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Chandkheda, Ahmedabad



Affiliated

C. K. Pithawala College of Engineering and Technology, Surat

A Report On:-

SMART PARKING MANAGEMENT SYSTEM

Under subject of

DESIGN ENGINEERING – II B(2160001)

B. E. III, Semester – VI

(Computer Engineering)

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Abstract

In the recent, the concept of smart city has gained appreciation. One of the important considerations of being a smart city is the Smart Parking facility. Finding a particular space to park our vehicle becomes an annoying issue. Besides, number of vehicles in like manner rapidly grows once every day. It has been seen that the drivers struggle to find a halting extent without thinking about where parking space is open. The request for the parking space prompts to develop the traffic congestion and excess consumption of fuel. To create a optimize solution for the crisis, many technologies evolved but it didn't benefit all varying with expense, efficiency, power, accuracy and other factors. In this review, we created a prototype of a novel smart parking framework for an urban domain in light of reservation utilizing Internet of Things (IoT) by using Arduino Uno. Initially, our research gives a brief overview of the concept of smart parking system and the need for IoT devices to be integrated with cloud. By highlighting the key features of our work we have then described the convenience and benefits. Towards the end of the paper, we prove with artifacts that the prototype based on smart parking system using IoT finds a solution to the traffic congestion and ease the way to get a parking slot.

- **Keywords:** Smart Parking; Internet of Things (IoT); ESP8266 NODE MCU.

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1. Introduction

1.1 What is Design Thinking?

- Internet of Things (IOT) is used to communicate with the devices. By using this devices could be controlled or monitored through the internet, IOT acts as a platform to store data from the remote locations. IOT consists of web enabled devices that collect the data from the surrounding environments using processors, sensors and other communication devices. The device could be monitored and tracked using computers connected through internet.
- There are different types of car parking system available to reduce the time and the traffic congestion. The types used in day to day life are by using cameras, parking space is detected and the camera is fixed at the parking area pillars then another method is by using laser beams it detects the corner and target parking position. Then another method is by using Light Detection and Ranging sensors.
- With the latest proliferation of the vehicle availability finding the parking place availability is more difficult. Car parking is a main problem because of increasing in the vehicle number. Searching of a parking place around the cities is the routine work.
- In the smart parking system the parking space information is available at the real time. It consists of real time data collection, low cost sensors and mobile phone enabled systems.
- The proposed smart parking system is implemented using mobile application and the system helps the user to know the parking space availability.
- The user can be able to interact with the system by installing car parking application on their mobile phones.
- In this Ultrasonic sensor is used in every parking slot. The basic principle of Ultrasonic sensor is emit short, high-frequency sound pulses at regular intervals. If they strike an object, then they are reflected back as echo signals to the **sensor**, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo and IR sensor to entrance and exit gates. The basic Principle of Infrared Sensors is there waves emitted by the transducer is reflected back from the object and received by the transducer. So that by using this sensor the user can be able to understand whether the parking lot is occupied or not.

- The Ultrasonic sensor is connected with the ESP8266 Node MCU board. The obtained details are send to the server.

1.2 Project importance

The importance of smart parking is:

1. Accurately sense and predict spot/vehicle occupancy in real-time.
2. Guides residents and visitors to available parking spot.
3. Optimize Parking Space Usage.
4. Simplifies the parking experience and adds value for parking stakeholders, such as merchants and drivers.
5. Helps the free flow of traffic in the city leveraging IoT technology.
6. Enables intelligent decisions using data, including real– time status applications and historical analytics reports.
7. Smart Parking plays an important role in creating better urban environment by reducing the emission of CO2 and other pollutants.
8. Smart Parking enables better and real time monitoring and managing of available parking space which results in significant revenue generation.
9. Provides tools to optimize workforce management.

2. Canvases

2.1 AEIOU Summary framework

AEIOU is an investigative tool to help interpret observations gathered by ethnographic practices in the field. It is an Observation tool. Its two primary functions are to code data, and to develop building blocks of models that will ultimately address the objectives and issues of a client.

1) ACTIVITIES :

General Impressions :

In this activity section , we will take a look on the activities performed by us to develop the project. activities done like:

Element Features :

- Sensors Selection
- Chip Selection
- Building user device
- Centralized server management
- Display device management
- Programming Language selection for project SET-UP

2) ENVIRONMENT :

General Impressions :

In this we discuss that in which environmental conditions our users are and usage of our product and implementation of our product to be done. The environment like:

Element Features :

- Noise Pollution
- Traffic
- Noisy Atmosphere
- Air Pollution
- Hotels / Shopping / Malls / Airport / Cinemas Places

3) INTERACTION :

General impressions :

Interaction generally means a conversation or exchange of any information between individuals. Here we have to summaries the interactions which our users have during performance of activity. In our case interaction of users with each other shown below:

Elements Features :

- Engineer ~ Engineer
- Engineer ~ Technicians
- Engineer ~ Manager / Administrator
- Engineer ~ Employees / Workers
- Project Owners ~ Engineer
- Technicians ~ Workers
- Engineer ~ Employees Different Department

4) OBJECT :

General Impressions :

This section includes the objects which users use during their activities or during some work. In our case we spotted many objects like:

Elements Features :

- Centralized Server
- ESP8266 NODE MCU
- Jumper Wires
- Web server
- Sensors [IR & Ultrasonic]
- Display Devices [LED / COMPUTERS]

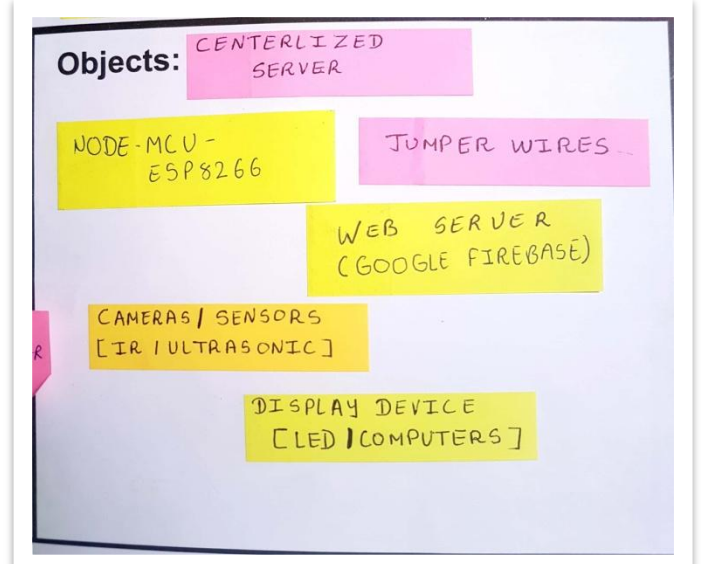
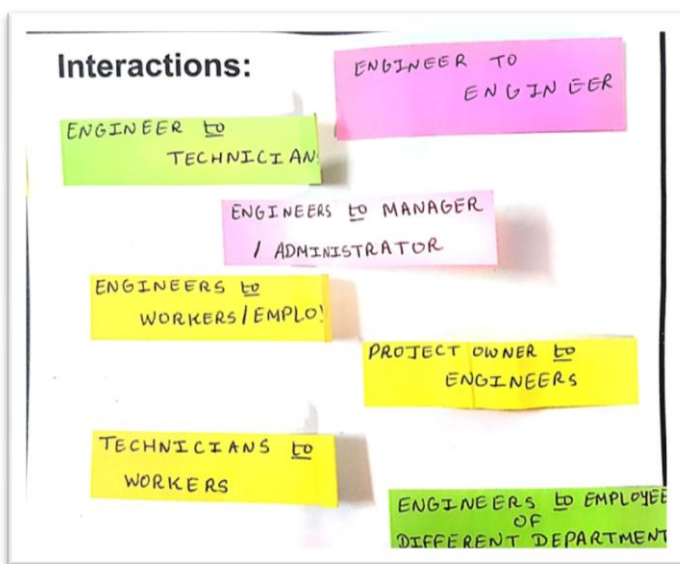
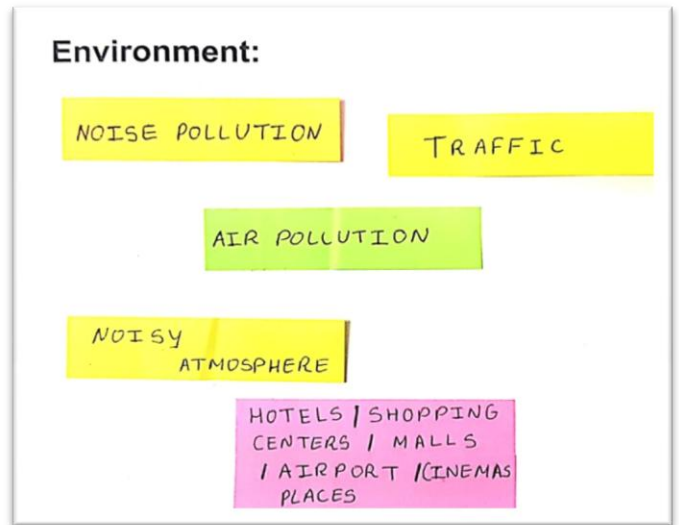
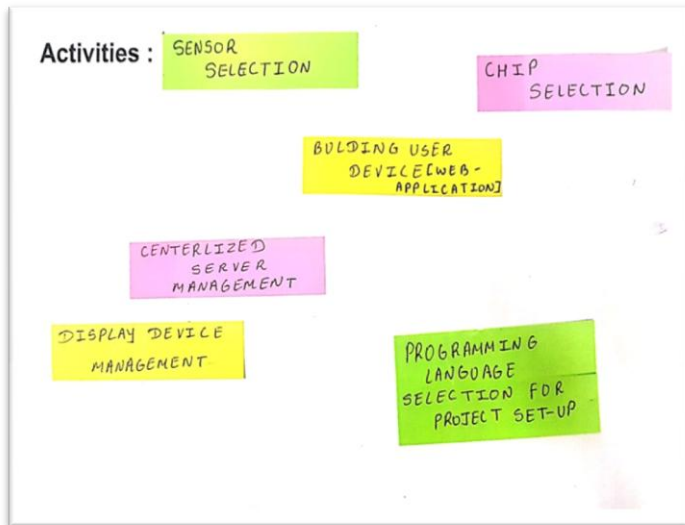
5) USERS :**General Impressions :**

