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Internet of Things (IoT) based Smart Parking Reservation System using Raspberry-pi

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Abstract

In the recent, the concept of smart city has gained appreciation. One of the important considerations of being a smart city is the Smart Parking facility. Finding a particular space to park our vehicle becomes an annoying issue. Besides, number of vehicles in like manner rapidly grows once every day. It has been seen that the drivers struggle to find a halting extent without thinking about where parking space is open. The request for the parking space prompts to develop the traffic congestion and excess consumption of fuel. To create a optimize solution for the crisis, many technologies evolved but it didn't benefit all varying with expense, efficiency, power, accuracy and other factors. In this review, we created a prototype of a novel smart parking framework for an urban domain in light of reservation utilizing Internet of Things (IoT) by using Raspberry-pi. Initially, our research gives a brief overview of the concept of smart parking system and the need for IoT devices to be integrated with cloud. Promote, we expand our view about the framework design and the working of the proposed system architecture utilizing Optical Character Recognition and Facial Recognition to provide two way security using Raspberry-pi. By highlighting the key features of our work we have then described the convenience and benefits. Towards the end of the paper, we prove with artifacts that the prototype based on smart parking system using IoT finds a solution to the traffic congestion and ease the way to get a parking slot.

Keywords: Smart Parking; Optical Character Recognition; Internet of Things (IoT); Facial Recognition, Raspberry-pi.

INTRODUCTION

Finding a parking slot to park their vehicle has ended up being a disappointing issue to the drivers all the time. It has paved the way for traffic congestion which has turned out to be an alarming problem on a global scale. Also, it has been found that it has led to the burning of world's oil over a million. According to a report[1], Smart Parking system could benefit in saving 2,20,000 gallons of gas till 2030 and 3,00,000 gallons of gas by 2050 , if it is executed perfectly. In order to alleviate this condition, many smart parking facilities evolved but failed to bring relief to all. They could only give the parking information but didn't prove to "smart" enough. For example, if they could publish the vacant parking slots many drivers rush to fill the limited spaces. So, we have tried to address these issues in this paper. Here, we propose an idea to realize Smart Parking structure in perspective of reservation using Internet of Things (IoT). The wonder of Internet of Things is inter-communication using the Internet where server ranches could assemble the data and look at and control anything. The two magnificent words in IoT are "Internet" and "Things". The Internet is the vast global network of connected servers, computers, tablets and mobiles using the internationally used protocols and connecting systems. Things could be commonly said as any possession or object. The machine-to-machine (M2M) data that is generated has a wide range of uses, but it is specifically seen for Smart Parking here. They aim to give convenience as well as correctness. For the better comprehension of Internet of Things, we state it as,

Real Objects + Internet + Sensors and Controllers = Internet of Things

Internet of Things plays a vital role in the creation of Smart Cities. The most important factors for the emergence of smart cities are cozy parking facilities and efficient transportation and management [2]. Due to the advancements in the sensor technology and the low-cost features of the Embedded Systems, we say that applications can be created using Internet of Things. According to the latest report made by The International Parking Institute [3], we found that many innovative parking ideas have been developed.

They were able to deliver the parking information about the vacant parking lots. These systems used effective sensors in the parking areas and by tracking information from various sources and also deployed active data processing units. Here our proposed idea could be implemented using a mobile application so the drivers could get their parking information and reserve the vacant spaces of their wish as per their vehicle's width via Wi-Fi or Internet because today almost everyone can possess a smart phone with them. Next section covers the literature review of the existing models.

LITERATURE REVIEW

i.) Smart Parking System using optic Wireless Sensor Network [4]:

This system experienced the use of video cameras where they are deployed in the parking slots and are able to capture the license plate of the car and also monitor the parking spaces.

Advantages:

1. They are cost-efficient.
2. Optic WSNs are easy to maintain and to install.

Disadvantages:

1. They are not much powerful as there is a high chance of failure in the device.
2. Accuracy of the license plate detection is quite impossible.
3. Also, the size of the vehicles are predicted which is not much beneficial.

ii.)Smart parking reservation systemusing Bluetooth and Zigbee sensors[5]:

This system uses a Bluetooth communication technique which is used for verifying the driver's identity and also to book a slot by identifying the vacant spaces. Zigbee sensors are used to detect the vehicle.

