

IOT based Smart Parking Management System

J. Cynthia, C. Bharathi Priya, P. A. Gopinath

Abstract: In this fast-growing economy, the number of vehicle users increases exponentially demanding more parking space. Pervasive presence of smart phone encourages users to prefer mobile application based solutions. Growth of IoT has paved way for integration of mobile devices, wireless communication technologies and mobile Applications. This paper proposes an IoT based Smart parking system that integrates with mobile Application. It provides a comprehensive parking solution both for the user and owner of the parking space. Features are provided for reserving a parking space, authenticating a reserved user, identifying nearest free space depending on the size of the vehicle, navigating to the parking slot and computes accounts information on daily, weekly and monthly basis. IR sensors are used to identify if a parking spot is free. Availability of a free slot with its location information is transmitted using WIFI module technology, microcontroller and wireless communication technology to the server and is retrieved through a mobile application. RFID tag attached to a vehicle is used to authenticate a user who reserves the parking slot on a hourly, daily, weekly or monthly basis. A scheduling algorithm is used to identify the nearest free slot based on the size of a vehicle. The owner of the parking space can get the analytics of the number of free and available slots for a given period, the occupancy rate on week days and weekend and the amount collected for a given period and can use it for fixing variable parking fees. The mobile application is designed to provide rich customer experience.

Keywords: Smart Parking, IoT, Mobile Application, RFID, Analytics

I. INTRODUCTION

Smart city uses the information, communication and technologies to improve the operational efficiency for the public, helps in accelerating towards the improvement quality of life for citizens. Internet of Things (IoT), Automation, and Machine Learning are the emerging trends which drive towards smart city adoption. Any city can be considered for smart city initiative, by introducing system like, smart parking system uses a mobile app to help the drivers to locate parking slots, smart traffic management to track and analyze the traffic flows,

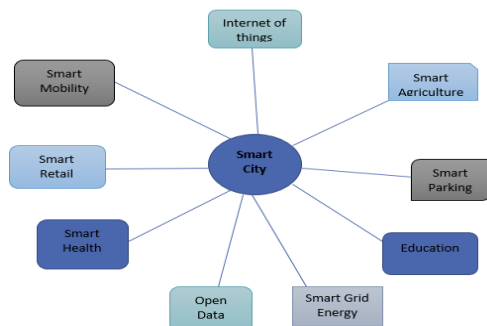


Fig 1. Smart City Components

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Sharing information electronically, monitor the environment changes enabled sanitation etc.

The figure1.shows strategic component to develop smart city mission improvement, smart innovation, energy, smart transportation, smart traffic light ,automatic street light, smart parking, smart innovation on thinking and etc.,.

Any smart applications include sensors, which are deployed in environment, collects the information from device/sensor are processed and analyzed to manage the applications. This approach would reduce the cost man power and increase the productivity. The Internet of Things (IoT) is set of physical devices, vehicles, home appliances, embedded with electronics, software, sensor, actuator and network connectivity which enable to connect and exchange data. It facilitates connections beyond Machine-To-Machine communications, involving various protocol, domains and real-time applications. Sensors can be networked together to sense several physical phenomena such as soil, vegetation, water bodies[24], habitat monitoring, object tracking etc. Smart parking system is a classic example demonstrates how the Internet-of-Things will be effectively and efficiently used to make life easy for a common citizen.

Main purpose of smart parking system is to reduce time to locate the parking areas, hence to it reduces fuel consumption. Sensors would be deployed in the parking area and through the mobile app, user books for the parking slot and allows online payment option as well.

Developing countries like India, face problem for large free parking space management. Conventional parking management systems use sensors and other communication module, but does not address solution for both open and closed parking space. Mobile application that are used to find a parking slot use GPS connect through the Google map API to find free parking space location, but does not find the free parking slot location exactly. The main drawbacks of parking space detection systems are low accuracy, light and weather condition. In this work, methodology to implement Mobile application to find parking space use IR sensor to find vacant slot.

The organization of the paper is given as follows: Section I deals with introduction, section II reviews the existing work for smart parking system. Section III outlines the system architecture and section IV describes the modules developed. Experimental results are discussed in section V. Section VI gives the summary of the smart parking application.

