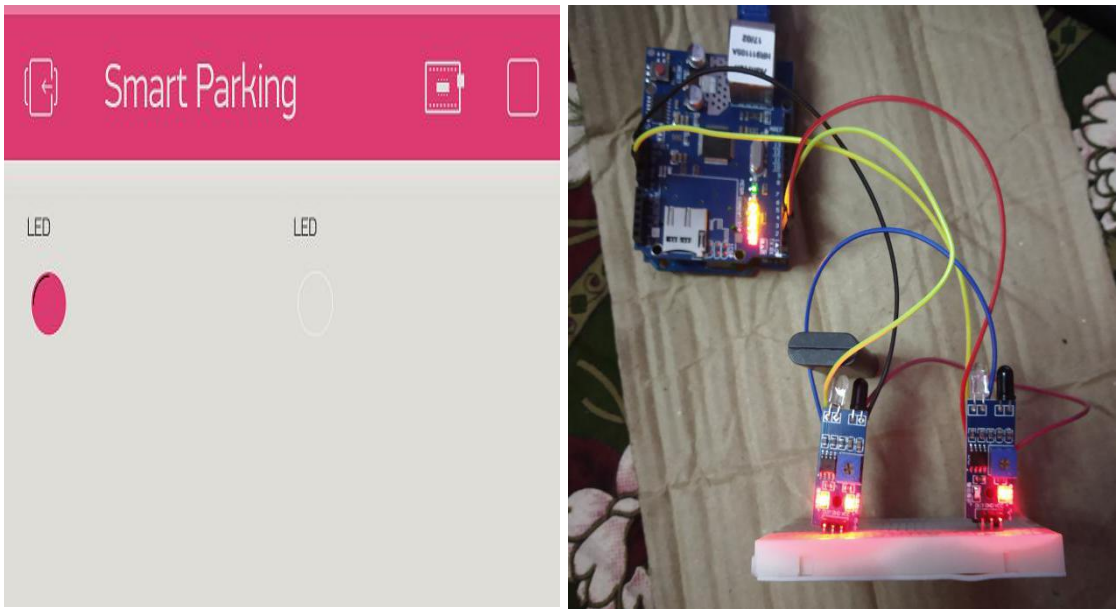

Figure 5.1:Slot 1 occupied(a) and (b).

- When slot2 is occupied, LED2 will be on and LED1 will be off.

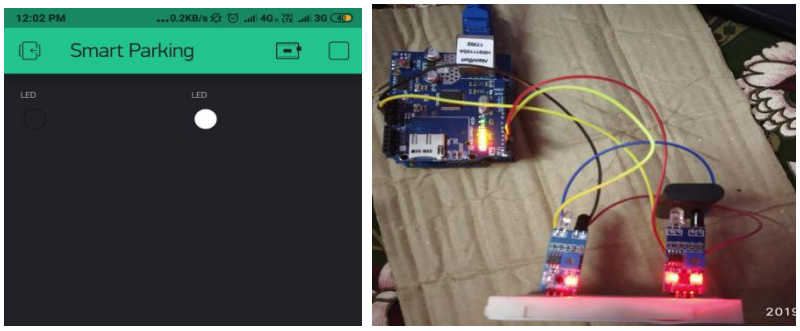

Figure 5.2: Slot 2 occupied (a) and (b).

- When slot1 and slot2 both are occupied, LED1 and LED2 will be on.

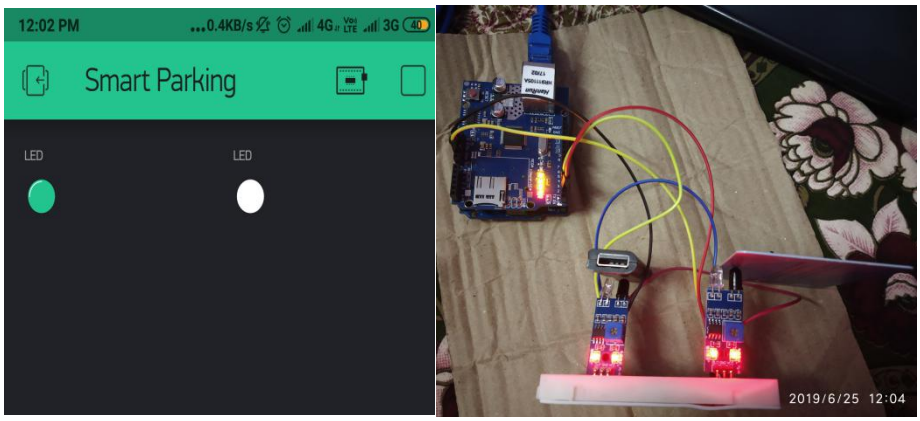

Figure 5.3: Slot 1 and 2 occupied (a) and (b).

5.2 Results of NodeMCU connected to Blynk

After uploading the code to NodeMCU open the Blynk application. Four scenarios are shown in the following figures.

- When slot1 is occupied, LED1 will be on and LED2 will be off.

