

# An Intelligent Approach for On-Street Parking Reservation and Toll Management System

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**Abstract** - Proper parking management is a common attempt to reduce road traffic by providing a certain amount of space for the vehicle to park for a certain time and to collect parking charges for the time the vehicle is parked. Considering the growth in population, large parking areas horizontally or vertically are not inherently the best option, because it involves enormous expenditure on the acquisition of vacant land and development of high-rise buildings for parking. On Street Smart Parking System is therefore one solution to provide efficient information on the availability of empty parking spaces and to perform verification and transaction process quickly. The proposed project is a smart on-road parking management system that provides customers with a convenient way to book a parking spot. This technique overcomes the problem of unavailability of parking in commercial areas by providing parking space alongside the roads. This proposed project provides a web-based reservation system where users can view the various available parking spaces and book the slot. The area will be labelled Reserved. Added the additional One Time Passcode (OTP) functionality for identification. After the slot is booked, the customer will receive 2 OTP's to the registered mail address, which will be validated at the gate to ensure that the person who booked the slot enters the slot. If the 1<sup>st</sup> OTP matches, the barricades will open. Again, when the user leaves the parking spot, they will be displayed the amount they need to pay for the time the vehicle was parked after validating the 2<sup>nd</sup> OTP.

**Key Words:** Smart Parking, Toll Management, On - Street Parking, Reservation, Web-Application

## 1. INTRODUCTION

Finding a parking spot is tiresome and frustrating if you can't find one. A study indicates that every car driver wastes an average of about 100 hours annually looking for a parking place, which accounts for 1/3<sup>rd</sup> of the city's congestion. Nowadays traffic congestion pollution has increased rapidly with the increasing growth of population in major cities because of more personal vehicle usage instead of public transportation. Getting to know the unavailability of the parking area after you enter the location is a concern. In addition, the loss of petrol, diesel or CNG gas, as well as the emissions generated by it, is another concern. With the increased usage of cars, the traffic congestion occurs on the road as parking there is

free and not regulated. Also finding of free parking slot takes more time period than usual. Hence, we loss certain amount of time period and also made greater than 80% of fuel wastage to find the empty parking slot. Off Street paid parking is underutilized as free parking on road exists.

To solve this problem, we need a smart system and proper toll management for On-Street Parking alongside the roads to measure empty space and show the updated information to the people who are looking for the empty space using internet and charge them for parking. By parking the vehicle in public place, the vehicle can be claimed by towing person but in this case, there is no towing problems and no need to give fine instead pay for it and park your vehicle securely.

### 1.1 Types of Parking:

➤ **On Street parking:** - On street parking means the vehicles are parked on the sides of the street itself. This will be usually controlled by government agencies itself. Common types of on-street parking are as listed below. This classification is based on the angle in which the vehicles are parked with respect to the road alignment.

1. **Parallel parking:** - In this parking vehicles are parked along the roadside. No backward movement is involved here when the vehicle is stopped or no parking. This is, therefore, the safest car park from the viewpoint of an incident. This absorbs however the entire curb length and hence only a limited number of vehicles can be parked for a specified curb length. This parking approach provides the least obstacle to ongoing road traffic because less road width is used.

2. **Angle parking:** - As parking angle increases, a greater number of vehicles can be parked. Different types of Angle parking are 30°, 45°, 60°. Vehicles are parked at 30, 45, 60 degrees with alignment of the road. In this case, more vehicles can be parked than parallel parking. But this type of parking involves backward movement while taking out the vehicle parked which may lead to accident.

3. **Right angle parking:** - The vehicles are parked at a 90-degree angle i.e. perpendicular to the direction of the lane in right angle parking. So, it requires maximum width of curb length which is necessary. This arrangement causes road traffic obstruction particularly if the width of the road

is narrower. Moreover, for a given curb length it can accommodate the maximum number of vehicles.

- **Off-Street Parking:** - When parking at a separate place away from the curb is offered, it is known as off street parking. The main drawback is that some motorist may have to walk a greater distance after parking their car. Off-street parking facilities cannot be provided at various close intervals, especially in a city's business centres. Different types of off-street parking are:

1. **Surface parking:** This parking is usually seen at supermarket, complex & office parking.

