IoT BASED SMART PARKING WITH IMPROVED USER EXPERIENCE

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Abstract

This paper provides a method which brings in user interface improvement and improvement in the performance of a smart parking system. The system designed and developed has cloud and an IOT based architecture. The model developed helps the users to book parking spaces which are at closest distances. This system offers an efficient parking solution for major cities where identifying the right parking place is a tedious task. The reservation ticket will be available as soon as the user requested for it. If all the parking slots in the closest parking space are full, a slot which is available in the next nearest parking space will be allotted. The model helps users in reducing their time in finding a spot/slot to park their car. There shall be a threshold time duration to be fixed within which a person can book his or her parking space and can park in the reserved space. If he or she not able to park within that threshold time duration, a grace time to be decided and the user can be given one chance to do the extension of reserving the same parking slot with additional fee. Apart from those facilities the model can be further used for implementing different car models or two wheelers, which in turn optimizing the usage of parking spaces and for efficiently handling reservations done by the customers.

Keywords-- optimization algorithm, shortest path, effective parking system

INTRODUCTION

Smart cities have adopted many new Internet of Things (IOT) technologies for the better quality of life style of people. By using new technologies, day to day activities of the public can be improved a lot. The concepts of Internet of things and machine learning algorithms are being adopted all over the world to take smart and right decisions. Even the decision maker need not be physically present in the place of event. Even small initiatives like smart traffic control can be used to bring a big change in the life style of and comfort ability of public. Hence, detailed research is happening globally about IOT.

In this work a smart parking system is designed with the intention of improving the user experience. The parking system developed uses the real time location to identify the nearest parking space with a vacant slot. The system is developed as a mobile app to improve the usability of the system and enhance the user experience. The user can reserve a parking slot using the mobile app developed. The main function of any smart parking systems is to share the live information electronically. It should monitor the environment changes and update the shared information dynamically.

The mission of developing new smart cities starts with introducing smart energy meters, making the transportation system smart, bringing smartness in traffic light signals and in street light, implementing IOT enabled parking, enhancing farming systems by introducing smart farming etc.,. Smart applications use sensors that are deployed in environments. These applications use the necessary data collected from the devices/sensors to take the smart decisions. To take the right and smart decisions the applications do the operations such as cleaning, integration, transformation of data and then do the analysis. Also the application developed for the specific purpose is tuned to declare the results in the form which is expected by the sophisticated users. The figure1 shows few components which contribute in the formation of smart systems.

Productivity in the manufacturing industries increases with less manpower using this approach of automation. IOT connections are beyond machine-machine communications. It includes sets of devices in home appliances which are used in day to day activities with embedded sensors, network connectivity that can connect and exchange data, and piece of code to enhance the user experience. Hence, these kind of smart systems involve sensor data, protocol/algorithm, perfect connectivity, tested software code and the required amount electric power.

All these things can be combined together for various purposes of testing physical phenomena like tracking objects, soil moisture, living environments of water bodies, any kind of traffic, etc. Smart parking system can be claimed as a very effective example of how an IOT concepts help in making the life of common people easy and enjoyable.
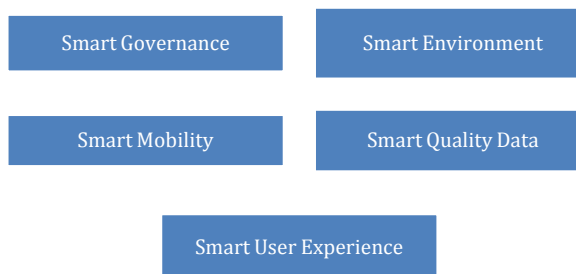

Figure 1. Major Components of Smart System

In our discussions, we are considering the given location as the parking venue. For example, our University is the parking venue. Each venue has many parking spaces and in our case near every building of the university there exists parking space(s). Any parking space has more than one parking lot. Every parking lot can be occupied by different vehicles according to their slot. It means that, every parking lot is going to be used by different users/vehicles at different time duration of a day. Since we have considered

our university as the environment for implementing smart parking, it has a special requirement. The special requirement is that few parking lots are reserved for the professors and administrators. Even though those reserved lots are not to be available for others to book in principle, we wanted to utilize some of the slots without compromising on the convenience of the professors / administrators.