Advantages:

1. Internet usage is not necessary.
2. It is a decentralized system.

Disadvantages:

1. Range of Bluetooth is limited.
2. Installation and maintenance is difficult.
3. Connection gets disconnected if the driver is inactive and again a new slot has to be booked.

iii.) Smart Parking System using IR sensors [6]:

This proposed system uses feedback mechanism to find the availability of parking spaces. Infrared sensors are used to monitor the parking spaces.

Advantages:

1. Proper utilization of slots is managed properly.
2. This could be implemented in a small budget.

Disadvantages:

1. Availability of the space could be found only after the car enters the parking lot, so if parking space is not available it has to avert from there and it might cause traffic congestion.

iv.)Smart Parking System using RFID[7]:

This system uses RFID to match the vehicle's unique RFID tag with the value in the database when it is read by the RFID reader in the parking lot entrance.

Advantages:

1. This is a fast method of identification and quite cost efficient.

Disadvantages:

1. If the RFID tags are damaged or more than one tags are read at a time, the system fails to work accurately.

ARCHITECTURE & WORKING OF THE SYSTEM

The design architecture of the Smart Parking System is illustrated in the following Figure 1.

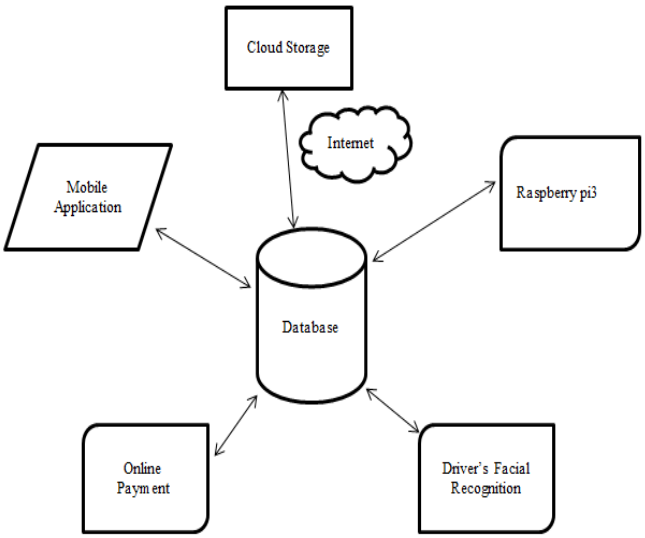

Figure 1: Design of Smart Parking system

Initially, the user has to register the details in the mobile application to store his necessary details into the server. After the credentials are registered, he is allowed to sign in to his account, and book a slot for his parking his car. If he has booked a slot, he is given a lapse time limit of 15 minutes within which he has to enter the parking slot. So, once his vehicle reaches the parking lot, his vehicle's number plate is verified with the number plate entered while booking a parking slot. This is done using a Raspberry pi3 camera. Also, the driver's identity is authenticated by clicking a photo using a Raspberry pi3 camera. This is done in case to avoid vehicle theft and other security issues. Once the process is completed, the vehicle is permitted to enter the parking lot and slot number is given of the nearest available slot. So, once the vehicle is successfully parked in the slot, his parking time starts. So, once the driver returns to the car and takes his car, the parking time can be stopped and the receipt is sent to his mobile. He can then pay using his e-wallet through online

payment. Then at the exit barricade the driver's face identity is again verified to match with the previous images using facial recognition and then he is allowed to move out of the parking lot.

IMPLEMENTATION AND WORKING

As we have discussed the architecture in Section III, we here explain the real time working of the system with the help of a flowchart as given in Figure 2.

