Chapter 1: Introduction

1.1 Introduction

There has been a great demand of some automated system that will prove to be beneficial to the users. Our project aims to find a solution to this problem where due to increasing population in metropolitan cities, the number of cars on the roads increase, simultaneously resulting a scarcity of the availability of the parking slots. Our system gives an automated approach which involves minimal human intervention. Our objective is to come up with this system which will be economical, easy to understand and requires less effort.

1.2 Motivation

Since the proposition of Smart Cities in the country, there has been a growing need of automation and introduction to new systems that can reduce human involvement. This has motivated and created a need to develop a change in the parking system making it more convenient and fast. Albeit, several parking solutions are available, this system integrates all problems into one single idea that can be permanently embedded as a solution. The system will incorporate different modules like parking availability calculation, proximity estimation and payment service.

1.3 Drawback of the existing system

- As the driver spends great amount of time in search of a slot, the manual system proves to be **time consuming**.
- Similarly, searching for a slot will also result in **traffic congestion**.
- If a driver roams around to find a safe slot, it may result in **wastage of fuel** eventually leading to **pollution**.
- **Unstructured payment system**, which is tedious and time consuming.

1.4 Problem definition

The issue of parking in metropolitan cities has created a havoc. Even before leaving homes, people give a second thought to take their vehicles along with them as they get worried about finding a safe slot to park. To create a car parking system that can function automatically and efficiently allow the owners of the cars to find parking spots that are close to their choice of entrance. The system should enable car owners to check the availability of parking spaces using an application. The project aims to provide users with information about peak hours of visit in a particular facility using the data recorded by the sensors. Also, the system should reduce the time of entrance to parking lot and allow users to make payments using the application itself.

1.5 Relevance

A step needs to be taken at this hour. In a globalising world where everything is getting automated, transformation from a manual system to a modernised one sounds to be a great idea. People can find a parking slot in any facility at their homes itself. In big cities, finding a proper parking slot is a tedious task. This problem will keep increasing as the population is growing day after day. With the advent of new technologies, people have a wide range of choices in the market. Hence the number of vehicles on road elevates. The ratio increases but with a declivity of vehicle parking slots. Nevertheless, as people roam around in search an appropriate parking slot, great amount of fuel is used, leading to air pollution. Hence, this system will help eradicate this.

Chapter 2: Literature Survey

2.1 Papers

2.1.1 Smart Routing: A Novel Application of Collaborative Path-finding to Smart Parking Systems by Callum Rhodes, William Blewitt, Craig Sharp, Gary Ushaw and Graham Morgan

ABSTRACT --We utilise collaborative path-finding to improve efficiency of smart parking systems and therefore reduce traffic congestion in metropolitan environments, while increasing efficiency and profitability of parking garages. A significant portion of traffic in urban areas is accounted for by drivers searching for an available parking space. Many cities have adopted a parking guidance and information system to try to alleviate this traffic congestion. Typically these systems entail informing the driver of the whereabouts of an available space, reserving that space for the specific driver, and providing directions to reach the destination. Little or no account is taken of how much congestion will be caused by multiple drivers being directed to the same car-park concurrently. We introduce the concept of collaborative path- finding to the problem. We simulate a smart parking system for an urban environment, and show that a novel approach to collaboratively planning paths for multiple agents can lead to reduced traffic congestion on routes toward busy parking areas, while reducing the amount of time when parking spaces are vacant, thereby increasing the revenue earned.

INFERENCE - Utilise collaborative path-finding to improve efficiency of smart parking systems and therefore reduce traffic congestion in metropolitan environments.

2.1.2 Cloud Based Intelligent Transport System by K.Ashokkumar, Baron Sam , R.Arshadprabhu, Britto

ABSTRACT- The advances in cloud computing and web of things (IoT) have provided a promising chance to resolve the challenges caused by the increasing transportation problems. We tend to gift a unique multi-layered conveyance knowledge cloud platform by exploitation cloud computing and IOT technologies to resolve the challenges caused by the increasing transportation issues. We present a novel multi-layered vehicular data cloud platform by using cloud computing and IOT technologies. Two innovative vehicular data cloud services, an

intelligent parking cloud service and a vehicular data mining cloud service in the IoT environment are also presented reviews.

INFERENCE- A tendency to gift a unique standard and multi-layered conveyance information cloud platform supporting cloud computing and IoT technologies.

2.1.3 Efficient Automated Smart Parking System using IOT Technologies by S. M. Bhadkumbhe , Anuj Narayan , Dnyaneshwar Narayan , Sarfraj Shaikh & Yogesh Kunjir.

ABSTRACT: The number of non-public vehicles usage is increasing. Individuals like personal vehicles to commute than rely upon public transportation. Finding a parking zone in most metropolitan areas, particularly throughout the push hours, is troublesome for drivers. it's usually frustrating for drivers to seek out parking areas, and parking itself is a problem in nearly each major town within the world. In this paper, an automatic automobile parking application is proposed that regulates the amount of cars to be place on selected park. The proposed application keep tracks of free and occupied by parking slots. The user can reserve a parking slot by selecting the area. An estimated buffer time will be calculated between the source and destination places. The reservation will be cancelled if the user reached the parking slot after the buffer time. The payment of usage of parking service will be done using wallet.

INFERENCE- The proposed application is based on the client-server architecture. The client is provided with an interactive Android based user interface for the process of pre-booking of parking slot. The server side processing will be enabled using Java and MySQL.

2.1.4 A Cloud Based Car Parking Middleware for IoT-Based Smart Cities : Design and Implementation by Zhanlin Ji , Ivan Ganchev , Mairtin O'Droma , Li Zhao , and Xueji Zhang

ABSTRACT- This paper presents the generic concept of using cloud-based intelligent car parking services in smart cities as an important application of the Internet of Things (IoT) paradigm. This type of services will become an integral part of a generic IoT operational platform for smart cities due to its pure business-oriented features. A high-level view of the

proposed middleware is outlined and the corresponding operational platform is illustrated. To demonstrate the provision of car parking services, based on the proposed middleware, a cloud-based intelligent car parking system for use within a university campus is described along with details of its design, implementation, and operation. A number of software solutions, including Kafka/Storm/Hbase clusters, OSGi web applications with distributed NoSQL, a rule engine, and mobile applications, are proposed to provide 'best' car parking service experience to mobile users, following the Always Best Connected and best Served (ABC&S) paradigm.

INFERENCE- This paper is based on three layers : Sensors, Communication and application. The paper criticised about the image processing algorithms and suggested a better sensor based solution.

2.1.5 A Cloud Based Smart Car Parking System Based on Internet of Things. Thanah Nam Pham , Ming-Fong Tsai , Duc Binh Nguyen , Chyi-Ren Dow , Der-Jiunn Deng

ABSTRACT- This paper introduces a novel algorithm that increases the efficiency of the current cloud-based smart-parking system and develops a network architecture based on the Internet-of-Things technology. This paper proposed a system that helps users automatically find a free parking space at the least cost based on new performance metrics to calculate the user parking cost by considering the distance and the total number of free places in each car park. This cost will be used to offer a solution of finding an available parking space upon a request by the user and a solution of suggesting a new car park if the current car park is full. The simulation results show that the algorithm helps improve the probability of successful parking and minimizes the user waiting time. We also successfully implemented the proposed system in the real world.

INFERENCE- This paper represented the system for street parking using a mathematical cost effective model.

2.1.6 Vision-Guided Automatic Parking for Smart Car by Jin Xu, Guang Chen and Ming Xie.

ABSTRACT- Presents our work on automatic parking of a smart car that relies on vision to estimate free parking slots. All problems involved in implementing an automatic parking behavior are discussed. Solutions are given together with experimental results obtained from real data.

INFERENCE- This paper provided insights to different methodologies that should be implemented to deploy the system. The paper talks about how can car parking be automated and why will it be beneficial.

2.1.7 Automatic Smart Parking System using Internet of Things (IOT) by Mr. Basavaraju S R.

ABSTRACT- Internet of Things (IOT) plays a vital role in connecting the surrounding environmental things to the network and made easy to access those un-internet things from any remote location. It's inevitable for the people to update with the growing technology. And generally people are facing problems on parking vehicles in parking slots in a city. In this study we design a Smart Parking System (SPS) which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. And it mainly focus on reducing the time in finding the parking lots and also it avoids the unnecessary travelling through filled parking lots in a parking area. Thus it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere.

INFERENCE- Proposed a system implemented using IOT and cloud computing so as to reduce traffic congestion and emission of fuels on a larger scale.

2.1.8 IoT Based Smart Parking System Using RFID by Prof.S.S.Thorat , Ashwini M , Akanksha Kelshikar , Sneha Londhe, Mamta Choudhary

ABSTRACT- With the exponential increase in the number of vehicles and world population day by day, vehicle availability and usage on the road in recent years, finding a space for parking the bike is becoming more and more difficult with resulting in the number of conflicts such as traffic problems. This is about creating a reliable system that takes over the task of identifying free slots in a parking area and keeping the record of vehicles parked very systematic manner. This project lessens human effort at the parking area to a great extent such as in case of searching of free slots by the driver and calculating the payment for each vehicle using parking area. The various steps involved in this operation are vehicle identification using RFID tags, free slot detection using IR sensors and payment calculation is done on the basis of period of parking and this is done with the help of real time clock.

INFERENCE- RFID and IR sensors used for gathering data of the parking slots available. This is an IOT based smart car parking system.

2.1.9 Internet of Things Approach to Cloud-based Smart Car Parking by Yacine Atif a,*, Jianguo Dinga , Manfred A. Jeusfelda

ABSTRACT- Concerns for parking are becoming imminent to best support the urban core. These persistent parking problems could be turned into new opportunities, brought by current trends in meeting the globally connected continuum. This paper reveals a work-in-progress to capitalize on private land properties for parking, in order to relieve stress on public agencies, create new sources of revenue, and enlist new entities in the intermediary market. These intermediaries, labelled as Parking Service Providers (or PSPs) play a broker role through advertising parking lots on a shared cloud platform. To streamline these business collaborations and related processes, physical parking lots are augmented with Internet connectivity allowing cloud-provided applications to congregate these lots into a larger inventory. The Internet of Things (IoT) paradigm expands the scope of cloud-based intelligent car parking services in smart cities, with novel applications that better regulate car-parking related traffic. This paper presents a work-in-progress agenda that contributes to new business solutions and state-of-the-

art research impacts. We reveal a multi-layered system of PSP-business model through interdisciplinary research blocks where original results are expected to be made at each layer.

INFERENCE- A middleware that masks the heterogeneity and distribution of connected objects (such as parking sensors). While the IoT layer provides the infrastructure for sensing devices and communication technologies, the middleware layer provides an open interface between the infrastructure layer and the application layer.

2.2 Patents

2.2.1 Patent Name: Parking Management System (US 7391339B2)

Information:

Publication number	US 7,391,339 B2
Publication type	Grant
Application number	11/114,615
Publication date	Jun. 24, 2008
Filing date	Apr. 25, 2005
Priority date	Sep. 1, 2005
Also published as	US6,885,311.
Inventors	Charles K. Howard, Kenroy Cayetano, Olufemi Omojola .

Table 2.2.1

Abstract -- The systems described herein include one or more wireless vehicle detectors, along with a distributed parking payment system such as parking meters or a paystation. Information from the payment system and the vehicle detectors may be combined to determine when a parking violation occurs, or is about to occur. This information may then be transmitted through a communication system to a parking enforcement officer, along with information about the geographic location of the violation. The information may also, or instead be transmitted to a parking payer to notify the payer of an impending infraction so that the payer may purchase additional parking time before the violation.

2.2.2 Patent Name – Automated Parking System: US 8,632,290 B2

Information:

Publication number	**US20160300392 A1**
Publication type	**Application**
Application No:	13/008,578
Publication date	Jul. 28, 2011
Filing date	Jan. 18, 2011
Inventors	Christopher Alan .
Original Assignee	Auto Parkit, LLC, Los Angeles, CA (US) .

Table 2.2.2

Abstract -- An automated parking system for a parking structure includes a controller which receives a vehicle loading request from a vehicle customer. A loading bay accepts the vehicle and transfers to the parking system. Equipment is provided for transferring the vehicle horizontally and vertically through the parking system. The vehicle parking system includes a rack structure that is integrated as part of the parking structure.

2.2.3 Patent Name: Bibliographic Data: Car Parking System

Information:

Publication number	US005336031A
Publication type	Application
Application No:	3,563
Publication date	Aug. 9, 1994
Filing date	Jan. 13, 1993
Inventors	Zeev Golan

Table 2.2.3

Abstract -- A parking system for vehicles includes a vehicle support platform adapted to support a vehicle over a parking area and having a rear end portion permitting travel of a vehicle there across, a front end portion, and side portions extending longitudinally between the rear and front end portions; and support apparatus for the platform located at a predetermined end portion of the parking area and adapted to engage the platform front end portion only. The support apparatus also includes lifting apparatus which is operative to cause an initial pivoting of the platform about the rear end portion such that the front end portion of the platform becomes elevated above the rear end portion, and which is also operative to cause an additional pivoting of the platform about the front end portion to elevate the rear end portion of the platform relative to the front end portion, thereby bringing the platform into a raised position and provide vertical clearance between the platform and the parking area that is sufficient to enable entry of a vehicle beneath the platform.

2.2.4 Patent Name: Bibliographic Data: Vehicle parking system

Information:

Publication number	US005336031A
Publication type	Application
Application No:	3,563
Publication date	Aug. 9, 1994
Filing date	Jan. 13, 1993
Inventors	Torrent Hjelmvik
Assignee	odul-SystemSwedenAB,Järfäla (SE) .

Table 2.2.4

Abstract -- A parking system in which a mobile telephone can be used to commence and terminate a parking period. A user sends at least one code to a receiving computer at the commencement and termination of a parking period via a mobile telephone system or a permanent telephone system. When a user first connects to the parking system by telephone in order to be able to park the user's vehicle within the system and to communicate parking commencement and termination times with the aid of a telephone, either a pay meter, a cash card terminal, or some corresponding device is caused to read mechanically a cash card that is owned by the user and that is accepted by the parking system as a means of payment. The data read from the cash card is stored in a database in a parking system computer, and at least one user-specific reference is entered and stored in the database and is associated with the cash card data for subsequent identification of the user and for billing the user for parking.

Chapter 3: Requirement Gathering

Requirements analysis, also called requirements engineering, is the process of determining user expectations for a new or modified product. These features, called requirements, must be quantifiable, relevant and detailed. A requirement gathering process should be carried out to know the current system and the need to reform it. Our proposed system gives a fully automated solution to the problem of finding an appropriate parking slot. It overcomes the issues faced due to the manual parking system. For our proposal to work in an efficient manner, some inputs are needed to guide us. This can be achieved by requirement gathering. With the help of this, the usual trends of parking patterns are known which will help us to develop an efficient algorithm. Nevertheless, the suitable software and hardware tools are analyzed. The appropriate sensors are known which will be used to detect a free space in the parking area.