2. **Multi-storey parking:** This kind of parking is designed for 400 – 500 car park and is built on large area. Parking configuration up to 4-5 floors in this form of parking.

3. **Roof parking:** As there is less space for parking, in many cities parking facilities are offered on the building's roof.

4. **Mechanical car parks:** Cars are moved from one floor to another floor using lifts in this system. With the aid of mechanical trolley, cars are parked in stalls.

5. **Underground car parks:** In this parking, cars are parked in building basement.

Limited, time-slotted on-street parking and higher rates will complement multi-storey parking. Multi-storey parking will fail to reduce congestion on the streets by implementing these measures, and will be a pointless exercise. While implementing On-Street Parking Facility, other basic road necessities should not be compromised defining parking lots for vehicles only after providing sufficient space for footpaths, cyclists, trees and street vendors.

For all 3 & 4 wheeled vehicles like motor cars, light commercial vehicles (LCVs), trucks, and buses, parallel parking configuration shall be adopted. For motorized 2 wheelers as well as for bicycles, the perpendicular parking configuration shall be adopted. Only single lane parking on street parking lots shall be permitted. Parallel car parking is the most effective parking configuration in terms of vehicle number compared to the space occupied. 2-wheelers can use the same lane as perpendicular parking area.

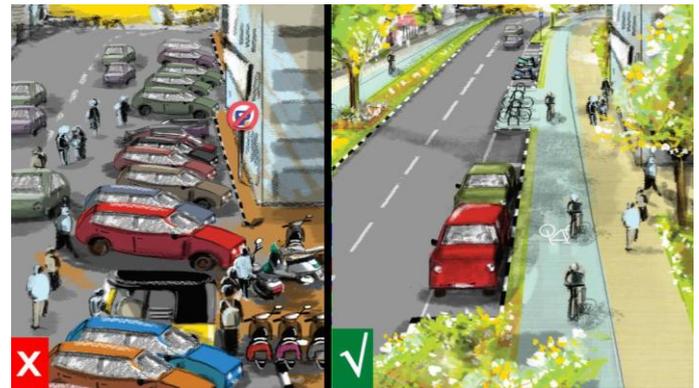


Fig -1: On-Street Parallel Parking

## 2. LITERATURE SURVEY

Smart parking using Internet of Things (IOT) [1] have proposed a system using Google Maps application. Ultrasonic sensor is used for data collection and stored in cloud. Map in Android application provides information regarding vacant place near you. Each parking slot has 1 Light Emitting Diode (LED) display which helps in finding the right parking spot. IOT based parking system using [1] Google have proposed the system which allows the user to reserve the parking place before reaching there. Mobile application is used to first find the parking place. Also Infrared sensor is used to find the number of empty place and is shown at entry gate. Radio Frequency Identification (RFID) tag issued to every user to authorize a person's entry to the parking place. After verifying if the person is authorized then signal is sent to open the gate [2]. Advanced CAR Parking [3] System using Arduino and Raspberry Pi detects the free slots and uses web server for booking, Google Maps using GPS for finding empty spaces. Results are displayed using mark graphically on map.

Effective car parking [4] system has proposed system which uses Infrared sensors and authentication is performed using RFID tag. ZigBee is used for communication protocol in Android Based Smart Car Parking [5] System.

Smart Parking System based on Embedded System [6] uses embedded and sensor network using android application. In this system, Raspberry PI is used, IR sensor is used to finding a vacant parking slot. Quick Response (QR) code is used for the security purpose, webcam is used to scan the code and authorize and show the parking lot direction [6].

A Privacy-Preserving Pay-by-Phone parking system [7] was proposed. Reservation is done by pay by phone method. Mobile application using credit card payment method is implemented. Concept of e-coins is introduced. New user can register and have to purchase new e-coins. Each e-coin having a parking duration time of slot. Parking officer queries of on-board devices by performing RFID query [7].

India's capital New Delhi from year 2015 has started planning to collect all relevant data about parking lot and parking areas, current infrastructure of off-street parking place ownership. Web page or mobile app is used for booking parking place [8].