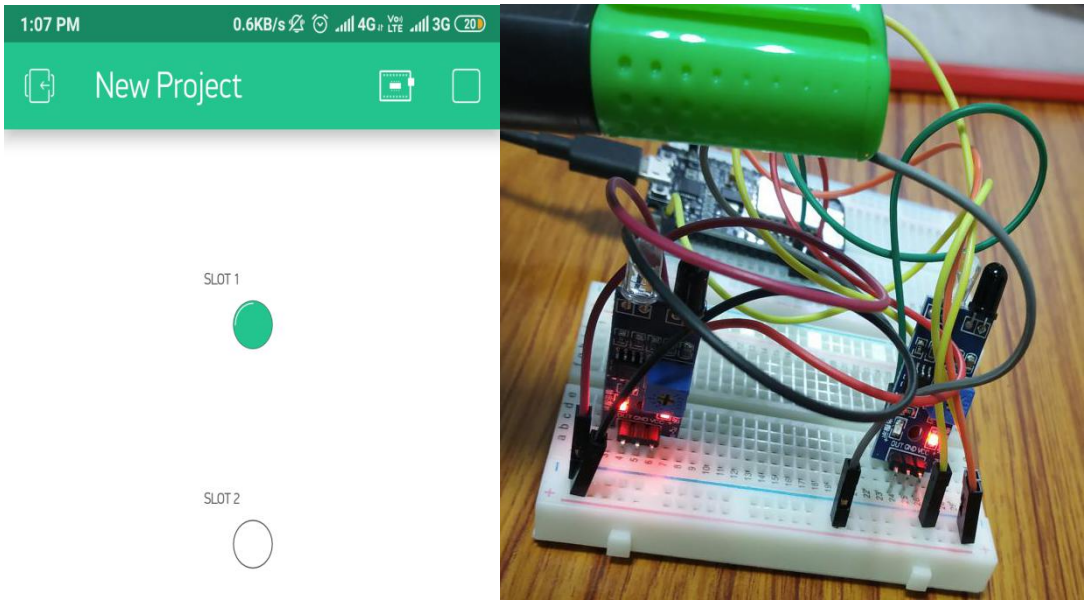

Figure 5.4: Slot 1 occupied (a) and (b).

- When slot2 is occupied, LED2 will be on and LED1 will be off.

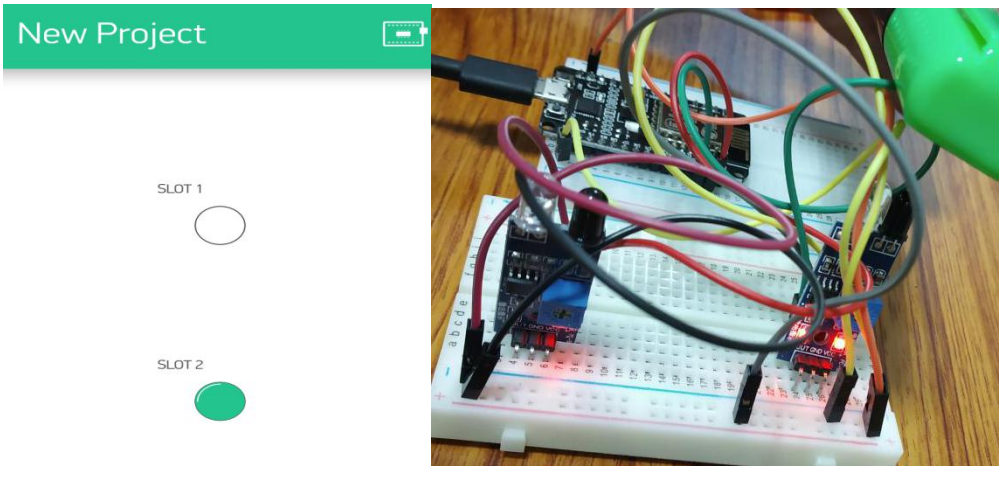

Figure 5.5: Slot 2 occupied(a) and b).

- When slot1 and slot2 both are occupied, LED1 and LED2 will be on.