This section includes the people who are using objects in order to perform their activities. They are called users. users like:

Element features :

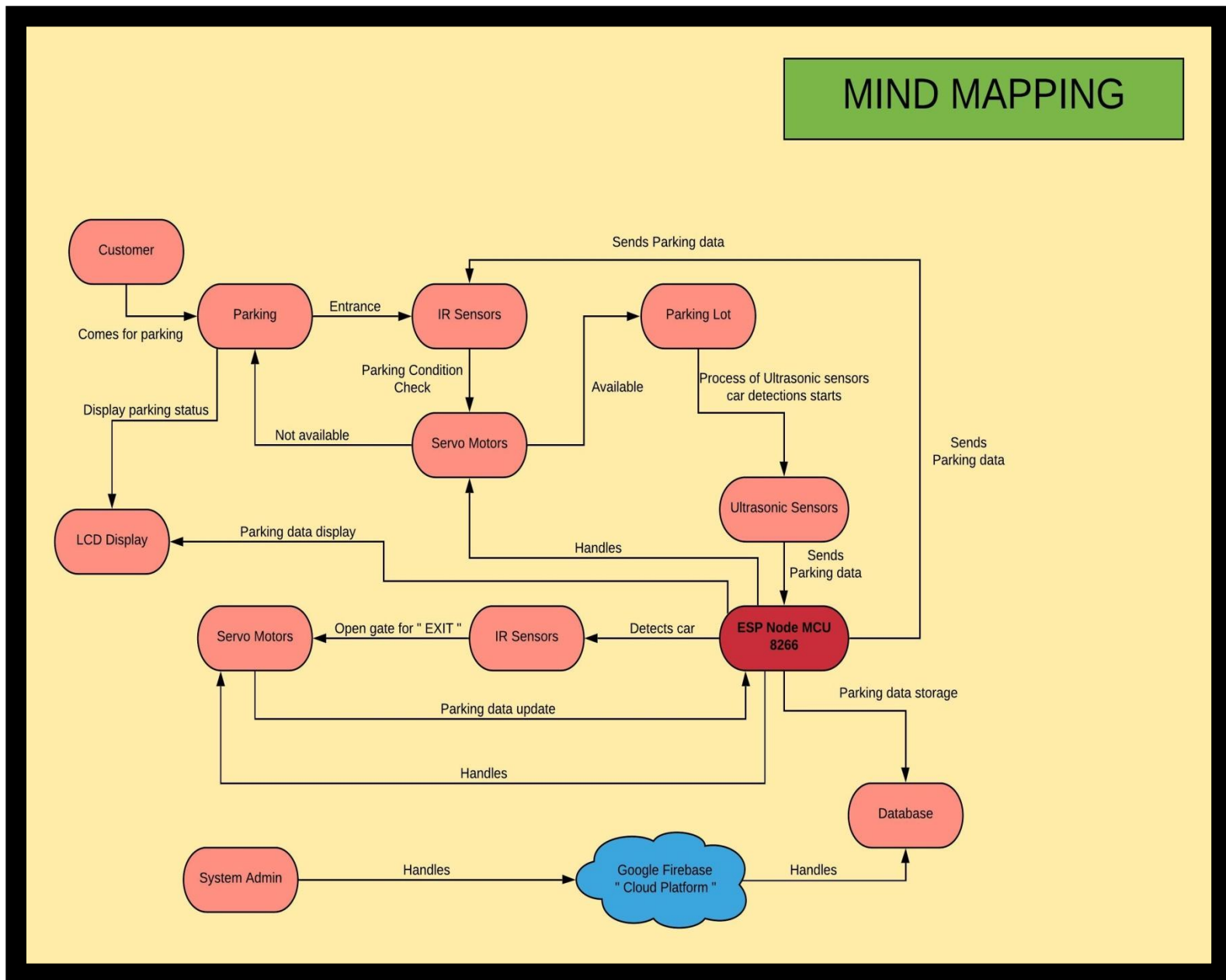
- Manager / Administrator
- Drivers / Customers [Peoples]
- Project Owners
- Technicians
- Workers / Security Guards
- Security Department
- Customer Dealing Department
- Billing Department

AEIOU Summary framework



2.2 Mind Mapping (Data analysis)

Mind mapping refers to a technique that designers and engineers use to express and generate ideas. All that mind mapping really is, however, is a way to get all of the ideas in your head down onto paper. There is no right or wrong way to mind map. It is simply a visual representation of the thoughts in your head, and it often looks like organized chaos.



2.3 Empathy Mapping Canvas

An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers. Much like a user persona, an empathy map can represent a group of users, such as a customer segment.

1) USER:

- Manager / Administrator
- Drivers / Customers [Peoples]
- Technicians
- Security Department
- Customer Dealing Department
- Billing Department

It includes the person who develop our product and use it. They are the main domain area and people of interest whom we are targeting.

2) STAKEHOLDERS:

This term basically means a person with an interest or concern in something especially in business, this was the definition according to business. But here stockholders can be defined as a person who takes care of the users or guide the users

- Drivers / Customers [Peoples]
- Manager / Administrator
- Technicians
- Project Owners
- Engineers

3) ACTIVITIES:

Activities centered design is an approach to interaction design, which does not focus on the goals and preferences of the users but on the activity a user would perform with the given piece of the technology . Activities can be defined as action taken by the user to achieve a goal.

- Sensors Selection
- Chip Selection
- Building user device
- Centralized server management
- Display device management
- Programming Language selection for project SET-UP

4) STORY BORDING:

➤ HAPPY:

1. Jay is going for movie and running late so when he enter the smart parking he saw empty parking space on the screen and was easily able to parked his vehicle without any vexation.
2. Vir is going for shopping and he parked his vehicle in smart parking due to which his time was saved and was able to go for shopping quickly.

➤ **SAD:**

1. One day Bony is going for some shopping and unable to find free parking spot so in hurry he parked his vehicle on road due to which his car got towed by traffic police for creating traffic by blocking road and parking inappropriately.
2. when there is no parking space available the traffic gets generated and everyone gets stuck in traffic so that causes them delay in work.

Empathy Mapping Canvas

Empathy Mapping Canvas

Design for

SMART PARKING MANAGEMENT SYSTEM

Date

29/9/2019

Design by

Version

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USER

ADMINISTRATOR/ MANAGER

TECHNICIANS

CUSTOMER SERVICE DEPARTMENT

SECURITY GUARDS & WORKERS

BILING DEPARTMENT

STAKEHOLDERS

DRIVERS/CUSTOMERS [People]

ENGINEERS

ADMINISTRATOR/ MANAGER

TECHNICIANS

PROTECT OWNERS

ACTIVITIES

SENSOR SELECTION

CHIP SELECTION

PROGRAMMING LANGUAGE SELECTION FOR PROTECT SET-UP

BUILDING USAGE DEVICE

DISPLAY DEVICE MANAGEMENT

CENTERLIZED SERVER MANAGEMENT

STORY BOARDING

HAPPY

Tony is going for movie is running late so while entering he saw the empty space on the screen & he easily parked his vehicle without any variation

HAPPY

His is going for shopping & parked his vehicle in our smart parking due to which his time was saved & able to go for shopping quickly

SAD

One day Tony is going for some shopping & he want to park his car happily but parking space is not available at that area so Tony park his vehicle on the footpath & Police towing vehicles tow his vehicle & fine to him.

SAD

When there is no parking space available in any area then the traffic was jammed & everybody stuck in traffic.

2.4 Ideation Canvas section in section

Ideation means creating innovating ideas. Hence this canvas represents the development of ideas and solutions for the problem identified. It also specifies where the idea will be useful.

