

Smart Parking System and Slot Allocation with Congestion Avoidance Technique

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ABSTRACT : Among the challenges that we face in our day to day life one of most unavoidable challenge is parking the car wherever we go. Due to drastic increase in usage of vehicles and population we face the tough task of parking our car particularly during busiest hours of the day. During peak hours most of the reserved parking area gets full and this leaves the user to search for their parking among other parking area. This creates more traffic and leaves them with no indication on availability of parking space. To overcome this problem there is definitely a need for designed parking in commercial environment. To design such parking slot we need to take into the account of reservation of parking slot with optimal parking space which depends on cost and time. However, here designed the system which solves the problem of parking using slot allocation method. This system proposes an android application, which is used to implement a prototype of Smart Parking System based on Reservation (SPSR) that allows drivers to effectively find and reserve the vacant parking spaces with the help of IoT with slot allocation method and performs automatic billing process. This paper also presents an automatic road traffic control, monitoring system and an efficient way to avoid traffic congestion for the entire time sequences (24 hours) using wireless communication networks with the help of ZIGBEE protocol and RSU.

KEYWORDS: IoT, ITS(Intelligent Transport System),Smart Parking System(SPS),Parking Area Control Unit(PACU),Smart Parking Allocation Centre(SPAC), Android application, Image Processing, Road- Side Unit(RSU), Zigbee.

I. INTRODUCTION

As the population increased in the metropolitan cities, the usage of vehicles got increased. It causes problem for parking which leads to traffic congestion, driver frustration, and air pollution. When we visit the various public places like Shopping malls, multiplex cinema hall & hotels during the festival time or weekends it creates more parking problem. In the recent research found that a driver takes nearly 8 minutes to park his vehicle because he spend more time in searching the parking lot. This searching leads to 30 to 40% of traffic congestion. Here we going to see how to reduce the parking problem and to do secured parking using the smart parking under Slot Allocation method with the help of Android application. [1][2] RFID application is used for debit the amount for parking charges through the RFID tag. The main contribution of our proposed systems is to find out status of the parking area and provide secured parking [3]. The main motivation of this paper is to reduce the traffic congestion that occurs in and around the urban areas which is caused by vehicles searching for parking [4][5]. In the newspapers, we can able to see many articles regarding the parking problem all over India like Delhi, Mumbai, Chennai, Bangalore and many metropolitan cities. Growing population has created many problems; parking problem is one of the big problems in our day to day life.[6]. In a recent survey, researchers have found that for one year, car cruising for parking created the equivalent of 38 times trips around the world, burning 177914.8 litres of fuel and producing 730 tons of CO₂. To reduce all these factors we go for the smart parking system.

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II. RELATED WORK

In earlier days, different models like CLAMP, PARKISM, PARAGENT, MULTILAYERS were used for parking. Over the past 20 years, traffic authorities in many cities have developed a model called Parking Guidance and Information (PGI) system for good parking management. PGI systems, tells about the dynamic information of parking in the controlled area and guides the users to the vacant parking slots. Parking information will be displayed in the VMS (Variable-message sign) board at major roads, streets and at the intersections. The parking guidance system has several shortcomings, hence to overcome all these problems we go for smart parking. Designing, developing and producing a leading edge parking technology is called as Smart parking. It is a vehicle parking system that helps drivers find a vacant spot. Using the IR sensors in each parking slot, it detects the presence or absence of a vehicle, and sends messages to user. Smart Parking system is proven as an exact, robust and cost efficient way to ensure that road users know exactly where unoccupied car parking spaces are. The features of the proposed system are:

1. Guides drivers find available parking spaces near them.
2. Less number of drivers searching to park thus reduces the traffic congestion.
3. Avoids air pollution & global warming.
4. Scalable, robust and reliable.
5. Reduces the driver stress and improves the urban area.
6. Provides tools to optimize the parking space management.
7. Accurately find out the vehicle occupancy in real time.

This system explicitly reserves and allocates optimal parking space to drivers, as opposed to simply guiding them to a space that may not be available by the time it is reached. The reservation in our “smart parking” system is different from that in the e-parking platform and others mentioned earlier. In the “smart parking” system parking slots will be reserved for the user and by the user which are selected to be optimal based on a well-defined objective function structure.

II.a. Overview of smart parking

This proposed system, uses the “Smart Parking” which takes the basic structure of PGI systems as one component. It includes Driver request processing centre (DRPC), smart parking allocation centre (SPAC) and Parking resource management centre (PRMC). The overall view of the smart parking is shown in **Fig-1**.