The requirements for our proposed system name "CAR PARKING AUTOMATION USING IOT comprises of:-

3.1 Functional Requirements

1. Sensor based system that detects vehicles in a parking lot and streams the data via a wireless network.
2. Server Based architecture that stores the data and allows basic processing of data.
3. Detect user location and notify the closest vacant parking facility.
4. To provide an application that allows the users to view the availability of parking in a facility.
5. A System that predict the best parking spot based on the user requirement like entering a particular area of the mall.
6. Provide users with sufficient information and relevant directions to their parking spot.
7. Slot assigned to the user according to the type of vehicle.
8. Users can make payments for parking using the application directly using in-built money transfer apps.
9. User can reserve the parking slot in the desired parking area.

3.2 Non-Functional Requirements

1. Accessibility- Application should work on every mobile device.
2. Modifiability- The application should easily modify the data and update the database.
3. Security- Our system should ensure that the user integrity is maintained.
4. Reliability- Even after the device hangs or stops working due to some reason, a backup should take place.
5. Scalability- The system should be capable to handle a large amount of slot data in the database.

3.3 Constraints

1. Testing sensors after deployment at a certain facility during course of project development isn't possible. Testing can be made possible using prototype models.
2. This project will be functional for an android device. In order to deploy, there must be an IOS version/web version of the application to be accessible by visitors, as there is huge number of IPhone users in the market as well.
3. Significant results can be evaluated only from implementing this project on a large scale. Hence analytical results cannot be obtained from this project.
4. Setting up network for data transfer.
5. Deployment of the Hardware.

3.4 Hardware and Software Requirements

Software:

Software technology:

1. Arduino IDE
2. Visual Studio

Android development:

1. Windows 7 or 8
2. Java
3. Xml

Software Apps and Online Services:

1. Bluehost Cpanel (Server Management System)
2. Android Studio

Hardware:

1. SparkFun SparkFun Block for Intel® Edison – Arduino
2. Ultrasonic Sensor - HC-SR04 (Generic)
3. IR receiver (generic)
4. Buzzer

Technology:

1. Android Development
2. Internet of Things (IOT)

3.5 Techniques Utilized Till Date For The Proposed System:

- A unique standard and multi-layered conveyance information cloud platform supporting cloud computing and IOT technologies.
- Providing the client with an interactive Android based user interface for the process of pre-booking of parking slot. This motivated us to enhance and add more functions to the application such as to choose the type of vehicle the user had.
- The booking services will allow the system to store user data on the system. This can be used for payment processing.
- Identification of the appropriate sensors which will be used for collecting information about the empty spaces in the parking area.

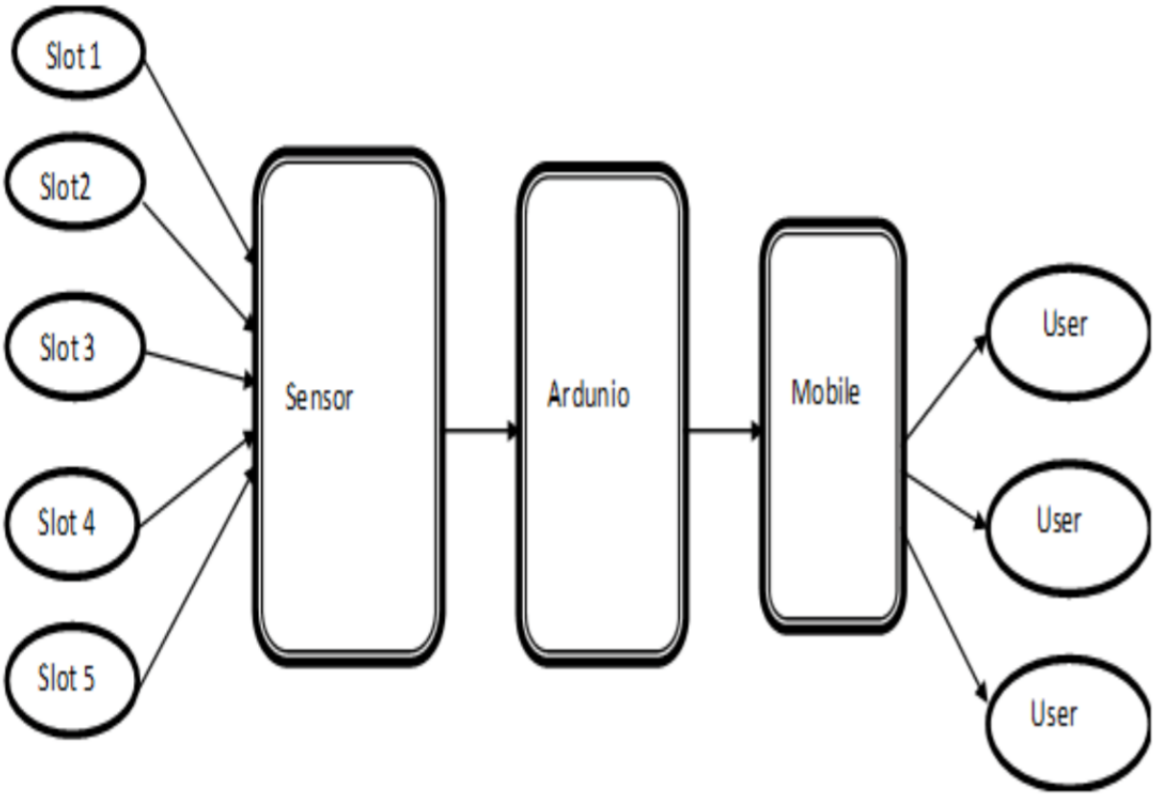


Figure 3.1

The figure above shows the basic structure of our proposed system. The sensors act as the interface between the cars objects in the parking lot and the system. Data from sensors will be critical information for the system.

Chapter 4: Proposed Design

4.1 Block Diagram of System

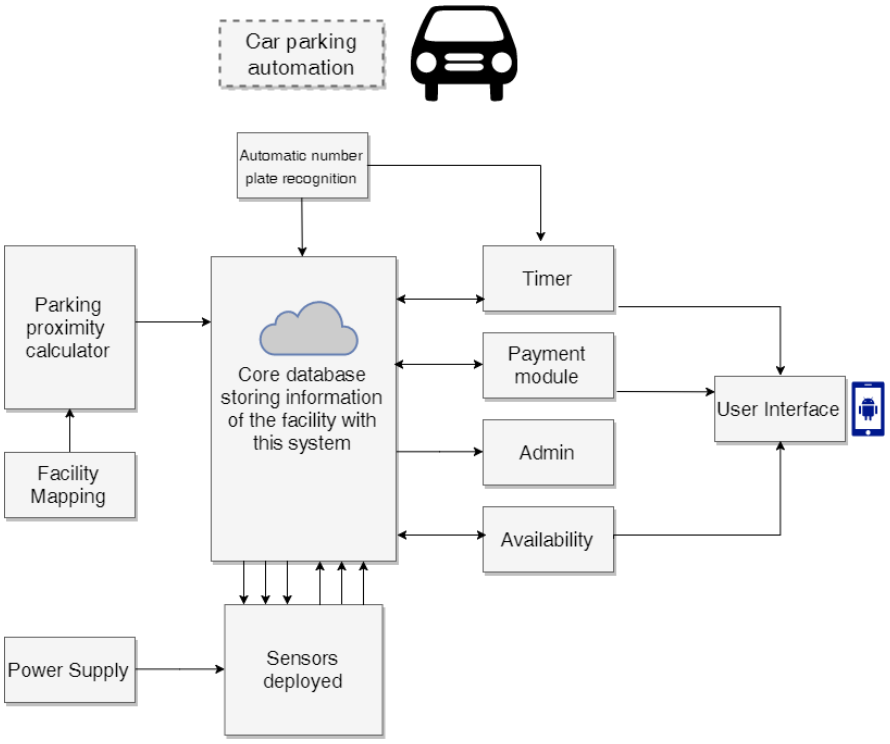


Figure 4.1

The above diagram shows the block diagram of our proposed system. The sensors are deployed and provided with a power supply. The whole system will work efficiently if the core database is stores all the information needed. Firstly, the mapping of the facility's parking area is done. When the user wants to find a slot which is close by, proximity calculator is used which will calculate the distance of the closest slot. All this is updated in the database. The license plate number is given to the database which is stored along with the arrival and the departure time. Timer, payment module and the availability module has a two way relationship with the core as these information keeps changing depending on the user/vehicle owner. The owner of the vehicle will be updated with all the information which will be provided by the cloud database. Finally, after all the data gathered from the database, the user will be notified through the user interface.

4.2 Modular Diagram Representation of the Proposed System

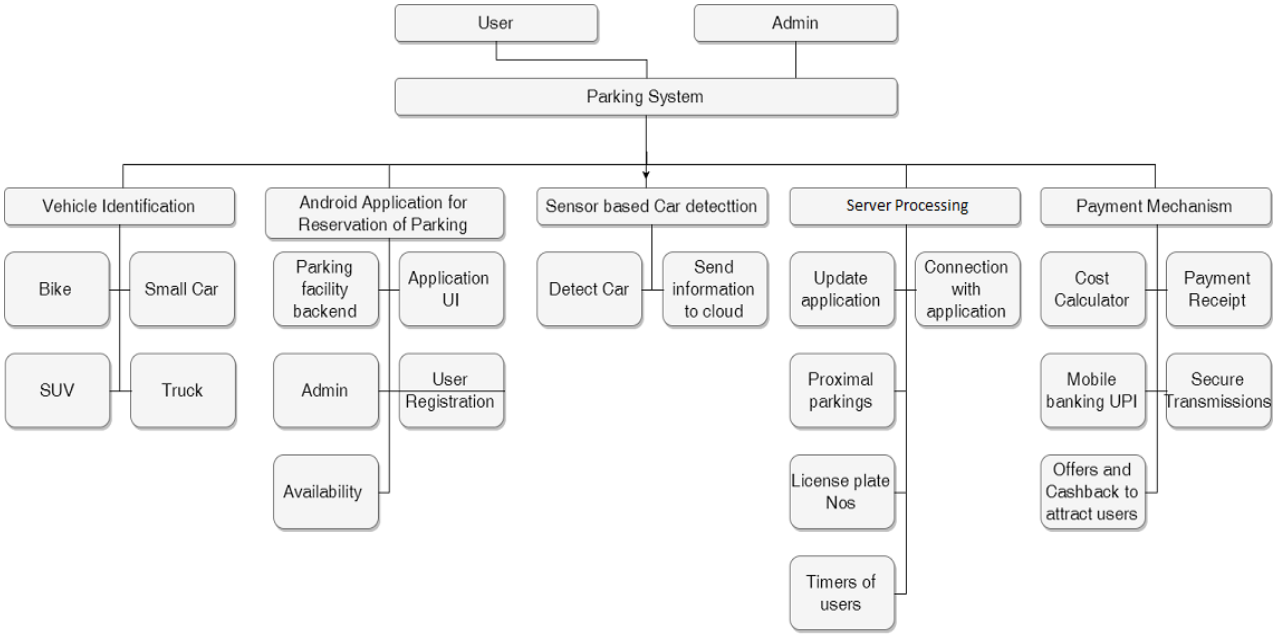


Figure 4.2

Modular design is a design approach that subdivides a system into smaller parts called modules that can be independently created and then used in different systems. A modular system can be characterized by functional partitioning into discrete scalable, reusable modules; rigorous use of well-defined modular interfaces; and making use of industry standards for interfaces.

We've five major modules in our proposed project which are as follows:

1. Vehicle Identification
2. Sensor based car detection
3. Server based Processing
4. Android Application
5. Payment Gateway

Each module has several sub-modules that perform respective functions and form the entire system. The sub-modules are created integrated to obtain the most benefits from the resources that will be utilised to implement this project and form a network responsible for automating the parking system.

Considering the existing systems and the costs encountered for executing the project, these modules will be the most efficient solution till date and be fully capable of dealing with difficulties that might arise during its implementation.

4.3 Detailed Design Of The System

4.3.1 Data Flow Diagram

LEVEL 0:

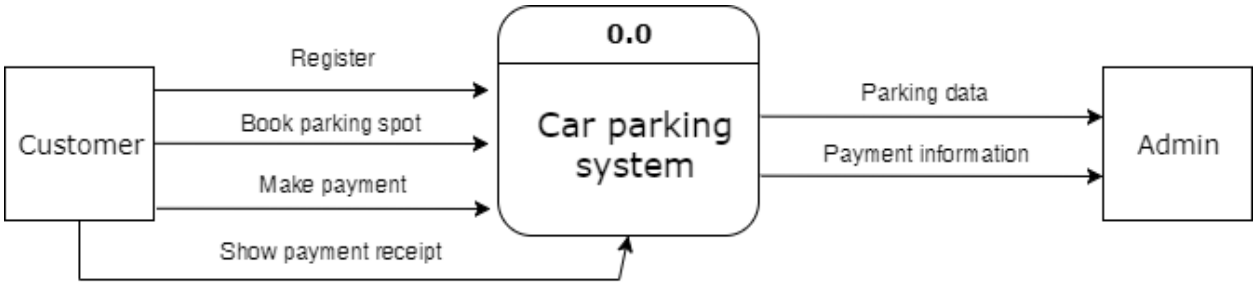


Figure 4.3.1

The customer will register with the system for once and create an account. After logging in, the user will search for a parking slot and if a favourable one is available, he/she can book a slot immediately. Before the user leaves the premises, payment has to be done. The amount to be paid is calculated by the backend of the system and is deducted from the users account balance. For confirmation of the payment, the user is provided with a payment receipt.

LEVEL 1:

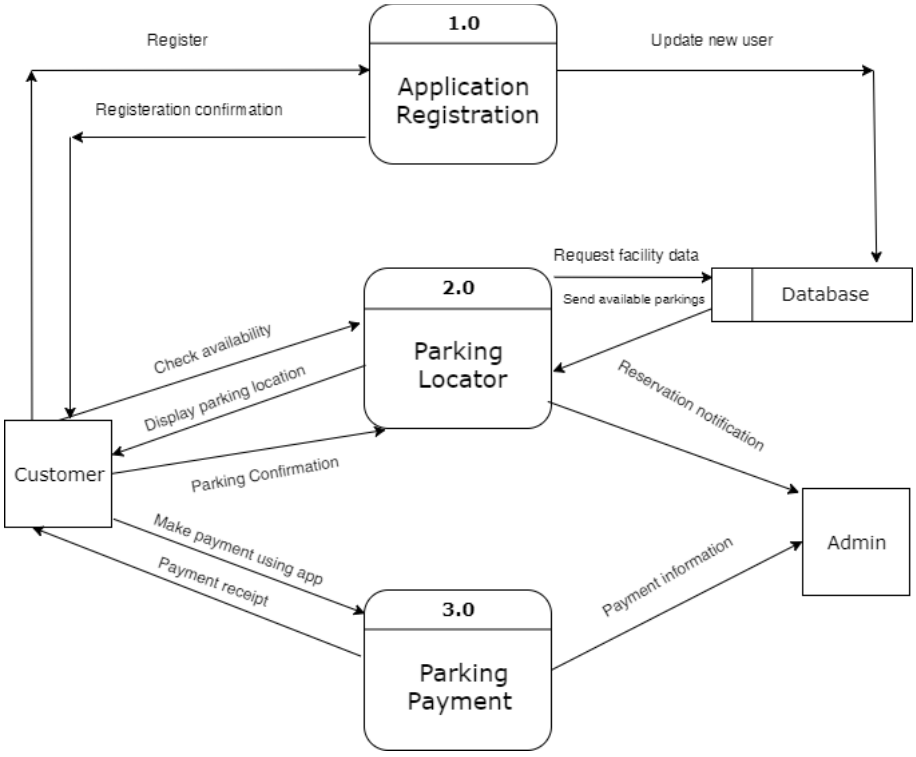


Figure 4.3.2

There are 3 main modules in this DFD are nearest parking calculator, Server Processing and time calculator. The customer specifies the location they wish to visit and accordingly the nearest parking slot will be allocated. A confirmation will be sent to the customer. All these tasks are performed by the nearest parking system. Before assigning a slot, this module requests the database to provide the information of the nearest slot available. Time calculator gives a buffer time to the user to enter and exit the facility.

