

A Prototype for IoT based Car Parking Management System for Smart Cities

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Abstract

Background: Present day's car parking has become a major issue in urban areas with lack of parking facilities and increased amount of vehicles, due to this drivers who are searching for parking space they were roaming around the city in peak hours. This causes traffic, waste of time and money. **Methods:** To solve those problems, this prototype is developed using sensor circuit, RFID and IoT. RFID used here to detect the car details, IR sensor is used to find the presence of the car and all details are accessed from remotely through IoT. **Findings:** This system helps user to find parking space availability with the help of Internet of Things (IoT) technology by providing parking free space information. The IoT maintains the database of the parked vehicles through a shared server. So drivers can book the slots in advance and the parking information updated in server. In addition to the parking, theft management will be done i.e. a theft vehicle came for parking then the number plate is checked with theft list in the database, if it is in theft list then a message is sent to the police. **Applications/Improvements:** This prototype developed for the parking system with less human interaction, increases flexibility and security. This system is employable in airports and multiplexes parking.

Keywords: Internet of Things, IR Sensor, Ipv6, Parking Management System, RFID

1. Introduction

Present day's getting a parking space in urban areas is very difficult in peak hours due to lack of parking spaces. Due to this driver stuck in traffic or looking for parking spaces around the location makes traffic congestion. This causes waste of money and time. So if we have parking space information, we can plan for advance booking based on requirement, for that we developed a prototype of car parking management system using Internet of things. Parking spaces are large in size for airport or multiplexes, so it's difficult to maintain system manually. The major issue with car parking is that improper parking and damages others cars while parking the car. Hence the damaged car parking owners unhappy with parking management and get frustrated. The car parking system communicates with each and every slot to server. Car parking management system guides the user to park the car perfectly and maintain database, hence we can find who damaged the car.

In urban areas, car parking becomes critical issue with increased amount of cars. A Study showing that 30% of the cars in the traffic jam are looking for parking space and on an average eight minutes' time required to find a parking space^{1,2}. This results wastage of oil or gas, money and time. To overcome these drawbacks park IT is a platform independent mobile application working for parking management system^{1,2}. In case of dynamic vehicle parking first come first serve based GSM/GPRS framework is used without manual interaction³. To reduce the parking damages an intelligent valet parking system is designed, it guides cars automatically park the car within parking slot⁴. AMR sensors are used to get accurate availability of parking spaces⁵. By using neural networks, we can specify the vacant spots extracted from parking spaces and by adjusting light intensity we can predict the slots at night time⁶. With great revolution in IOT brings flexibility to the user, it will provide parking availability and maintain database can be possible through a web interface^{7,8}.

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Finding the theft vehicles makes big issue for police man. They are facing difficulties to find the theft vehicles because thefts are changing the number plate of the vehicles. We can overcome this by using RFID technology. RFID tags need to install in the car, these RFID tags placed in different areas in the car, so thefts fails to find the RFID tags. Radio Frequency Identification (RFID) is uses radio frequency waves to identify the objects wirelessly. In earlier days, RFID technology is used for tracking the objects. Toll-gate fee collection is also earliest application. It can be configured through different range of frequencies; if the frequency is high then data transfer is also high. Using RFID tags we can identify the cars and its details using unique identifier. RFID uses two types of tags, passive tags do not have own power source or transmitter and it uses parasitic power, those tags have their own power source or transmitters are called active.

This car parking management system consists of IR sensor nodes which are arranged in centre of the each parking slot to detect the car. The data is sends to the server. The server processes the data and maintain database and uploads into web page. The user can check available slots and price from remotely for that IoT developed. It is an environment that transmits and receives data over a network for controlling the devices with or without human interaction. The things provide data storage, processing and collection of data. Here data captured by sensors and transmit data through internet.

A survey telling that 70% of the devices in the world are connected to internet by 2020. It involves in taking control of devices and making objects speak one to other. In this process IoT becomes internet of everything where anything can be connected to any network, anywhere, any time and anybody. IoT uses cloud sources for connecting any networks. For connecting the things to internet we require internet protocol, it is used for internet connection and it is uses an addressing format for any data transfer on the internet. In IoT, we use IPv6 instead of IPv4 due to limited addressing capacity. IPv6 is used to address the things. One host can be connected to other host directly by using unique identity provided by IPv6. To control the parking issue, IoT plays major role by using this user gets parking availability on smart phones and get accessed. Every object uniquely identified and accessible with the help of IoT.

Car number plates can be identified by automatic number plate recognition system and also we can do parking management and toll fee collection also^{9,10}. But these

algorithms are not applicable for Indian car number plates. The Indian number plates far different from other country number plates and the available algorithms are also not giving accurate results. Those algorithms are extracts alphanumeric values from the number plate instead of complete car image extraction. So we adopted an advanced technology that is Radio Frequency Identification (RFID) technology. This RFID technology replaces number plate recognition techniques in toll booth systems for toll collections and smoke emission¹¹.