Best Rules for Parking Fees: [9]

- Pricing must vary per zone and per demand levels. Zones with higher parking demand will have higher fees.
- Fees should be proportional to vehicle size, so the fee for motorized two-wheelers should be approximately one fifth of the fee for four-wheelers.
- Fees should be proportional to the duration of the parking event (i.e. no discount for long-term parking).
- On-street parking fees should be relatively higher than for off-street public parking.

### 3. PROPOSED SYSTEM

#### 3.1 System Module

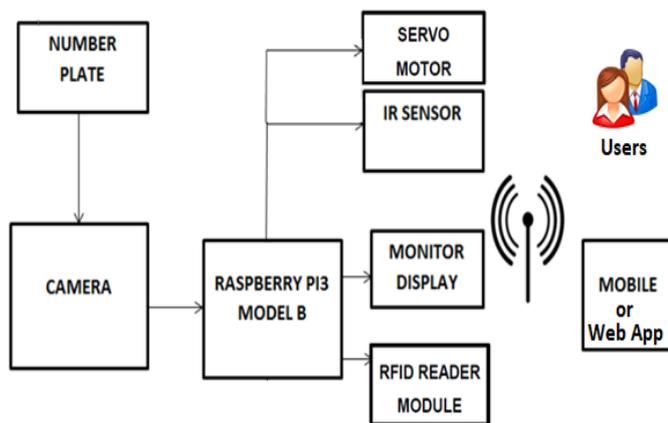


Fig -2: Block Diagram

To overcome some of above-mentioned problems, we propose a specially designed system which allows user to reserve their own likely parking spot using webpage through the internet access. Our system provides quick response to every user and also the parking information is quickly updated into the web page almost real time. Also, the Toll is calculated from the user's entry and exit time on the parking spot. This web page is specially designed for our Street Parking Reservation & Toll Management System (SPRTMS).

In our parking reservation system, we have included one special security application for the security maintenance at parking area. We have provided 2 One Time Passcode (OTP) feature with each booking to user's registered mail address, each to be used while entering and leaving the spot so proper verification can be performed. Also, SPRTMS contains barricade gate for vehicle security. By entering correct OTP user can open or close the barrier

gate in the appropriate parking slot. Chapter 3 tells the operation of every block in system.

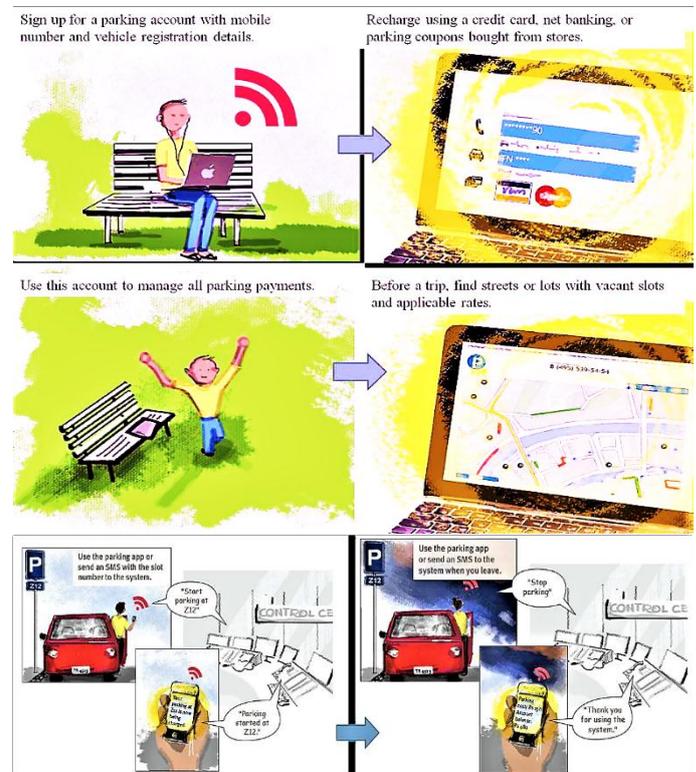


Fig -3: Online Reservation on webpage

Creating parking account for easy payment and using parking webpage to find out availability of parking lots.