LEVEL 2:

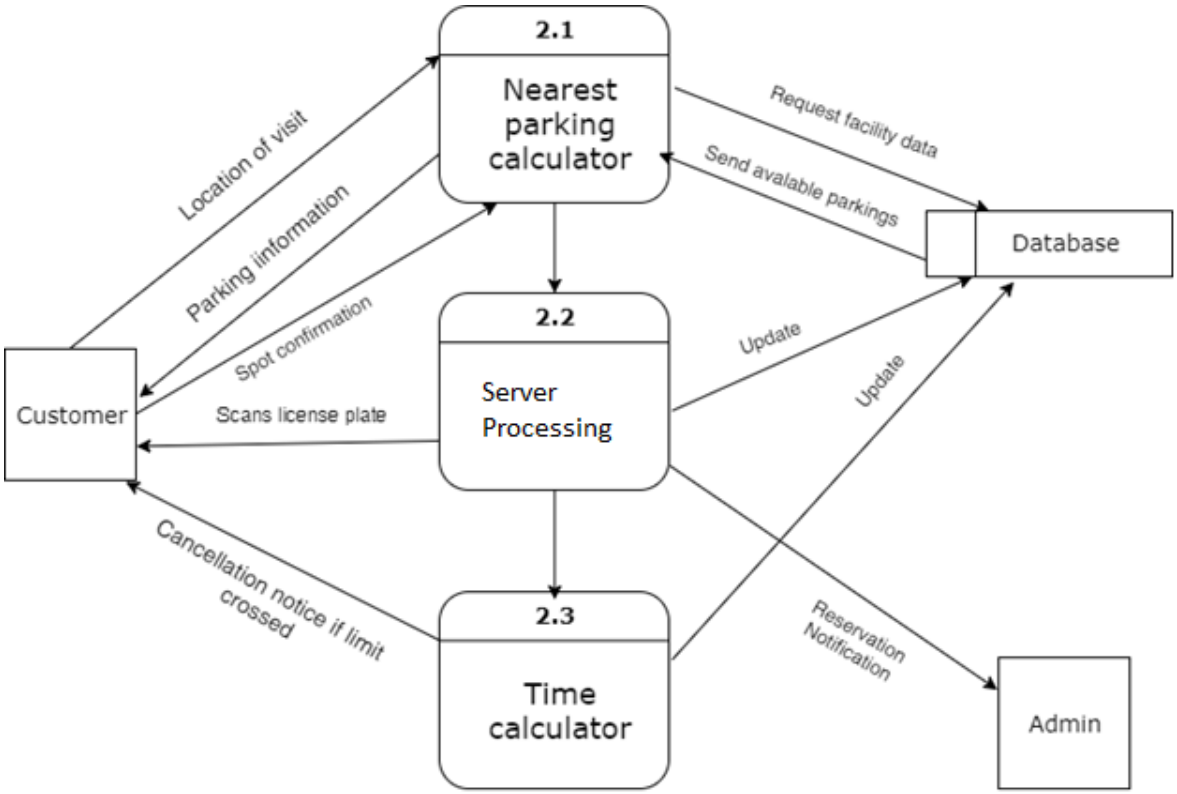


Figure 4.3.3

A new user will first register with the system. After registering, the user will be notified with a confirmation. A different module will be made which will facilitate the online parking. The user will make payment through the application and the user will receive a payment receipt. All these actions performed will be updated in the database and the user will be informed time to time.

4.3.2 Flowchart Diagram

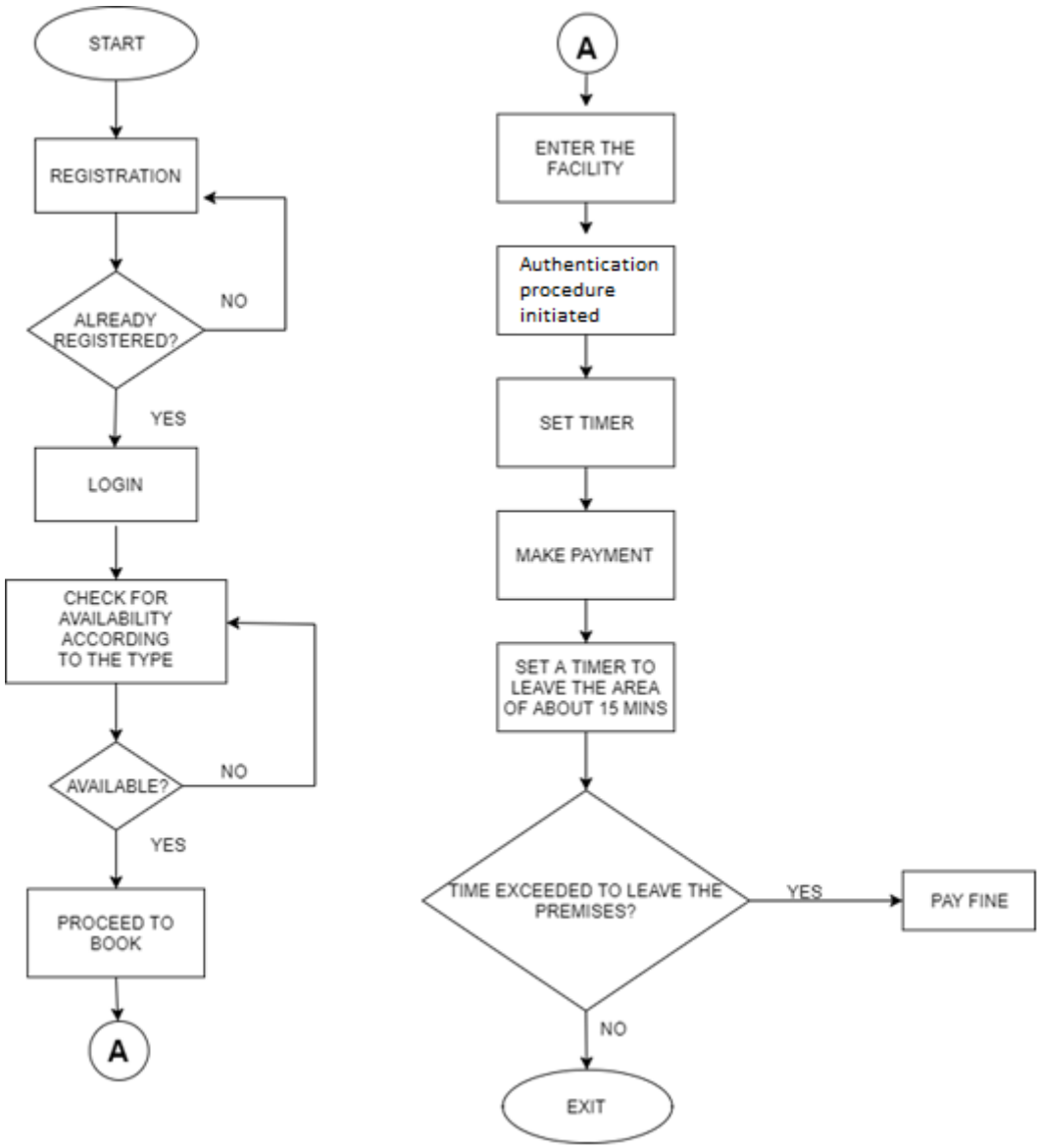


Figure 4.3.4

The above diagram shows the basic flow of system. The user will first register with the application if he/she are the new users. If the user already has an account, only logging in is needed. After logging in the user will search for a parking slot according to the type of vehicle. If the parking slot is not available the user can wait or try again. If a slot is available, the user can proceed to book.

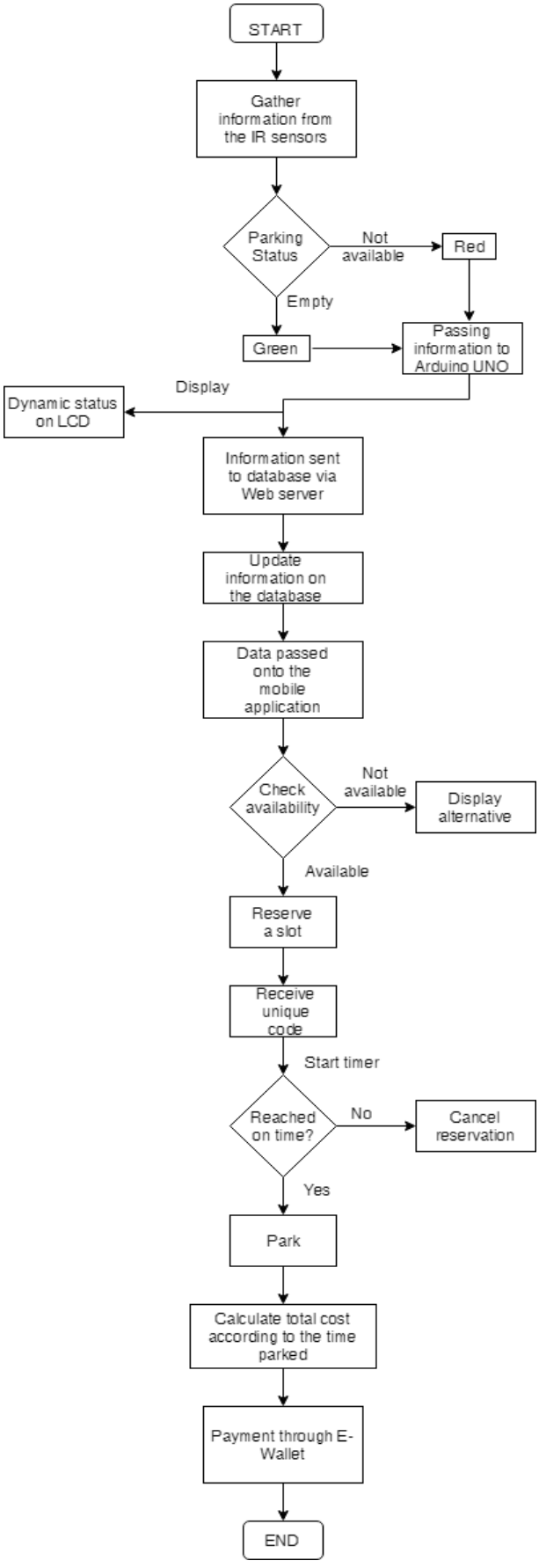

START
Gather information from the IR sensors
Parking Status
Not available
Red
Empty
Green
Passing information to Arduino UNO
Display
Dynamic status on LCD
Information sent to database via Web server
Update information on the database
Data passed onto the mobile application
Check availability
Not available
Display alternative
Available
Reserve a slot
Receive unique code
Start timer
Reached on time?
No
Cancel reservation
Yes
Park
Calculate total cost according to the time parked
Payment through E-Wallet
END

Figure 4.3.5

4.3.3. ER Diagram

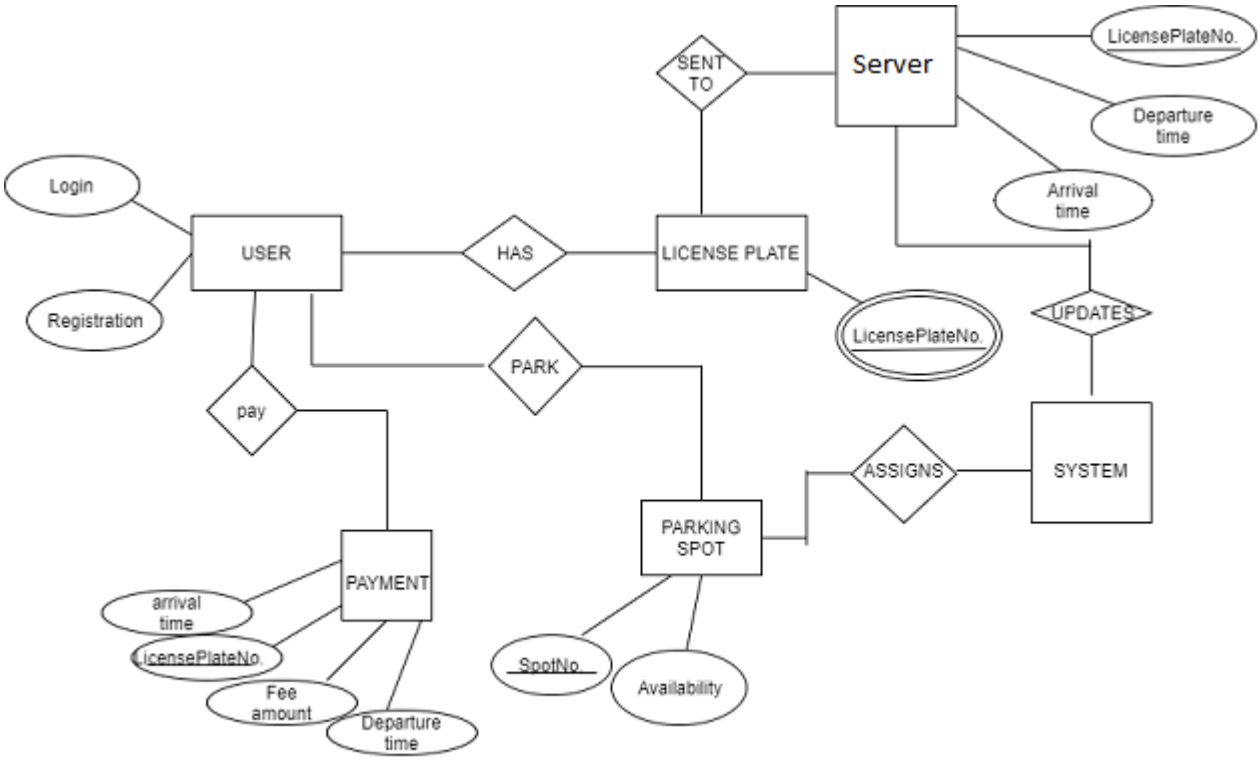


Figure 4.3.6

An entity relationship diagram consists of the objects represented in the system and its attributes. Attributes are a part of a particular entity.