II.b. Driver request processing center (DRPC)

It is the first stage in the allocation process; drivers who are looking for parking spots will send requests to the DRPC. The request consists of two constraints: parking cost and the walking distance between a parking spot and the driver’s actual destination. It also contains the user’s information, such as current location, license number, car size, etc.

II.c. Smart parking allocation center (SPAC)

The SPAC collects all the driver’s requests from the DRPC over a certain time and makes an overall allocation at decision points in time. An assigned parking space is sent back to each driver via the DRPC. If a driver is satisfied with the assignment, he/she has the choice to reserve that spot. The allocated parking space is updated in the PRMC.

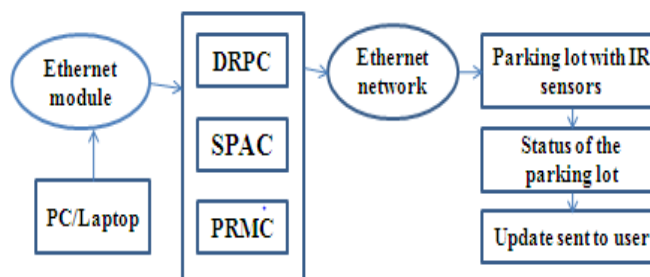


Fig-1. Smart parking frame work.

The above **Fig-1** gives the overall view of the smart parking system that how the data from the user reaches the parking resource management system via smart parking allocation centre with the help of the Ethernet module.

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II.d. Parking resource management center (PRMC)

The PRMC updates the corresponding parking spot from vacant to reserve state and makes sure that other drivers have no permission to take that spot. If a driver is not satisfied with the assignment or fails to accept the slot, he has to wait till the next allocation decisions are made by the SPAC. Drivers with no parking assignment have the opportunity to change their cost or walking-distance. The status of the parking space is updated in the VMS (variable message sign) such as the number of parking spot occupied, reserved and also that are open to reserve.

III. PROPOSED METHODOLOGY AND DISCUSSION

The proposed system is the combination of smart parking and the Slot allocation with the Android application. In the existing system, a dynamic algorithm is carried out, which is a random allocation method. It randomly allocates parking lot to the users.

III.a.SLOT allocation algorithm

The slot allocation method follows a sequence as discussed above. It has the Parking Area Control Unit and the Smart Parking Area control Unit (SPAC). The functions are as follows:

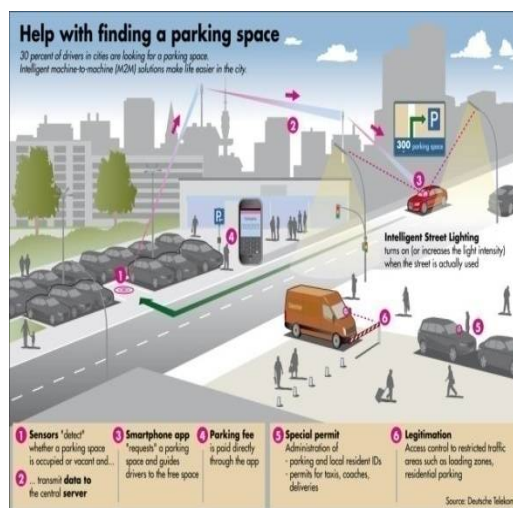


Fig-2. Data flow diagram

The data flow diagram **Fig-2** which depicts the flow of operation in the smart parking system and the slot allocation mechanism for the parking of the vehicle.

1. Initially the slot selection is made from the mobile phone.
2. Transforming request for parking slot from the mobile using Android application.
3. The Parking Allocation Control Unit (PACU) gets the request slot number from the mobile.
4. Checks for the parking slot availability, if it is free go to the next stage. If the slot is not free goes to the initial state.
5. If the parking slot is free, the requested slot is reserved in the parking area.
6. After reserving the parking slot in the parking area, it checks for a condition if it is available.