Each parking slot is provided with a sensor at the entrance to detect the presence of vehicle in the respective lot. If a vehicle is parked in a lot, then based on the sensor's data, any other user who is looking for parking lot should not be able to see that specific parking lot. This will reduce the customer's frustration. At the same time, once a vehicle leaves the parking lot, that lot to be available for the users to book at that instant. This will improve the effective utilization of the resources while improving customer satisfaction. Due to this effective parking reservation system, consumption of fuel, time spent in searching for parking are reduced while user experience, user satisfaction and resource utilization improve drastically. The system which we develop uses the shortest path algorithm which works on the live data and takes the quick, correct, dynamic decision and helps the user to identify and reserve the nearest parking space of his/her choice.

RELATED WORKS
Google [1] proposed IOT based parking system to allow the user of the vehicles to reserve the parking space. In this model IR sensors are used as shown in figure 2, to find the vacant places. These vacancy states are shown to the people with the Liquid Crystal Display (LCD) units. The LCD panels are fixed on the entry gate for parking slot. This system used the data from Google map and ultrasonic data. The collected data stored in the cloud was used by the application developed. Android map application will give user friendly information regarding vacant places.
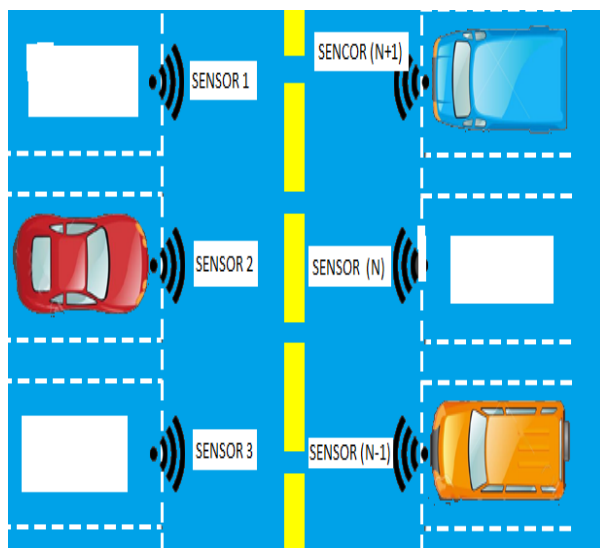

Figure 2. A Simple arrangement of receiving availability of parking lots

Advanced CAR parking system [2] uses Raspberry PI system and micro controller arduino uno for detecting the free slots. This system uses Google maps and Global Positioning System (GPS) data. The web portal developed, processed the data collected and concludes the parking slots for booking. The web portal allows the user to enter the entry and exit time and also for choosing available parking lot.

Each parking lot has IR sensors, which help to find the right parking space and LED display unit which indicates whether the parking lot is empty or occupied.

An embedded smart parking system [3] uses Raspberry PI and IR sensor for identifying a vacant parking lot. The application uses windows operating system. The communication between the Vehicles to Infrastructure (V2I) happens which is shared to the driver of the respective vehicle, provided the driver is registered user. V2I communication is also used to reserve parking lot and to show directions to reach the reserved lot. This system uses JSON format for data interchange. For security purposes Quick Responsive (QR) code is used. The dynamic QR code, which is machine readable unique identification code, is scanned at the entrance and from that point it helps the vehicle in navigating to the respective reserved parking slot.

Mobile applications using credit card payment method is implemented in Pay-by-phone parking system [4]. New users can register and they can use their contact information to purchase new e-coins, which are used for reserving. The registered users can locate the vacant parking slot and book. The e-coins have parking duration, which means that the user needs to buy more e-coins for longer duration of parking.

Since the government is willing to invest on Smart cities and relevant developments and projects, many researchers invested their time and efforts and came out with many innovative solutions [5-8]. Specifically in smart parking system, everyone is very much interested, since traffic jam is the most bothering term for most of the people worldwide. The next bothering term is finding the right parking place in a crowded location.

