Smart Parking System and It's Simulation

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Abstract: The number of vehicles in the world is increasing rapidly due to the hike in demands. Increasing population density in urban centers calls for adequate provision of service and infrastructure to meet the needs of the residents. This is where the concept of Smart Cities has gained great popularity. With the help of Internet of things, we can connect the surrounding environment to the internet and access those things from any remote location. This will help boost productivity and reliability of already existing infrastructure and will also help in future planning[1]. In this paper, we have proposed to design a smart parking system which enables the user to find the nearest parking lots and also informs the user about any vacancies in the parking lots using IoT. The main purpose is to prevent the user from wasting time in looking for parking lots and unnecessary traveling and fuel consumption in an already filled-up parking lot. We have also proposed to develop a mobile application to allow the user to book parking spot and utilize his time efficiently.

Keywords: Smart City; Smart Parking Systems; Internet of things; Intelligent Parking Assistant.

I. INTRODUCTION

Internet of Things (IoT) is one of the major technologies beaming in today's world.[2] Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with a heart monitor or an automobile with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. A Smart Thing is a physical object that is digitally augmented with one or more of the following:

- **Sensors** (temperature, light, motion, etc.)
- **Actuators**(displays, sound, motors, etc.)
- **Computation** (can run programs and logic)
- **Communication interfaces** (wired or wireless)

Together, they make the Internet of Things. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects thedecisions taken. Thus we can gather information about one environment while being present in another.

IoT plays a major role in improving the quality of our life. It is a way though which we can connect to everything around us. The concept of smart cities is highly dependent on IoT. A **smart city**[3] is an urban area that uses different types of electronic data collection sensors to supply information which is used to manage assets and resources efficiently. This includes data collected from citizens, devices, and assets that is processed and analyzed to monitor and manage traffic and transportation systems, power plants, water supply networks, waste management, law enforcement, information systems, schools, libraries, hospitals, and other community services. Traffic delays and alternative routes can be communicated to mobiles. The deployed sensors on the road sense vehicles, switch on the street lights and switch them off when there is no vehicle passing. Thus IoT has significant contribution in every aspect of our life.

Smart Parking system is one such system important for the establishment of a smart city. The underlying technology behind this system is IoT itself. This system will enable a user to effortlessly park his vehicle at safe parking locations. We aim to provide users with a facility to reserve and pay for their parking online without having to wait in queues or look for parking spots throughout the city. It is a hustle to find a proper parking space in many of the city areas, especially during the peak hours. During such times we find it obligatory to develop an application that can cater to the public's parking needs. Smart parking can undoubtedly fulfill all such needs and will prove to be an efficient system working on some robust technologies behind it.

This is a one-time investment and the revenue for its maintenance can be generated easily using this system as everyone using it will have to pay a minimal charge for parking facility. In addition their vehicles will be under proper supervision and will be taken care of while the customer is busy doing his work.

II.   EXISTING SYSTEM

The biggest problem in the cities is that more than 30% of travelers are looking for parking. The traditional ways of finding parking was to go to a particular area, check if there's parking space and then park your vehicle. This method of finding parking was time consuming and frustrating. As a majority of the people are migrating to cities every year, eventuallythe number of vehicles is increasing thereby resulting in urban traffic congestion. People parking randomly anywhere on the roads causes traffic jams and discomfort to the other commuting vehicles like buses, cabs and private vehicles. So many of the plans are even dropped due to parking issues and it is one such problem that needs to be looked after as soon as possible. Such a system also has adverse effects on the environment too, causing air pollution. Thus,a better and efficient parking system is needed.

III.   PROPOSED SYSTEM

All these factors led to the idea of building a robust and efficient system that will help solve the parking problem in the cities and avoid parking space wastage by allotting every single slot to a needy customer. It comprises of two parts - a mobile application and a web application. The mobile app being very user-friendly, will allow the customer to search for parking spots in the area of his choice and book them as per his time schedule. Moreover he can make the payment for the same online on the mobile app itself. After he chooses his slot a ticket will be generated that the user needs to carry. The web application is a little different from the mobile one as the user can use it only to look for available parking slots or download the mobile app from it. A system likethis will boost the parking business as well and prove to be useful to the customers in return. Smart Parking also reduces the pollution caused by unnecessary circling vehicles and lowers the fuel consumption for parking purpose. Moreover, the traffic will be reduced and the travelers will be able to conveniently travel on the roads. Customers who want to park their vehicles for multiple days in case they go outstation can also find this system extremely helpful as they'll be able to enjoy safe and harmless parking facilities. Companies and their employees will be able to manage the parking system in their premises in much better way and this way the parking needs of the public can be fulfilled significantly.