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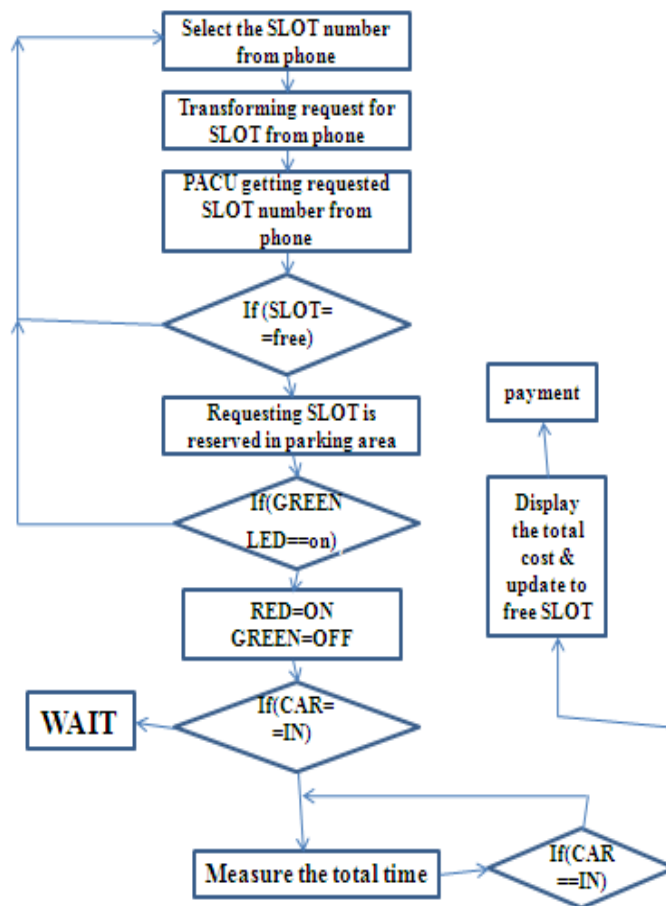


Fig-3. Slot allocation

Fig-3 shows the slot allocation algorithm that how the mechanism of the parking of the vehicle flows in a manner.

7. If the parking slot is not free then it will go to the initial stage.

8. After reserving the parking slot in the parking area then the status of the led will be RED=ON && GREEN=OFF.

9. If car gets entered into the parking slot, the timer gets ON and measures the total time. 10. If not, the timer waits till car to get in.

11. Once the car is to move out of the parking slot, the timer gets OFF and displays the total cost.

12. Displays the total cost finally and updates the free Slot information.

The above steps conclude the slot allocation algorithm. Initially the driver sends request via mobile phone using Android application and do reservation as mentioned in the smart parking overview. They have the database of all drivers request and according to the requests with the slot allocation method; the parking slot is allocated to the drivers in the parking area. And finally updates the information to the mobile phone users. Here we can reserve our own parking slot. It is user friendly. Driver can choose the parking slot which is comfortable for them. It overcomes the process of time saving compared to the dynamic resource allocation method and also cheaper than that. Using the FCFS scheduling method the priority will be scheduled.

III.b. Congestion Avoidance System

The following block diagram consists of AT89C51 microcontroller, IR sensor, RFID tag, Relay, LED and Android Mobile device.

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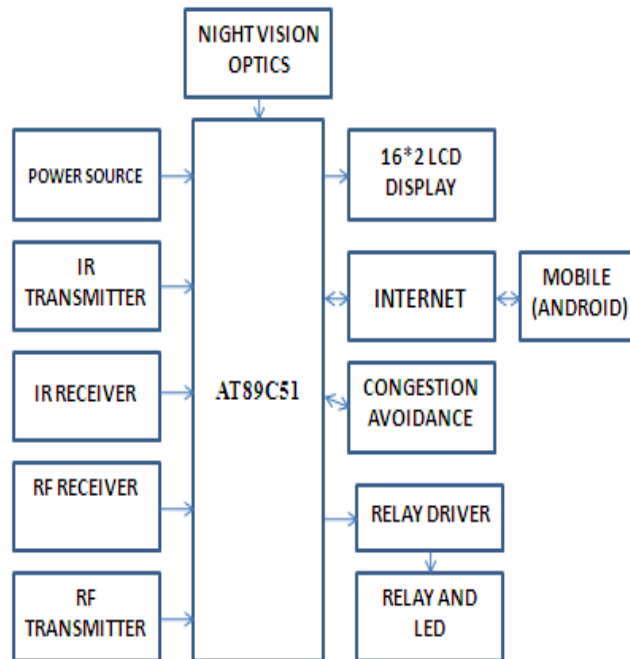


Fig-4. Congestion Avoidance System.

With the help of the congestion avoidance system technique the congestion in a particular area can be predetermined and the alternate route could be taken as shown in **Fig-4**.

III.b.i.RFID

A Radio Frequency Identification Tag (RFID) tag is an electronic tag that exchanges data with a RFID reader. Here we are going to use Active tag of RFID. While RFID's original uses were primarily for inventory tracking in retail environment, this technology has quickly created a presence in an extremely diverse number of fields including easy gas payment, credit card replacement. RFID tag has chip, memory and an antenna.