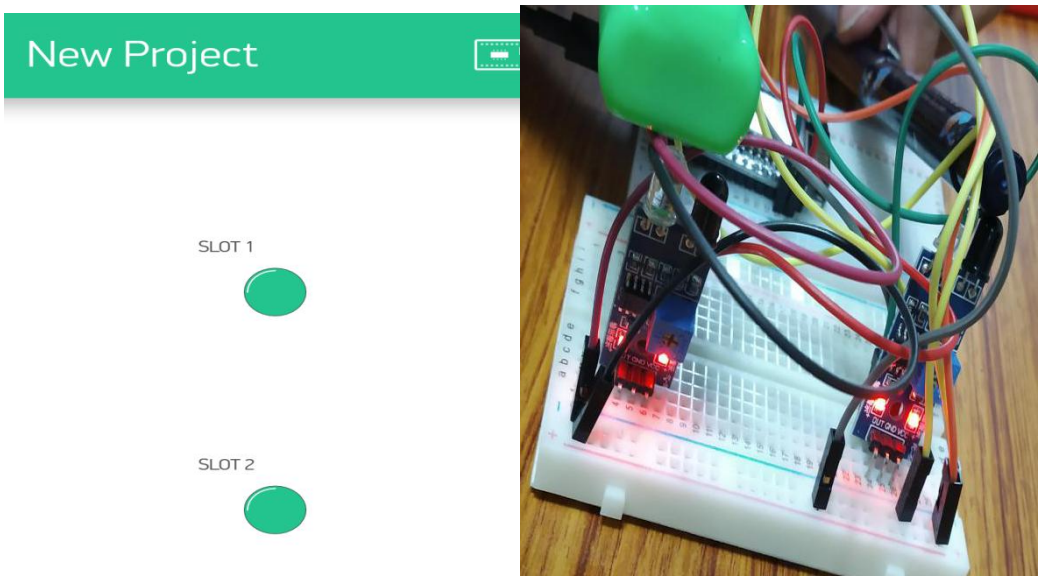

Figure 5.6: Slot 1 and 2 occupied (a) and (b).

- When both the slots are empty, LED1 and LED2 will be off.

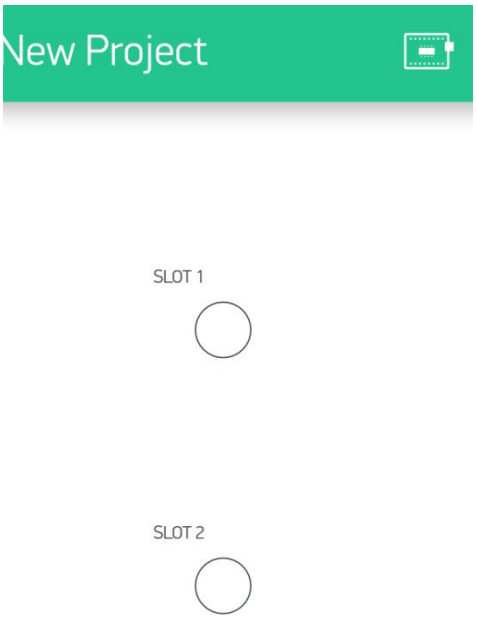

Figure 5.7:Slot 1 and 2 empty (a).

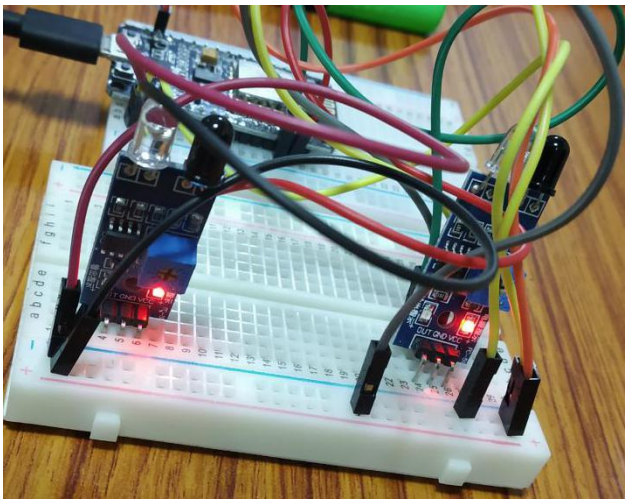

Figure 5.7:Slot1 and 2 empty (b).

CHAPTER 6

CONCLUSION

Internet Of Things (IoT) is one of the current hot topics and lot of research is going around it and new applications are being developed involving IoT for helping users and improving their experiences. IoT has played important role in making our environment smart i.e environment take action on its own based on the conditions. There are numerous applications of IoT and Smart Parking is one of them and it is employed at various places like malls, companies, residential buildings etc. which provide an easy and time saving facility to park their vehicles.

The proposed solution for Smart parking is simple and secured. It doesn't involve any multiple sensors/hardware, it just require as many sensors as there will be slots in the parking area. All the connections made are very easy. Devices used in this project are easily available over the internet and are cost effective. Using Blynk application is also easy.In this project two approaches have been introduced for designing Smart parking System. One way to implement is using Arduino and Ethernet shield but the user needs to be in the same network as that of parking area. Other way of implementation is to use NodeMCU which allows user to connect from anywhere. Rest functions are same for bothe cases. When a user wants to park in the parking area, it needs to be connected to the internet. Open the Blynk application. It will show how many slots are vacant. LED will be on for those slots which are already occupied and off for those which are empty. Driver can park at their desired location and as soon as vehicle will be parked, changes will be reflected in the application. In this way it helps in reducing traffic congestion, time saving, pollution control.

There are few concerns in this project. When one user1 checks the status the last slot is showing empty but in the mean time someone else park their vehicle at that spot before

user1. So it can be expanded by providing the functionality of reserving the slot from the application and reflecting changes immediately.

There is a lot of scope in this field as there is a great emphasis on building smart cities in our country. This project can be expanded further by providing several more functions to the users such as book the parking slot from their location in advance and navigation can also be provided from the application. Security measures can also be incorporated in the project by using RFID tags. It will be used to allow only authorized users enter the parking area and can easily be caught in case of any violation. It can also be expanded to collaborate with smart toll tax collection, monitoring traffic congestion.