

BPM: Bluetooth Parking Manager

Wookjong Kwak
Carnegie Mellon University Silicon Valley
Moffett Field
California 94035
wookjong.kwak@sv.cmu.edu

Sungho Cho
Carnegie Mellon University Silicon Valley
Moffett Field
California 94035
sungho.cho@sv.cmu.edu

ABSTRACT

The goal of our Bluetooth Parking Manager, parking lot gate opening system, is providing seamless authentication without additional user effort and additional devices. We propose to use Bluetooth technology as a communication channel with a smartphone as a control device. Given that most smartphones have embedded Bluetooth module, and most users bring their device in everyday life, especially when driving, the combination of Bluetooth with smartphone is a strong candidate for our solution. In this paper, we demonstrate that parking lot gate can be easily controlled by a smartphone using Bluetooth technology with a reasonable waiting time. We will also show that through thoroughly analyzing the signal strength of Bluetooth module, the system can verify the location of the user and eliminate possibilities of granting access to unauthorized users.

Keywords

Android, Arduino, Bluetooth, Parking lot, Garage

1. INTRODUCTION

According to [3], the United States parking industry is an \$18 billion dollar industry, and there are more than 40,000 parking facilities in the United States. [4] also reported that the revenue of the parking lots and garages industry has reached \$9 billion dollars, and over 136,000 employments and 8,000 businesses are involved with the industry. Although the industry has been decreasing for the past five years mostly due to the recession and under capacity of airport parking lots, [4] had reported that the demand will pick up in the next five years as em-

ployment improves and demand from airports and other businesses revives.

The access of these parking lots and garages are managed through different types of gate openers, and they are mostly operated with access card using RFID or dispensing paper tickets to customers. Although the gated parking lots and garages provide more security and guaranteed parking spaces, there are few problems to both users and the parking service providers in current systems. The most cumbersome task users have to bear with is physically swiping the access card to the reader or inserting the paper ticket to the machine to open the gate. As the result, it creates extra user actions such as finding the access card or the paper ticket, opening the window, and finally swiping the access card or inserting the paper ticket to the machine. From the service provider's perspective, it is inconvenient to issue a new access card or a paper ticket for each new client. For the access card, it is hard to retrieve or revoke expired access cards.

Through our BPM (Bluetooth Parking Manager) system, we demonstrate that users can easily use parking lots and garages with minimum user action using Bluetooth technology embedded in their smartphones. In our approach, we allow users to easily purchase parking permits through our client Android application, and seamlessly control the gates of desired parking lots and garages using Bluetooth communication channel between the user's smartphone and the Bluetooth module which controls the gate. Additionally, our approach only requires attaching a Bluetooth module to the current parking lot system, which is a low cost solution. It allows most parking lot service providers to implement the solution and improve their parking lot and garage services.

2. RELATED WORK

There has been active and extensive researches focusing on improving the parking lot and garage user experience. Motorola has been actively researching Automatic License Plate Recognition system [1], which reads

the vehicle's license plates and checks them against the database to quickly identify the verification of vehicles (as shown in Figure 1). This system has been widely used not only the parking ticketing systems, but also locating stolen or wanted vehicles, tolling, boarder control, etc. As the name of the system indicates, this system uses illumination, such as infra-red, and a camera to take the image of the license plate of vehicles, then analyzes the image with an image-processing software to extract the license plate information. Once the license plate information has been extracted, it is checked against the database to identify the vehicle, and the parking lot gates opens automatically if the vehicle is authorized to use the parking lot [2]. This system has an advantage of not requiring any installation on the vehicle.

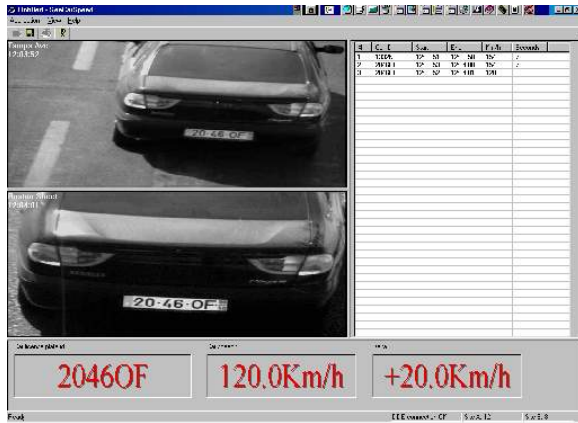


Figure 1: Automatic License Plate Recognition system takes an image of the vehicle and extracts the license plate information

However, such system requires a major upgrade in the parking lot, because it requires a completely different set of components, such as cameras, illumination, frame grabber, computer, and image-processing software. These equipments can be very expensive, in order to achieve a certain level of accuracy. This high cost of the system is not very appealing to the parking lot service providers. Additionally, the external effects, such as sun and headlights, and bad license plates, can severely affect the performance of the system.

The rest of this paper will explain the system overview of our low-cost parking lot system, followed by the details of the system, evaluation, and conclusion.

3. SYSTEM OVERVIEW

The BPM system can be broadly divided into three components (as shown in Figure 2). The first component is the client Android application. It is the core component of the BPM system, which provides an in-

interface allowing users to register with our system. In addition, the application also allows users to easily look up available parking lots and buy permits for desired parking lots. Another main task of the Android application is scanning available Bluetooth devices around the user. It periodically scans a discoverable Bluetooth device which is attached to the gate of parking lot or garage.

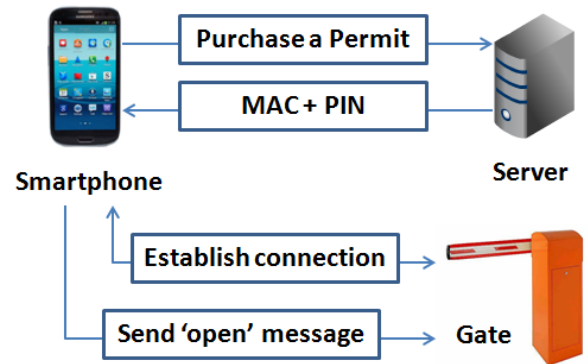


Figure 2: The BPM system consists of three components: client Android application, server, and Bluetooth enabled parking lot gate

The second component is the application server, which provides RESTful end-points for useful functions that are used by the client Android application. These functions include registration, parking lot searching, buying parking lot permits, etc. When a user registers with our system, he/she may search for parking lots simply by providing a ZIP code, which then the server retrieves available parking lots and garages for the user. Once the user purchases the permit, the server returns the MAC address of the particular parking lot's Bluetooth device and the PIN associated with the Bluetooth device for pairing to establish a communication channel between the user's smartphone and the Bluetooth device.

The last component is the Bluetooth device which is attached to the gate of parking lot. It is essentially a combination of an Arduino board and a Bluetooth module. Once the user purchases the permit, the user's smartphone maintains the MAC address and the PIN. Once the client Android application finds the correct Bluetooth device by matching with the MAC address, it automatically initiates pairing process and establishes a communication channel. Once the communication channel is successfully established, the client Android application sends a message to the parking lot Bluetooth device to open the gate. The parking lot Bluetooth receives the message and command the gate to open via the Arduino board attached to the gate.

4. SYSTEM DETAILS

5. EVALUATION

6. CONCLUSION

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