II. LITERATURE SERVEY

Smart parking [1] have proposed a system which used Google map application. Ultrasonic sensor and data collected are stored in cloud. Android application map gives user friendly information regarding vacant place.

Each slot has one LED display which help to find the right parking place. IOT based parking system using Google [1] was proposed to allow the user to reserve the parking place. Mobile application, finds the current parking place. In this system IR sensor is used to find a vacant place and is displayed at entry and exit gate. RFID tag issued to authorize a person entry to the parking place. If the person is authorized signal is sent to open the gate [2].

Advanced CAR Parking System [3] using Arduino and Raspberry PI to detect the free slots. This system uses web server for booking, Google Maps using GPS. Results are displayed in the mark graphically.

Effective car parking system [4] was proposed which uses IR sensors, authentication is done using RFID tag. ZigBee is used for communication. Android Based Smart Car Parking System [5]

Android based application the obtain information about available empty parking slot. The android application would have customer detail include area, state, vehicles number. Application having user enter and exit time and choosing a parking location. User details are stored in MYSQL database. LED indicates to display the parking slots are empty or filled. Camera is used to capture the car number plate and convert the image to check whether the car is authorized user car or not [5].

Smart Parking System based on Embedded System [6] uses smart parking system using embedded and sensor network which uses android and windows application. In this system, Raspberry PI is used, IR sensor is used to finding a vacant parking slot. V2I(Vehicle To Infrastructure) communication to driver sending the parking request providing, user information status of conform reservation. Infrastructure to Vehicle (I2V) communication is used for reserve parking place application and shows direction. JSON format used to inter changing the data. QR code is used for the security purpose, webcam used to scan the code and authorized to show the parking lot direction [6].

A Privacy-Preserving Pay-by-Phone parking system [7] was proposed. The parking system can be reserved by pay by phone method. Mobile application using credit card payment method is implemented. New user can register and the new user contacts the system server and 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].

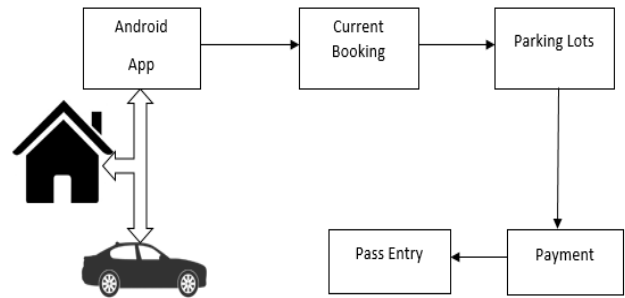
Smart parking guidance system [8] proposed the parking guidance and information. System provide driver information and availability of parking slot through the VMS on internet. This system can be classified two different type off-road and on-road. Off-road used Pneumatic tube, loop deducted, Pneumatic tube to deduct presence of vehicle, Acoustic sensor-noise level to presence of vehicle, piezoelectric sensor-vibration to identify presence of vehicle security purpose used RFID. On-roadway ultrasonic sensor-transmit wave to identify, IR sensor-emitting reflected wave to identify vehicle is present or not.

American countries uses park me app or google map API to find a vacant place[22]. India's capital New Delhi from 2015 start planning to collect all relevant data about parking lot and parking areas current infra-structure of parking place ownership. Web page or mobile app is used to booking parking place [23].

Real time tracking of cars can be localized using range based or range free algorithms. Review of various range based /range free algorithms were discussed in [25]. Based on its location, parking areas may be reserved.

III. SYSTEM ARCHITECTURE

In metropolitan areas, people prefers cab or car as convenient to go to shopping centers, theaters or hotels. Finding place to park vehicles in densely populated area would waste time and consumes fuel during searching for parking space. Hence there is a need for assistive technology, which would communicate the availability of parking slots to the registered user's. Mobile app would allow the users to register for the service and if the destination and estimated arrival time is specified, app need to find the free parking space and send the location to the user. User makes the online payment to book the parking slot. Figure 2, illustrates the architecture of smart parking system.



Advance booking

Figure 2. Architecture of Online booking for parking slot

For each parking region, Infra-Red (IR) sensors are deployed and IR sensors would detect the number of parking slots, Number of free and booked slots are graphically displayed in LCD screen, WIFI module is used for communication between mobile app and sensors. Figure 3 shows a detecting of empty parking slot and communicating used Wi-Fi to Arduino.