User is an entity that consists of attributes login and registration. Every vehicle of the owner will have a unique license plate number that will recorded through image processing with the use of camera. The user will park the vehicle on the spot provided according to its availability. Here also, the user will be given a spot number.

The license plate number will be sent to the cloud where it will be stored along with the arrival and the departure time.

The cloud will keep updating the system about the different license plate numbers and timings. Accordingly, the system will assign a slot to the user.

4.4 Project Scheduling & Tracking Using Timeline/ Gnatt Chart

This approach has been defined for the development of the various stages and modules of the Project. Gnatt chart also helps us identify and create deadlines for each module to be developed. It is a sequential flow of events and operations to be carried out to build this project. Given below is the deadline and stages that have been followed while creating this system.

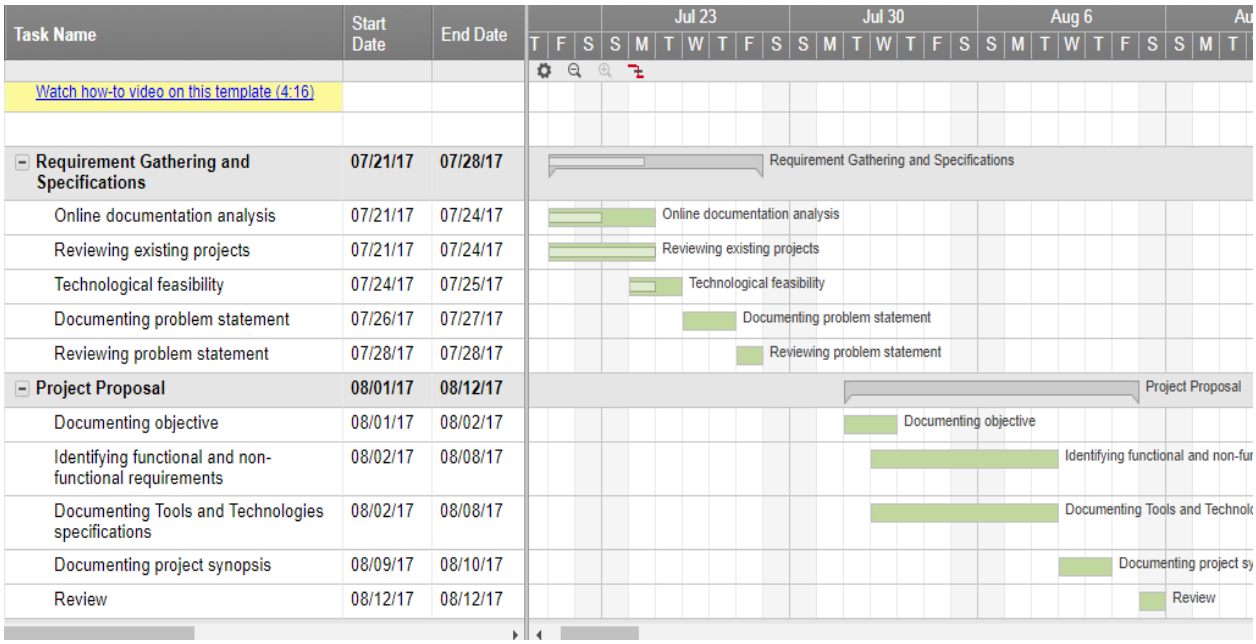


Figure 4.4.1

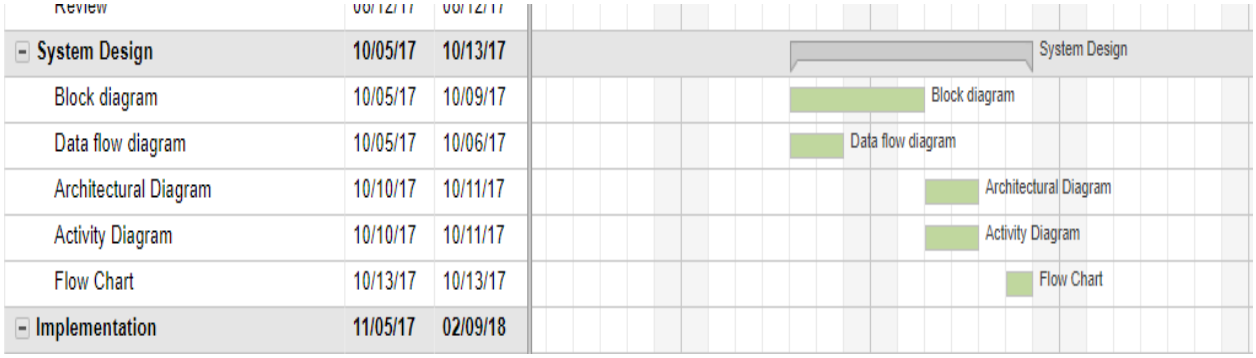


Figure 4.4.2

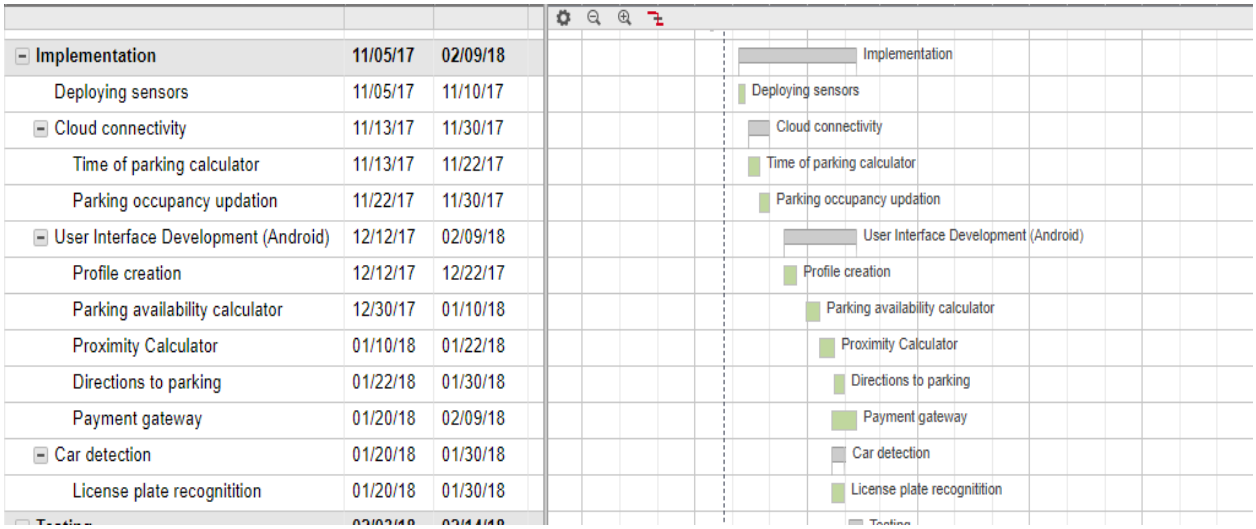


Figure 4.4.3

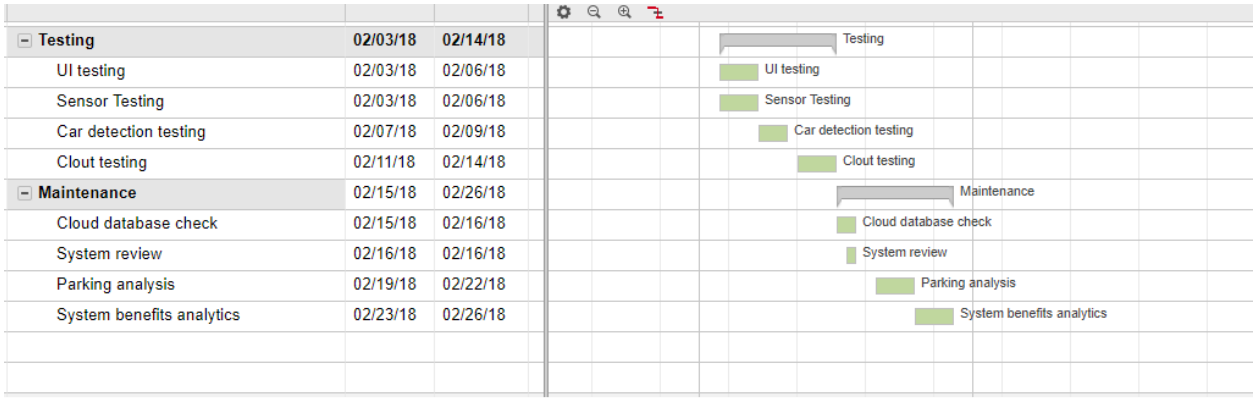


Figure 4.4.4

Chapter 5: Implementation

5.1 Algorithms of Modules Developed

New simple Algorithms were developed on the basis of the requirements in this project. The system created efficient algorithms to generate bills for parking after reservation and calculating and deducting the amounts from the registered users account.

5.1.1 User Authentication

An algorithm was created to check the authenticity of the User. It required the user to enter the unique code created in reference to his/her booking of the parking slot. The user is required to enter the code in order to get an entry into the parking lot.

5.1.2 Payment Processing

Also this particular entry code is also responsible for calculating the duration for which the user uses the services of the parking lot. Based on this, the user can be charged appropriately.

5.1.3 Car detection

A module is created in this project that has live interaction with the user. This algorithm serves the purpose of providing live data to the user whenever the user requests for it. The information from the sensors is conveyed in an instant to the user informing the user which parking slots are available for him/her to book.

5.2 Evaluation of the Developed System

Project implementation is a phase where the visions and plans becomes a reality. This is logical conclusion, after evaluating, deciding, visioning, planning for a project. Implementation means carrying out activities that have been planned. The basic requirement for starting the implementation process is to have the work plan ready and understood by all the actors involved.

We started our implementation by writing and executing the code for server processing in Visual Studio by creating a backend UI and then developed the prototype of the IoT based Car parking system.

The hardware of the system consists of the following components:

Arduino Uno: Used as a hardware module for IoT projects.

IR sensors: Used for detecting the object/car.

This section rightly explains the steps we carried out for the implementation of the prototype, having a parking lot connected to a working application. This prototype stands as an exclusive proof for the system in the real-time environment.

The sequence of flow of the functionality of the system and the objective of each step during the course of implementation is explained below:

1. An android application is downloaded by the user for the reservation purpose. We have developed the application on Android Studio Development Kit, which enables parking availability check, reservation and cancellation to the registered user. The user maintains a profile within the application stores the user history.
2. The IR proximity sensors detect the availability of the slots and update the database which eventually notifies the application.
3. Arduino UNO is a computer in itself which sends the data detected from the sensors to the database through http server. The Arduino code has been developed on Arduino Create Agent.
4. The prototype has a display connected to Arduino which gives live availability status. The image below tells that 1 indicates that the parking slot 1 is full and 0 signifies that slot 2, 3, 4 are empty.
5. All the gathered data from the Arduino and the sensors is passed onto the database server. Microsoft SQL server .NET Framework is used at the backend to store the user information along with the slot availability including entry and exit time of the car.

6. After the user selects a slot for parking, he/she needs to reach the premises within a predefined time. The functionality of timer is also added which is used for the cancellation purpose. The car owner is also provided with a unique code which is used for authentication.
7. The amount to be paid is calculated on the basis of the total time the car stayed in the premises.
8. E-Wallet is used for the purpose of payment wherein the user maintains a certain amount of balance which gets deducted in every visit.
9. When there is no sufficient balance in the account, the user is notified to add electronic cash into the wallet. This functionality proves to be easy and quick to the car owners.

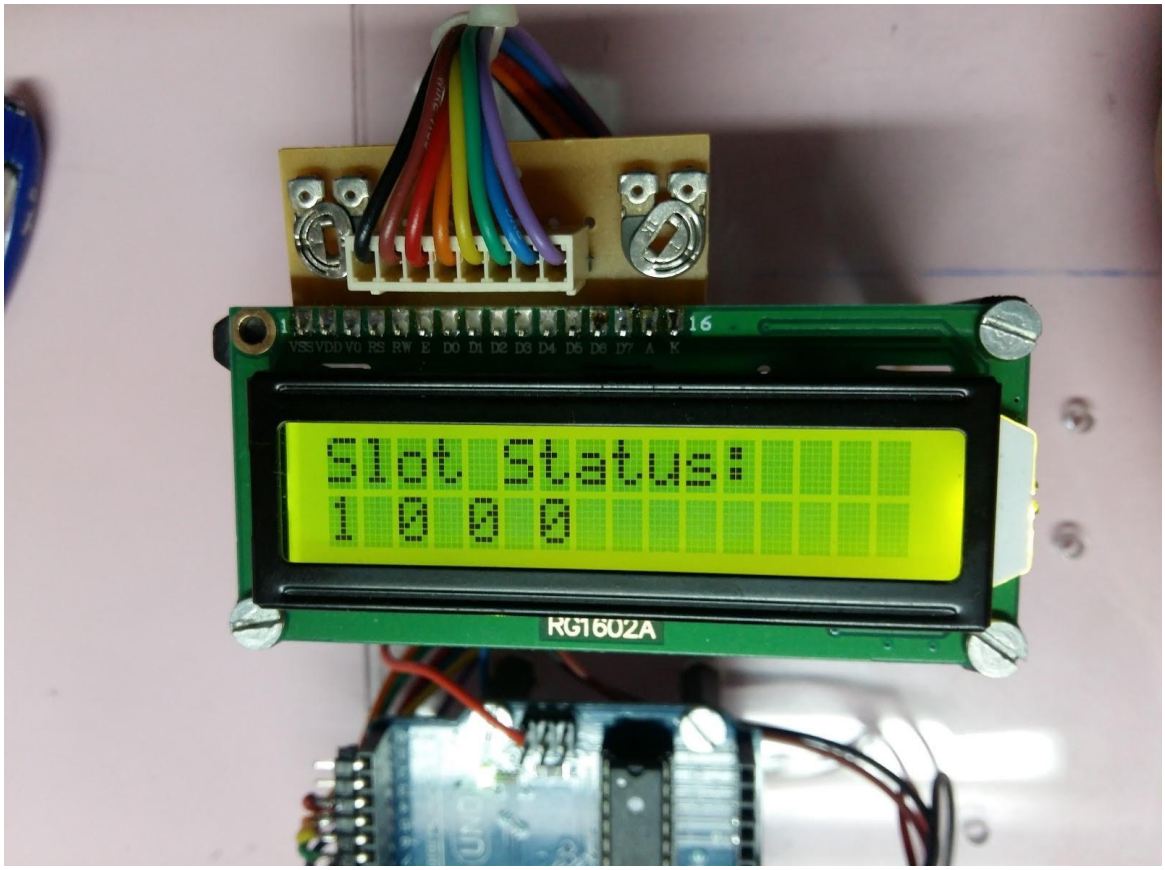


Figure 5.1

10. According to analytics, if a particular area is full, an alternative parking area will be suggested to the user which will be nearby.
11. This facility ensures that the car gets a slot even in highly congested areas.
12. Moreover, analytics is carried out, telling about the peak hours and days. The application user will be notified about the same.