#### 3.2 System Overview

Components used are:

- Raspberry Pi 3B+ - As a Microcontroller
- Raspberry Pi Camera V1 - For Capturing License Plate
- RFID Reader Module - For Reading RFID Card
- Servo Motor - As a Barricade gate
- Infrared (IR) Sensor - For Detecting the vehicle's presence
- Monitor Display - For entering the OTP's and other uses
- Web App - For slot booking
- Backend Database - For maintain and verifying data entries

The overall project is divided in 3 parts;

- Availability of Parking Space and Booking
- Verification
- Payment for time vehicle parked
- A **user** can create an account to web interface by entering following details such as Name, Address, Email address, Password, Unique ID (RFID), Phone number.

- Now users can view **available parking spaces** on Dashboard and be able to book a certain spot and system will send him the 2 OTP's for the verification purpose to email address.
- Now user can reach the parking space he/she booked and there with the help **IR Sensor** vehicle's presence will be noted and Camera will be triggered for capturing image and Open Automatic License Plate Recognition (ALPR) is used for user's **Licensed Number plate** to be digitize and will be matched along with the OTP 1.
- Hardware interfacing of **Raspberry Pi** with **Servo motor** and **RFID Reader** and Card.
- User will enter parking space after scanning his RFID Card at the reader and if his booking is there then Servo Motor (Gate) will open.
- And the area will be marked occupied and if user fails to reach the spot in 30 mins, the spot will be made available for booking again.
- At the time of exit the user enters the OTP 2 and the amount for the time user used the parking facility will be deducted from prepaid account.

System server contains number small process blocks. These process blocks in combination of each other perform the operation of SPRTMS.

We used XAMPP v3.2.4 that abbreviated for Cross-Platform (X), MariaDB MySQL (M), Apache Server (A), Perl (P) and PHP (P). It contains the built-in Apache Server which makes it very simple for developers to build a local web server to test and deploy. It contains a system database which is used to manage the records and data entries. This also has mail function that can use Simple Mail Transfer Protocol (SMTP) Server to send electronic mail to desired address.

The following tools are used for creating webpage for SPRTMS and database: XAMPP is used to design a database, Hypertext Preprocessor (PHP) and Hypertext Markup Language (HTML) are used to interface and authenticate user details and make a connection to the database, Cascading Style Sheets (CSS) is used to build a web page interface, such as fonts, sizes, and JAVASCRIPT is used to add user interactivity and web page validation.

The database comprises of Users, Slots and Logtable. Users section contains details of registered users who has created account in our webpage entering following details Name, Address, Email address, Password, Unique ID (RFID), Phone Number. After successful registration, system generates a User Id Number for every user.

Slot section contains Number of Slots available alongside roads in particular region. For the demonstration purpose we have kept 10 slots. Each Slot is

given Slot Name like P1, P2... and has Status option like Free, Booked, Leaving Soon. As soon as any user after logging in our system will get view of all the Slots on his/her Dashboard, where the available Slot can be booked and following this user has to enter licensed Number Plate details.

Logtable section contains log entries of slot bookings by different users. Each entry has User Id Number, Number Plate details, OTP 1&2, From Time, To Time, Payment and Status.

### 3.3 User Module

The Dashboard which shows the Status of Slots is updated every 10 seconds, so each user gets almost Realtime information through their phones, laptops or any other internet accessible device. The user can reserve his parking spot if available or can wait if filled. User has once to create account and it will be very easy to book the slot even while he/she is driving. The user can park the vehicle in their booked slot and relax about the security of vehicle as each slot will have the barricade so no stealing, no towing. The user will get very smooth, enrich graphic design and efficient booking experience on the webpage. The user will have full parking area layout and the ability to pick the desired slot if necessary, during the specially built SPRTMS web page access. As soon as the slot is booked user will receive the System generated Mail having booking details and Verification codes for security. Hence user can be sure that their slot has been booked. The complete Flow Diagram of booking process is explained in Section III of the paper. At the end, when user is leaving the parking area, the amount for the time vehicle stayed in the slot will be charged to user. By the internet banking and digital payment, user can pay the charge by swiping the RFID card near the reader for parking. Also, the reservation process with web view and vehicle checkout process are explained with the flow diagram in section 4.

## 4. SYSTEM FRAMEWORK

In section 4 we will observe the system flow diagram and steps to follow in webpage for successful parking slot booking.