RFID simply provides info that can be used to track and monitor goods, assets, even people¹². In retail industries, RFID are used to track the loss of goods. If the RFID tags not properly placed then we can provide warnings. Smart parking system developed by RFID and wireless sensor networks; it detects the nearest parking spaces and directs the driver to that parking area¹³. Near field communication technology is used to develop the parking systems¹⁴, author also developed a mobile application for parking the slots online.

In present days, car sizes are varying and sometimes use more than one parking size, hence beside parked cars are affected. So AMR sensors are used to find out size of the car based on that car is parked¹⁵. Wireless sensors are placed on parking lot each wireless sensor node is placed on each slot from that we can detect the parking space allotted or not¹⁶. The author is developed architecture by using that we can request the slot for parking and also we can know the availability but booking is message based request response manner¹⁷. The internet of things can be described as a combination of identification, sensing, communication, computation and services¹⁸. Identification methods are used to identify the objects¹⁹, sensor gives the data and it is sent to the database after that data is analysed to take specific operations, communication protocols like ZigBee or Wi-Fi used for IoT communication²⁰, different hardware platforms are used for developing applications and is used for specific services like smart cities²¹, health-care systems, industries²² etc.

2. Methodology

A prototype is developed for making the car parking better, flexible and secured, for this we developed a framework that is shown in Figure 1. This proposed architecture having a Raspberry pi board, this board is small sized but it works like a computer. The entire central processing unit replaced by this simple debit card sized board and

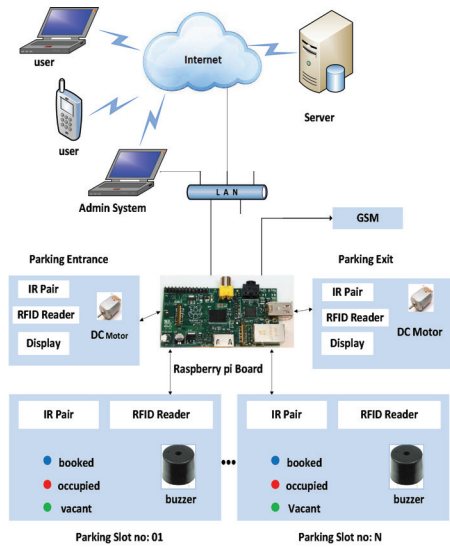


Figure 1. Prototype of IoT based car parking management.

it is available for lower prices in market. This will uses Raspian (tiny OS), similar to Linux based environment. It'll act as a server also for smaller applications. This system using IoT technology, we can access, control and communicate the things remotely.

This system consists of different modules to perform parking management. Those are 'online booking', 'parking entrance system', and 'parking exit system' and 'parking management'. User faces the problem to finding the parking places in and around the city for solving that problem, we developed the module 'online booking' from this user can book the spaces in advances that is shown in Figure 3.

When the car appears at parking location then it deals by parking management module. Here RFID technology is used to detect the number plate, car details first checked with database for predicting that car theft or not. If the number plate matches then we'll send SMS to near police station. For that here we are using IPv6 protocol, used for internet connection and we can connect our own smart things with rest of the world. This makes IoT employing anywhere. The Figure 2 shows the packet format of IPv6 with encapsulated RFID message.

The address space problem in IPv4 is overcomes with IPv6, and client no need to approach any server because they gives permanent address by this protocol. Here version is 6 (4 bits), traffic class generates packet priority, flow label maintains sequence flow of packets, payload length describes how much information contains in each packet,

version	Traffic class		Flow label
Payload length		Next header	Hop limit
Source address			
Destination address			
Next header	Header length	Option type	Option length
RFID type		Message type	reserved
RFID code			
Message data			

Figure 2. IPv6 packet with RFID message.

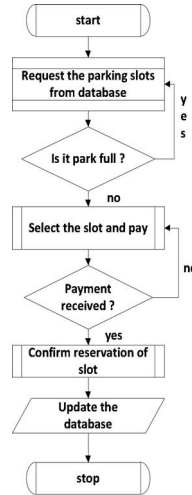


Figure 3. Flow chart for online booking.

next header field contains address of the next packet, hop limit tells that how many nodes can passes this data, after that packet vanishes and address contains (128 bits) of source and destination in hexadecimal format. RFID unique code (96 bits) can send through this protocol, it also consists RFID tag details like that RFID is active or passive decided by RFID type and type of message and message data also included with unique code. After that it'll assign the slots based on availability (from database) and that is discussed in Figure 4.

Sometimes user confuses to park his car in a given allotment, he may wrongly parked and while parking his car he can damages others cars also that makes owner angry and we can't find him at all, for solving this problem we developed parking management system that is shown in Figure 5. From this user can pay attention to park perfectly and if damaged that will predicted from database.