IV. ZIGBEE CHARACTERISTICS

- ❖ Maximum data rates allowed for each of these frequency bands are fixed as 250 kbps @2.4 GHz.
- ❖ Master/slave topology.
- ❖ Automatic network configuration
- ❖ Dynamic slave device addressing
- ❖ Virtual peer-to-peer links (pairing)
- ❖ Low power consumption.

Zigbee has high network capacity in a small area using multiple access. Generally, the traffic congestion is configured by enormous and uncertainty amount of terminals. We use a kind of wireless personal area network IEEE 802.15.4 structuring network communicated enormous amount of terminals. When image matching percentage is very less, then it means there is heavy traffic, in such case program will activate ZIGBEE module through microcontroller and a message will be transmitted to nearby Road-side unit(RSU) or RSUs along the same route. The message can be displayed at that RSU with the help of any displaying device. Message about heavy traffic/ jam on a route can help people to avoid it by rerouting.

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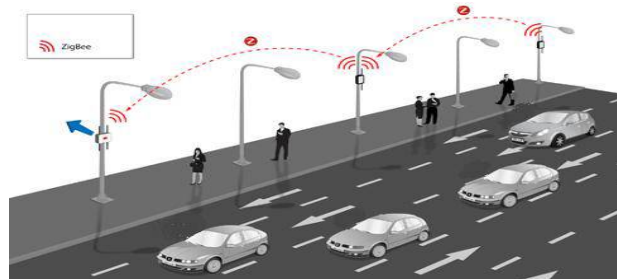


Fig-5. Road network through Zigbee

The amount of vehicle is detected with the help of Zigbee and road side unit (RSU) to predetermine the congestion in a particular area is shown in **Fig-5**.

V. RESULTS AND DISCUSSION

Slot allocation is implemented using Android application for the smart parking, which are as follows. Here we have created two slots using Android application in my mobile and up dated to the embedded kit using the internet. Initially both slots are free it is indicated in the embedded kit, green LED glow as denoting the parking status free initially. The slot P1 is booked so it is changed as red colour in mobile and in the embedded kit particular kit the corresponding LED is changes to red from green. It is a cost-effective as well as feasible to implement. This system can be modified (Future work) by adding some more features such as:

- Vehicle number plate detection.
- Detection of speed of vehicles on Road.
- Traffic monitoring at night.
- Uses of better communication system for wirelessly transfer of real-time videos of traffic scene.

VI. SIMULATION RESULTS

VI.a. Client Side::

VI.a.i.Starting the application

The user needs to install the “Smart Park” application on his Android based device. After installation, the icon of the app will feature on the Home Screen of the user’s device. Then want to create the sign-in user name and password.

VI.a.ii. Registration

Initially, the user has to register his details with the application for the first time. This is a one-time registration. The user has to enter details like username, gender, phone number and email-id. All this data will be stored on server. Booking for slots mandatorily has to be done four hours prior to arrival. In the registration process the user has the register in the app with the vehicle identification number for the reservation process.



Fig-6. To enter username & password

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Initial process is the registration process where the user have to login to the smart parking app with the help of the user name and the password and have to register their vehicle number as shown in **Fig-6**. In the above registration format the user can keep remember the password for further use.

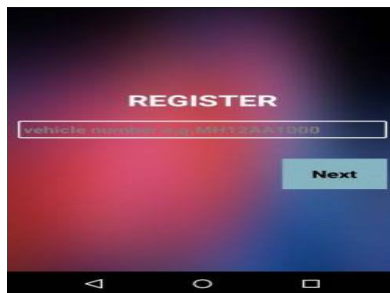


Fig-7. To register the vehicle number


In the above **Fig-7** it shows that how the vehicle has to be registered with the vehicle no. and the next process is done.

VI.a.iii. Selection of Location for Parking

The client is provided with multiple parking locations. Client has to select one of the locations provided where he desires to park the vehicle. In the selection of the location from various parking slots the fig (c) is made used. It provides the details regarding various parking slots such as P1, P2, P3, P4, P5. Among those parking slots the user can select the lot based on their needs.

VI.a.iv. Availability status of the slots

Based on the location selected availability of the empty slots will be displayed on client’s device. Colour coding is used to indicate empty v/s reserved slots. If the parking slot P1 is selected it provides information such as total slots available, number of slots occupied, total number of free slots.