IV.   SYSTEM ARCHITECTURE

Below we have described the various elements being used in our system.
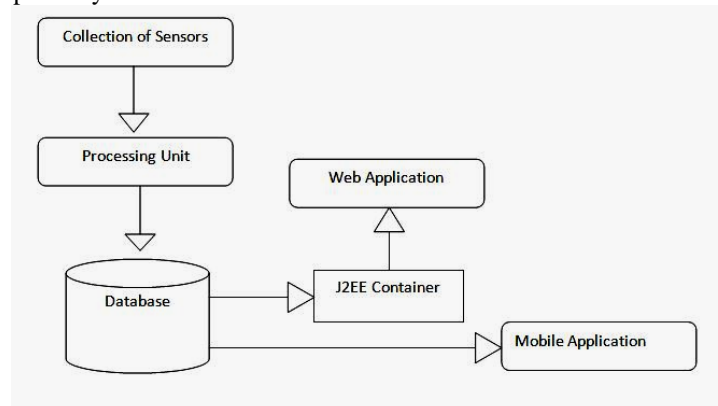The architecture of our proposed system:

Figure 1: Components of the Smart Parking System

1)   Sensors:
Sensor is a device which detects or measures a physical property and records, indicates, or otherwise responds to it. In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. In our project, Smart Parking System, we are using sensors to check whether the parking slot is available or not. Sensors will take input that whether the parking slot is available or not and will give this output to android application. Sensors will be connected to the microcontroller. Sensors will be taking input either in analog form or in digital form. Sensors will be given to every parking slot so that the data of every parking slot is maintained. Therefore, sensors are only used to fetch the parking slot availability.

2)   Processing unit:
The main role of the Processing unit is to process all the information from all the sensors in a particular area and decide what information it's supposed to send to the database for further ease the overhead on the database.

It takes all the data from the sensors and forwards all this information to the server and database regarding all the slots and their parking occupancy.

3)   Database:

In our application, we are use oracle database to manage all the user information, map details, payment information, parking information and query forms. Thedatabase is responsible for managing all the user information, parking information, payment information and map details, so as to allow proper functioning of the mobile app and the web app.It takes data from the micro-controller regarding all the parking lots on different locations. It is also directly linked to the web app and mobile app as the data is then sent to these applications. It receives input from the admin panel and the Processing units from various locations it then stores the data in the database. The end applications then display the filtered data to the users.

4)   Admin Panel:

This module is particularly developed for the Administrators of the system because an overall view of the functional system should be given to them and should be abstracted from users and customers. It's accessible to administrators only after they login to the system. Within the admin panel, we have the following tabs :

a)   Dashboard : Shows all the parkings done till now along with some statistics so that the administrator knows how many transactions happen everyday, how popular is the product growing and the revenue the app is generating.
b)   New User Registration : This has forms through which all the customer data can be taken in and a new account can be created. This tab has actually been developed as a fault-tolerance mechanism meaning that in the rare case of the mobile application failing, the customer can contact the administrator through the website and register a complaint. The administrators will immediately look after the complaint and create an account for the user or book a parking for him through this tab.
c)   Views :When an administrator wants to look at the booking history of a user, he can enter the user ID and get an abstract view of his transaction history. Similarly when the administrator desires to see how many parking bookings have been done in a specific venue, he can enter the name of the venue and Views will show him the entire booking history belonging to that venue.
d)   Complaints : A table displaying all the registered complaints for the system till date. These complaints can be submitted either through the mobile application or the website. Also this table marks whether these complaints have been responded to yet and the date of response in order to achieve better customer service and satisfaction.
e)   Feedback :Much like the complaints table, this tab also displays a table that stores the feedback given by the customers which can again be given through the mobile application or the website. Feedback table contains data that can be used for analytics in future.
f)   Sales Enquiry : This tab is used to keep the records of the parking venue owners/managers who want to collaborate with our system and include their spot in our application. The table contains appropriate contact details of these owners so that the administrative team can get back to them.
g)   Simulator :The simulator is one of the most important components of the entire system as it depicts the functioning of the system. It gives the user the facility to see which slots are vacant and/or booked in a particular venue.And it demonstrates how the system will work. Basically the data collected by the sensors will be incoming here at the simulator thereby showing the booked slots and vacant slots separately. A facility to book a parking from the simulator has been provided as well so that we can see what all data will go inside the database at the time of booking. Once a slot has been booked, it becomes unavailable until the current time is equal to the out time specified by the user. In time and Out time are the time values specified by a user at the time of booking a parking, which denote the duration of the parking.