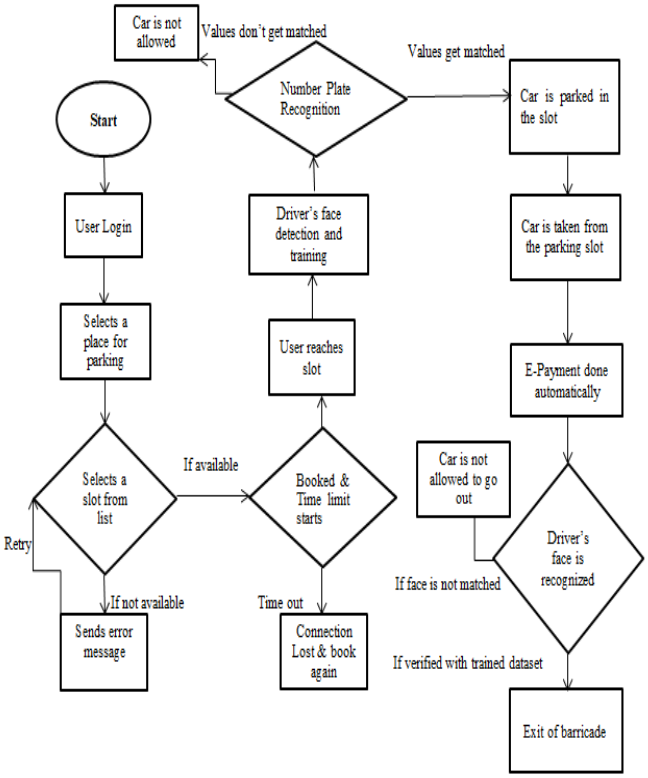

Figure 2: Flowchart of the system

We had implemented the system using a toy car and android app, but this system could be implemented in malls and multi storied buildings. Below are the steps involved in booking a slot in our parking system.

Step 1: Install the android app in the mobile.

Step 2: Register the app using the credentials.

Step 3: Login to the system.

Step 4: Select the area where you need to book the parking slot.

Step 5: Select the sub location and the slot number for booking.

Step 6: If it is available, the app asks for the License plate number.

Step 7: Within a time limit, the car has to reach the parking slot and then the verification process is completed.

Step 8: Once the car is parked and then taken off from the parking slot, the parking charges are deducted from your e-wallet.

The steps above are elaborately explained with the below screenshots.

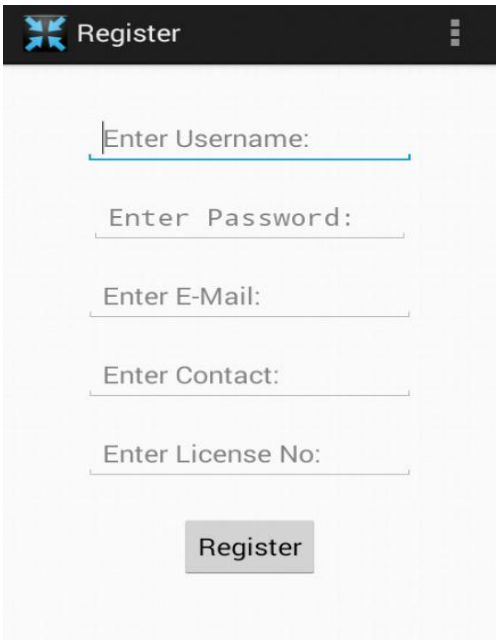

Figure 3. Registration of application

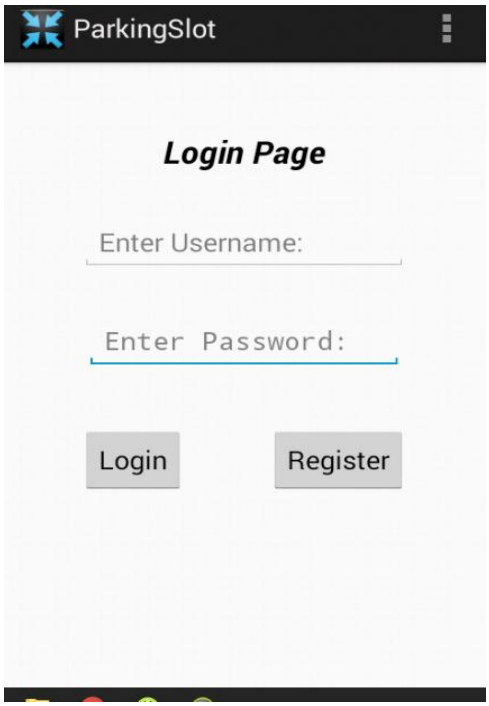

Figure 4 Login of the driver

The above picture Figure 3 and 4, shows the registration and the login details for the parking slot application.