CITY	COIMBATORE				
Parking place	P1	P2	P3	P4	P5
Total Space Available	150	200	250	300	220
Occupied Space	50	85	225	100	150
Free Space	100	115	25	200	70

Fig-8. Total number of parking lots uploaded in the database server

Fig-8 shows the availability of parking lots in different places such as P1,P2,P3,P4,P5 etc., in a particular city.It consists of the parameters such as parling places, Totally available places, Occupied places and the free places remaining.

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PARKING SPACE (P1)	
VEHICLE SPACE <input type="radio"/> 2 Wheeler <input type="radio"/> 4 Wheeler	TIME PERIOD <input type="radio"/> < 1 Hour <input type="radio"/> 1 - 3 Hour
VEHICLE SIZE <input type="radio"/> Less <input type="radio"/> Medium <input type="radio"/> Large	PAYMENT METHOD <input type="radio"/> Cash <input type="radio"/> Debit Card <input type="radio"/> Credit Card

Fig-9. Details of the Parking lot 1(P1)

Fig-9 depicts the various parameters that to be entered when the particular parking lot (P1) is selected as shown above. It has parameters such as vehicle space, vehicle size, time period and the payment method.

VI.a.v. Details to be entered for slot reservation

If the parking slot P1 is selected the details such as vehicle description (2 wheeler/ 4 wheeler), Vehicle size (large/medium/small), Time duration i.e for how much time will the vehicle will be parked in that particular slot (<1hour/1-3 hours/4-6hours). The above details should be selected along with the payment method (cash/credit card/ debit card) .

VI.a.vi. Enter duration period of the vehicle

In case the slot required by client is available, the client can proceed further with the reservation process or else he can go back to change the location or else can terminate the entire process.

VI.a.vii. Confirmation

On successful reservation, a confirmation page with user details and parking location is shown on client's device. The conformation page also shows where the vehicle has been parked.

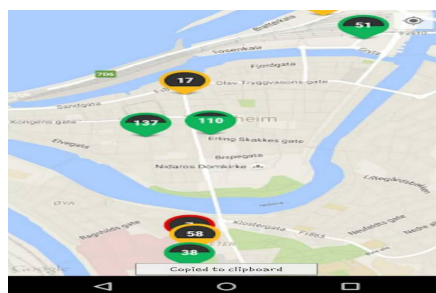


Fig-10. Schematic picture of available parking lots

The above Fig-10 shows the schematic picture of the availability of the parking lots for a particular area in a city. The non-availability of the lots are shown with the shaded portion and the availability of the lot is shown in the dark area.

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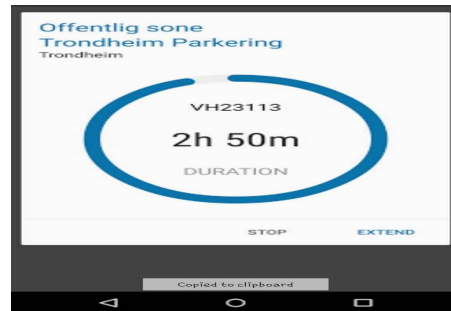


Fig-11.To enter the parking time of the vehicle.

Fig-11 shows that the user have to enter the time duration that the vehicle will occupy that particular lot. This facilitates the other user to identify when that parking lot will be free for use. Thus, it reduces the time consumed.

VI.b. Server Side::

The server side processing will be developed using Java and MySQL. The administrator has to register his details with the server side application.



Fig-12. Indication of led showing the availability of slots.

This is also one time registration. Whenever a new user registers with the application, the record will be stored in the server side database. When the registered user selects the location, immediately server receives the client's request. After receiving the request for the desired location, server processes the related information and responds accordingly.

Fig-12 shows the hardware implementation of the smart parking system.

VII. CONCLUSION AND FUTURE WORK

The Smart parking system based on Slot booking is implemented, using the Android application. Using the slot allocation method we can book and block our own cheapest and shortest distant parking slot. It is an efficient one for solving parking problems, which overcomes the traffic congestion and provides automated billing process using the RFID tag. This work is further extended as a fully automated system using multi layer parking method. Safety measures such as tracing the vehicle number face recognition of the drivers so as to avoid theft & automatic billing process can also be designed. We plan to expand the tests on the real time environment where the users can have the "Smart Parking" system in their handheld devices. This paper shows how the parking problem at crowded places can be handled with a well-thought plan. It helps the clients in finding out the availability of a parking slot, get the availability confirmed, and reach the place within the time slot allotted. It also makes the management easier at administrator side. It also saves the time of clients required for searching a parking slot.

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