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Integrated Car Park System for Smart Parking Solution

Harprith Kaur Randhawa[1*], Deshinta Arrova Dewi[1] and Nirmal Kumar Karmani[1]

[1]Faculty of Information Technology, INTI International University,
Nilai, Negeri Sembilan, Malaysia.

[*]**Email:** harprith.randhawa@newinti.edu.my

Abstract

This paper studies a smart parking solution by implementing an integrated car park system using the Internet of Things (IoT) technology that is combined with an android application. The proposed system enables users using android devices to view the current state of the car park (vacant/occupied slots) and reserve a parking lot. Subsequently, the system automatically generates a unique QR code for each booking that allows users to enter and exit the car park. The proposed system also includes e-wallet capabilities for automatic payment at the exit gate. A microcontroller with sensors to monitor the current state of the parking lot are adopted for this purpose, as well as control a mechanism to physically reserve a parking lot for the users. The system will greatly streamline the parking process as users will be able to monitor the car park availability beforehand and this will help combat the issues related to the search of a parking lot.

Keywords

Car Park System, Smart City, Internet of Things (IoT), Android

Introduction

In the present day, finding an available parking spot is always difficult for drivers, and it tends to become harder with an ever-increasing number of private car users. A recent survey (Gandhi, B. K., & Rao, M. K., 2016) stated in most big cities in the world, the massive traffic jam happens during rush hour and the traffic is actually generated by cars that are searching for parking spaces. It takes up to 40% of the total traffic. The survey also stated that vehicles looking for parking burn around 47,000 gallons of gasoline and produced 730 tons of carbon dioxide, which is equivalent to 38 trips around the world. Clearly, the problems associated with parking has imposed significant societal costs, both economically and ecologically.

This situation can be seen as an opportunity for smart cities to undertake actions in order to improve the efficiency parking resources thus leading to a reduction in searching times, traffic congestion and road accidents (Park Whiz., 2018). In this paper, we propose the use of IoT (Internet of Things) concept integrated with Android application for a smart parking system. Starting with a pre-booking process that directly locks a specific location of parking slot, a user

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unlocks it using QR code which is produced at the end of the booking process. The android application is designed in a way it provides effective device management from user enter parking location, provide direction to go to the pre-booked car park location until payment made at the exit gate. Within this complex environment, all connected devices must feature at low power consumption and low cost. Hence a microcontroller is adopted in our system because it running at lower power consumption. The IoT, android technologies together with the cloud-based database are employed because those technologies are well-known as a recent advance of open sources to create low-cost and low-power embedded systems (Arduino, 2018; Woodford., C, 2018).

Methodology

The methodology carried out in this paper is following three steps i.e. requirement gathering and quick design, system implementation, and integration follows with system testing. The information gathering and quick design produce a system architecture as illustrated in figure 1 and 2. The system implementation and integration produce system feature as depicted in figure 3. System testing produce unit and integration testing for system functionalities which is not covered in this paper. However, we explain the novelty of our proposed system that is compared with other previous works. This part can be found in table 1.

The following architecture shows four main components i.e. IoT module, firebase, android operating system and application, PHP and MySQL. The explanation of each module is outlined below.

Figure 1. System Architecture

Component 1: IoT Module

The IoT module is the most important module in the proposed system that consists of four sub-modules i.e. Wifi, ultrasonic sensor, servo and LED.

- *NodeMCU ESP8266 Wi-Fi Module* is adopted as an integrated microcontroller board with a fully-functional TCP/IP protocol stack that provides a microcontroller the ability to connect to a Wi-Fi network to send and receive data. This will be used to connect the Firebase Realtime Database, the board will upload telemetry data and receive commands from the application with the help of this module.

- *Ultrasonic Sensor* measures distance by using ultrasound, sound waves with a frequency above 20000 Hz, beyond the human hearing range. There are two main components the transmitter and the receiver. The transmitter generates the ultrasound, and these reflected waves are

detected by the receiver. The time taken for this process determines the distance. The ultrasound sensor will be used to detect vehicle presence in a parking lot.

- *The servo* will be used to control the physical barrier in each parking lot. The servo will be raised (90 degrees angle) when a reservation is made and lowered (0 degrees angle) when there is no reservation.

- *LED* green and red used to highlight vehicle occupancy. The red LED indicates that the car park is either occupied or reserved. A green LED indicates that the car park is available. These lights will be controlled on or off depending on the vehicle occupancy and reservation status.

The illustration of the IoT module is depicted in figure 2.

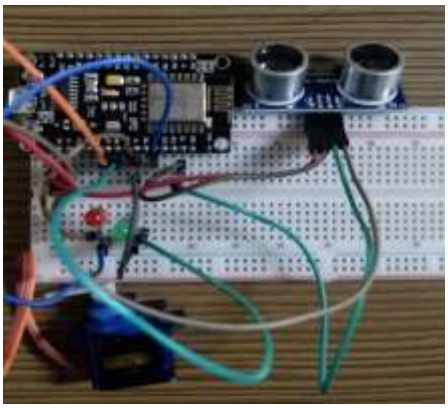

Figure 2. IoT Module Prototype

Component 2: Firebase

Firebase is a backend service which is a subsidiary of Google. Firebase is a cloud-based platform which provides numerous services. The prototype utilizes Firebase Authentication and Firebase Realtime Database. Firebase Authentication is used to authorize users signing up and logging in to the application. Firebase Realtime Database is a NoSQL database that can be updated in real-time. This is used to monitor and control the IoT module in real-time.