1) PEOPLE:

As in the Empathy Mapping We found many users so now we have to limit the users and select limited people only for our product. So we developed this project for Peoples/users like

- Manager / Administrator
- Project Owners
- Technicians
- Workers / Security Guards
- Security Department
- Customer Dealing Department
- Billing Department

2) ACTIVITIES:

Activities are almost same as that of the empathy mapping canvas difference is that Now only main activities are targeted. So now we are restricting everything and lead towards activities like

- Sensors Selection
- Chip Selection
- Building user device[web application]
- Centralized server management
- Display device management

- Programming Language selection for project SET-UP

3) SITUATION/CONTEXT/LOCATION:

Situation means in what condition our product can be used. context means in reference to what while location means the place where our product is going to be used.

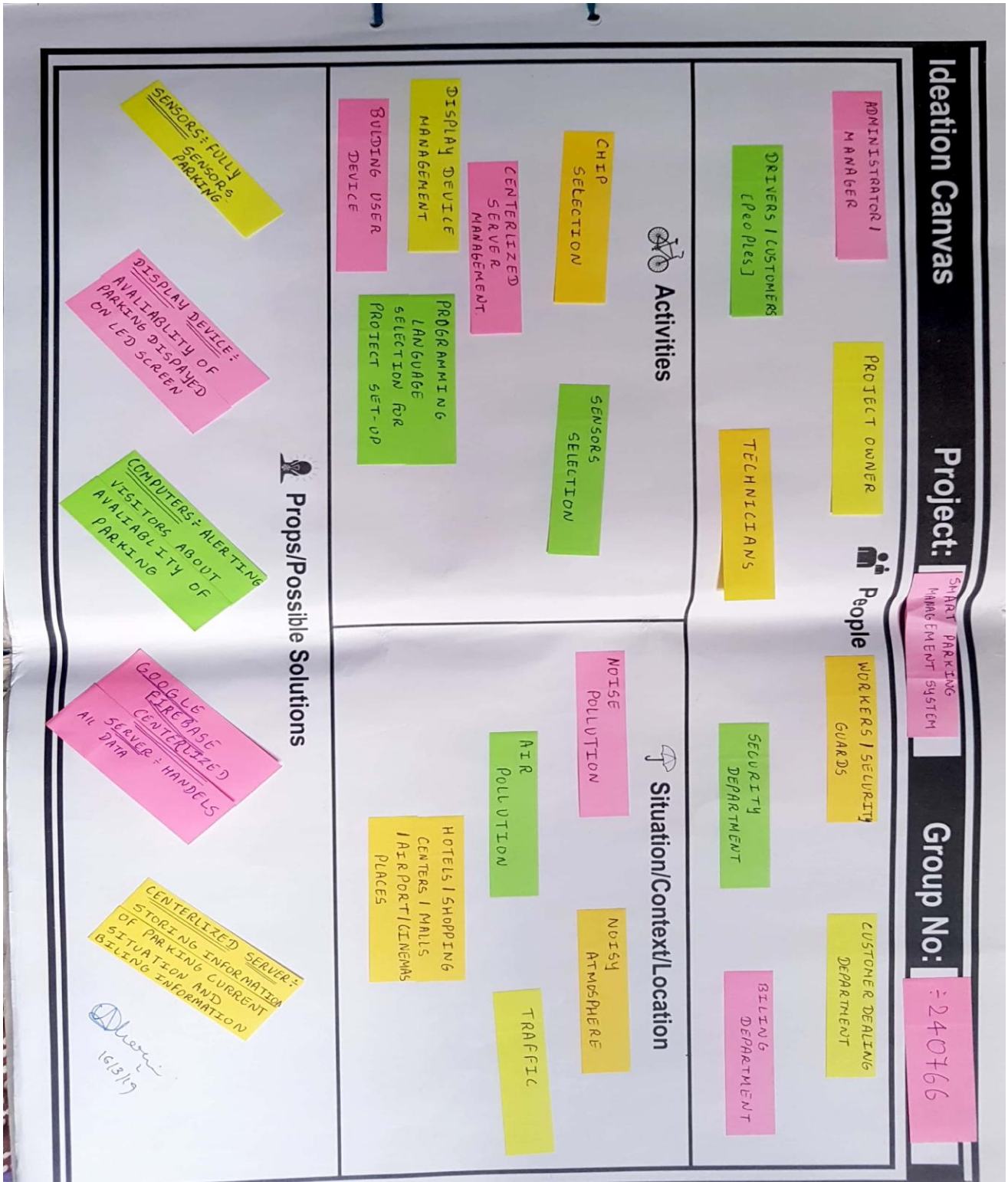
- Noise Pollution
- Air pollution
- Traffic
- Noisy Atmosphere
- Hotels / Shopping / Malls / Airport / Cinemas Places

4) PROPS:

The solution of the ideation canvas helps in

- Sensors: Fully sensors based parking
- Display Device: Shows Availability of parking slots on LED
- Computers: Alerts visitors for availability of parking space or not
- Google Firebase Cloud Platform : Handles all parking data and database.
- Centralized Server: Storing parking current situation and billing information

Ideation Canvas section



2.5 Product Development Canvas

In this section we are supposed to work on our concept in little detail.
In 'purpose', we mentioned the purpose of developing this application.

1) PURPOSE:

We have made SMART PARKING FOR METROPOLITAIN CITIES by considering purpose and that is given below:

"SMART PARKING" is fully based on sensors device that helps visitors to gives direction towards the free parking slots and alerts also for availability of parking or not on computer so visitors time not get wasted in finding free lots in full parking and decrease waiting in parking queues.

2) PRODUCT EXPENSE:

MATERIALS	COST	LINKS
ESP8266 NODE MCU CHIP	450 Rs	https://www.amazon.in/Generic-NodeMcu-Esp8266-Internet-Development/dp/B07262H53W/ref=sr_1_1?crid=1GN6W6SEJ5GGN&dchil d=1&keywords=esp8266+nodemcu&qid=1589650690&s=electronics&spref ix=esp8266+Node%2CElectronics%2C261&sr=1-1
IR SENSORS (X3)	150 Rs	https://www.amazon.in/gp/product/B07N4MSC2Q/ref=ppx_yo_dt_b_asin_i mage_o02_s00?ie=UTF8&psc=1
SERVO MOTORS (X2)	150 Rs	https://www.amazon.in/gp/product/B00MTFFAE0/ref=ppx_yo_dt_b_asin_i mage_o05_s00?ie=UTF8&psc=1
JUMPER WIRES [All Types]	151 Rs	https://www.amazon.in/gp/product/B0711JDRPV/ref=ppx_yo_dt_b_asin_im age_o07_s00?ie=UTF8&psc=1
16x2 I2c LCD DISPLAY	330 Rs	https://www.amazon.in/Generic-Character-Display-Module- light/dp/B01M8PGLPD
BREAD BOARD	90 Rs	GANDHI ELETRONICS, SURAT
LED LIGHTS	20 Rs	GANDHI ELETRONICS, SURAT
RESISTOR	10Rs	GANDHI ELETRONICS, SURAT
UTRASONIC SENSORS	150 Rs	https://www.rhydolabz.com/sensors-distance-sensors-c-137_144/ultra- sonic-sensor-module-hcsr04-p- 2516.html?gclid=CjwKCAjwh472BRAGEiwAvHVfGvDhN6mtuQZU_cY6KTFBM

Approx cost of our basic prototype is 1450 RS, If more Ultrasonic Sensors/IR Sensors/Led Lights/Jumper wires are bought than cost will be increase

3) PRODUCT FUNCTION:

The main function of our project is as follows

- 1.Gives direction towards free parking spots.
- 2.Alerts on full parking
- 3.check availability for parking space.
- 4.Recieves Signal when parking i full

4) PRODUCT FEATURES:

Features means apart from the function what it extra features. So our product has additional features such as:

- Its environmental friendly nothing will be harmed to environment by our project.
- Minimum electricity usage
- It is small in size.
- Easy maintenance.