Chapter 6: Testing

What is testing?

Testing is measures taken to check the quality, performance, or reliability before putting it into use. Testing assesses the quality of the product. In terms of Software, Software testing can be defined as it is a process of executing a program or application with the intent of finding the software bugs. It can also be stated as the process of validating and verifying that a software program or application or product: Meets the business and technical requirements that guided its design and development. Some tools can also be used for testing of a software.

Why is software testing required?

Testing is required for an effective performance of software application or product. It's important to ensure that the application should not result into any failures because it can be very expensive in the future or in the later stages of the development. Basic things when software testing required to:

- Point out the defects and errors that were made during the development phases.
- Make sure of the Customer's reliability and their satisfaction in the application.
- Deliver a high quality product or software application which requires lower maintenance cost and hence results into more accurate, consistent and reliable results.
- Meet the requirements that guided its design and development.
- respond correctly to correct inputs and prompts error message on incorrect input
- Perform its function within an acceptable time.

What is Validation?

The process of evaluating software during or at the end of the development process to determine whether it satisfies specified requirements. Validation checks that the product design satisfies or fits the intended use (high-level checking), i.e., the software meets the user requirements. This is done through dynamic testing and other forms of review. In terms of modelling, Validation is the process of determining the degree to which a model, and their associated data are accurate representations of the real world from the perspective of the intended use.

What is Verification?

The process of evaluating software to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase. In terms of modelling, Verification is the process of determining that a computer model implementations and their associated data accurately represent the conceptual description and specifications.

In other words, software verification is ensuring that the product has been built according to the requirements and design specifications, while software validation ensures that the product meets the user's needs, and that the specifications were correct in the first place.

- Validation: Are we building the right product?
- Verification: Are we building the product right?

Our system performs the verification of the user at two stages. First is the user login stage and second is when the user has made a booking and is about to enter the parking lot. User request is verified and then the user is allowed to enter.

Test Case:

A test case is a set of conditions under which we can determine whether a system under test satisfies requirements or works correctly. The process of developing test cases can also help find problems in the design of an application. Various tests were performed on the booking activity of the application to determine the reliability of the system. Given below is the figure of the booking activity on which the tests were performed.

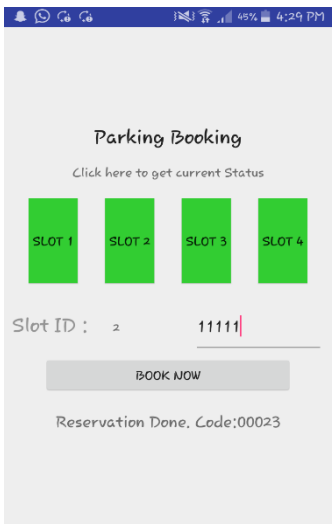


Figure 6.1

Chapter 7: Result Analysis

7.1 Simulation Model

- An automated parking system application is developed in order help the car owners to get a desirable parking spot in a crowded area. The user can view the parking lot as well as get information about availability via the user interface. The user can request the application to get the current status of parking lot by the click of a button.
- The user can ask the application to book a parking spot of choice after entering its vehicle ID. In case of the parking spot being already booked, the user is duly notified. Also a case of double booking has been tested to not occur since a session is created and assigned to only a single user for a particular parking spot.
- The user will be charged on the basis of the duration for which the car is inside the parking lot which is done using the backend processor of the system. The user is required to enter authentication code that is generated for each parking booking at the entry and exit.

7.2 Screenshots of UI and Backend

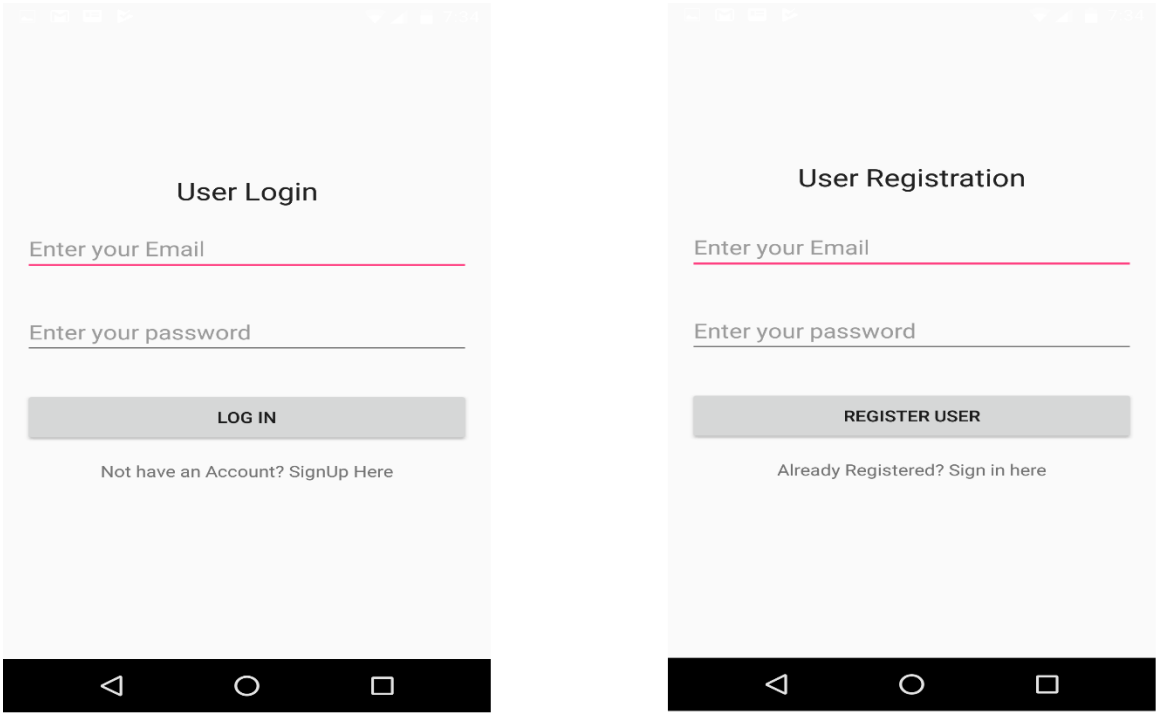


Figure 7.2.1

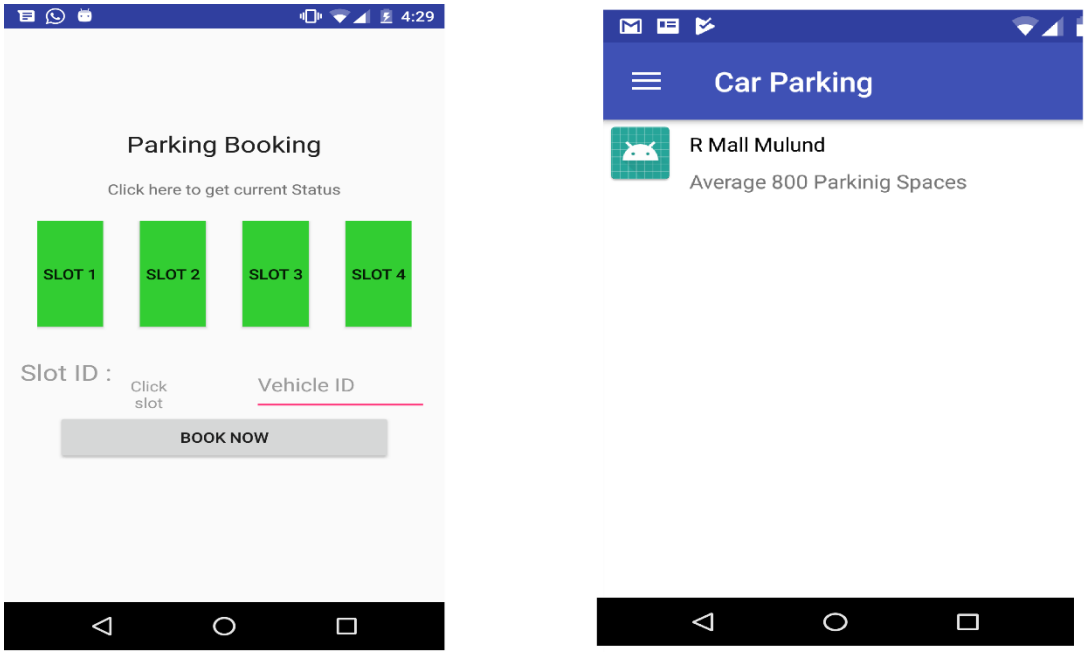


Figure 7.2.2

Figure 7.2.1 displays the registration and the login page of the application. The right side of figure 7.2.2 displays the first activity of the application i.e. a list containing the facilities that are equipped with this system. The left image shows the booking UI of the system through which the parking spots can be selected and booked.

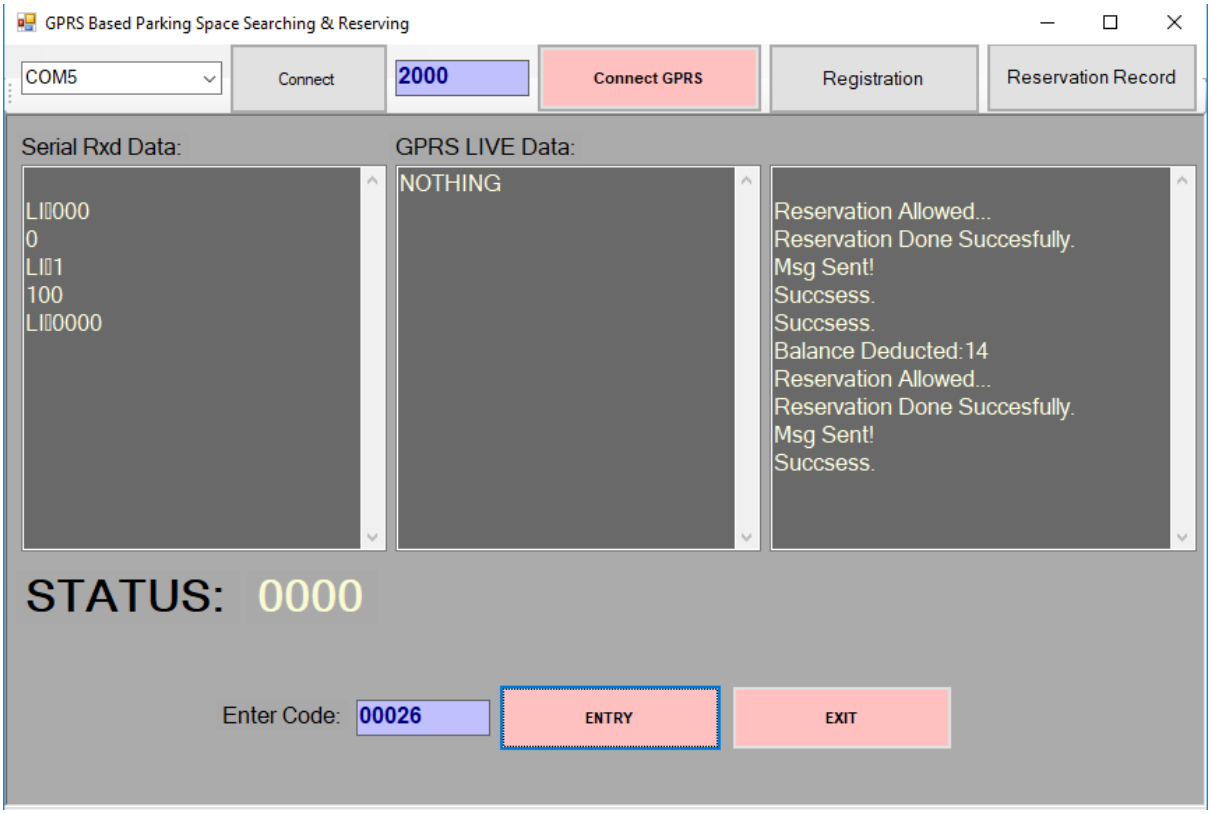
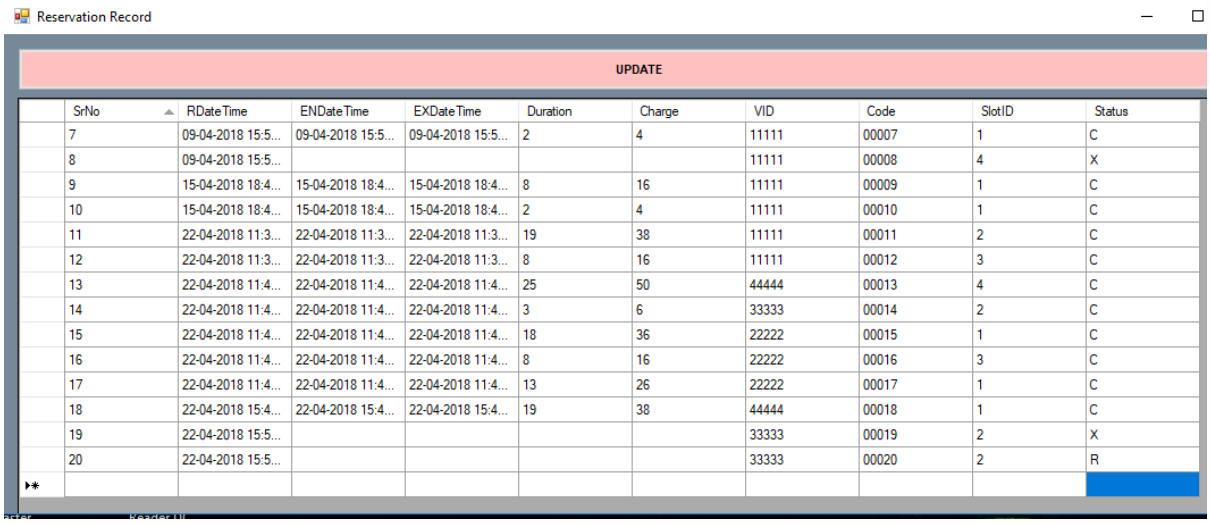


Figure 7.2.3

The above figure displays the backend UI of the system. The backend is developed on the VB .Net software acting as the interface between the Arduino hardware and the android application using a server link. All activities and communication occurring between these elements are displayed here showcasing how the system is working.