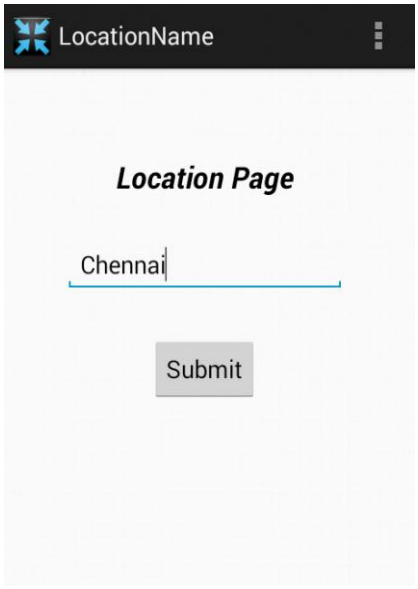

Figure 5. Location details

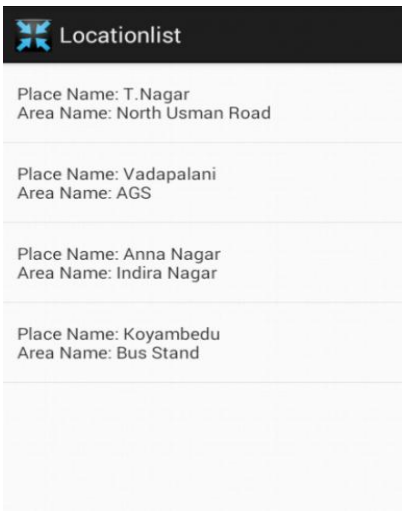

Figure 6: Sub location details

The above step in Figure 5 and 6, shows the location details and sub location details.

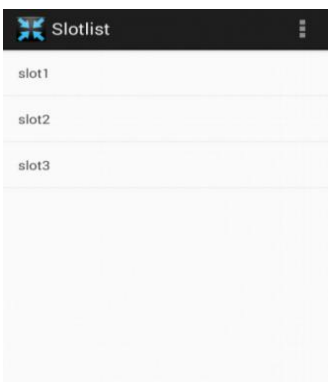

Figure 7. Slot list of the booking

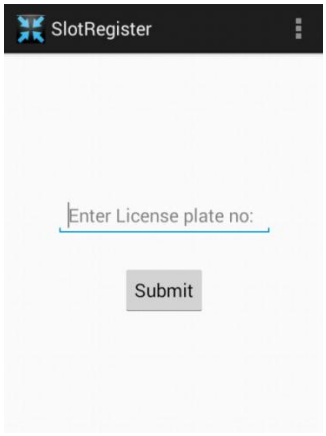

Figure 8. Vehicle Registration Plate of the booking

With the above steps in Figure 7 and 8, you can book a slot and if it is free, you can confirm your occupancy by entering the license plate number. Once, if the driver fails to park the car within a certain time limit, the connection will be lost and he has to book again.

INTERNAL MECHANISM AND RESULTS OBTAINED

Facial Recognition

When the car enters the parking lot, the face recognition of the driver is done for security purposes. The Raspberry pi camera uses OpenCV to create the dataset of the driver's face and then it is trained with the dataset to recognize the driver's identity. When the driver comes out of the parking slot, his face is again recognized at the barricade to provide complete security and only if the face matches with the trained dataset he is allowed to exit out of the parking lot. To develop this model we have used Eigenfaces method based on Principal Component Analysis and Support Vector Machine algorithm (SVM), It is illustrated through Figure 9.

Figure 9: Facial Recognition at the entry and exit of the parking slot

Automatic License Plate Recognition

Once the driver's image is snapped and trained in the database, a signal is sent to the raspberry pi to recognize the license plate in Figure 10. This is based on Optical Character Recognition. This process has three important stages – License plate detection, Character Segmentation, Character Recognition.