5) COMPONENTS:

- Centralized Server
- 16x2 I2c LCD DISPLAY
- ESP8266 NODE MCU
- LED Lights
- Display Devices [LED & COMPUTERS]

- Sensors [IR & Ultrasonic]
- Jumper Wires

6) CUSTOMER REVALIDATION:

- Quick Parking
- Quick Easy Payment
- Queue & Waiting problem will be solved

7) Reject, Redesign, Retain

- **Project Redesign :-** By implementation of wireless sensors for long term
- **Project Redesign :-** Building Replica of centralized server in case of any problem
- **Project Redesign :-** Replacing Arduino UNO with ESP8266 NODE MCU as it has in built Wifi Module and also cost effective compare to ARDUINO UNO and Wifi Module together

Product Development Canvas

Product Development Canvas		Group No: 240766
② Purpose TO DECREASE WAITING IN PARKING QUEUE MAKING PARKING SMART BY MAKING FULL OF SENSORS PARKING & HELP TO FIND FREE SLOTS ALERTING VISITORS ABOUT AVAILABILITY OF PARKING ON COMPUTERS	Product Expense 1. NODE-MCU-ESP8266-240₹ 2. SERVO MOTORS - 160₹ 3. JUMPER WIRES (X3) - 150₹ 4. IR SENSORS (X3) - 150₹ 5. LED LIGHTS (X10) - 20₹ 6. BREADBOARD - 90₹ 7. MINI BREADBOARD - 100₹ TOTAL PRODUCT EXPENSE ₹ 1300 4. JUMPER WIRES / IR SENSORS / LED LIGHT BOUGHT MORE FOR MORE PARKING LOTS COST MAY VARY	
People ADMINISTRATOR / MANAGER DRIVERS / CUSTOMERS (PEOPLES) PROJECT OWNER WORKERS / SECURITY GUARDS CUSTOMER DEALING DEPARTMENT TECHNICIANS BILLING DEPARTMENT	Product Function GIVES DIRECTION TO FREE PARKING SLOTS ALERTS ON FULL PARKING RECEIVES SIGNALS WHEN PARKING IS FULL	Customer Revalidation QUICK PARKING QUICK EASY PAYMENT QUEUE & WAITING PROBLEM WILL BE SOLVED
Product Features EASY MAINTAINANCE ECO-FRIENDLY SMALL IN SIZE MINIMUM ELECTRICITY USAGE		
Components CENTRALIZED SERVER NODE MCU-ESP8266 JUMPER WIRES DISPLAY DEVICE (LED COMPUTERS) CAMERA / SENSORS (IR / ULTRASONIC)		
Reject, Redesign, Retain PROTECT REDESIGN? BY IMPLEMENTATION OF WIRELESS SENSORS FOR LONG TERM PROTECT REDESIGN? BUILD IN REPLICATION OF CENTRALIZED SERVER IN CASE OF ANY PROBLEM PROTECT REDESIGN? REPAIRMENT OF HARDWARE WITH NODE MCU-ESP8266 FOR MINOR WIRE MODULE		

2.6 Learning Needs Matrix(LNM)

There are in total 4 quadrants as a part of learning needs Matrix(LMN). Currently our group has made LMN of the 4th semester DE – 2B (Stage 1)

Purpose / Product Concept

Making parking full of sensors to find free available slots and alerting visitors about availability of parking on computers and to decrease waiting by quick billing through RFID

Quadrant 1 : Theories/ Methods/ Application process involved / Mathematical Requirement

Stage 1:

- In this we had discussed the basic aim or purpose of our topic Smart parking system which implemented on basis of **IOT BASED APPLICATION**

Stage 2:

- We had basic knowledge of IR SENSORS
- We had basic knowledge of Arduino Uno chip
- We had basic knowledge of Ultrasonic SENSORS
- We had basic knowledge of ESP8266 NODE MCU.

Quadrant 2 : Applicable Standards and design specifications / principles and experiments

This include application standards and design specifications of our Smart parking system by :-

Stage 1:

- 1. ARDUINO UNO:-** On which project implemented.
- 2.Centerlized Server:-**To store each activity of parking and payment.

Stage 2:

- 1.Control Circuit design.**

2.Cloud Platform:- Used for storing data to database and handles parking lot data

Quadrant 3 : Software / Tools /Simulation Methods / Skills :

It includes the software reference and language which will be used for the application like:-

Stage 1:

- 1. Arduino Uno “C” Language**
- 2. Basic DATABASE Management**

Stage 2:

- 1. Overall Stimulation**
- 2. Learn basics of Arduino Uno “C” Language**
- 3. Learn basics of ESP8266 NODE MCU “C” Language**

Quadrant 4 :

Component materials and Strength criteria (exploration – varieties / testing requirements) are:-

Stage 1:

- 1. Display Devices[LED / COMPUTERS]**
- 2. IR Sensors**
- 3. Jumper Wires**

Stage 2:

- 1. Testing of Control Circuit**
- 2. Ultrasonic Sensors**

Learning Needs Matrix(LNM)

Learnings Need Matrix		Group ID	Date
Theories/Methods/Application Process Involved/ Mathematical Requirement	During BE IV / Stage III	During BE III / Stage II	Applicable Standards and design specifications/ Principles & Experiments
<p>KNOWLEDGE OF NODE-MCU - ESP8266 CHIP</p> <p>KNOWLEDGE OF IR SENSORS</p> <p>KNOWLEDGE OF ULTRASONIC SENSORS</p> <p>KNOWLEDGE OF ARDUINO UNO CHIP</p> <p>LEARN BASIC OF NODE-MCU - ESP8266 "C" LANGUAGE</p> <p>OVERALL STIMULATION</p> <p>LEARN BASIC OF ARDUINO UNO "C" LANGUAGE</p>	<p>IOT BASED APPLICATION</p> <p>During BE II / Stage I</p> <p>ADDEND UNO - ON WHICH PROJECT IMPLEMENTED</p> <p>CENTRALIZED SERVER - TO STORE EACH ACTIVITY OF PARKING & PAYMENT</p> <p>CLOUD PLATFORM - USE FOR SHARING & HANDLES PARKING DATA TO DATABASE</p>	<p>CONTROL CIRCUIT DESIGN</p> <p>DISPLAY DEVICE [LED / COMPUTER5]</p> <p>IR SENSORS</p> <p>ULTRASONIC SENSORS</p> <p>TESTING OF CONTROL CIRCUIT</p>	<p>Purpose / Product</p> <p>CONCENT</p> <p>MAKING PARKING FLOW OF SENSORS TO FIND FREE AVAILABLE SLOTS & ALERTING VISITORS ABOUT AVAILABILITY OF PARKING ON COMPUTER & TO DECREASE WAITING</p> <p>JUMPER WIRES</p> <p>Component materials & Strength criteria (exploration - varieties/ testing requirements)</p>

Software/ Tools/ Simulation Methods/ Skill

16/3/2020

3. Modeling and Analysis using Software

- The whole project developed on Arduino Integrated Development Environment (IDE) which is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards
- We had used the ESP8266 NODE MCU development board for our project and used C and C++ language for code and uploaded from Arduino IDE to develop the smart parking management system.
- The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub *main()* into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program *avrdude* to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, *avrdude* is used as the uploading tool to flash the user code onto official Arduino boards.
- With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers & tools (cores) that can build and upload sketches to other MCUs that are not supported by Arduino's official line of MCUs.
- In October 2019 the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features.

4. Engineering Economics of Design

Smart parking management system is IOT based project whose cost always varies as the project is developed using different components and on basis of the components the total cost is carried out also if components always upgraded so again product cost varies. If any component stop working it should have to be replace which also can varies the product cost but our product cost approximately for 3 parking lots is shown in below table.

MATERIALS	COST	LINKS
ESP8266 NODE MCU CHIP	450 Rs	https://www.amazon.in/Generic-Nodemcu-Esp8266-Internet-Development/dp/B07262H53W/ref=sr_1_1?crd=1GN6W6SEJ5GGN&dchild=1&keywords=esp8266+nodemcu&qid=1589650690&s=electronics&sprefix=esp8266+Node%2CElectronics%2C261&sr=1-1
IR SENSORS (X3)	150 Rs	https://www.amazon.in/gp/product/B07N4MSC2Q/ref=ppx_yo_dt_b_asin_image_o02_s00?ie=UTF8&psc=1
SERVO MOTORS (X2)	150 Rs	https://www.amazon.in/gp/product/B00MTFFAE0/ref=ppx_yo_dt_b_asin_image_o05_s00?ie=UTF8&psc=1
JUMPER WIRES [Male-Male, Female-Female, Male-Female] each (X20)	151 Rs	https://www.amazon.in/gp/product/B0711JDRPV/ref=ppx_yo_dt_b_asin_image_o07_s00?ie=UTF8&psc=1
16x2 I2c LCD DISPLAY	330 Rs	https://www.amazon.in/Generic-Character-Display-Module-light/dp/B01M8PGLPD
BREAD BOARD	90 Rs	GANDHI ELETRONICS, SURAT
LED LIGHTS	20 Rs	GANDHI ELETRONICS, SURAT
RESISTOR	10 Rs	GANDHI ELETRONICS, SURAT
ULTRASONIC SENSORS	150 Rs	https://www.rhydolabz.com/sensors-distance-sensors-c-137_144/ultrasonic-sensor-module-hcsr04-p-2516.html?gclid=CjwKCAjwh472BRAGEiwAvHVfGvDhN6mtuQZU_cY6KTFBMr70YTIMz5DcNvUQJ2FY5_Gt4T3P8fcxBoCKv0QAvD_BwE

Approx cost of our basic prototype is 1450 RS, If more Ultrasonic Sensors/IR Sensors/Led Lights/Jumper wires are bought than cost will be increase

As well as the code is developed in Arduino IDE with approx 120 lines of code for 3 parking lots so the whole product cost calculated with hardware and software together shown below.

$$\begin{aligned}
\text{Effort} &= a_b * (\text{Line of Code})^{b_b} \\
&= 2.4 * (120)^{1.05} \\
&= 366 \text{ Person Month}
\end{aligned}$$

$$\begin{aligned}
\text{Time of Development / Integrating with actual ATM system} &= C_b * (\text{Efforts})^{d_b} \\
&= 2.5 * (366)^{0.38} \\
&= 23.5538 \\
&= 24 \text{ Months.}
\end{aligned}$$

$$\begin{aligned}
\text{Total Cost} &= \text{Cost of components} + \text{COCOMO Cost} \\
&= 1450 + (1000 * 24) \\
&= \text{Rs } 25450
\end{aligned}$$

HERE a_b , b_b , c_b , d_b are constants as 2.4, 1.05, 2.5, 0.38.

