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Design and Implementation of on-Street Smart Parking Circuits Controlled by an Android Application

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Abstract: *With the expansion of urbanization in today's world, transportation plays a crucial role in sustainable urban development. Meanwhile, with the advancement of technology and its significant impact on improving human life, smart transportation systems are one of the requirements of urban development and of the infrastructure of a smart city. These increasingly expanding and developing systems with their technological base increase productivity and safety of transportation. As such, the provision of a suitable place for car parks is one of the essential needs of a developed city. On the other hand, with the increasing number of cars and consequently the size of parking slots in metropolises, it is impossible to manage them without the use of new systems in practice. In this article, we will design and construct an on-street smart parking system based on GSM, GPS, and Google Maps using the Android app. One of the special features of this project is the online booking system and paying the cost of parking, as well as displaying road surface temperature information using the Android app, which will improve productivity. In addition to other benefits, a quick and accurate diagnosis of occupancy or being available of parking space in a practical implementation indicates the capability and proper efficiency of the proposed system.*

Keywords: *Smart Parking, Smart City, GSM, Smart Parking App, Google Maps.*

INTRODUCTION

Locating a parking slot in crowded urban and commercial areas is one of the problems every driver has, such that sometimes a driver wanders a long way in the street to find an empty parking slot. In other words, the lack of adequate parking spaces in all cities, especially in the central sectors, has become a general and problematic issue. Helping to find the closest spot of vacant parking through modern technological systems, including mobile phones and special applications, can play a significant role in reducing this dilemma. Sending instant information to mobile phones helps drivers make the best decision for their car park and optimally utilize this information. In metropolises, the proportion of cars rather than car parks is usually higher, hence finding a parking slot is a great deal of commuting time. Considering urban development and the emergence of metropolises and super-cities, attention should be paid to urban planning and design of appropriate transportation systems (Waraich et al., 2012; Mitchell et al., 2010). In (Benson et al., 2006), the design of smart parking using RF transceiver with the help of the ATMEGA128L microprocessor has been addressed. Ref. (Panayappan et al., 2007) uses VANET to determine empty parking spaces. Use of embedded surveillance cameras (Li et al., 2013) is to control parking slots. In this system, smart cameras that are embedded on the parking slot are used to find empty spaces, which transmit all information to the database. In each of the cameras, there are algorithms for identifying the parking space. In (Alhammad et al., 2012), the informed street

system is based on information station, which introduces an ad hoc car-based network based on a street park system that uses the concept of information station (ISs) and informed systems to track and reserves a park space. Ref. (Kumar et al., 2017) uses the technology of RFID and GSM to design a smart parking system. In order to design a smart parking system, a sensor and a camera have been used for vehicle and parking identification (Lookmuang et al., 2018). This article describes the on-street smart parking using the device and Android application designed for it. This device is located at the place of the on-street parking slot in accordance with Fig. 1. This system is equipped with GPS to determine the exact location of the parking slots, the SIM808 module to send and receive data and also the temperature sensor to collect road temperature information. The Android app displays empty, booked and filled parking slots, which can be used to book parking and pay parking fees according to the selected time period.

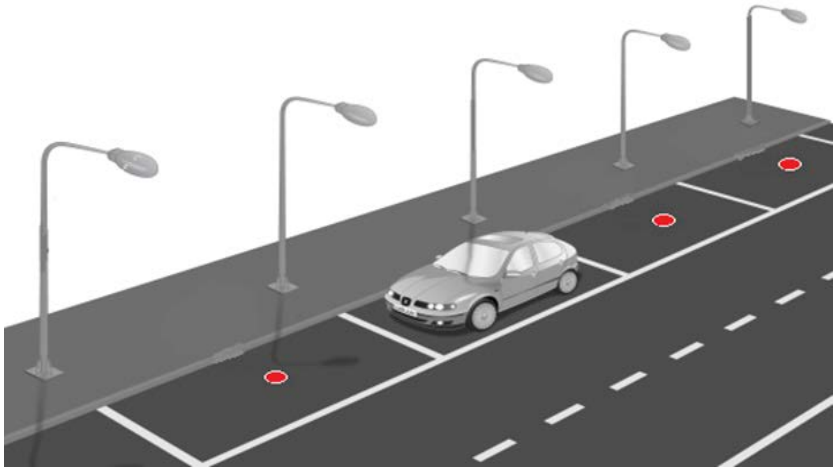

Figure 1: Location of on-street devices

Device design

The electronic components used in the device are as follows:

- Arduino Pro Mini
- GPS Antenna
- SIM808 module
- GSM Antenna
- Waterproof Temperature Sensor DS18B20
- Lithium polymer battery
- TP4056 Li-Po Battery Charger Module
- Solar panel

And the Arduino IDE software has been used to program the Arduino's range.

Suggested circuit diagram

Fig. 2 shows how the electronic components joint the device designed for smart parking.