### 4.1 System Process Flow

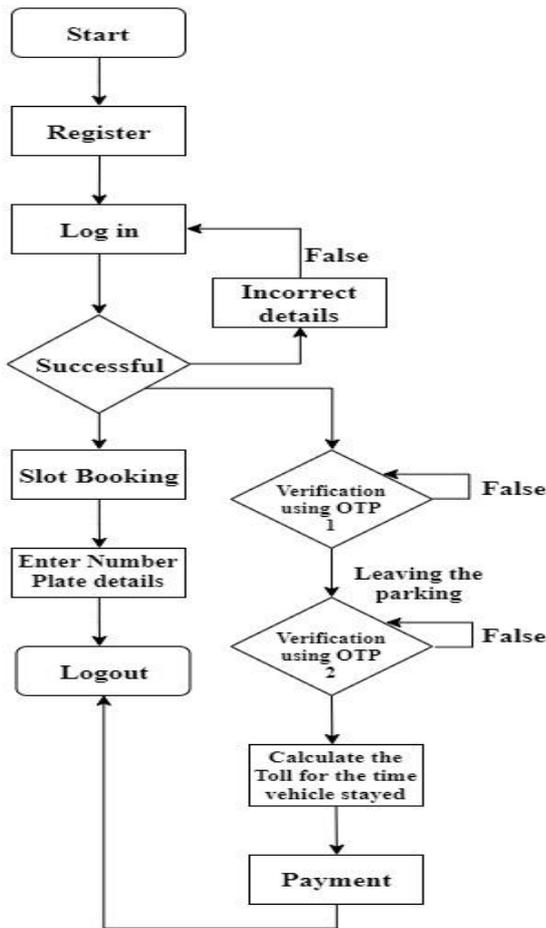


Fig -4: Flow diagram of reservation process

By the above flow diagram, we get the clear idea of the series of steps involved in whole system from registering on webpage to checkout of parking and paying the amount for time vehicle parked in perfect order. Whole reservation process is done on the webpage specially designed for SPRTMS using the internet access. Each registered user can only book one spot at a time. So, no mass and extra booking of slot is possible. Every single change in the parking spot will be automatically updated into the web page every few seconds. So, the empty, occupied or leaving soon slot information is quickly updated into the web page.

### 4.2 Steps in accordance with the webpage

The user has to perform following steps to make reservation in the webpage for parking spot.

- First of all, visit the webpage of SPRTMS.

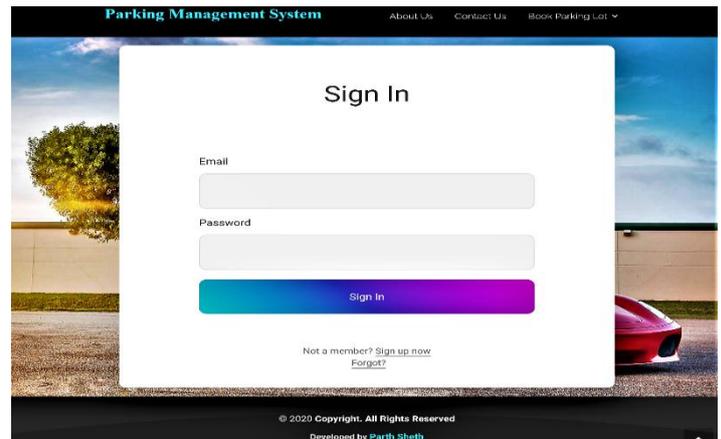


Fig -5: Homepage of website

- In the first step, the users have to create an account by entering following details such as Name, Address, Email address, Password, Unique ID (RFID), Phone number.