The product cost can increased if our project is installed in mall which results that product line of code can easily goes up to 2000-4000 lines of code so if project is installed in malls of 100 car parking lots than cost can be calculated on basis of the method shown above by adding all hardware component cost and software development cost estimation method COCOMO model cost.

5. Design for Use, Reuse and Sustainability

5.1 Design for Use

5.1.1 Reliability

The System is very reliable in terms of day to day operations as the whole project will be implemented in the underground parking which helps IR sensors to work in proper manner as IR sensors has disadvantage that it don't works in Sunlight and also Ultrasonic sensor carries out its work in proper manner because it will detects car and car can easily be detected as it is great in size because ultrasonic sensors has disadvantage that it can detect small and thin object also all data is handled by ESP8266 NODE MCU Microcontroller which sends and stores each and every detail of operation in database. Hence if any kind of failure it wont affects the database simply we can start the system again by replacing particular object with the defected object.

5.1.2 Maintainability

The maintenance required is quite high for the system as there are very few changes in terms of design and actual operation ability. However, we must ensure the system is working properly at every fixed interval of times to detect and prevent any further any kind of issues occurring in system. Also, the IR Sensors and Ultrasonic sensors should be checked at regular interval of time and should be ensure that ESP8266 NODE MCU Microcontroller communication with different object is proper in manner of sending and receiving data at every regular interval of time if any object stop from working simply we should have to replace it with new respected object keeping this all in mind we ensure that the system is always using latest object as this maintenance is most important.

5.2 Design of Reuse

Once the system passes all the tests, the same project solution [Code, Circuit Design] can be used again and again as all the features and design aspect are same for Smart parking management system. Also, we can reuse some of the common components other Malls parking as the basic operations remain same. So, we do not require to change various aspects for reusing the system at different places.

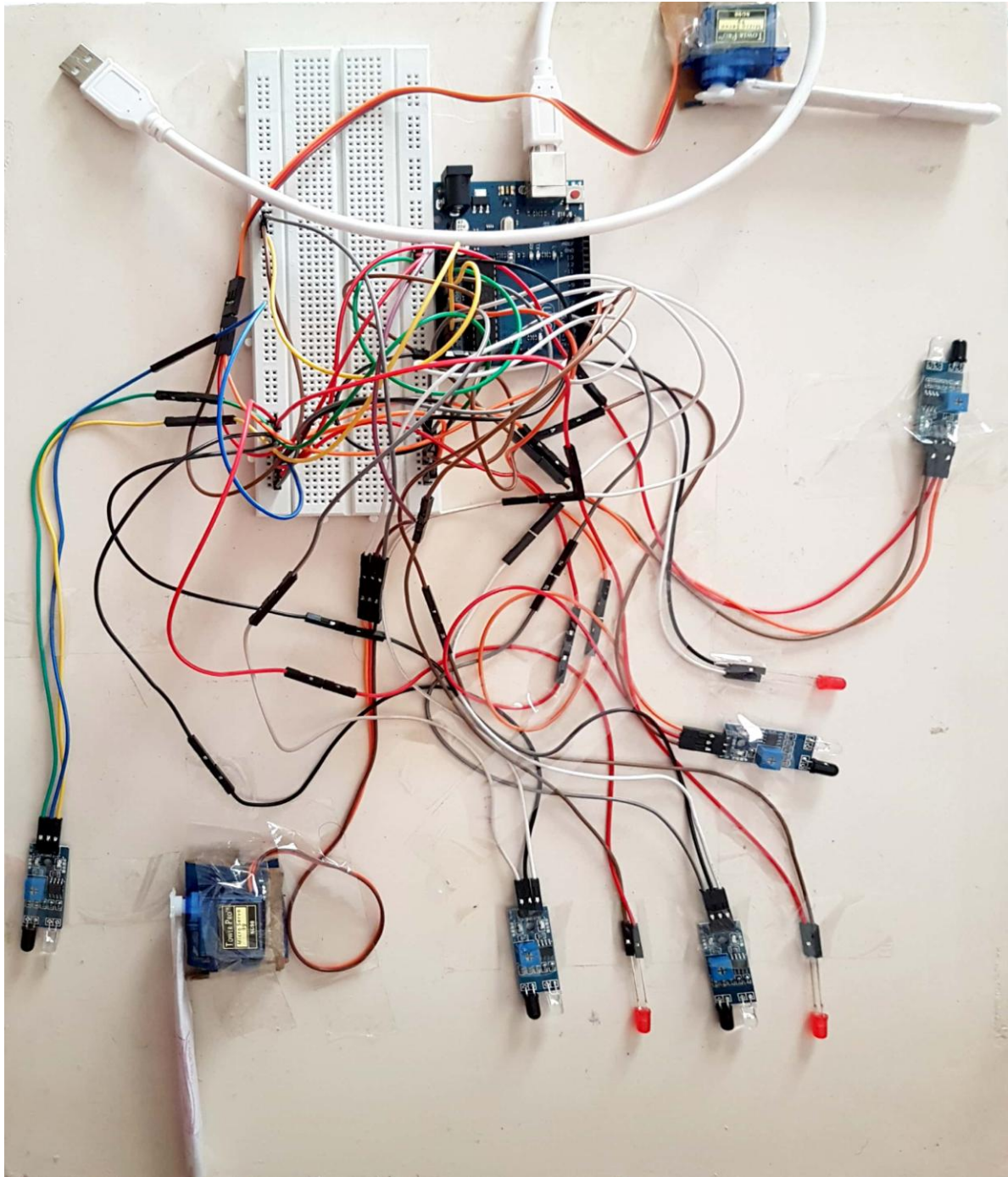
5.3 Design for Sustainability

The system would have any issues when tested or deployed in any environment as the actual working system of all Parking is very similar with few changes. However, if we try to deploy this system in other States then we might require to change some aspects accordingly. For actual, the system is quite sustainable because we had used ESP8266 NODE MCU instead of Arduino UNO means it is quite similar as the current IOT based smart parking system facility in parking which everyone is using from last few years.

6. Prototyping

Version 1.0

Rough prototype is the rough physical appearance of the project. It describes about how the product will actually look when we use it. Here we provided actual prototype of our project.