The best route to be chosen for travel is really a worthy task, which any smart person does well. Hence, public prefers that kind of solutions to be offered in any smart village/city. The study of finding the best route is classified under Traffic assignment. Usually any traveler who is traveling with a purpose wants to save time, have a best road/ mode of travel and of course with minimum cost. Some other parameters are also to be taken care such as climate, time of travel (day/night) , traffic density, type of regions to be crossed on the way, safety arrangements in the route and of course nature of traveler

ARCHITECTURE CHOSEN
In most of the cities, people do not prefer to take their personal car to public places like malls, parks, markets, etc because they find it difficult to locate a parking space near their destination. This will also lead to consumption of more fuel while searching for vacant parking slot. It is advisable to use assistive technology, which will help in booking parking slots. The assistive technology, which we decided is a mobile app.

The user should be able to download the mobile app and as soon they reach near the destination of the trip should be able to book for the parking slot. The mobile app is developed in such a way that, they will be able to view the vacant parking slot in their nearest location. Here the assumption is that the phone with the mobile app is inside the vehicle.

The nearest location is calculated by a shortest path algorithm. The algorithm has the source location as the current location of the vehicle and target location is a set of parking spaces, which are derived from the google map. In the backend, the server will get updated as per the chosen destination by the user. The users are already registered customers. The architecture shown in Fig

3 is simple architecture arrangement with Arduino board, Infra Read (IR) Sensors, a display unit and a WiFi module. And for security purpose Radio Frequency Identifier (RFID) is used. A vehicle can be identified by using ultrasonic sensor that transmit wave to identify and IR sensor senses the reflected wave. American countries uses park me app or Google map API to find a vacant place. From 2015, India's capital, New Delhi, started planning to collect all relevant data about parking lot, parking areas, current infra-structure of parking place ownership. Web potal or mobile app can be used for booking parking place.
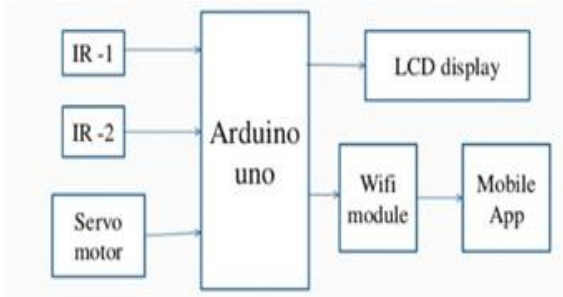

Figure 3. Block Diagram

In every parking area, Infra-Red (IR) sensors are deployed and IR sensors would detect the number of parking slots, free slots and booked slots are graphically displayed in Liquid Crystal Display (LCD) screen, communication between sensors and mobile app will be through WiFi module and RFID. Figure 4 represents, communications happening in Wi-Fi to Arduino and detection of available parking space.
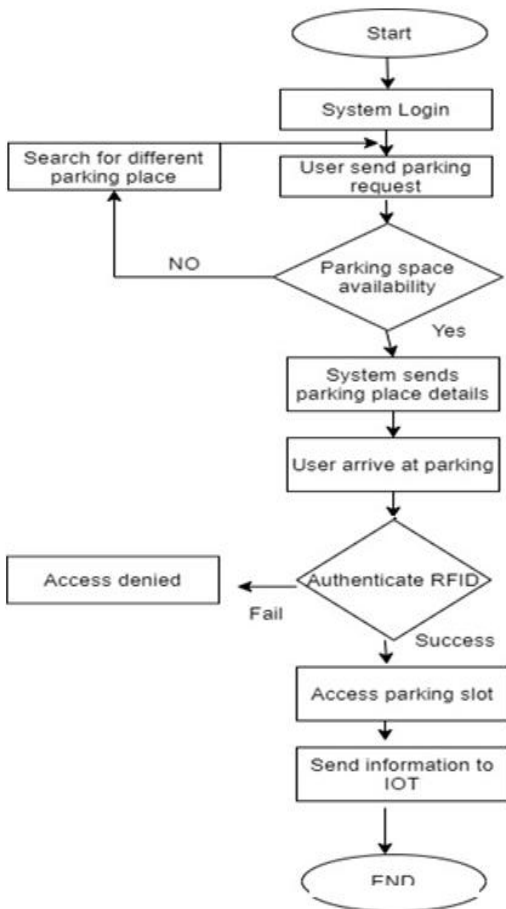

Figure 4. Flow Chart

IMPLEMENTATION
The parking automation is developed as a mobile application on android bundle and android studio. The android application is built on a compatible module that allows it to work or run on all types of android handsets. The mobile application developed has the modules such as Registration, Login, Booking, Booking details, Navigation.