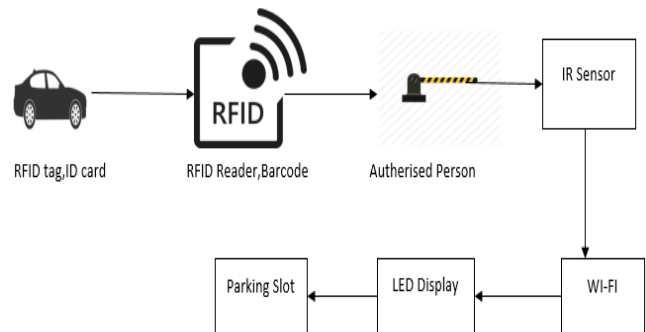


Figure 3. Architecture of Deducting Empty Parking Slot

IV. PROPOSED SYSTEM

The proposed system consists of phases. Each of the phase is explained below:

1. Development of Android app
2. Free Space Identification
3. Authenticating user vehicle



4. Classify parking slot
5. Navigating to parking Slot
6. Visualization in Server for Owner to Analyze

To enable a user to use the smart parking system, user need to register with user ID with vehicle number. User can set up the default payment option in his account settings. The android app is built for booking parking slot and payments. The application is used to find the free slot and user need to specify the estimated time of arrival and parking slot usage start and end time. The IR sensors used to identify the parking slot is free or occupied. Parking slot is empty LED shows slot number N (empty), D (occupied).

After booking for free parking slot, if the vehicle enters the entrance gate, it is assumed that each car has built in RFID card and RFID reader verifies the vehicle and is authenticated. The parking slot may be allotted for small vehicle and large vehicle.

Navigating to parking Slot

Android application having GPS location to navigate the allotted parking area to booked user. It graphically navigates from current location to parking area location. Web page shows lane details date and time, booking time lane status, user detail and user feedback.

V.IMPLEMENTATION

A. Mobile App: Parking App

The mobile app is developed using Android bundle and Android Studio application platform is used. Application Modules are Registration, Login, selecting date and timing or how many days, Parking slot selection, Price calculation and payment. App also supports current booking and advance booking option. If the booked vehicle doesn't enter parking slot within fifteen minutes of threshold booking is automatically canceled. Figure 4.1 shows on the android mobile application starting page user login and registration option.