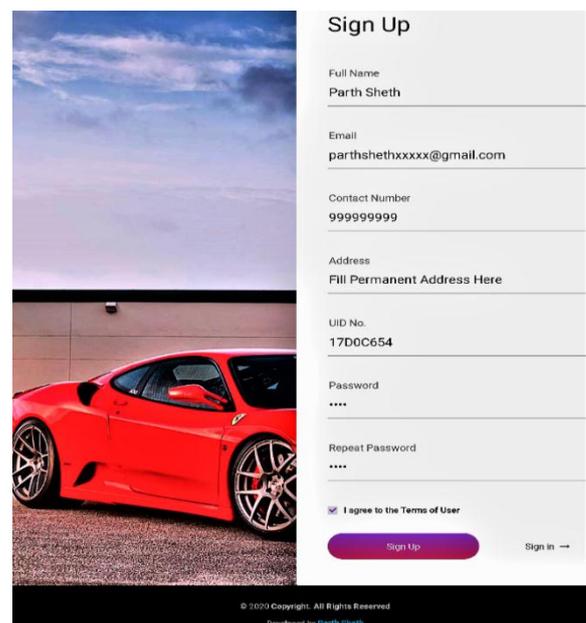


Fig -6: Sign Up Page

- In second step, user has to login with their registered Email address and Password. After successful Login, Dashboard Screen will appear where user chooses his/her own likely parking spot to reserve in a web page if available. User chooses his/her slot with respect to its status. Hence the empty slot will be available to select. The occupied slot is notified by black colour. If a slot is marked Leaving Soon means Slot occupied by other vehicle is Checking out the area and is paying his/her dues.

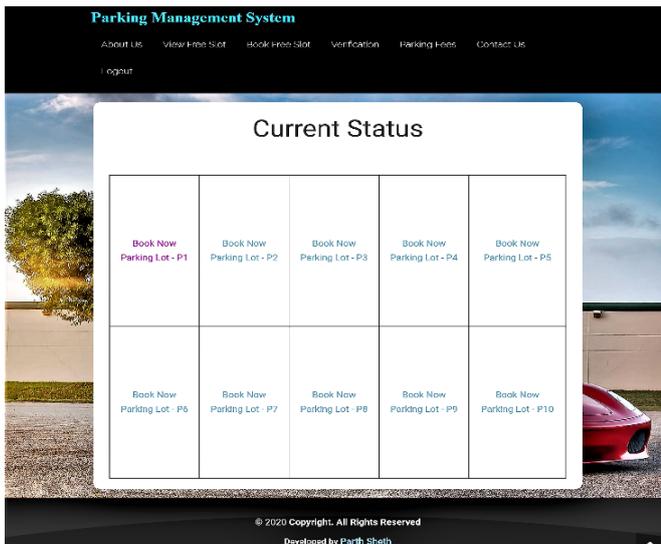


Fig -7: Dashboard view of all Slots

- Third step, after selecting available slot, user has to enter the Licensed Number Plate Details of the Vehicle to be parked. Below that Selection of the Slot is there. Then accept user agreement terms by clicking the checkbox ahead of it and Press Book Now.

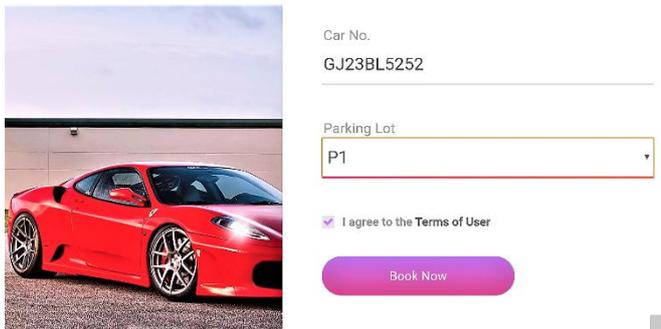


Fig -8: Vehicle Details along with Lot Selection

- Fourth step, user will receive a mail at his/her email address registered with the system containing Booking details such as Vehicle Registration Number, Slot Number and 2 OTP's. OTP 1 is used while entering the parking spot and OTP 2 while moving out of the spot.



Fig -9: Mail from SPRTMS about the booking details

- Meanwhile, if some another user accesses the website to book his slot. Dashboard will be shown as Slot P1 is marked Booked already and will be unavailable to book.

Booked Parking Lot - P1	Book Now Parking Lot - P2	Book Now Parking Lot - P3	Book Now Parking Lot - P4	Book Now Parking Lot - P5
Book Now Parking Lot - P6	Book Now Parking Lot - P7	Book Now Parking Lot - P8	Book Now Parking Lot - P9	Book Now Parking Lot - P10

Fig -10: Dashboard when one slot is already booked

- Fifth step, user has now to reach the booked parking spot in 30 minutes of booking. Upon reaching the spot user passing nearby the IR Sensor it will trigger Pi Camera to take the picture and analyse and digitize the number plate using Open ALPR and match with the database records for any booking on that number plate is there or not.