If the user wants to leave the parking space, user need to pay the parking fee either in online or offline that will be managed by parking exit system, that is shown in Figure 6. These all data continuously updated in database

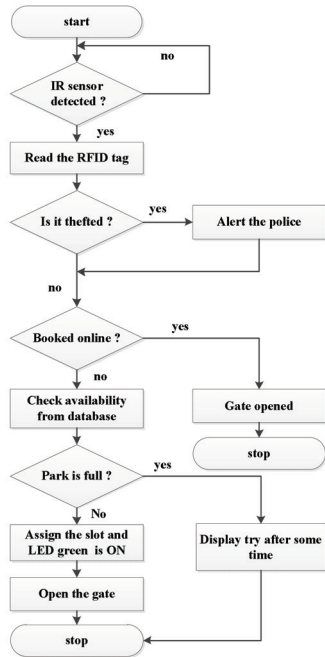


Figure 4. Flow chart for parking entrance system.

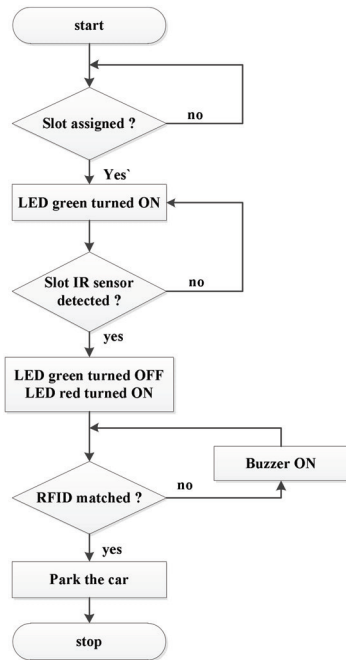


Figure 5. Flow chart for parking management system.

using internet. The system admin can see the database using admin login in web portal and also user can book the spaces by login to the web portal.

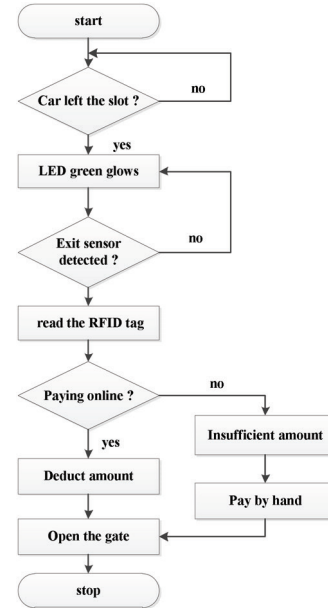


Figure 6. Flow chart for parking exit system.

2.1 Online Booking

In urban areas finding parking space is difficult in rush hours. So here we developed online booking system by using this we can book the parking slots in advance like movie tickets booking online. We can book the parking slots by using a mobile app or web portal. The booking procedure explained in the below flow chart. Database provides parking availability information; if there are any vacant slots available then we can book the interested slot and complete the payments. When we finished booking, the database is updated with current availability.

2.2 Parking Entrance System

This parking entrance system uses IR sensor, DC motor, LCD display and a RFID reader. IR sensor is used to know the presence of car for parking, DC motor is used to open the barrier, LCD is used to display. The parking information and RFID reader is used to detect the car details like number plate, owner name etc. After detecting the number plate, it will be checked with theft list, theft list will be provided by police and list will be maintained in database. If that matches with present number plate then an SMS sent to the police. If the user booked online his parking space then gate is opened and can move inside. The LCD displays the allotted parking slot and parking status also. This allotment details continuously updated to database.

2.3 Parking Management System

This part provides directions to the owners to park their car correctly. Here each slot allotted by one IR pair, one RFID reader, three LEDs and a buzzer. Initially it will check the slot is assigned or not, if it's assigned then LED green turns 'ON'. If any car entered in the parking slot then IR sensor detects, LED red turned 'ON' and LED green goes 'OFF'. Now RFID reader reads the car's RFID tag, if allotted car RFID is not matched with present detected car RFID then buzzer is 'ON' otherwise park the car. If buzzer 'ON' user can understand he parked his car wrongly then he can left the slot and goes to his allotted slot. This data continuously updated in database.

2.4 Parking Exit System

This parking exit system contains peripherals similar to parking entrance system. If the car left from the parking space then LED green turned 'ON' and at the same time LED red turns 'OFF'. At exit, the RFID reads the car details and shows the parking fee. Payment is users choice, he can pay either online or offline. Since we finished the payment then gate opens and the data all uploaded to server.

3. Conclusion

The main intention of this prototype is to develop a car parking management system using Internet of Things. IoT is the present trending area in internet, used to access the information remotely. Present days everybody uses smart phones and internet, so online booking provided solution to the predicting the parking space issue and user can pay parking fee online. RFID technology is used to detecting the car identity (number plate) within fraction of seconds and the main issue of theft recovery is also done. We can send messages through internet, if we achieved that reduces cost of the hardware.

The parking management provided solution to the perfect parking and reduces man power. This system employed in airports, multiplexes and corporate offices. Still it has consequences, if number of slots increases controller cannot handle for that wireless sensor networks need to be replaced in order to make this system more convenient, and we can develop an android application and collect all other parking spaces information in urban areas we can include that into the application.

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