1. License Positioning

The License Plate positioning starts with the pre-processing by graying of the image because sometimes the color of the car and the license plate might be same. It is followed by the morphological operation which includes expansion, corrosion, opening, closing etc [8] to convert it into binary image. The edges of the license plate are marked based on the aspect ratio with the rectangular frame as shown in Figure 11.

2. Character Segmentation

Initially, tilt correction is carried out by positioning a horizontal line with the characters and marking a detection line with the complete character. Then, noise detection is done and based on the width of a character, segment it into parts. The segmentation line is clearly determined based on the center of the character. Thus, we get the characters by segmentation as in Figure 12.

3. *Character Recognition[9]*

This paper proposed a new method of character recognition based on KNN algorithm. This is a simple algorithm which is used to find the training points nearest to the required character. Then it is compared with the characters in the database. Thus we get the characters in the image as shown in Figure 13. The 26 letters of English Alphabet and 10 numeric literals of different sizes and fonts are trained to the character image using KNN. But the downside is that is this algorithm is quite expensive to implement.

Figure 10: Original Image

Figure 11: License Positioning Image

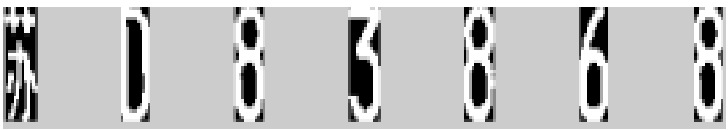

Figure 12: Character Segmentation

Figure 13: Character Recognition

KEY FEATURES FOR CONVENIENCE IN THE PROPOSED PROTOTYPE

A. Development of Mobile Application for Drivers

An easy to use app can be built in both the platforms Android and iOS. This very well comforts the driver to keep the day under control as it does the maximum help by eliminating stress for looking for a convenient parking position at the nearest and driving towards it. He can register the credential details along with the payment modes they use routinely. These details will be stored in the cloud database.

The main significance is that they can reserve their parking slots before entering the parking lot. This would be much beneficial to handicapped as well as senior citizens. Also they could generate the payment in the app once the car is released from the parking slot the driver could pay instantly through electronic cash mode for the length of time his vehicle is parked.

B. Entry and Exit

Once a vehicle makes its entry to be parked in a slot, the driver's identity has to be verified. If a space is unfilled, it will be denoted by a green light whereas filled (or) blocked position could be denoted by a red light. This makes the entry of the car in the parking slot quiet easier and satisfies the customer. Upon exit, the need for queues is eliminated by making the payment through automatic e-payment which helps the driver to be more sophisticated. Also, it provides double security by identifying the driver's face upon entry and exit.

C. Social and Economical Benefits

- Helps in reducing traffic pollution by minimizing emission of greenhouse gases [10].
- Saving gallons of petrol and gasoline prices could result in major change in the society and economy.
- Monitoring traffic congestion with IoT enabled services could contribute the most to Smart City.
- Automatic Cashless payments could save time to the users to a great extent.
- Tons of Paper wastes could be saved due to electronic slips instead printed paper receipts.
- Since paper receipts are avoided in this proposed system, there is no need for human bill supervisors.

CONCLUSION AND FUTURE SCOPE

The rapid urbanization of the world has made the concept of "smart cities" gain momentum in the international agenda. The transformation of cities into smart cities brings along an incredible opportunity for improving citizens' welfare and fostering economic progress. The vision to be a smart city has always been a thought to all the urban cities. Since a couple of years, projects were taken and ideas were employed in many countries to make it into reality. Internet of Things stands out to be the indispensable technology implemented along with Cloud Computing. To be a smart city, Smart Parking facility is an essential service. Previous technologies were exploited which proved to be either not efficient or too expensive. The sensors used to detect the vehicle are the essential components. Here, we have employed Raspberry-pi which seemed to be cost efficient with easy installation and maintenance. In future we would develop application for iOS and also with virtual reality [6] and test its workability in a real time environment. We infer that our future work would facilitate parking issues and decrease traffic congestion and pollution created by the search for parking.

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