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A Prototype Smart Parking System Accessible via Android

K. DAHRI[++], Z. HASSAN*, G. LAGHARI**, SEHRISH NIZAMANI*** SAAD. NIZAMANI***, A. R. NIZAMANI

Institute of Information and Communication Technology, University of Sindh, Jamshoro, Pakistan

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Abstract: Cruising for parking per se is time consuming and energy wasting task. Finding the vacant parking position for the vehicles, especially in urban cities, is difficult and unwanted job, which oftentimes keeps people wandering around the vicinities of their desired areas where they want to stop for a while. To readily provide the drivers with the information of vacant parking slots, many smart and intelligent parking systems have been proposed. In this paper, we provide the prototype implementation of such a smart parking system. The specific perspective of the system is of the user, so that the system is easy and simple to use. Thus, we provide the Android based interface to the system.

Keywords: Smart Parking system, Android, Global System for Mobile, Arduino.

1. INTRODUCTION

Parking a vehicle is one of the growing problems in urban cities. It manifests itself when going to many public places such as, shopping malls, restaurants, hospital, etc. Parking a vehicle becomes a difficult and time consuming task, oftentimes vehicles keep wandering in cruising for parking. Some studies of international cities show that from 8% to 74% of the traffic was cruising for parking with average ride time of at most 14minutes (Shoup, 2006).Similarly, via the study of four urban areas of France, it was estimated that 70 million hours were spent per year cruising for parking, which is tantamount to the loss of 700 million euros per year (Eric Gantelet and Amélie Lefauconnier, 2006). Although there is scarce of such studies in Pakistan, yet the problem is equivalently or more pronounced in major urban cities of Pakistan. As such, not only these cruises waste energy (fuel) and time but also contribute in unnecessary traffic on the roads.

With the premise that information on free parking slots readily and easily available to drivers may reduce the cruise times and hence contribute less towards traffic congestions, many smart and intelligent parking systems have been proposed (Idris, 2009, Inaba *et. al.*, 2001, Bonde, *et. al.*, 2014, Kotb, *et. al.* 2016).There are many such implementation options, such as vision based (Al-Absi, *et. al.*, 2010, Sheng-Fuu Lin *et. al.*, 2006, True, 2007) or sensor based approaches (Tang, *et. al.*, 2006, Revathi and Dhulipala, 2012). Despite the availability of these approaches, the choice of a particular implementation may be an involved decision: for example the vision based approaches may require heavy machine learning apparatus, while the sensor based approaches may involve the selection of a particular sensor from numerous available sensors (Revathi and Dhulipala, 2012). Besides these implementation models, which can be utilized, however, the quickly available prototype system may help managers in their decision on the adoption of a smart parking system. We provide such a prototype system. The perspective of the prototype system is from the user (driver) side such that the system should be usable (simple and easy to use) so as to minimize the wandering time. Such a incentive system, thus, may attracts potential buyers towards a shopping mall or drivers to a priced parking system, for instance. Therefore, we aim for an Android based app for the users, which is convenient and easy to use in order to let the users benefit from the parking system.

In this paper, we describe the particular details about the prototype system including the design choices, implementation choices, and testing of the system.

We organize the rest of the paper as follows. We provide brief details on the proposed system in Section 2 and its implementation and Testing in Section 3. In Section 4, we provide the related literature and finally conclude in Section 5.

2. PROPOSED SYSTEM

Here we describe the design of the proposed system. Before proceeding to describe the system, we start with the several uses of user interaction with the system. This should conveniently help understand the proposed parking system.

(Fig. 1) sketches several user interactions with the system, each described bellow:

[++]Corresponding Author: kamran.dahri@usindh.edu.pk

*Department of Information Technology, Shaheed Benazir Bhutto University, Nawabshah, Pakistan

**Institute of Mathematics and Computer Science, University of Sindh, Jamshoro, Pakistan

***Department of Information Technology, Sindh University Campus Mirpurkhas, Pakistan

User registration. This is a natural case where the users need to register themselves with the system by providing their information that needs to be recorded in the system.