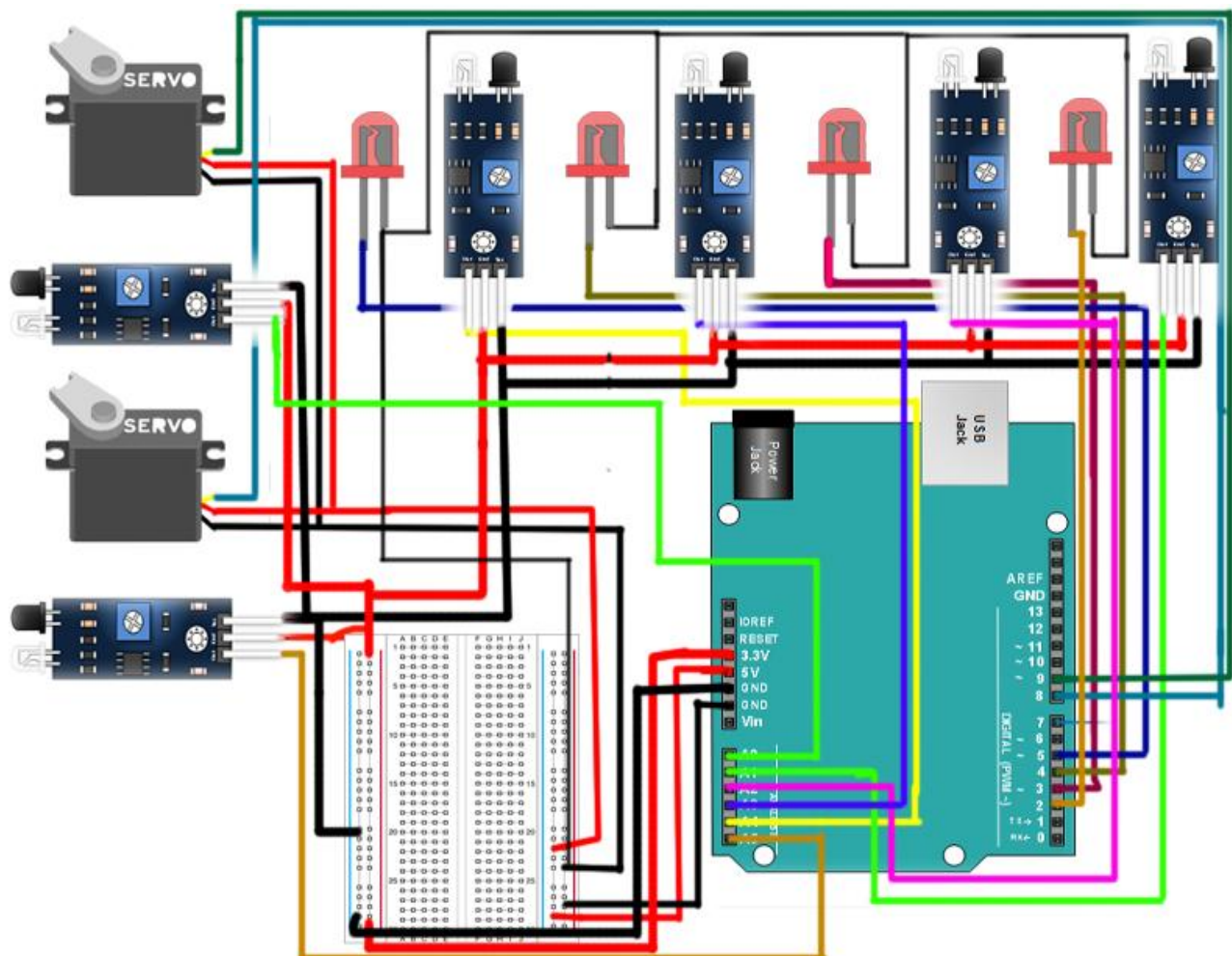


Prototype Working Explanation

Smart Parking uses sensing devices such as IR/Ultrasonic sensors which are installed in pavements to determine occupancy of the parking lot. More and more robust sensing systems are being built to analyze and transmit the information to the database in real time.

The system increases the availability of parking with the use of sensors. It prevents the drivers from spending too much time searching for a parking space. Internet of Things wireless sensors detect the vacant parking spaces and transmit the data to help the drivers get an idea about the vacant spaces for parking through LED lights if all Lot is occupied then entrance gate will not open and if any one lot get free again then entrance gate will start to open again.

PROTOTYPE CIRCUIT DIAGRAM

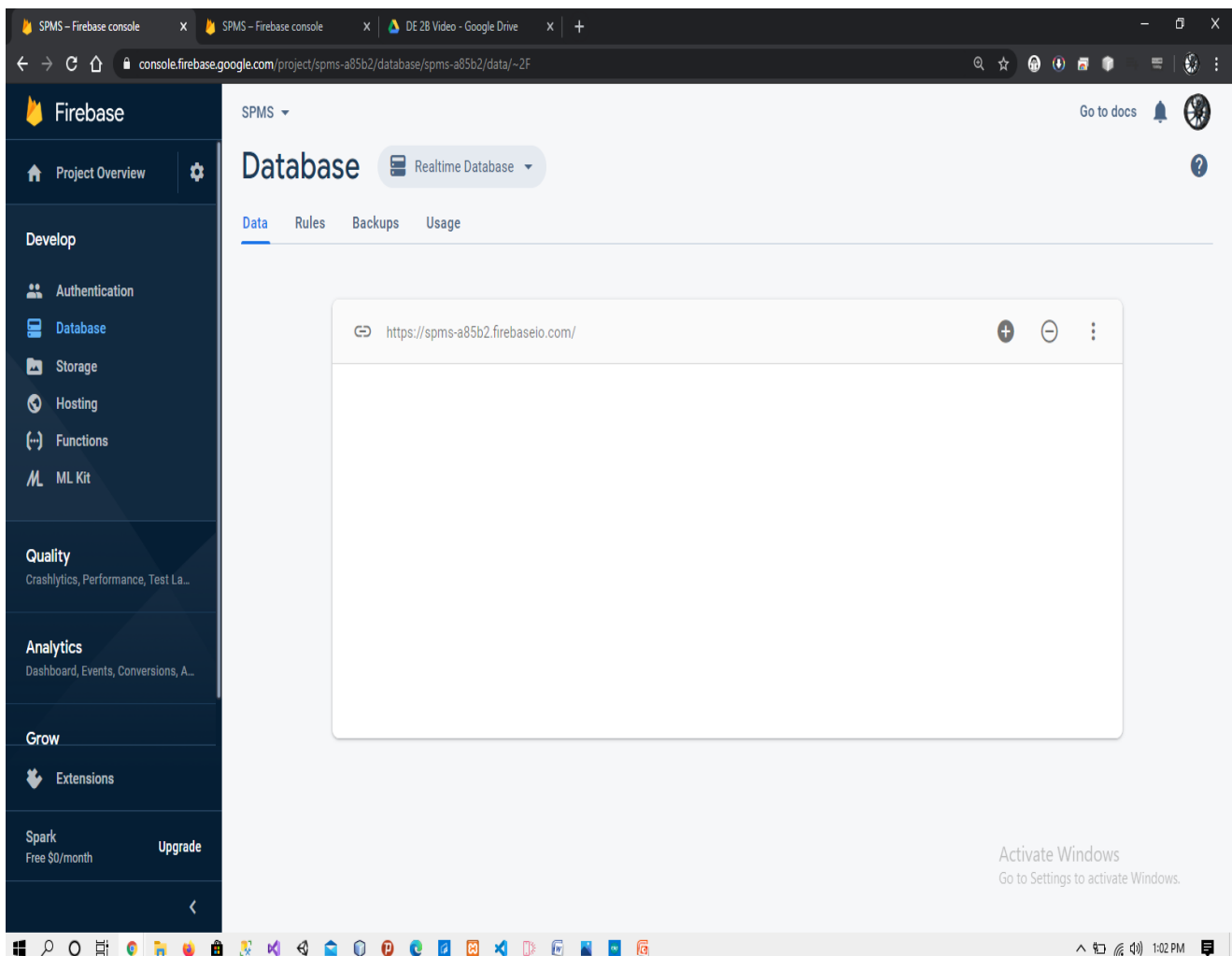


Version 2.0

Here in version 2.0 we will handle all parking data on cloud platform of google named google firebase in form of database and save data in it so that we can use it for any purpose in future and on large scale project we can show real time data using this cloud platform database to user using website

So for that first of all we had created the account on Google firebase cloud platform to connect the whole project with internet for that we need host name and authentication key which was achieved from the Google firebase cloud platform shown below.

As shown we will take the firebase host and authentication key after creating account, Firebase Host name from Database as shown in below screenshot. The **Firestore-host** = “**spms-a85b2.firebaseio.com**” [Note :- Select without “ / ”] and pasted it in code as `#define FIREBASE_HOST “spms-a85b2.firebaseio.com”`.



Same for authentication key which was available in Settings → Service account show in below screenshot. On copying it we pasted it in following way **#define FIREBASE_AUTH "HzMb.....HKXVjmRBz"** from spms -a85b2 HzMb.....HKXVjmRBz as show in below screenshot

The screenshot shows the Firebase console interface for the project 'SPMS'. The left sidebar contains navigation links for Project Overview, Develop (Authentication, Database, Storage, Hosting, Functions, ML Kit), Quality (Crashlytics, Performance, Test Lab), Analytics (Dashboard, Events, Conversions, A/B Experiments), and Grow (Extensions, Spark). The main content area is titled 'Database Secrets' and includes a warning: 'Database secrets are currently deprecated and use a legacy Firebase token generator. Update your source code with the Firebase Admin SDK.' Below the warning, there is a table with two entries for the database 'spms-a85b2', each with a masked secret. An 'Add secret' button is visible in the top right of the table. The bottom of the screen shows the Windows taskbar with various application icons and the system clock indicating 1:01 PM.