SrNo	RDateTime	ENDateTime	EXDateTime	Duration	Charge	VID	Code	SlotID	Status
7	09-04-2018 15:5...	09-04-2018 15:5...	09-04-2018 15:5...	2	4	11111	00007	1	C
8	09-04-2018 15:5...					11111	00008	4	X
9	15-04-2018 18:4...	15-04-2018 18:4...	15-04-2018 18:4...	8	16	11111	00009	1	C
10	15-04-2018 18:4...	15-04-2018 18:4...	15-04-2018 18:4...	2	4	11111	00010	1	C
11	22-04-2018 11:3...	22-04-2018 11:3...	22-04-2018 11:3...	19	38	11111	00011	2	C
12	22-04-2018 11:3...	22-04-2018 11:3...	22-04-2018 11:3...	8	16	11111	00012	3	C
13	22-04-2018 11:4...	22-04-2018 11:4...	22-04-2018 11:4...	25	50	44444	00013	4	C
14	22-04-2018 11:4...	22-04-2018 11:4...	22-04-2018 11:4...	3	6	33333	00014	2	C
15	22-04-2018 11:4...	22-04-2018 11:4...	22-04-2018 11:4...	18	36	22222	00015	1	C
16	22-04-2018 11:4...	22-04-2018 11:4...	22-04-2018 11:4...	8	16	22222	00016	3	C
17	22-04-2018 11:4...	22-04-2018 11:4...	22-04-2018 11:4...	13	26	22222	00017	1	C
18	22-04-2018 15:4...	22-04-2018 15:4...	22-04-2018 15:4...	19	38	44444	00018	1	C
19	22-04-2018 15:5...					33333	00019	2	X
20	22-04-2018 15:5...					33333	00020	2	R

Figure 7.2.4

This shows the reservation record of the users. Whenever a booking operation is performed, an entry is made in this table which is used to calculate the duration of stay, payment and also perform user authentication.

7.3 Graphical Outputs

7.3.1 Data loaded in R Studio

```
'data.frame':   20 obs. of  11 variables:
 $ Sr.No         : int  1 2 3 4 5 6 7 8 9 10 ...
 $ RDatetime     : Factor w/ 20 levels "03-04-2018 14:13:51",..: 5 6 7 8 1 2 3 4$
 $ EntryDatetime: Factor w/ 17 levels "","03-04-2018 14:14:20",..: 5 6 7 1 2 3 $
 $ ExitDatetime : Factor w/ 17 levels "","03-04-2018 14:14:58",..: 5 6 7 1 2 3 $
 $ Duration      : int  44 22 60 NA 38 4 2 NA 8 2 ...
 $ Charge        : int  88 44 120 NA 76 8 4 NA 16 4 ...
 $ VID           : int  11111 11111 11111 11111 11111 11111 11111 11111 11111 11$
 $ Code          : int  1 2 3 4 5 6 7 8 9 10 ...
 $ SlotID        : int  4 3 2 3 3 2 1 4 1 1 ...
 $ Status        : Factor w/ 3 levels "C","R","X": 1 1 1 3 1 1 1 3 1 1 ...
```

Figure 7.3.1

Experiments conducted on the prototype version enabled us to produce certain meaningful insights that can be obtained from a live system. Figure on the right is a scatter plot of the duration for which the vehicles entered and stayed in the parking lot. This information can be useful to create specific business plans

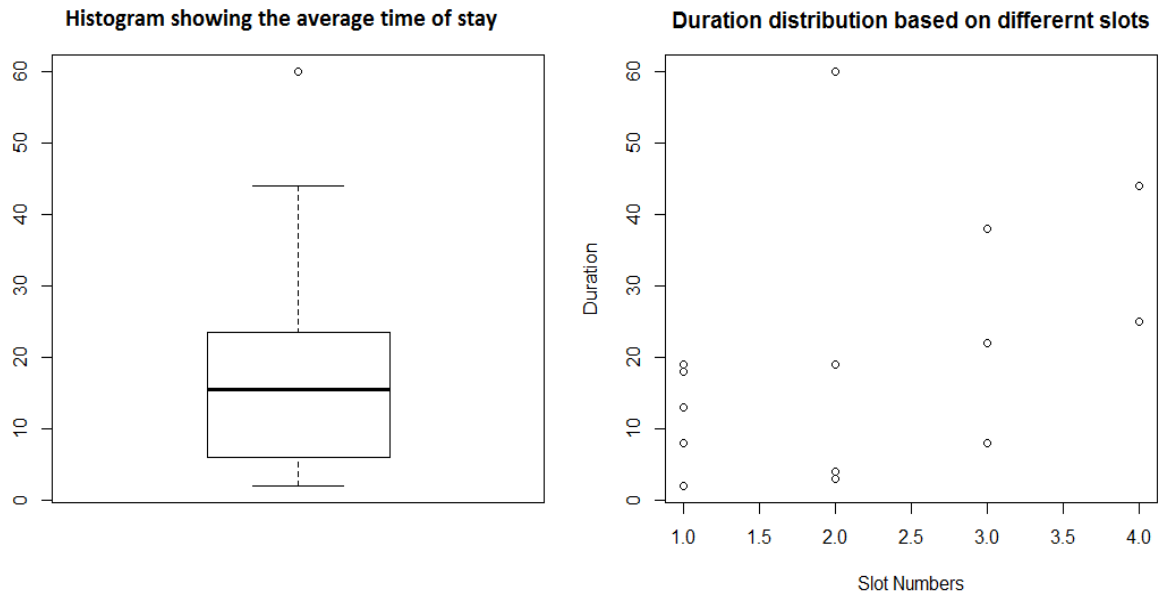


Figure 7.3.2

Figure on the left shows a histogram plot to in correspondence to the duration of stay of each vehicle. Further, the booking data of the user can enlighten with the peak hour information and the best and worst time of the day to visit a particular parking facility.

E-wallet facility using the application is also tested successfully using the prototype. The user has to have a minimum balance of 50 in order to make the booking. Also, payment calculation is done by the system and a bill is generated for the same.

Chapter 8: Conclusion

8.1 Limitations

The prototype developed by us is having a limited number of parking slots i.e. 4 parking slots. The implementation cost of our proposed system in a mall would be much higher. Sensors used in prototype are much cheaper compared to the sensors that will be deployed in the mall.

8.2 Conclusion

This project proposes a Vehicle Parking Automation system which facilitates the user to book a parking spot with the help of an application. It also searches for the nearest parking spot with the help of sensors and cloud computation. The online payment option eliminates the need for human intervention and making the system automated in real sense. Also the proposed system is very economical and easy to implement as it does not involve any expensive hardware or devices. The spot will be allocated according to the size of the vehicle. To sum up, the automated system of vehicle parking promises to be beneficial in all terms.

On a larger scale, this project has several benefits and will be of high significance in facilities where incoming and outgoing traffic is considerably high during all times of the day, airport for example.

Metropolitan cities are in high need of such a system which promises to be completely automated. This paper presents a solution to an ongoing crucial problem in our everyday lives related to manual vehicle parking. We tried to implement a system which clears out the issue by making the whole system automated. This system stands out to be completely feasible and makes the task of the user quite convenient. The functionalities such as E-Wallet is a unique element created for the vehicle owner's to make this system reliable and user friendly. Moreover, the environmental factors are also affected in a good way, saving fuel and avoiding pollution. The proposed system in highly flexible, thereby making it suitable for enhancements. Additional functionalities like number plate recognition at the entrance for authentication can be deployed easily with the help of a camera. This system can be shifted to a cloud based system for large number of vehicle owners using the application.

8.3 Future scope

The system prototype developed by us can be implemented in a facility on a large scale and maps and parking directions can be integrated in our android application.

The system prototype is a model version of a real project that can be developed in any parking lot with any size of parking slots.

The system can be introduced in smaller parking areas as well as on the streets where getting parking in a hustled up city like Mumbai is pretty difficult.

As of now, the proposed system proposes payment gateway using the user interface. A fully developed system can have a dynamic payment module that could charge according to the peak hours and peak days, data for which can be obtained from the system itself.

Also, to be able to make the system fully functional, an ios version of the software or a website providing similar features must be created.

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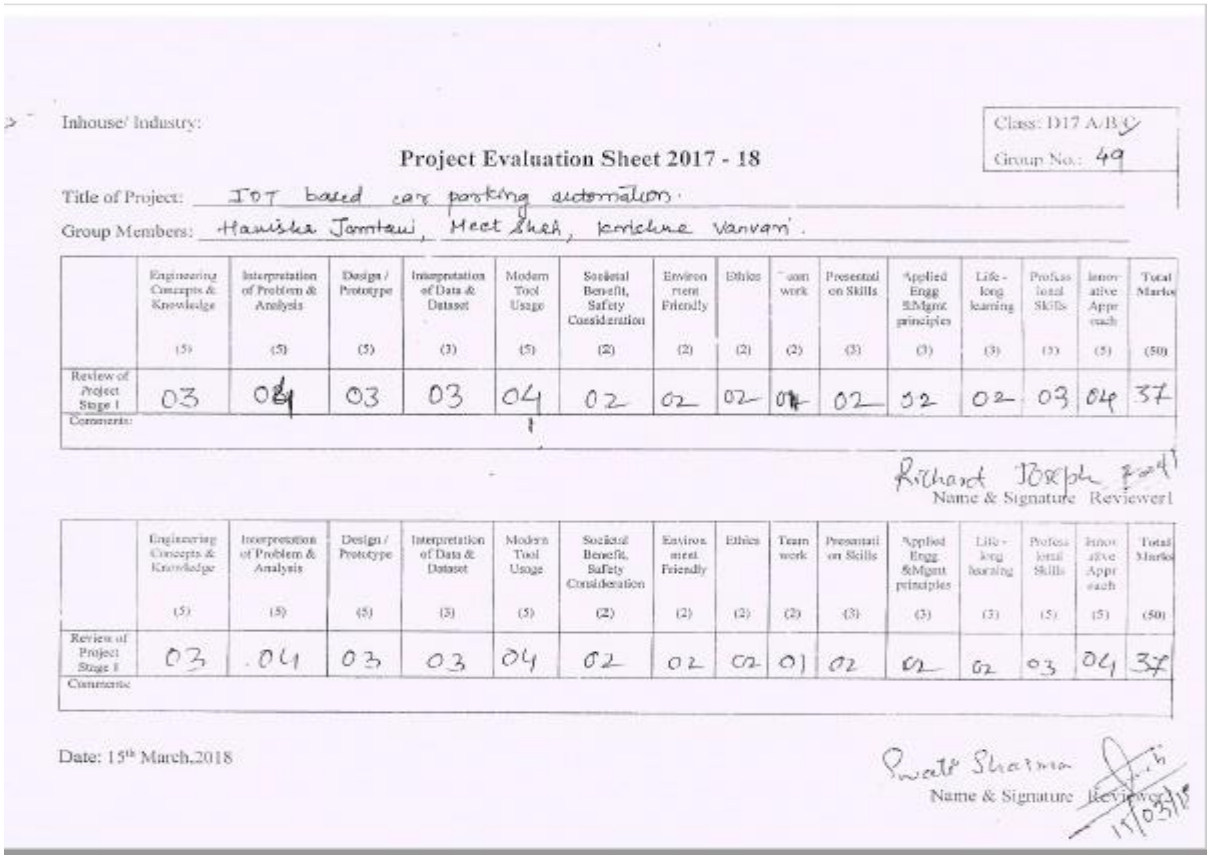
Project Evaluation Sheet 1 & 2



Inhouse/ Industry:

Class: D17 A/B

Group No.: 49

Project Evaluation Sheet 2017 - 18

Title of Project: IOT based car parking automation.

Group Members: Hanisha Jamtani, Meet Shah, Krishna Vanvani.

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	03	04	03	03	04	02	02	02	01	02	02	02	03	04	37
Comments:															

Richard Joseph

Name & Signature Reviewer1

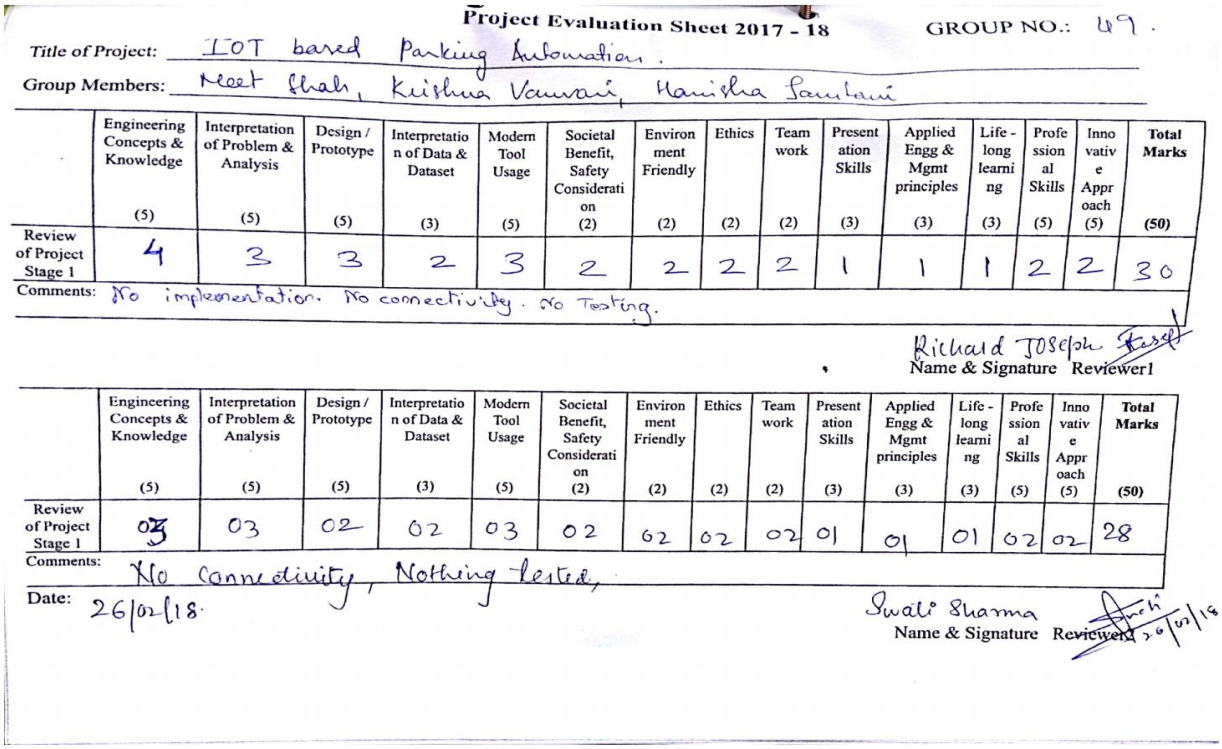
	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg &Mgmt principles (3)	Life - long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	03	04	03	03	04	02	02	02	01	02	02	02	03	04	37
Comments:															

Date: 15th March,2018

Swati Sharma

Name & Signature Reviewer2

15/03/18



Project Evaluation Sheet 2017 - 18 GROUP NO.: 49.

Title of Project: IOT based Parking Automation.

Group Members: Meet Shah, Krishna Vanvani, Hanisha Jamtani

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg & Mgmt principles (3)	Life - long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	4	3	3	2	3	2	2	2	2	1	1	1	2	2	30
Comments:	No implementation. No connectivity. No Testing.														