User login. Once the users are registered with the system, they should be able to login to the system to effectively use the system. This implies that only the authorized users can exploit the parking facilities.

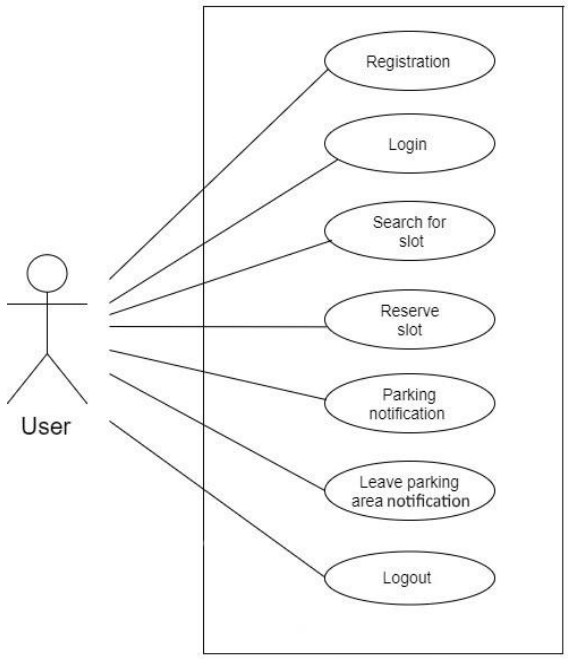

Fig 1. Use case diagram of user

Search for vacant slots. To effectively avail the parking facilities, the authorized users should also be able to search for the vacant parking slots to park their vehicles. Thus, the system should provide the users with the list of available vacant slots.

Reserve the vacant slot. Next the users should be able to reserve the slot before they physically park their vehicle at the vacant slot.

Notify the users. The system should also notify the users with their successfully accomplished activities, a sort of confirmation. The simplest and instant of such notifications are the vehicle parked and disembark.

User logout. After a successful session with system, users should finally be able to log off from the system.

The previous use cases illustrate several of the key components of the system. One such basic component is the database system to keep the information about the users and verily about the parking slots. Then there are two interfaces to access and also modify the database to do the business transactions. One interface is the user app for the users to use the parking facilities, such as user login, search for and reserve the vacant slots. While the other interface is of tracking hardware to update the information about the parking area, such as vehicle parked.

We adopt the client-server architecture for this parking system. Thus, the user app remotely interacts with the parking server through the Internet. The server, on the other hand, involves the database system, the server software where the user app interacts with it, and also the interface with hardware sensors installed at each parking slot. The interplay of these complimentary system elements and the hardware as well as software choices are provided in the next section.

3. RELATED WORK

In this section, we provide some of the related work on smart and intelligent parking systems.

One of the closely related works to ours is from (Bonde, *et. al.,* 2014). They also provide the Android app to the users, however, the communication medium they choose is Global Systems for Mobile (GSM), while we use the Internet. Further, they also use LCD to display the relevant information at the parking site. They use image processing for object detection. (Sheng-Fuu Lin *et. al.,* 2006) proposed a vision-based parking management by using cameras to monitor the parking space. They use sufficient image processing apparatus to detect the objects in color images. Similarly, (Al-Absi, *et. al.,* 2010) also proposed vision-based parking system where they use image classifier to detect the presence or absence of the cars. They train the classifier on two types of images. The images of cars, which the classifier is expected to identify and also the empty images (without cars) to let the classifier tell the difference between empty parking slot and the slot occupied with the car.