Database	Secret
spms-a85b2
spms-a85b2

On following the above steps and when we upload the code and run it we will be able to get all parking data on our cloud platform as shown below in screenshot as example.

smart-parking-7f5b6

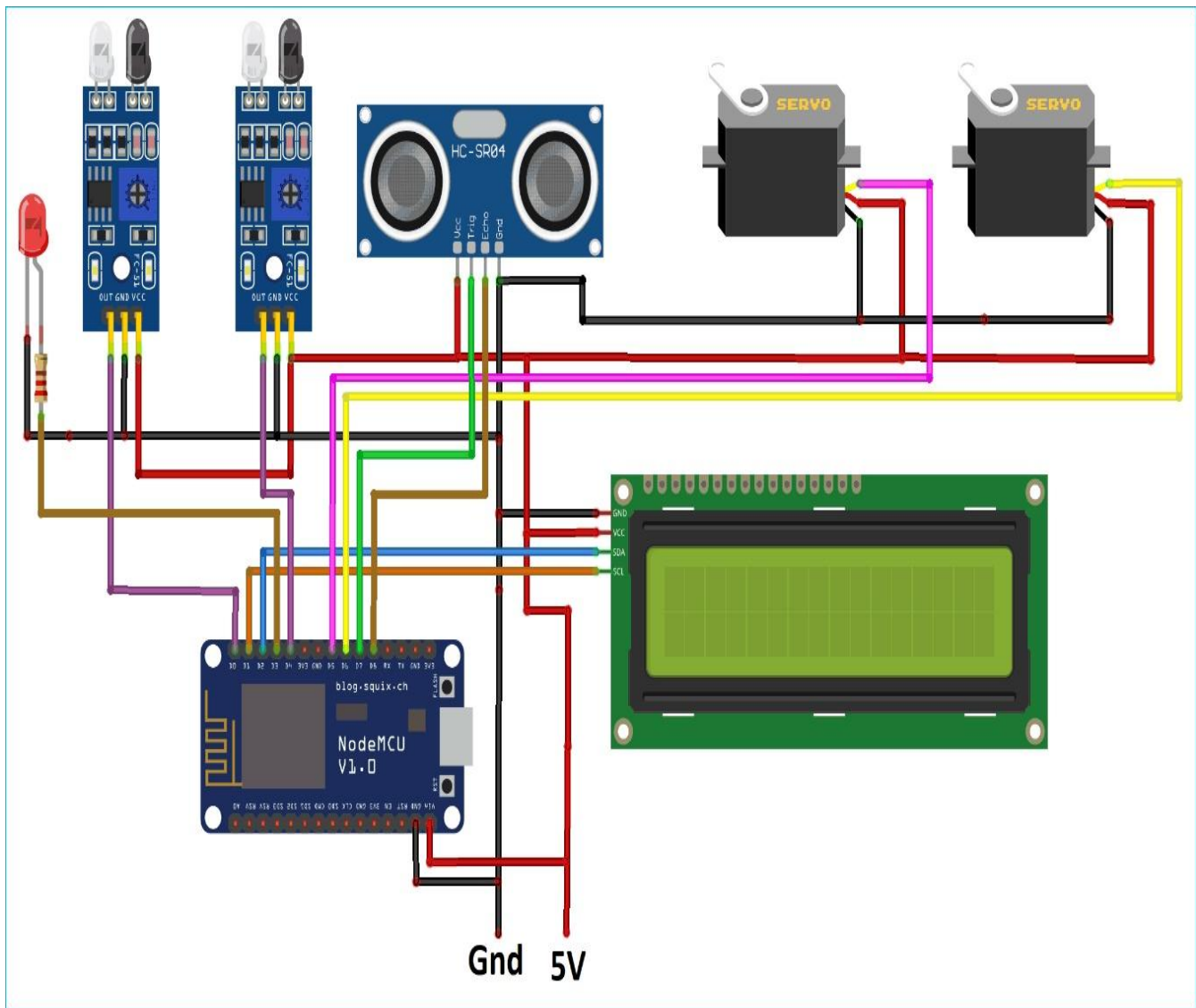
Parking Status

```
--- -LiRj8MVIlzSScNXkWaG: "Available=90/90"
--- -LiRj9DcO88_DcLIJaak: "Available=89/90"
--- -LiRjDuDe4y2tejSJ_X8: "Available=88/90"
--- -LiRjEiXXI4UHKITNvCL: "Available=87/90"
--- -LiRjJsmEEqknwU5-knN: "Available=86/90"
--- -LiRjM85RGwUdU9Z6xcA: "Available=85/90"
--- -LiRjQU4CnZuuDxXY0WK: "Available=86/90"
--- -LiRjVNJk0FwAwI9ebyo: "Available=87/90"
```

Below shown is Smart parking management system Circuit which makes the prototype working in following manner

First of all the entry and exit IR sensors, Ultrasonic sensors, entry and exit servo motors LED light through resistor and LCD 16x2 I2c with ESP8266 NODE MCU for 5V power through VCC pin in serially on bread board and GND [ground] in serially on bread board then entry and exit IR sensors Out pin with ESP8266 NODE MCU for communication purpose in D0 and D4 respectively after which ultrasonic sensors TRIG and ECHO pin with ESP8266 NODE MCU in pin D7 and D8 so than when car got detected by ultrasonic sensors it will communicate with ESP8266 NODE MCU that lot is occupied or not where trig is used to **trigger** the **ultrasonic** sound pulses through which car detection process done and **Echo** pin produces a pulse when the reflected signal is received means car is detected and this data will be send to the ESP8266 NODE MCU that caar is detected and lot is occupied. The length of the pulse is proportional to the time it took for the transmitted signal to be detected after which Servo motors of entry and exit gate with ESP8266 NODE MCU in pins D5 and D6 so that when car detected by IR sensors it sends respected signals to ESP8266 NODE MCU from where ESP8266 NODE MCU Sends signals on basis of parking data to servo motors and servo motor open and close gates basis on what signal servo motors received from ESP8266 NODE MCU, now LED is attached with resistor in D3 pin of ESP8266 NODE MCU because LED only need 3V to work but we have provided LED 5V as ESP8266 NODE MCU only have 5V so resistor helps LED in gaining the 3V power from ESP8266 NODE MCU and lastly LCD 16x2 I2c Display devices which has SDA and SCL ports attached with pin D2 and D1 of ESP8266 NODE MCU with whose help we are able to display messages like “PARKING AVAILABLE”, “PARKING FULL”, “CAR ENTERED”, “CAR EXITED” AND SLOTS OCCUPANCY where SDA is serial data send and receive which helps LCD 16x2 I2c Display devices to communicate with ESP8266 NODE MCU for displaying any of the above message on display base on condition received by LCD 16x2 I2c Display devices from ESP8266 NODE MCU and all data on LCD 16x2 I2c Display devices will be displayed on specific interval by SCL where SCL stands for serial clock signal. So this is the full explanation of Smart Parking Management System prototype Circuit that how all objects are interacting with each other though ESP8266 NODE MCU microcontroller makes the system runs in successfully manner.

Whole Circuit is shown below for reference.



Actual working of prototype after the project got implemented in parking will work in following manner.

First car will be entered where car will be detected and gate will be open for car only if lot is available in the parking if parking is not available than display device will display “PARKING FULL” and if parking available than gate will be open and display device display “Car Entered” also this data will be send to Cloud where whole parking data will be stored in database after car entered the lot is occupied by car or not detection process will be started if car <6 CM from parking lot so LED will be high indicating that lot is occupied so display devices and cloud database will be updated and shows the slot is occupied like [Available=86/90] and when car detected on exit gate than gate will be opened and display device will display car is exited and display device and cloud database will be updated again like [Available=85/90] with LED light turn to low indicating lot is available.

7. Test the prototype

STEP 1:-

As shown in below First car is entering in parking where car is detected by Entry gate IR sensors and IR sensors send the data to the ESP8266 NODE MCU after analyzing parking data if parking is available then gate will be open by entry gate servo motor where 16x2 LCD display I2c display car entered and occupancy message like [Available=85/90] and if parking lot is not available then ESP8266 NODE MCU will send signal no to open gate and it display parking if full on 16x2 LCD display I2c as parking is full and occupancy message like [Available=90/90].

STEP 2:-

So here parking lot is available in the parking so Entry gate servo motor is opened and car is entered in parking so 16x2 LCD I2c display is displaying Parking is available and occupancy data [Available=85/90] as well as on cloud database when car entered in Parking 16x2 LCD I2c display is displaying “CAR ENTERED” .

STEP 3:-

Now car is heading towards the parking lot where ultrasonic sensors is detecting for car presence using it sound pulses continuously so here car is detected by ultrasonic sensors and is <6 CM away from parking lot so that ultrasonic sensors send parking lot data to ESP8266 NODE MCU that parking lot is occupied and 16x2 LCD I2c display device and cloud database updated by ESP8266 NODE MCU and updated Occupancy data will be displayed on 16x2 LCD I2c display device and cloud database as [Available=86/90].

STEP 4:-

Now Car is heading towards Exit gate where IR Sensor of exit gate detects the car and sends data to ESP8266 NODE MCU and ESP8266 NODE MCU sends signal to exit gate servo motor to open the gate so after communication get completely successful the exit gate is opened by exit gate servo motor and 16x2 LCD I2c display device display “CAR EXITED” after car exited 16x2 LCD I2c display and cloud database updated by ESP8266 NODE MCU and updated Occupancy data will be displayed on 16x2 LCD I2c display device and cloud database as [Available=85/90].

STEP 5:-

Now parking is full and new car is entered in parking so 16x2 LCD I2c display is displaying “Parking is full” means on full parking gate won't be open.

8. Tools and Technology

Tools:-

Smart parking tools consist of sensors, microcontroller technologies and applications which are used to identify parking occupancy information and facilitate to improve parking efficiency.

IR Sensors:- These sensors would emit infrared energy and detect any object or vehicle by the amount of energy reflected. They are also sensitive to environmental changes such as rain or snow. Therefore, they should be placed in all the parking spaces and require high investment and maintenance. Deploying sensors in all the parking spaces would help to attain parking occupancy status. These sensors are usually placed overhead and are suitable for indoor closed parking lots. As these sensors are sensitive to environmental changes it is not suitable to open parking lots.