Richard Joseph

Name & Signature Reviewer1

	Engineering Concepts & Knowledge (5)	Interpretation of Problem & Analysis (5)	Design / Prototype (5)	Interpretation of Data & Dataset (3)	Modern Tool Usage (5)	Societal Benefit, Safety Consideration (2)	Environment Friendly (2)	Ethics (2)	Team work (2)	Presentation Skills (3)	Applied Engg & Mgmt principles (3)	Life - long learning (3)	Professional Skills (5)	Innovative Approach (5)	Total Marks (50)
Review of Project Stage 1	03	03	02	02	03	02	02	02	02	01	01	01	02	02	28
Comments:	No Connectivity, Nothing tested.														

Date: 26/02/18.

Swati Sharma

Name & Signature Reviewer2

26/02/18

Appendix

SR. NO.	CONTENTS
1	Paper I
2	Plagiarism Report (1.1)
3	Certificates
4	Paper II
5	Plagiarism Report (2.1)
6	Certificates

IOT based Parking Automation System

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***Abstract*-- Technology has enabled us to imagine beyond our working capacities and think of solutions that can replace the monotonous work with automated machines and systems. This research paper is aimed at making the parking system agile, robust and more convenient for people. Albeit, several parking solutions are available, this system integrates all problems into one single idea that can be permanently embedded as a solution. The system will incorporate different modules like parking availability calculation, proximity estimation and payment service. The system will also guide the vehicle owners to navigate through the parking lot. Moreover, an analysis will be conducted to examine the benefits of the current project and how it can be improved.**

Keywords--Android application, IoT, Cloud computing, Data Analytics, Image Processing

I. INTRODUCTION

IOT plays has a significant role when it comes to connecting environmental factors to the network from any remote loaction[1]. In today's highly traffic congested cities where there is a great need of parking spots, it becomes difficult to find one. People spend lot of time to find a proper parking where they can be assured about the safety of their cars. While going to any big facility like malls or supermarkets, it's an arduous task to search for parking especially during the weekends. To overcome this issue, we have come up with a solution that will enable the vehicle owners to get a spot with a single click.

Existing parking system faces simple issues considering the scenario in *"Fig 1"*, the user who is looking for a convenient parking spot or a car with a handicapped person has to search through the parking space until he gets a spot close enough to the entrance say "15" and ends up assuming the best spot he can get, however in the above situation a better spot was available at "46".

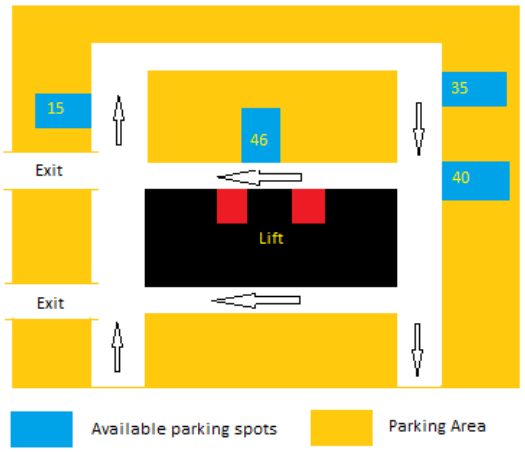

Fig. 1. Parking system overview

This system comprises of an android application which will provide an interface through which the users can completely handle their parking task from finding a parking spot to making payment. Additional feature of the system will be analysing different patterns of the users of the system. The parking data can give insights to the patterns of demand for the amenities in the mall specific to days and time of the day. Another study will be made on the benefits of time reduction and congestion at the entrance and inside the mall searching for parking.

The car owners can make bookings through the application and will be separately guided by the application to reach their spot of booking.
The entire system beats the conventional paper ticket and human interventions and makes the whole process automated. Also, the system enhances a secured payment method involving cashless transactions.

II. Literature Review

Various ideas have come up to alleviate the issues faced due to the existing parking system, though proven to be good solutions, most of them have failed to be efficient concerned with different parameters.

The author S. M. Bhadkumbhe et al. [1], introduced a technique which provided the client with an interactive Android based user interface for pre-booking of parking spot. This gave us insights to the android application functionalities and motivated us to focus on more features that can be implemented using the application

In [8] the authors proposed a collaborative path-finding technique to improve the efficiency of smart parking systems and therefore reduce traffic congestion in metropolitan environments. With the properties of heuristic values, shortest path is searched for in the A* algorithm. However there were limitations to the usage of A* while reserving parking spots due to uncertainty of the algorithm.

Thanah Nam Pham et al. in [6] developed an approach similar to a layered architecture to support cloud computing. The related research paper gave us some guidance about the usage of IOT based equipments.

A study in [10] suggested to implement a three layer mechanism consisting of sensors, communication mode and the application. The paper criticized about the image processing algorithms and suggested a sensor based solution.

J. Wolff et al. introduces the idea of using magnetic field sensors to calculate available parking spots and make the system automatic using that data. Experimental results suggests that the hardware cannot be explicitly reliable to obtain real time data.

Parking automation has been proposed by many authors, however every other system has certain shortcoming for real-life implementation. There are systems suggesting use of QR code to identify the car owners who have reserved parking spot [4]. This causes a similar delay that is present in the current system of affairs. Also image processing techniques have been suggested to sense the parking facility for vehicles, however, IP algorithms haven't proved reliable enough to accurately tell the parking lot state. There are road blocks in these existing systems due to limited scope of usefulness.

III. Requirement Gathering

TABLE I.

Facility	Parking Requirements	Parking Capacity	Levels	Staff Requirement
TCS Powai	150-200	300	2	8
R-Mall, Mulund (Weekends)	400-500	800	3	10-15
D-Mart Mulund W	100-150	80	1	5-6
Viviana, Thane (Weekends)	800-900	1000	1	20-25

A survey conducted by our team in local malls revealed a stringent requirement for a systematic approach to parking in these malls. From the above statistics, it can be seen that the system will have large benefits for managing parking for the facility owners as well as the users.

A. *Benefits to the Owner*

The staff requirements can be neglected after introducing the parking system. This will reduce costs for management and make parking a small revenue generating part of the facility.

B. Benefits to the Users

The user would not have to search for the parking slot as a contemporary need while visiting a mall which will save time and increase fuel efficiency of cars inside the parking lot. Payment through the application will eliminate the need for waiting in a long queue for payment.

IV. IoT Framework

IOT has facilitated the development of new technologies that can make use of cloud based distributed processing systems to create creative solutions to bring about automation. IOT technology grows in various fields of smart applications but we have not yet found boundary constraints of this technology [11]. Real time data logging will allow us to keep the parking lot data updated and send accurate information to the users of the system.
The Smart Parking System is designed by making use of some IOT supportable hardwares' such as raspberry pi, arduino boards[11]. There are various companies developing processing softwares for IOT, one amongst such is the "Arctik Cloud Service", developed by Samsung, that we're going to use in our project. Since we're talking about sensory data involving binary updates, the data upload rate required by the system will be minimal. However, in scenarios where the parking lot has a size larger than 1500 units, a robust cloud service will be required.

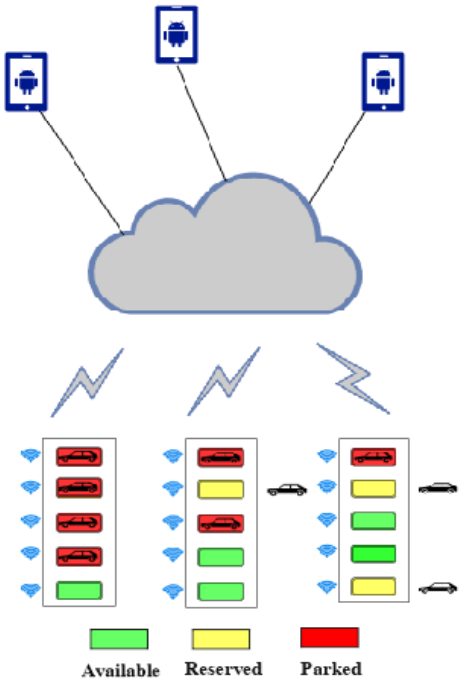

Fig. 2. Overview of proposed IOT Architecture

The Network used to make IOT must be reliable and secure for which we're going to make use of new "Raspberry Pi 3 Model B" circuits for processing and uploading data[11]. Raspberry pi is a small, credit card sized computer which is user friendly as it can be used by people of all ages to learn new languages from scratch. Object sensor like the IR sensor created by the Silicon Technolabs is specifically useful for detecting cars and sending data through arduino kits to cloud as can be seen from the *"Fig 2"*.

V. Proposed System

This research paper tells about the development of a mobile application which will provide a set of functionalities. The major feature of collection of parking lot data will be handled by the sensors connected to the cloud infrastructure which will form the core of the system. Cloud architecture must consist of dependable nodes for distributed processing to avoid failure of the system.
The prime functionalities of the proposed system are:

A. Custom Availability

User will be given availability details of the mall he's going to visit at one click after which he can book the parking. The availability will be sectorised on the basis of the size of the vehicle and the available number will be of that particular size

B. Proximity Calculator

Using Dijkstra's algorithm, we can compute the shortest path between two nodes, however, a separate algorithm will decide the starting and destination nodes to be considered. For this purpose, proximity functions in the system are created with two scenarios

1. User walks least distance in the parking lot.
2. User drives the least inside the parking lot.

These algorithms will be computed on cloud platform and will allocate the best parking spot for the user.

C. Payment Mechanism

The dynamic information is updated in the database mapped to the license plate number of the user which is stored along with the arrival and the departure time. Vehicle owner will then be charged for parking through the app when he wishes to leave and the payment will be processed through various mobile banking UPI available. Protocols will be set up to ensure that the system cannot be duped or cheated in any way. Moreover, the user will be notified with a pop-up or a normal text through the user interface regarding the various stages of his usage of this application.

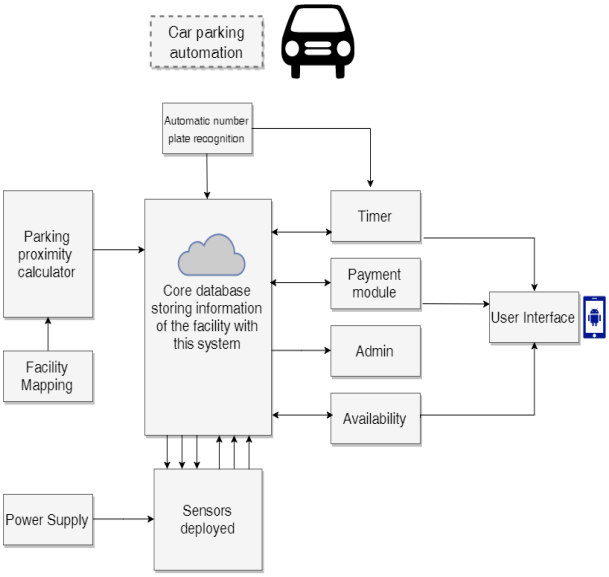

Fig. 3. System Design

VI. Methodology Used

The application aims to provide online payment to the user with the help of internet banking. Nevertheless, the application promises to be quite easy to understand so that the user finds a parking spot in a big facility with minimal efforts. This will be done with the help of navigation that will guide the user through the shortest route available.
As soon as the user browses the application, he/she will have to choose the type of vehicle. The spots will be divided according to the type. Following is the detailed explanation of the methodology:

1. The application and the Raspberry pi 3 module will be connected to the IoT serving server i.e. Artik Cloud Server by Samsung.

2. The user will first choose the type of vehicle they own, i.e a four wheeler or a two wheeler. According to the information provided, the spot will be searched. This will save a good amount of space in the parking area

3.The user then checks for the parking spot availability and also at the same time the application informs the user through a notification or pop-up if the user enters the parking premises in the peak hour of the day.

4.The vehicle owner will be given the closest spot by applying an algorithm internally. For this purpose, Dijkstra's algorithm will be implemented. It will find the spot by considering the least cost of the path in the map.

5. With the help of the Google Maps and the location of the user , the applications detect the location of the user and gives the information about the nearby parking spots and give directions to that spot after entering the parking premises .

6. IR Proximity Sensor for Obstacle Sensing of Silicon TechnoLabs will be used to gather information about the empty spots available. Every spot will have a sensor which will sense and update the application, telling whether the respective spot is free or no. Accordingly, a free spot depending on the type of vehicle will be allocated to the user.

7. The user looks for the free spot in the application and if the parking spot is free, the requested spot is reserved in the parking area and the user is provided with a parking spot number to validate the user at the time of parking in that respective spot.

8. After reserving the parking spot in a particular facility, the application updates the spot from Free to Reserved on Cloud immediately.

9. The status of the sensor will change when the parking spot is occupied by a vehicle. The following categorisation of status signals can be observed from the *"Fig 2"* : RED=Parked. YELLOW=Reserved. GREEN=Free.

10. At entrance of the facility, the license plate number of the vehicle will be obtained using image processing which will be used as a unique ID of the vehicle for payment purposes.

11. The information about the License plate number along with the arrival and departure times will be updated in the cloud. This will be used to keep a time check for further payment purposes.

12. After the recognition of the license plate, a timer gets ON, which will measures the total time the vehicle was parked and according to the that calculates the cost of the parking.

13. Once the vehicle is to move out of the parking spot, the timer gets OFF and displays the total cost and the user is given the payment options and updates the free spot information.

14. After the payment , again a timer of approximately 15 minutes will be set within which the user has to leave the premises. If he/she is not able to do so, a penalty will be charged. This is done to ensure that the new users entering the facility get a spot within no time.

VII. Conclusion

In this paper, we propose a Vehicle Parking Automation system which facilitates the user to book a parking spot with the help of an application. It also searches for the nearest parking spot with the help of sensors and cloud computation. The online payment option eliminates the need for human intervention and making the system automated in real sense. Also the proposed system is very economical and easy to implement as it does not involve any expensive hardware or devices. The spot will be allocated according to the size of the vehicle. To sum up, the automated system of vehicle parking promises to be beneficial in all terms.

On a larger scale, this project has several benefits and will be of high significance in facilities where incoming and outgoing traffic is considerably high during all times of the day, airport for example.

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Plagiarism Report Paper I

Plagiarism Scan Report

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Plagiarism Scan Report

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Plagiarism Scan Report

Summary	
Report Genrated Date	01 Nov, 2017
Plagiarism Status	100% Unique
Total Words	383
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Intelligent IOT based Car Parking Using an Android Application

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***Abstract*-- Parking system is a critical arena that requires a revolutionary change with the growth of technology that is needed to support this change. This paper presents the design and implementation of the prototype developed of the car parking automation system based on IOT, that provide robust searching and booking feature of a parking lot for a vehicle owner. The proposed system consists of IR sensors, embedded web-server, and a mobile application. Low cost sensor network is deployed on the prototype which represents a parking area. Initially, the existence of objects being sensed provides significant data for parking slot detection. Secondly, sensor quality has a material correlation with the performance by the sensors deployed. From this, we propose a) the development of a topological sensor detection system b) Traditional server rather than cloud system that allows local data processing c) Application based UI interaction with the users of the system.**

Keywords--Android application, IoT, Data Analytics, Web server

I. INTRODUCTION

In today's highly traffic congested cities, parking becomes a tedious task for the vehicle drivers consuming precious time and energy of the drivers. Eventually, it also results in fuel wastage and air pollution. According to recent reports and statistics, it is observed that traffic generated due to vehicles searching for parking spaces, takes upto 40% of the total traffic. Considering the situation, various efficient parking methodologies have been suggested. Few mechanisms used video camera sensors to gather information of the parking spaces[3],[14], although it's an expensive reform to execute along with certain drawbacks resulting from the transmission issues in wireless networks.Today, wireless sensors have emerged successfully due to its simple and low expense solutions[5],[6],[8].