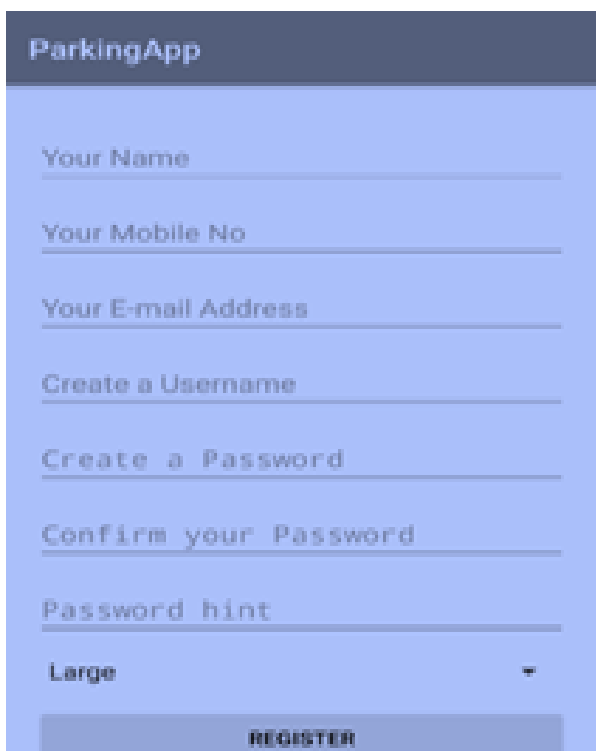


Figure 4. Register

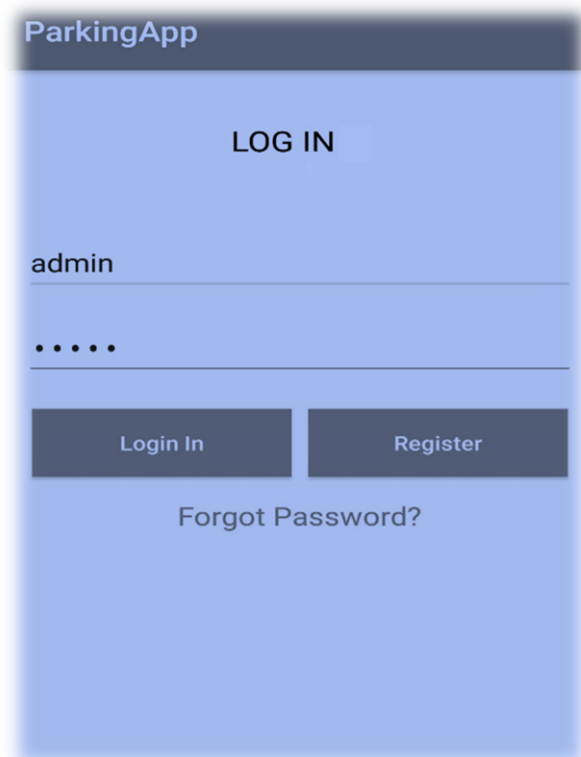


Figure 5. Login Page

Figure 4& 5 depicts the screen shot of Android Mobile phone application login/Register page.

The figure 5 shows on the parking selecting the duration of parking start and end time and identify the availability of the parking slot.

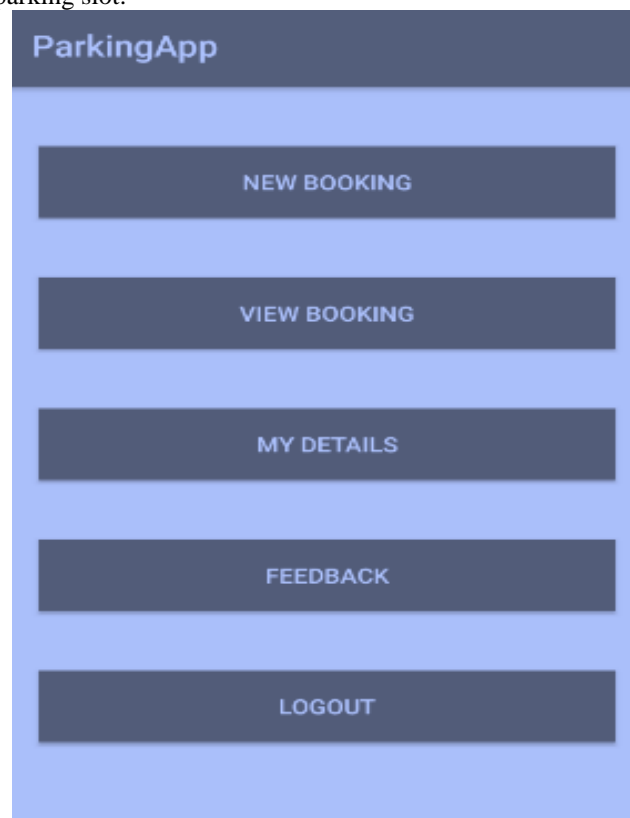


Figure 6. Application Options

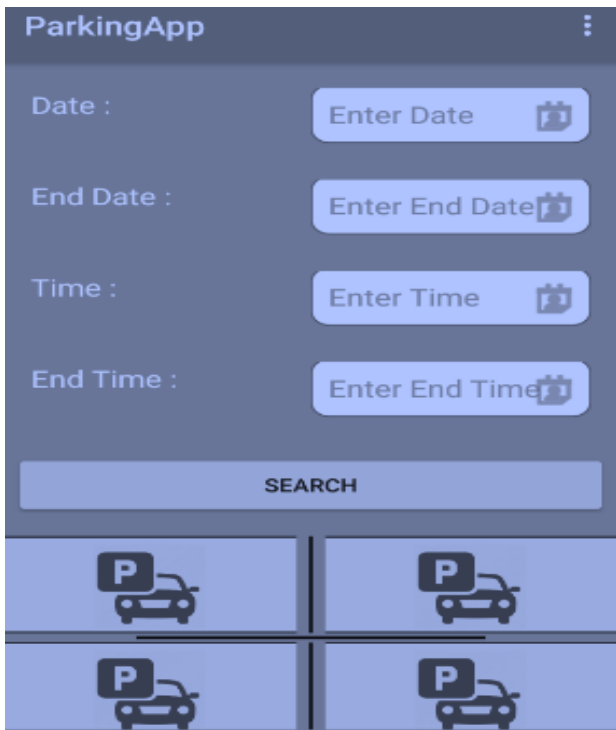


Figure 7. Parking Duration

Figure 6&7 Parking App and Android Mobile application parking duration and slot availability

