IoT Based Smart Parking System

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Abstract. Difficulty to find parking space is major problem for users that want to park car especially at crowded spot. The old technique to find parking space is manual by finds free space area by self. This makes the users take more time and energy that end up lead to traffic jam. Due to these problems, based smart parking system is developed to ease user to find parking space. This method is developed to approach the user to using application to review available parking space and pay parking through mobile phone application. The requirement for this project is a Raspberry Pi 3, Python IDE for software, an ultrasonic sensor and a Pi Camera. There are two objectives for this project. Firstly, to develop monitoring system that detect presence vehicle using ultrasonic sensor and camera artificial intelligence. The second objective is to propose the parking fee payment can be made through mobile applications via PayPal. The project of the based smart parking system is work when the users reserve the parking and made a payment via PayPal through mobile application. While ultrasonic sensors and camera detect the present of the vehicle.

1. Introduction

Ongoing development in the economy and because of the accessibility of low value cars in the market, even poor or average class individual can buy a car. This may be a good thing because now people can easily travel more comfortably to any destination without need to aware of weather. Besides a good thing, yet the result of this maybe create concern. Some of the concerns are overwhelming congested driving conditions, less accessibility of street and place to drive the cars.

One of the critical concern is that issue of parking those vehicles. The increasing personal vehicles than public transport make parking slot may not enough to support all those vehicles. Even when there have enough parking slots, there still take a long time to find available slot because the people do not know the exact location of the available parking slot without round it. Consequent of these will increase fuel consumption and not environmentally friendly. It is very difficult and frustrating as well to find parking space in most metropolitan areas, especially during the rush hour such as mall, hospital and so on.
IoT based smart parking system in paper [1] ultrasonic sensor had been used to detect the presence of the vehicles. The sensor is attached to the microcontroller. The microcontroller will process the data received and send it to cloud via Ethernet shield. Cloud can be access using desktop or application to reserve the parking space.

In paper [2], the authors propose car parking and reservation system. The system would find free parking slot to customer that enter the parking lot. Image detection camera is used to detect car number plate to verify its cars owner and find the nearest parking slot. Image processing is being used by camera and the system also provided reservation service for parking lot and the payment can be done through payment wallet.

Parking is easier by booking online through mobile application or web portal as state in paper [3]. This paper used RFID reader to detect car plate number, owner name and it also can check theft list from number plate given by police. If the plate number is matched with the list given, a SMS will be sent to the police. Thus system also provide offline and online payment depend on customer needs.

Intelligence parking IoT application using IR sensor and crystal oscillator in paper [4] as an input while Wi-Fi module and LED indicator as an output. IR obstacles detector sensor fed as input to the microcontroller and microcontroller processed the data and transmit it over the Wi-Fi using mobile phone. The availability of parking slot will be displayed on webpages through mobile phone.

Android application for smart parking booking system in paper [5] make customer book or reserved parking easily. The booked can be done by select space and time. Customer also can cancel their booking space anytime. While in paper [6] Raspberry Pi was used as microcontroller and connect the IR sensor as input. The IR sensor will detect the present of vehicles and send data to Raspberry Pi. Green LED indicator will light up when the parking available and red LED will light up when the sensor detects the presence of vehicles. Android application is used to update the status of the parking space in real time.

2. Methodology

A. Proposed System Block Diagram

![System Block Diagram](image)

Figure 1. System Block Diagram

Figure 1 shows the system block diagram of proposed work it major constituent of it are:

**Ultrasonic sensor and Pi Camera**: Act as an input to collect the data from it reading and viewing sensor.

**Raspberry Pi**: The input from parking lot sensor is given to microcontroller system. Upon any changes in input, microcontroller will update the information collected from sensor to Firebase server.

**Firebase**: Information regarding registered users and status of the parking slot is maintained in firebase. The information regarding availability of parking lot is shared among all users who use mobile application. Firebase is updated from two terminals. One is from sensors and microcontroller. Another one is from user.
Mobile Application: An android application running on user and administrator mobile device for parking monitoring. User can check an empty parking slot and book it before making a payment. PayPal: Medium for user to make a payment in the mobile application.

Advantages considered while selection of Ultrasonic sensor for vehicle detection are
- Low voltage and power consumption.
- High accuracy that can detect an object in the range of 25cm until 4.5m.
- Ultrasonic sensor can work in critical condition such as rain.

B. System Flow Chart

Figure 2 depicts developed mobile application flow chart. It starts when the user enters the system by looking at the screen whether the parking is available or not. If yes, the user needs to arrive at available parking space. When the user already arrives, the user then can make payment of what parking space the user stays now. Then, the user can add extra time when park time about finish.