5)   Simulator:

Simulator is the page that will be used to display the on-going parkings and free slots. After selecting the area and venue, the slots belonging to that spot are shown. The customer can select a slot as per his choice and fill in his duration and user ID in order to book the slot. This data will be inserted into the databaseand this way our records will be successfully maintained. One important point to note here is that the value for slot status field in the slot table gets changed to 1,indicating that the slot is now booked. Thus, that slot will be shown as booked for that much duration. When the out time mentioned by the customer reaches the current time, the slot will be displayed as free and the value of slot status column in the slot table will be changed from 1 to 0, now indicating that it is free.
The algorithms are as follows:

1.   INITIALIZE THE SIMULATOR
for (each slot id in <THIS area> and <THIS venue>
        if<slot_status> == Occupied)

```
{
        SET CHECKBOX to <Ticked>
}
for ( each slot id )
        if<slot_status> == "Vacant"
        then set <Slotid_slot_status> = "Occupied"
                INSERT QUERY with that value
for (each slot id )
        if out time >= Current Time
                set slot status = "Vacant"
```
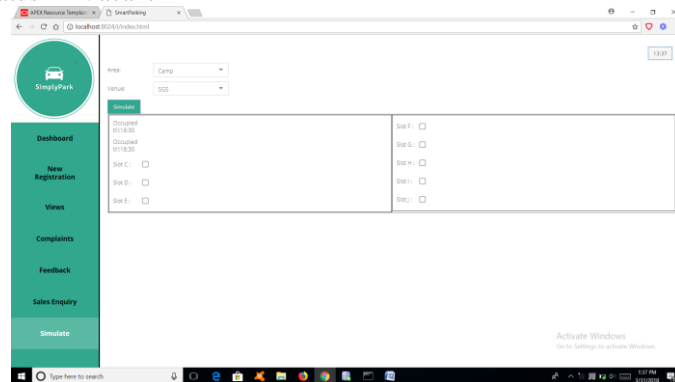

Figure 2: Proposed Simulator

6)   J2EE container:

A J2EE container is a server platform for executing the J2EE application. The reason we are using a J2EE container is that we don't want the customers to see any links to the database, so we provide this security layer to prevent users from getting sensitive information from the applications.[4] Hence, this keeps the database safe and secure. It is mainly connected to our web app and shows the user only what he's expected.The JEE containers provide a wrapper around your source code.

Typical containers are the classic EJB data bean, and, the message driven bean. To a certain extent servlets and portlets can also be regarded as containers.

What the container provides a large number of services:-
* Invocation -- your code gets loaded and started when required.
* Transactional context -- most container code occurs in an ACID transaction context.
* Configuration -- things like JDBC connections are passed to you by the container.
* Security -- the container will restrict access to your code and data to authorized users.
* Scalability -- since the container is in charge of scheduling it can automatically fire up extra copies if the load gets heavy, or, can be statically configured to run several instances in parallel.
* Encapsulation. Your program exposes a single interface to the container. However, externally it may expose this interface in a variety of forms.

7)   Web App -

In computing, a web application or a web app is a client-server computer program in which the client(including the user interface and client-side logic) runs in a web browser. Common web applications include webmail, online retail sales, online auctions, instant messaging services and many other functions. In this project we are proposing a web application to show the user the number of parking slots. There are people who don't use android phones but they have   computer.   Hence,   it   will   be   more   beneficial   for   them. They can see the parking slots available according to their comfort through this web app. We have used HTML, CSS, JavaScript, and ExtJs for this web app. Web application is connected to J2EE container for data security.

8)   Mobile App:

A mobile app is a software application developed specifically for use on small, wireless computing devices, such as smart phones and tablets, rather than desktop or laptop computers. Mobile apps are designed with consideration for the demands and constraints of the devices and also to take advantage of any specialized capabilities they have. Here, we are proposing a mobile application where the user can check for the parking slot and can also book the parking in advance. Our payment system is also automated. So, the user can do the payment through the mobile app only. Therefore, the mobile application is for searching and booking the parking slots and for payment.