A. Identifying Free Parking Slot

Free slot identification is verified using Infra-Red (IR) sensors. The IR sensor used for each parking slot. The infra-red sensor detect the vehicle in infra-red waves reflected and covers short distance. A pulse of IR light is generated by the IR sensor and emitted by emitter. Detected the information will be send via WI-FI module to transfer the information to Arduino board and results are displayin LED screen.

B. Authenticating User Vehicle

It is assumed that each vehicle has built in RFID tag and vehicle is authenticated by RFID reader. First time users need to register to avail the facility. Authenticated vehicle would get a pass for entry and slot number would be allocated.

C. Classifying Parking Slot

The parking slots may accommodate large or small size car. During authentication, user fills the user detail in the type of car.

D. Navigation to parking Slot

One of the main feature of this application is navigation service allotted to parking slot. Mobile app would start navigating from the gate to the allotted parking slot. Google map is linked with GPS and app to provide path navigation to the parking slot.

E. Visualization

Owner of the parking center can visualize the booking details, time to time slot availability, bill details periodically. Webpage is created using PHP and parking information (user feedback, Parking ID, Vehicle number, parking period, bill amount, and graphical representation of the parking

area). At the back end, MySQL database is used to store the information. The web page contains local host and global host connectivity.

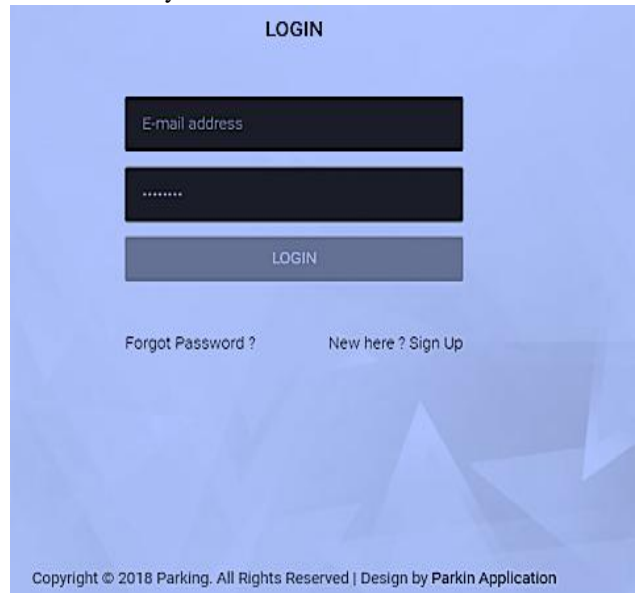


Fig 8. Web Login Page

The Figure 8 shows an admin loginpage, and other options on forget password and sign in option.

Booking History

#	Lane	Date Time	Booking Time	Status	User
1	A2	2/4/2018 01:05 PM	2018-03-29 07:46:16	0	2
2	A4	7/4/2018 04:53 PM	2018-04-07 08:37:55	0	18
3	A13	14/4/2018 08:02 PM	2018-04-07 14:35:20	0	17
5	A1	7/4/2018 08:11 PM	2018-04-07 14:45:43	0	17
6	A1	7/4/2018 08:20 PM	2018-04-07 14:32:22	0	17
7	A5	9/4/2018 05:01 PM	2018-04-09 11:33:52	1	18
8	A2	10/4/2018 01:02 PM	2018-04-10 07:35:42	0	17
9	A4	11/4/2018 08:44 PM	2018-04-11 15:17:41	1	20

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Fig 9. Booking History

The Figure 9 shows the number of user booking details and lane details duration hours. Over all flow diagram of IoT based smart parking management system shown in figure 6.

F. Experiment Details:

Arduino Uno is a micro controller, based on ATmega328P, 14 pin digital input/output pins, 6 analog pins, USB connection etc. Arduino IDE is used for programming and interfacing with the sensors.