![Figure 2. Mobile Application Flowchart](image-url)

Firstly, user start the application and will directly to login page. For the first time user, they can proceed to register page and make sure e-mail and username is not taken. After successfully register the application, the user can now login to the application. When user login the user e-mail will be check by
the system. If the e-mail entered is same with admin e-mail that being set in android studio, the user will be directly go to admin dashboard and if the e-mail is not same to admin e-mail, the user will enter to normal user dashboard. Lastly, admin or user can log out from the mobile application if they had finished their activities.

There are 10 menus that can be view in User Dashboard as listed below:

- Emergency: If there have an emergency occur in parking slot
- Message: User can check message from admin
- Map/Report: To view the parking and report any illegal parking.
- Profile: View user own profile
- Reserve: To reserve the parking with payment.
- Help: For more information regarding the parking.
- History: To see user past booking.
- Status: To view the status of booking.
- Parking View: To view the number of spot and occupied parking
- Log out: For user to log out from the application.

While for Admin Dashboard will have 7 menus that can be used which are:

- Emergency: To view any emergency being reported by user.
- Message: Compose a message to all user of this mobile application.
- Map/Report: To view illegal parking or reserve a spot.
- Price Setting: To change price per hour for the parking.
- Review: To view a user review.
- Parking View: To view number of spot and occupied parking
- Log Out: To end the session.

3. Mobile Application

In this section the working of “iParking” mobile application with the help of screen shots is explained in detail.

**User Login:** Figure 3 shows layout facilitates for existing user to login. During login user or admin need to write their preregistered username and password. For new user, they can register by tap on “Get registered now!” and the apps will bring the new user to layout as shown in Figure 4. New user need to provide their first name, last name, email, plate number, username and password and need to tick the agree check box before press submit.

**Menu Dashboard:** After successful login, user or admin will directly enter to dashboard menu as shown in Figure 5 and Figure 6. User or admin can choose which menu depends on they need. The administrator dashboard is different with user because admin can chance the parking price per hour on Price Menu as mention in Section 3 (B).
Figure 3. Login window

Figure 4. Register window for new user

Figure 5. Menu dashboard for user
4. Result and Discussion

1. Hardware Prototype

Figure 7 represents the prototype of the proposed system. The ultrasonic sensor was used to detect the vehicle and provides information about the vehicle in the mobile application. The circuit was designed to give a response for several objects within a range of 30 cm. The output from the ultrasonic sensor will be sent to Firebase Real-Time database to specify whether it is an illegal parking or not. The LED in the prototype indicates the presence of a vehicle. Red LED will turn on when the ultrasonic sensor detects the vehicle while green LED turns on when the sensor does not detect the vehicle.

![Prototype of the project](image)

Figure 7. Prototype of the project

Picamera with OpenCV implementation as shown in Figure 8 will detect the vehicle in the drawing line and send the data to Firebase Real-Time database. The drawing line will be green if there is no vehicle detected and will be counted as a free spot while red color will be counted as an occupied spot when there is a vehicle detected on the drawing line.
2. **Mobile Application Output Result**

When the user uses the application, every chance will be sent to Firebase Real-Time database. Figure 9 shows the application retrieving data from the database. When the user reserves a parking slot, the parking slot will change its color from green to yellow on the mobile application. When the user reports a parking slot, the parking slot will change its color from green to red. This situation can be seen as in Figure 10.

![Figure 9. Application retrieve data from Firebase](image)

**Figure 9. Application retrieve data from Firebase**

![Figure 10. View of parking slot in mobile application](image)

**Figure 10. View of parking slot in mobile application**

3. **Firebase Output Result**

User and administrator activity on mobile application will be recorded in the Real-Time database. The database that is recorded includes user registration information, parking lot reservation, administrator messages,
emergency history and user comments as shown in Figure 13. While in Figure 11 and Figure 12 shows the Real-Time database data change by ultrasonic sensor and data recorded send by Picamera.

Figure 11. Real-time database data change by ultrasonic sensor

Figure 12. Firebase real-time database record data send by Picamera
4. PayPal Payment

PayPal has been used as medium for the user to make a payment in the mobile application. The user can make a payment by entering e-mail and password or by entering details card bank number and the payment fee will be send to the admin. Figure 14 shows the PayPal interface on mobile application.

To test the PayPal payment, we need to enter Sandbox mode and create sandbox account. Figure 15 shows the history of the payment made by the user while Figure 16 shows the receipt of the payment.
5. Conclusion

Issue of parking in smart city is the main proposed of this system. This system is implemented using low cost ultrasonic sensor JSN-SRO4, Picamera, Raspberry pi microcontroller, “iParking” mobile application and Firebase server. This system provided real time information of availability of parking slots and allows user to reserve the parking slot through mobile application. User also can make a payment for their parking online by using PayPal without need to line up in ticket counter or machine. Proposed work not only to avoid from traffic congestion, it is also providing smart users management, no additional devices and fast payment. In the future, user can view the parking slot by using camera on mobile application and user can use popular online banking such as Maybank2u and CIMB Click for payment instead of using PayPal.

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