Sensor network is an integration of tiny devices which have wireless connections. For our purpose, INFRARED sensors are used which usually are low cost, user friendly and have fast obstacle detection via infrared reflection.This wireless sensor network is useful to many fields including environmental supervision, security purposes, home and workplace surveillance, agricultural inspections, etc. As it observed that these sensors are used in many application, we used it for the detection of free parking slots.

The proposed system, runs on an android application which is developed to offer an interface to the user for reservation. The user can select the desired parking space and confirm the booking. The functionality of pre-booking a slot makes it quite easy and flexible for the user. Facilities like registration, login and online payment are embedded in the application to make it completely automated. At the backend, the user details are updated on the database. A web server is integrated to pass the user information to the database. Moreover, the entry and exit time of the vehicle driver is recorded for the purpose of payment. The amount to be paid is proportional to the total time the vehicle parked. Another functionality tells that the vehicle reservation will be cancelled automatically if it does not enter in the specified time period. To achieve this, a timer is set which goes on until the pre-defined time (e.g. 20 minutes) is reached. If the user fails to enter within the time, reservation will be withdrawn. The user will be notified with the same. Analytics will be conducted to figure out the patterns

which comprise of the peak hours and days for parking and suggesting a nearby place if the current premise is full.

The system promises to overcome the issues faced by the manual system by making it completely automated. The payment facility is made simpler by having an E-Wallet in the application, where the user can add and deduct money depending on the history. If the user does not have sufficient balance, a notification will be sent to add money for further transactions.

II. System Architecture

This section covers the detailed description including architecture and components used in the system. *"Fig 1"* below, illustrates the functionalities and connections with each other.

A. Sensors

The prototype has a collection of four IR sensors which are connected to the Arduino circuit. The responsibility of the sensor is to detect any kind of obstacle on the parking slot. Infrared radiations are used for vehicle detection. *"Fig 2"* shows the connection of the Infrared proximity sensors.

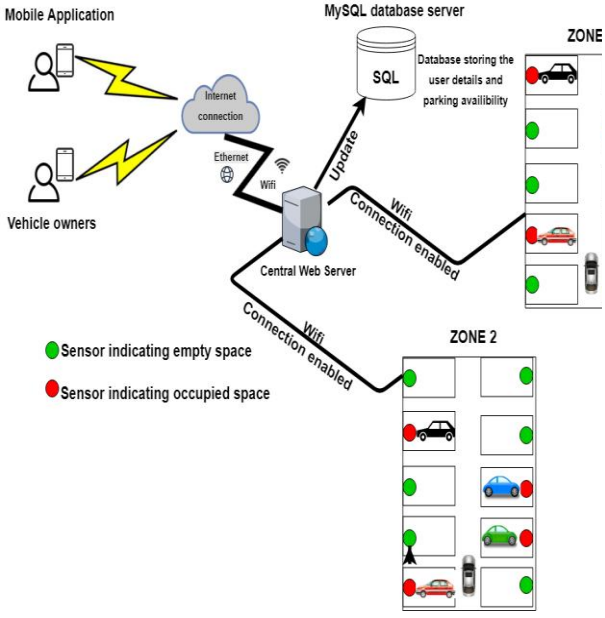

Fig.1. Overview of the proposed System Architecture

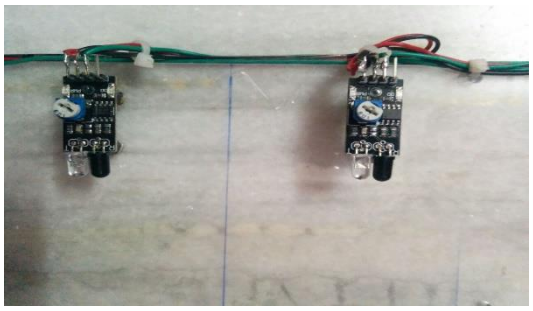

Fig. 2. IR Proximity Sensors

These sensors are easy to deploy due to its specifications like 4.5 to 6 operating voltage, can give both, analog and digital output and having a small dimension of 0.6" x 1.3" x 0.5" inch (15.25 mm x 33mm x 12.7 mm).

B. Arduino circuit

Arduino UNO is a microcontroller-based on the datasheet ATmega328. It has 14 digital input and output pins, out of which 6 can be used as PWM outputs, 6 analog inputs, a USB connection, a 16 MHz ceramic resonator, an ICSP header, a power jack and a reset button. *"Fig 3"* shows the image of the Arduino UNO circuit deployed in our system.

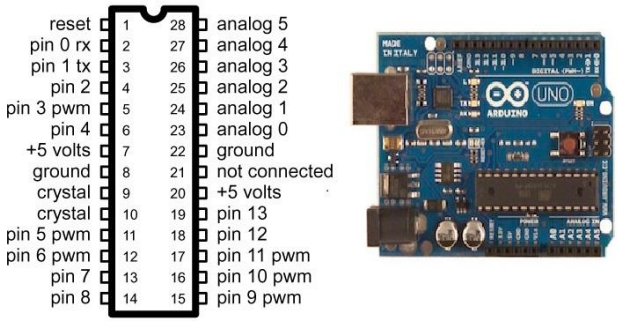

Fig.3. Arduino UNO pin configuration

We used Arduino UNO circuit in our prototype . Arduino is a well-known microcontroller to gather large amount of information and pass it to the web servers or cloud. Arduino gathers the parking slot availability status from the IR sensors and sends it to the web server which eventually updates the database.

C. Web Server

The web server is the backbone of the whole system. It consists of all the data related to the user including the dynamic entry and exit time. The information received from the sensors is accessed in the database through the server. The parking status which is

reserved, cancelled or available is updated in the database in real time. Nevertheless, it has a large capacity to accommodate a number of users.

D. Mobile Application

A mobile application stands as a interface between the user and our system enabling the user to perform booking operation in a parking lot. The user can simply book, cancel and make payments with the help of it. A wifi connection or 3G/4G network is needed for the application to work. Currently, an android application is developed which can be deployed for IOS as well in the future. *"Fig 4"* below, are few screenshots of the application named "CAR PARKING".

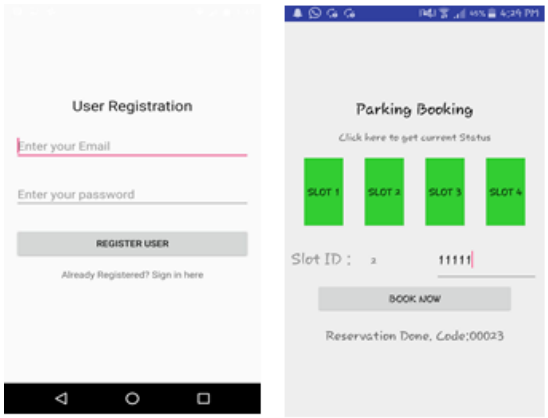

Fig.4. Android Application Screens

III. System Workflow

This section rightly explains the steps we carried out for the implementation of the prototype, having a parking lot connected to a working application. This prototype stands as an exclusive proof for the system in the real-time environment.

1. An android application is downloaded by the user for the reservation purpose. We have developed the application on Android Studio Development Kit, which enables parking availability check, reservation, and cancellation to the registered user. The user maintains a profile within the application which stores the user history.
2. The IR proximity sensors detect the availability of the slots and update the database which eventually notifies the application.
3. Arduino UNO is a computer in itself which sends the data detected from the sensors to the database through an HTTP server.The Arduino code has been developed on Arduino Create Agent.
4. The prototype has a display connected to Arduino which gives live availability status. *"Fig 5"* conveys that the parking slot 1 is full and 0 signifies that slot 2,3,4 are empty.

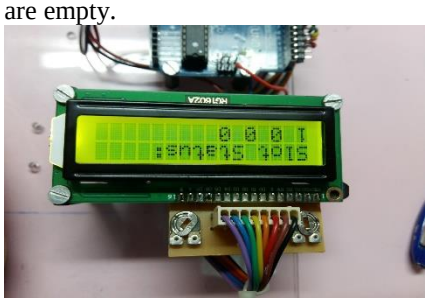

Fig.5. Android Application Screens

5. All the gathered data from the Arduino and the sensors are passed onto the database server. Microsoft SQL server .NET Framework is used at the backend to store the user information along with the slot availability including entry and exit time of the car.
6. After the user selects a slot for parking, he/she needs to reach the premises within a predefined time. The functionality of timer is also added which is used for the cancellation purpose.
7. The car owner is also provided with a unique code which is used for authentication.
8. The amount to be paid is calculated on the basis of the total time the car stayed in the premises.
9. E-Wallet is used for the purpose of payment wherein the user maintains a certain amount of balance which gets deducted in every visit.
10. When there is no sufficient balance in the account, the user is notified to add electronic money into the wallet. This functionality proves to be easy and quick to the car owners.
11. If all the parking slots are full then a nearby parking area is suggested to the user. This feature saves ample amount of time of the user as it avoids the efforts taken to search a slot in a fully reserved area.
12. Moreover, analytics is carried out, to find the peak hours and days which can be further used for informing the application user about the same.
13. *"Fig 6"* illustrates the flow of the modules.

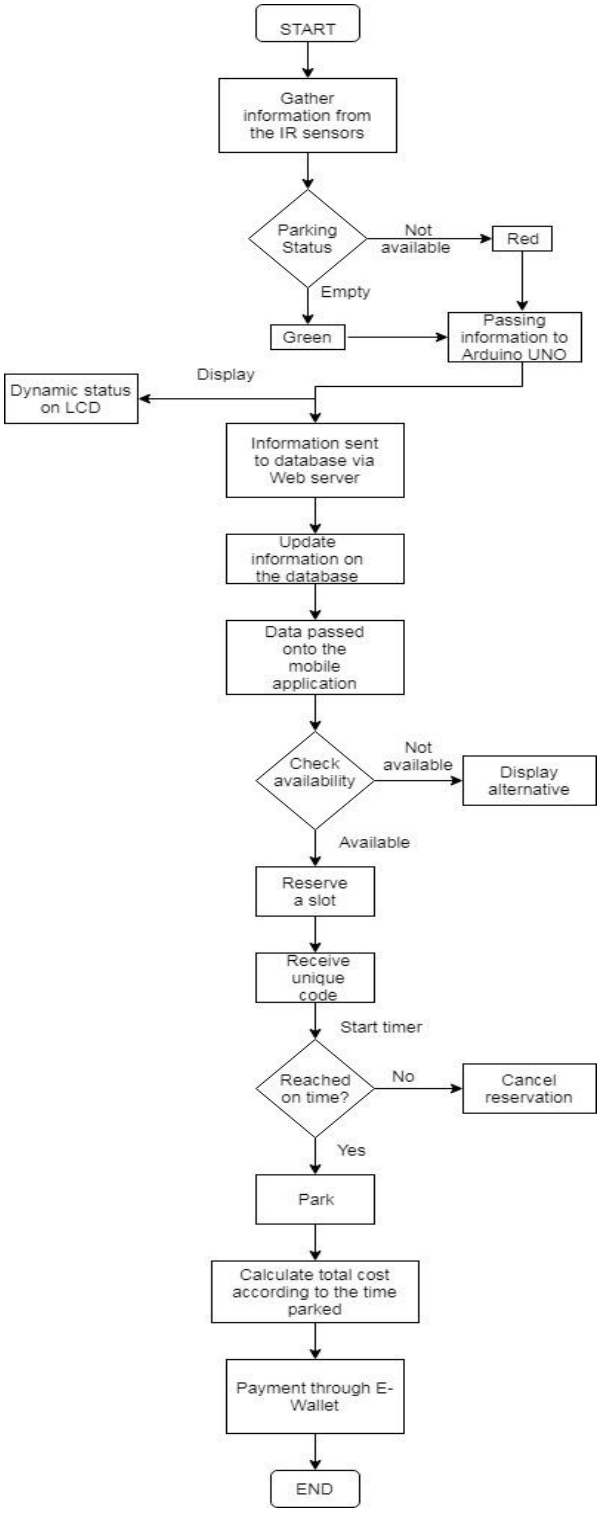

Fig.6. System Flowchart

IV. RESULTS

Experiments conducted on the prototype version enabled us to produce certain meaningful insights that can be obtained from a live system. Figure on the right is a scatter plot of the duration for which the vehicles entered and stayed in the parking lot. This information can be useful to create specific business plans.

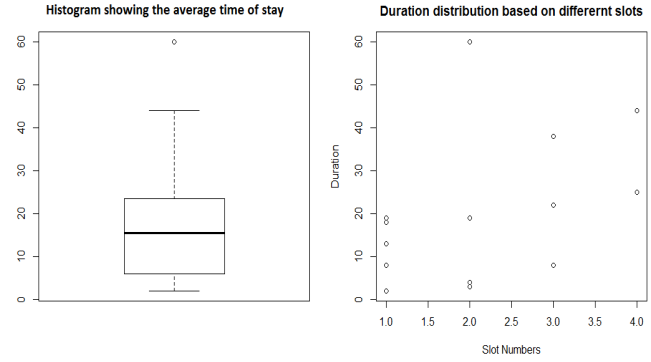

Fig.7. Duration distribution plot

Figure on the left shows a histogram plot to in correspondence to the duration of stay of each vehicle.

Furthermore, the booking data of the user can enlighten the peak hour information and the best and worst time of the day to visit a particular parking facility.

E-wallet facility using the application is also tested successfully using the prototype. The user has to have a minimum balance of 50 in order to make the booking. Also, payment calculation is done by the system and a bill is generated for the same.

V. CONCLUSION

Metropolitan cities are in high need of such a system which promises to be completely automated. This paper presents a solution to an ongoing crucial problem in our everyday lives related to manual vehicle parking. We tried to implement a system which clears out the issue by making the whole system automated. This system stands out to be completely feasible and makes the task of the user quite convenient. The functionalities such as E-Wallet is a unique element created for the vehicle owner's to make this system reliable and user friendly. Moreover, the environmental factors are also affected in a good way, saving fuel and avoiding pollution. The proposed system in highly flexible, thereby making it suitable for enhancements. Additional functionalities like number plate recognition at the entrance for authentication can be deployed easily with the help of a camera. This system can be shifted to a cloud based system for large number of vehicle owners using the application.

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Plagiarism Scan Report

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