Component 3: Android

The Android application is the main point of access for the end-users. The application relies on both Firebase and PHP to function. The applications main task is to retrieve information from both ends and showcase it to the user. In addition to that, the application is designed to send relevant user input to any of the two ends (Ganiyu, R. A., O., et.al., 2014).

Component 4: PHP and MySQL

The main function of PHP is to act as an interface between the Android application and the MySQL database. PHP is used to retrieve information from and send information to the MySQL database. JSON (Java Script Object Notation) is used to relay information from the database to the Android application.

Recently we have successfully build a prototype of an integrated smart car park system as presented in figure 3 below. The prototype showcases the key features mentioned earlier i.e. pre-

booking (barrier is up with green light), post-booking before car arrival (barrier is down with red light), post-booking after the car arrives (barrier is up with green light) and post-booking after car enter parking slot (barrier is down with red light). The application also showcases the other features necessary for the user such as QR code scanner, booking history, account information and payment process.

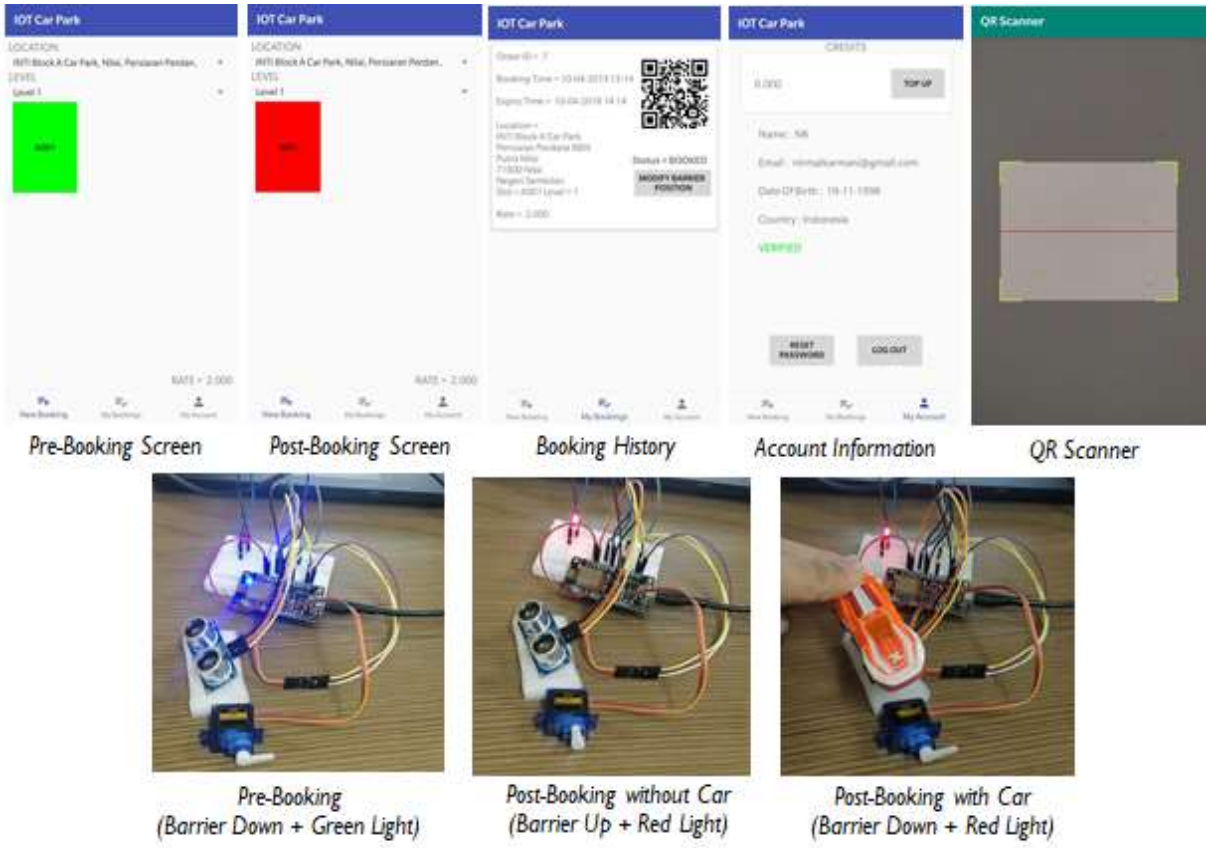

Figure 3. System features

Results and Discussion

Previous researches (Khanna, A., & Anand, R., 2016; Wang, H., 2011) have shown several types of smart car parking system however few are integrated with QR code scanner, IoT based barrier and payment process like our proposed system. The following table shows simple comparison of other works with our system's prototype.

There are seven features that we focus as comparison whereby the similarity of the three systems are occupancy check, booking system, and payment system. The novelty of the first system shown in traffic search for parking whereby the novelty of our system shown in the navigation feature, QR code, and the IoT based barriers. More insights are outlined in the following table 1.

Table 1. Comparison of our work with others

Features	Khanna, A., & Anand, R. (2016)	Wang, H. (2011)	Our proposed system
Traffic search for parking	X	√	X
Occupancy check	√	√	√
Booking system	√	√	√
Payment system	√	√	√
Navigation system	X	X	√
QR code system	X	X	√
IoT based Barrier	X	X	√

Conclusions

Smart parking system has always been at the core of building smart cities. In this paper, we propose a solution that tackles the issue of parking and presents an IoT with android based integrated smart parking system. The system that we propose provides real-time information regarding parking slots availability in a parking area. Users from remote locations could pre-book a parking slot for them by the use of a mobile application. The efforts made in this paper are indented to reduce search time for the parking slot and eventually aiming to enhance the quality of life of its people.

Acknowledgments

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