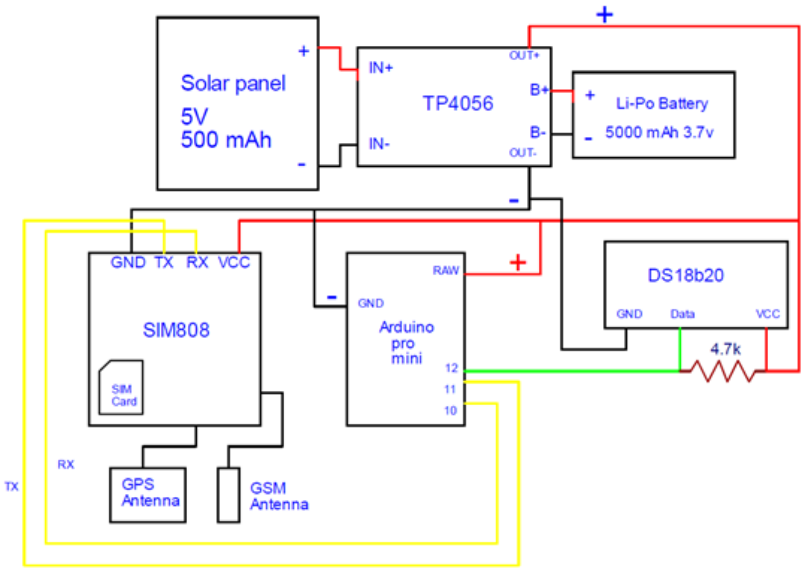

Figure 2: Connection of the used hardware to the on-street smart parking device

Hardware Implementation

A constructed sample of on-street smart parking device is shown in Fig. 3.

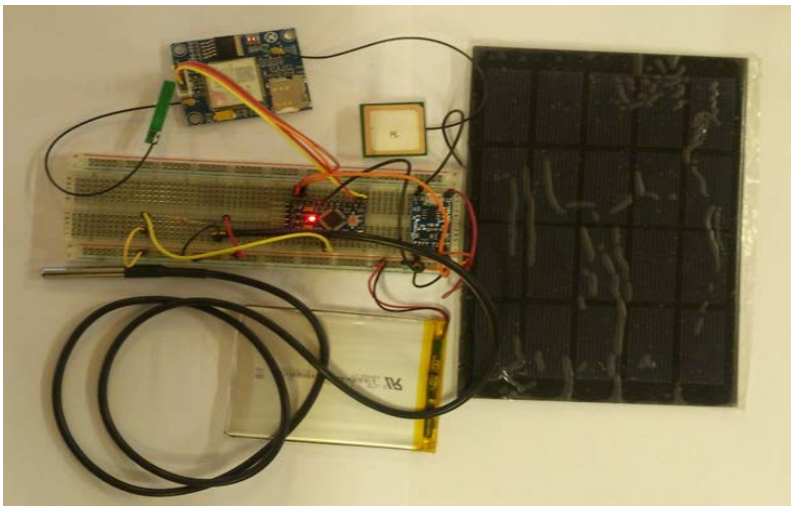

Figure 3: Experiment prototype

Android app design

The Android Studio software is used to design this application. The overview of the designed application is shown in Fig.4a. The app consists of three parts: parking search, parking information, park and payment. Clicking on the parking search, you find the nearest parking slot located on Google Maps, wherever you are, as shown in Fig.4b. The colors red, orange, green and blue represent occupied, reserved by drivers moving to the parking, and empty parking slots, as well as user location, respectively. By selecting an empty parking slot, the app shows the route and the nearest roadway to the desired parking slot, as shown in Fig. 4c. In Fig. 4d, clicking on the parking information, you will see the road temperature, which is used by the Municipality and the Toll to take the necessary actions if ice sheets are present.

Figure 4: Android application of on-street smart parking
a App Overview
b The status of the parking slots in the city map
c Route and the nearest roadway to the parking slot
d Parking slots temperature information

After stop and parking the car, clicking on the park and pay bar of the app, it shows the parking slot number, park time and cost settings as shown in Fig. 5. Park payments must be paid according to the chosen time period.

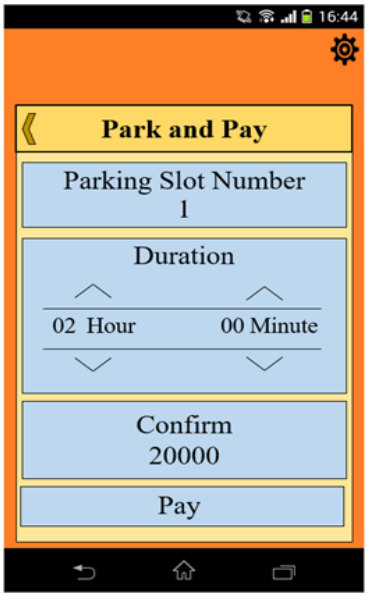

Figure 5: The page designed by the app for park time and costs

Function

Basically, the device works such that by installing it on the parking slot, the exact position of the parking slots, the temperature of the road surface and the condition of the parking slot (occupied, empty or booked) are processed by GPS, temperature sensor DS18B20 and Arduino Pro Mini respectively, and sent to the designed application using the SIM808 module. Users can click on the app search bar everywhere they are to see the nearest parking slots. The parking slots occupied by the cars are shown in red on the Google Maps app, and users can click on these red spaces to view the remaining park time. Reservations can be made by users of empty parking slots in green. By clicking on the empty parking slots, the parking slot will be in the booked state and the color changes from green to orange. A router and the nearest roadway to the desired parking slot are shown and the location of the users is instantly displayed on that router and as soon as the user is in the exact location of the parking slot, the booked parking slot is occupied and its color turns from orange to red. The maximum time to reserve a parking slot is for an hour (this time is adjustable). And after getting into the parking slot, entering the park bar and paying for the app, users can pay the park time and cost.

Conclusions

In this article, we have designed and constructed the device and Android application of on-street smart parking and a system was proposed to different drivers to locate dynamically their car to the nearest parking slot, based on the need and time. This system reduces the time of parking search, save time, eliminate congestion, facilitate traffic, reduce air pollution and costs, and improve access to parking slots. Also, as mentioned earlier, the Municipality and the Toll can obtain road temperature information. As we have seen, the proposed method does not use any sensors to detect a car in the parking slot, and uses GPS and Google Maps to do this. As a result, hardware costs are drastically reduced and it will be cost-effective to implement in smart cities.

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