In this diagram shows an overall working of the application



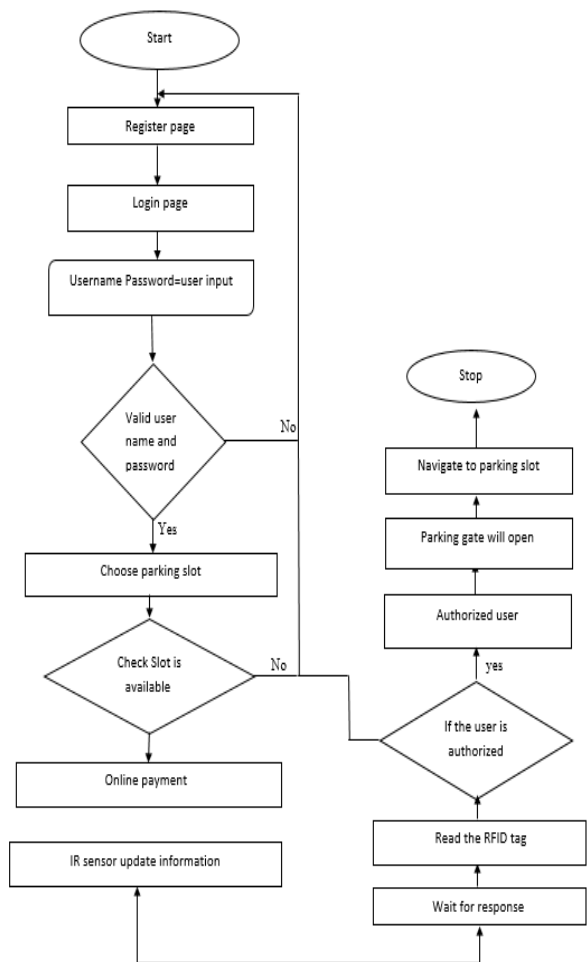


Figure 10. Flow Diagram for Overall System

Figure 10 Flowchart of overall flow diagram for IoT based smart parking management system.

Arduino IDE is used for communicating between sensor, WIFI module and RFID module. Implementation details are given in Fig 11.

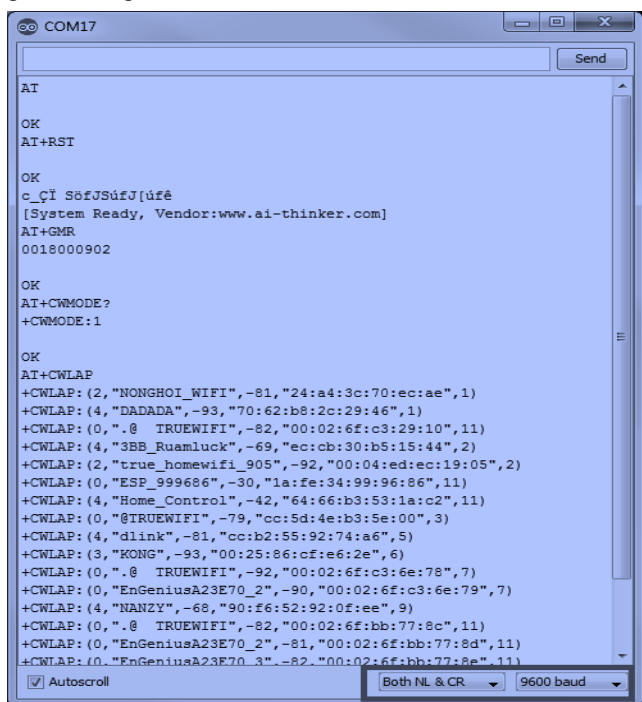


Figure 11. Communication from Wi-Fi Module to Android Application



Figure 12. Authorized User

Figure 12 shows on RFID reader to check user is Authorized person.



Figure 13. Unauthorized User

Figure 13 shows on first time users need to register to avail the facility, otherwise not allow to parking.



Figure 14. Parking Slots Available

Figure 14 shows on the how many parking slot is empty and booked detail on LED screen.

VI. CONCLUSION

In this work, IOT based smart parking system has been proposed which integrates several physical devices to check the parking slot availability. Mobile app allows the user to locate and reserve a parking slot in online, navigation from entrance gate to available parking slot is also the proposed system reduces the driver's effort and time to search parking space. Prototype is built for single storage parking slot, but this model can be extended for multi storage parking space.



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