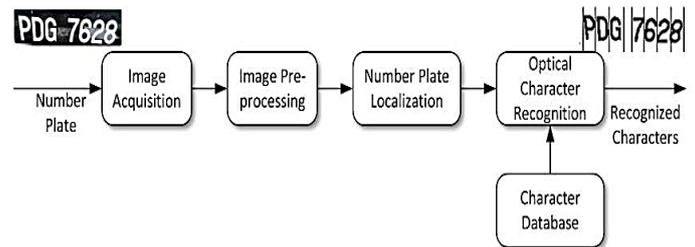


Fig -11: Flow of processes for number plate recognition

- Sixth step, if booking of this vehicle exits, then user has to swipe the RFID Card near the reader module and enter the OTP 1. If both the details Number of Licensed Plate and OTP 1 matches with the database, Gate or the barricade will open and user has to park the vehicle at booked slot and leave the parking area. Here, at backend database side entry time of the vehicle is updated.

### Verification

OTP-1 (While Parking)

788922

GJ23BL5252

31-03-2020 08:55:42

Verify

Fig -12: Verification of OTP 1 (While Parking)

- Seventh step, when user wants to leave the parking spot with vehicle, he/she needs to verify themselves with OTP 2. As soon as OTP 2 matches the database entry of this user at backend side Leave time of the vehicle is updated.

### Verification

OTP-2 (While Leaving)

860609

GJ23BL5252

31-03-2020 09:00:43

Verify

Fig -13: Verification of OTP 2 (While Leaving the Parking)

- Eighth step, SPRTMS System will show the amount to be paid by this user for the time vehicle was parked at the spot. The amount will be calculated based on difference of Entry and Leaving Time of the vehicle. At last user has to again swipe the RFID Card near the reader and amount will be paid from his prepaid account. At this point, Slot P1 in Dashboard will be marked Leaving Soon.

### Fee Generated

5

Pay

Fig -14: Fee Generated Receipt

Current Status		
Leaving Soon Parking Lot - P1	Book Now Parking Lot - P2	Book Now Parking Lot - P3

Fig -15: Status Leaving Soon at Slot P1 while Paying Fee

### Pay using RFID Card

17D0C654

5

Pay

Fig -16: Fee Payment using RFID Card

By following above eight steps properly user will achieve peaceful parking reservation and payment experience in the roadside parking area. Each and every step will be achieved only on the web page specially designed for SPRTMS corresponding on-street roadside parking area. This reservation process can only be achieved through the internet accessible devices. On every reservation process there is continue communication between localhost web server and database. Database stores every action taking place in a web page. This information is helps in checking every action of database.

### 5. CONCLUSIONS

We have proposed On-Street parking system based on reservation and pay for it to make easy and efficient use of roadside parking area. Reservation of slot can be carried out on specially designed webpage only after creating a parking account. Each user can only book one parking spot at a time after entering the vehicle registration details in the website. This system efficiently detects the empty parking slot and updates the information on the web page. The reservation process takes frequent of seconds to book and send the mail about the booking details with verification codes. The security of a system is much secured so unauthorized persons cannot park at any parking spot without proper verification. SPRTMS also checks the License Plate details using Pi Camera along with verification code to give the access to spot. At last

when user wants to leave the parking, system calculates the amount to be paid by user for using parking spot based on entry and exit time recorded in database. User has to swipe RFID card at the reader to get out of the parking and pay from their prepaid account linked with the Card. This system solves the problems of improper and unregulated parking practice which arises unnecessary congestion on the roads.

## 6. FURTHER SCOPE

Current research work focused to provide On-Street parking slots and its reservation and imposing a parking fee to the user. This proposed project is a small-scale demonstration which can also be up scaled with very few changes in the system. Further scope in this system is zone or area-based booking, dynamic pricing for different vehicles. This system is able to handle multiple bookings simultaneously.

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