(Tang, *et. al.,* 2006) proposed a smart parking system based on wireless sensor networks. They use these sensors as a means to inform the parking server about presence or absence of vehicles at physical parking site. Moreover, the system is controlled by the parking administrators than directly by the clients (drivers). The iParker parking system combines the parking reservation and pricing models as a solution to sketch the architecture of the parking problems (Kotb, *et. al.* 2016). The system is sufficiently rigorous to combine the real time reservations and share time reservations. Hence, the clients can reserve the slots while approaching to the site or can reserve the slots early on (say few days before). The pricing module calculates the parking prices accordingly.

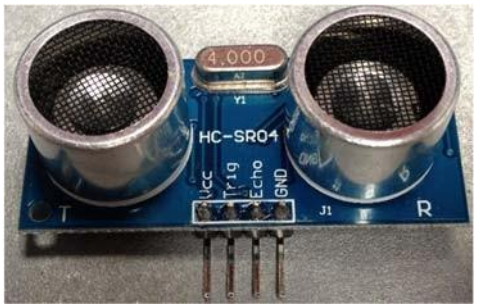

Fig 2. Ultrasonic sensorHC-SR04 (Gerardo Guevara *et. al.*, 2014).

4. IMPLEMENTATION AND TESTING

In this section we provide the detailed account on hardware choices, software implementation, and testing of the proposed parking system.

Hardware.

The very essential hardware is the one which can detect the vacant parking slot, in which case there is no vehicle physically occupying the slot or the reserved parking slot where the vehicle physically takes up the slot. Thus, to detect the presence or absence of the vehicle we use the ultrasonic sensor, more specifically HC-SR04 in (**Fig. 2)**. The sensor transmits ultrasonic sound with 40 kHz frequency to detect the objects.

The sensors are attached to Arduino microcontroller with jumper wires **(Fig 3).** zooms in to (**Fig. 4**). We also attach Ethernet shield as electronic board to connect the Arduino to the Internet for communication (to send and receive data). The Ethernet shield is a source to connect the router to Arduino. This is necessary as the proposed system is to be accessed via Android app remotely via Internet.

Fig 3.Ultrasonic sensor attached with jumper wires.

Software.

At the parking space, we use My SQL database server as database management server, where as at the web server side we use PHP to expose a REST API through which the Android app can use the services.

On the other hand, we provide the users of the parking system with Android app to let them use the parking services. The app uses the provided REST API to interact with the server via Internet. (**Fig. 4)** shows the homepage of the Android app which displaying the empty as well as reserved parking slots to the user for both cars and bikes. This implies that the users can find and reserve the desired parking slots for their vehicle types accordingly.

Fig 4. Homepage of the Android app.

Testing.

We implement a proof-of-the-concept prototype parking system. We evaluate the prototype system with few naïve test cases to demonstrate the interplay of the hardware and software components of the system described previously. In (**Fig. 5)**, we observe that all parking slots are empty and the Android app displays the same accordingly. The user then can select a desired slot and physically park their vehicle there.

Similarly, in (**Fig. 6)** we see that one of the physical parking slots is occupied and the Android app displays the same.

This simple prototype and its early testing encourages that the traditional parking systems can be easily transformed into smart parking systems and also with less and affordable cost.

Fig. 5. Prototype parking system. The parking slots are all empty, also shown in the Android app.

Fig 6. Prototype parking system. The parking slots are all empty but one, which is also shown in the Android app.

5. CONCLUSION

One of the growing problems in urban cities is parking the vehicles especially in public places, such as restaurants, shopping malls… Visitors in interested in visiting such public places often keep cruising in search of the parking and thereby unnecessarily contribute more in traffic congestion. To alleviate the problem many smart and intelligent parking systems have been proposed. In this paper, we also proposed and provided a prototype implementation of the system. Such readily available prototype system should aid concerned people in adopting the smart parking system. The specific perspective of the system was to ease the users of the system. Hence, the system was made accessible via Android app so that the users can remotely use parking services, such as searching the vacant parking slots and reserve them, before they physically arrive at the parking location. The prototype system worked well with very few naïve test cases, demonstrating that traditional parking system can easily be transformed into smart one.

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