Ultrasonic Sensors:- These sensors would emit sound waves between 25 to 50 kHz and detect objects based on reflected energy. They are usually mounted on ceiling and are sensitive to environmental changes such as rain and snow. Therefore, they are suitable for indoor parking lots rather than open parking lots. Based on the distance at which waves are reflected it can distinguish between a vehicle and a person. In order to get parking occupancy status these sensors should be placed on top of every parking space. These sensors would be available for low cost but installation and maintenance of multiple sensors and connecting them to a grid would be expensive in the long run.

ESP8266 NODE MCU:- NodeMCU is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. Also we can program it using C & C++ through Arduino IDE Software so that it can be able to handle all project tools of Smart parking Management System.

Servo Motors:- A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and

acceleration. It consists of a suitable motor coupled to a sensor for position feedback.

LED Light:- LEDs are smart and effectively manageable when integrated with IoT technology. With IoT, it is easier to keep track of data, like the number of operation lights and power consumption of each light fixture. A facility manager can also operate luminaries and control an entire power grid remotely

16x2 LCD I2c:- This is an 16x2 LCD display screen with I2C interface. It is able to display 16x2 characters on 2 lines, white characters on blue background.

Jumper Wires:- Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed

Bread Board:- A breadboard is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode etc).

Technology:-

IOT:-Internet Of Things

The Internet of Things is simply "A network of Internet connected objects able to collect and exchange data." It is commonly abbreviated as IoT. ... In a simple way to put it, You have "things" that sense and collect data and send it to the internet. This data can be accessible by other "things" too.

Recent Tools and Technology in use :-

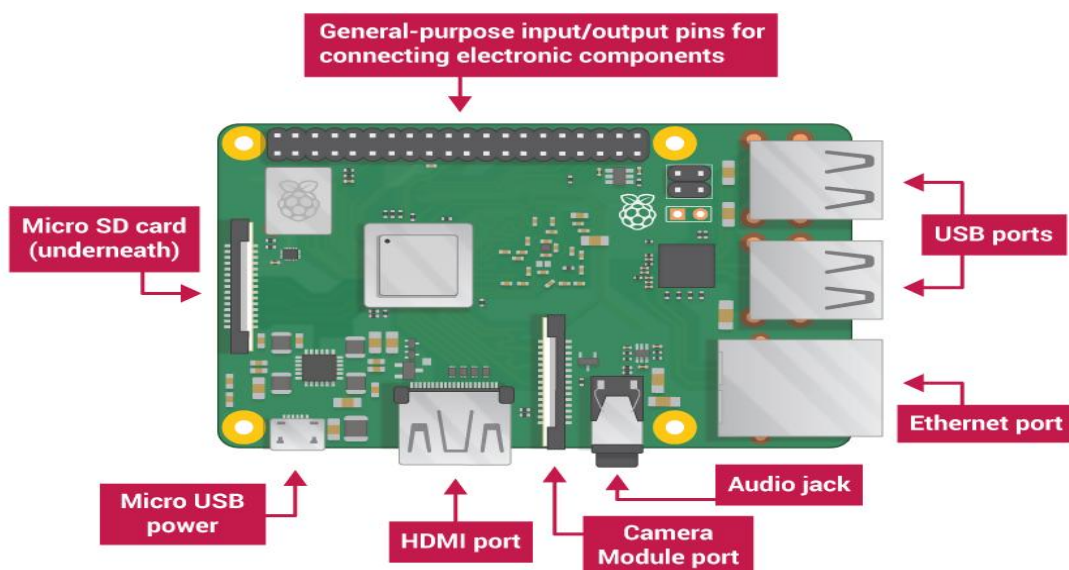
Recent technology using Arduino UNO in smart parking management system and we had use the ESP8266 NODE MCU as it has in built wifi module and also cost effective as compare to Arduino UNO and also we can use mega ESP8266 NODE MCU for big scale projects.

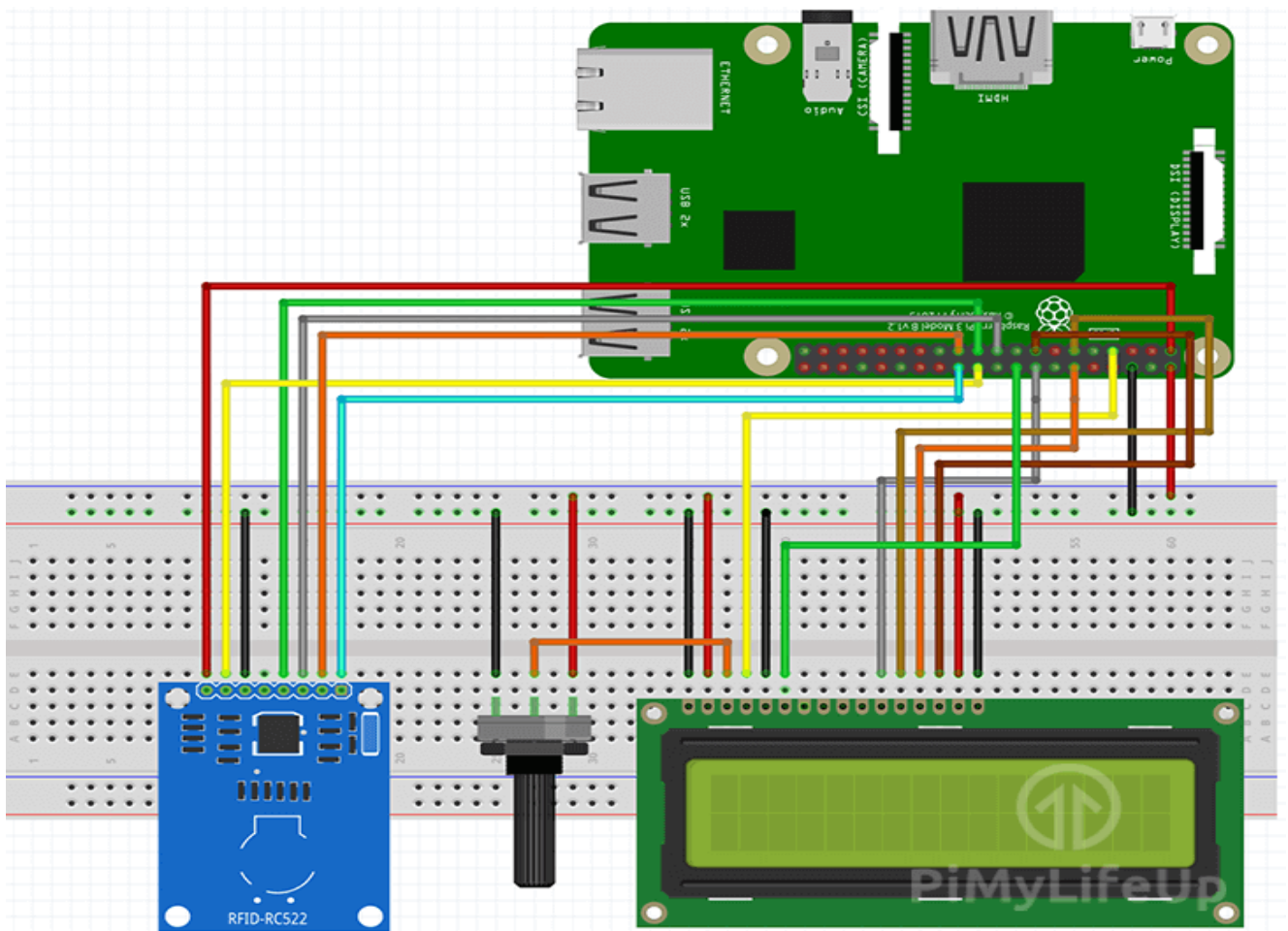
9. Conclusion and Future Scope

The rapid urbanization of the world has made the concept of “smart cities” gain momentum in the international agenda. The transformation of cities into smart cities brings along an incredible opportunity for improving citizens’ welfare and fostering economic progress. The vision to be a smart city has always been a thought to all the urban cities. Since a couple of years, projects were taken and ideas were employed in many countries to make it into reality. Internet of Things stands out to be the indispensable technology implemented along with Cloud Computing. To be a smart city, Smart Parking facility is an essential service. Previous technologies were exploited which proved to be either not efficient or too expensive. The sensors used to detect the vehicle are the essential components. Here, we have employed ESP8266 NODE MCU which seemed to be cost efficient with easy installation and maintenance. In future we would develop application for android and IOS as well as online website and test its workability in a real time environment.

Once if ours whole device starts working properly than we can redesign a whole new circuit with Raspberry-pi for making it more effective and to reduce maintenance cost and implement the new feature of fast billing with the help of RFID where customer can do fast billing as well as redeem their balance in RFID card instantly from billing counter using their credit card.

Raspberry-pi





RFID CHIP connection with Raspberry-pi



RFID CARD

We infer that our future work would facilitate parking issues and decrease traffic congestion and pollution created by the search for parking