The user needs to register on the mobile app using his or her email address and phone number. This is done by using PHP elements. The backend runs on PHP version 7.2 and PHP handles a dataset of all the registered users and store it in the server for login purpose. The registration page and login page are shown in Figure 4 (a) and 4 (b) respectively. User has to register with his or her name, email address and phone number along with a password of their own. The login module expects the user to type the registered email address and the right password and on verifying the same allows them to access the services.

Figure 4. (a) Registration Screen 4 (b) Login Screen

The third module, booking pinpoints the location of the user by the help of Global Positioning System (GPS) provided in user's android handset to find the nearest parking space[9]. The algorithm used for finding the closest parking space is the well known shortest path optimization algorithm, Dijkstra's Algorithm. As per the algorithm, the distances of each parking space are calculated with respect to the users location. The calculated distances are sorted from the minimum to the maximum distanced parking spaces and the details are sent to the user. In case, the closest parking space is full and don't have any parking slot at the time of user's enquiry, those parking slot will not be shown in the list sent to the user, for selection. The user can be provided with a threshold time limit, for example 30 minutes, within which, he/she can occupy the parking slot. If it can't happen, a notification will be sent to either to cancel the parking booking or to extend the booking with an additional amount. On booking confirmation the user will receive the parking space details such as Location, Parking slot, Date and time, Validation period, Payment details, RFID.

A payment gateway will open for the user to make the payment before they could enter the parking space. When the user reaches the location, they can enter the parking Slot using the RFID and park the in the allocated place. On parking the IR sensors will detect the presence of the vehicle and update the data base server and mark the parking slot as booked.

Components Used and Specification
The GSM module is a circuit used to have the correspondence between the mobile phones and microcontroller. It has the inbuilt versatile mechanism for sending SMS, MMS and voice messages. GPRS expansion in GSM permits high information transmission. IR Sensors and RFID module are also used.

Android Studio is the authority incorporated advancement condition for Google's Android working framework, based on Jet Brains' Intelligent programming and structured explicitly for Android improvement, which is used in this work. MPLAB, created by Microchip Technology, an exclusive freeware is also used for coordinating advancement condition in the installed applications on PIC and PIC microcontrollers.

The identification of nearest accessible parking lot is done based on the calculation performed, utilizing the GPS exploring frameworks. For a given source vertex the calculation can be done to discover briefest way from a solitary beginning vertex to a solitary goal vertex [7].

For instance, if the vertices of the diagram speak to urban areas furthermore, edge way costs speak to driving separations between sets of urban communities associated by an immediate street, Dijikstra's calculation can be utilized to locate the briefest course between one city and goal city. This calculation is generally utilized in steering convention frameworks. It is also called the single-source most brief way issue, in which the briefest ways from a solitary source to all different vertices must be found.

CONCLUSION
To check the parking slot availability and the nearest parking venue, several physical devices are integrated together. Mobile app allows the user to locate and reserve a parking slot, online. It will also help the user to identify the nearest parking place from the place of booking by using the shortest path algorithm which will save time and fuel.. Thus, the prototype is built and tested.

The Smart parking system protocol developed can be further be improved. As an additional feature an option for letting the user choose a parking spot which he might find convenient and easier for him as sometimes we do sometimes travel to other places after office and if he chooses to take the car from that place, then it would enable him to do the same as well[8].

Also, another feature which will optimize the parking space can be introduced. In case, the parking space identified is not having the parking lots of same size, accordingly the lots can be allocated to the vehicles based on their type and size. This will definitely avoid wastage of parking slots, a smaller car occupying the space of truck. In that scenario even the two wheeler and four wheelers need not have separate parking area.

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