V. PROPOSED IMPLEMENTATION AND WORKING

Log In into Mobile App - Mobile app is proposed to book the parking. If the user wants to book the parking slot in advance, he has to first register himself as the legitimate user of the application and then after logging in he can book the parking. Therefore, for booking the user must have to login.
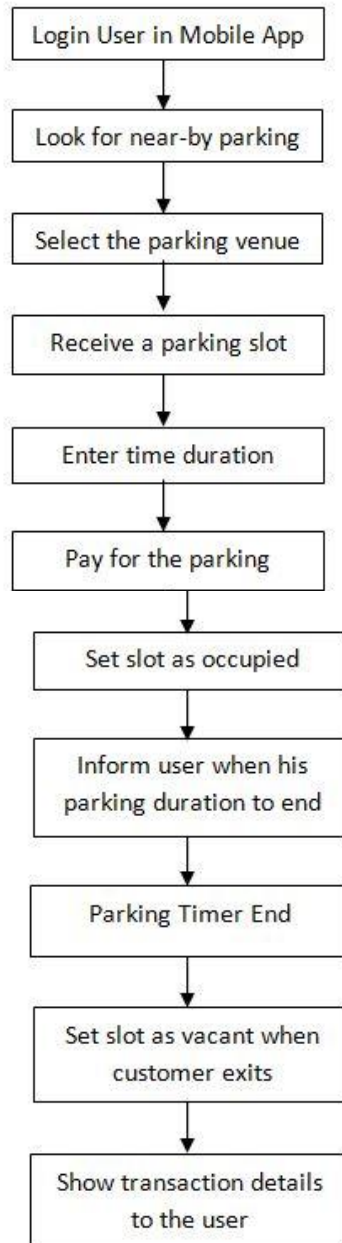

Figure 3: Working and Implementation of the Smart Parking System

Look for Parking Nearby - After logging into the application the user can search for the parking slot according to his comfort as in which city and area he wants to park. The app will let the user know about the different parking slots available in the nearby areas.

Book the parking slot - The user can either just search for the parking slot or he can book the parking slot in advance. So, the user can book the parking slot available of their own choice for as many hours they want.

Pay for slot - For booking the parking slot, the user will be charged some amount of money. After selecting the particular parking slot the user can book the parking by paying. The payment is also done through app. The application will lead the user to the payment gateway where he can choose his own method of paying as paytm, debit card, etc.

Get ticket - When the payment is done for booking the parking slot, the user will get a message including his transaction id and the parking information, i.e., the ticket will be generated by the database and will be given to the user.

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Parking done - The user can come and park the vehicle for as long as he booked the parking slot. When the time duration is about to end, the user will get the notification message about his parking time details as "Your parking time is coming to end. We request you to remove your vehicle from there on time." After the parking is done and the vehicle is removed from the parking slot, the server is updated about the availability of that vacant parking slot.

Therefore, in this way the whole mobile application is working which is getting information about the availability of parking slots through sensors and it is being kept updating as soon as any slot becomes vacant.

VI.   CONCLUSION

In the great majority of cities it is difficult and hardly expensive to create more parking spaces for vehicles since they have almost reached its full occupancy. Combining this problem with an inefficient use of parking spaces leads to congestions due to aggregation of parking seekers and regular drivers. Recent advances in low-cost, low-power embedded systems bring the opportunity to develop new applications to solve these problems. In particular, Smart Cities greatly enrich their sustainability by introducing new resource management applications that rely in those constrained devices a significant part of the functionality of the system. The proposed Smart Parking solution consists mainly in the on-site deployment of an IoT solution to monitor and signalize the state of availability of each single parking space. Clearly the existing system is unable to fetch parking slots to the customers as per their convenience and this system will save a lot of time, fuel and effort. We should focus on the solutions that can enhance the user experience and simultaneously eradicate the problem. The technologies to be used in this system are very efficient and secure.Furthermore, this system improves the management of parking resources by public authorities, for instance handling groups of parking spaces facilitating the whole city traffic management.[5]With all such benefits, leveraging IoT and its concepts in today's world will be a step towards an advanced future and thus systems built over it should be encouraged.

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Already Functional Parking Systems:
a)   Spothero
b)   GetMyParking
c)   ParkingPanda
d)   Parkwhiz