Scientific Journal of Silesian University of Technology. Series Transport
Zeszyty Naukowe Politechniki Śląskiej. Seria Transport

Volume 98 **2018**

p-ISSN: 0209-3324

e-ISSN: 2450-1549

DOI: https://doi.org/10.20858/sjsutst.2018.98.4

Journal homepage: http://sjsutst.polsl.pl

Article citation information:
Kirci, P., Saglamoz, S., Sener, M. An intelligent vehicle detection management model for parking spaces. *Scientific Journal of Silesian University of Technology. Series Transport*. 2018, **98**, 35-43. ISSN: 0209-3324. DOI: https://doi.org/10.20858/sjsutst.2018.98.4.

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AN INTELLIGENT VEHICLE DETECTION MANAGEMENT MODEL FOR PARKING SPACES

Summary. Today, technology has transformed humans' lives in all areas. Technology can be found in everyday life in the form of smart factories, smart cities and smart rooms. Thus, smart systems and devices are having a great effect upon human activities. Together with improving technology, in the last 50 years, the human population has seen an expeditious and substantial increase. The number of cars has also substantially increased and, as a result, parking spaces and car park have become more important. Areas in which to park cars have become wider in scope, including inside huge buildings; thus, the management of them become more difficult and complicated. Being able to discover an empty parking space as soon as it is needed is vital for both driver and multilevel parking garage owner, especially for the former, in order to avoid losing him/her time and money in a crowded city. Thus, we designed a smart car parking system, which is managed by Arduino control. Our main aim includes reducing time loss and the amount of fuel consumed while trying to find a parking space. By reducing the amount of consumed fuel, it will be possible to reduce air pollution levels, together with minimizing the negative impact on domestic finances caused by car usage.

Keywords: sensors, wireless networks, parking spaces, cost

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1. INTRODUCTION

Major increases in the human population has caused a corresponding augmentation in the number of cars. Thus, parking spaces and car parks have become more important. In the past, employees served customers by controlling the entrance and exit of cars. But, today, areas to park cars are becoming wider in scope include the insides of huge buildings. Thus, the management of such areas has become more difficult and complicated. Being able to discover an empty space as soon as it is needed is crucial state for driver and multilevel parking garage owner. Finding a parking space in a short time is particularly important for the driver, so as to avoid losing him/her time and money in a crowded city.

It can be quite frustrating for a driver to go around a car park looking for a space. If the driver cannot find one, then s/he has to leave the multilevel parking garage and find another. In response this situation, we designed a smart car parking system. Our project is composed of three basic system applications, namely, automatic car parking barriers, empty/occupied place sensing, and monitoring. The presented smart car parking system is managed by Arduino control, in which users can find an available parking space via their smartphone.

Of late, increasing energy costs, the need for greater efficiency, competition and developing technologies have prompted the emergence of smart car parking systems. Inspired by customer needs, at first, automatic barrier systems and warning systems for occupied parking spaces were produced. Thus, people have noticed that, by utilizing these types of systems, daily processes in multilevel parking garage have become simpler.

Intelligent transportation systems with vehicular ad hoc networks (VANETs) have been widely studied, as they include many useful specialities and ease road transportation by utilizing prior alerts about traffic conditions, automatic parking and collision determination warnings [1,2]. In [3], a model was improved for characterizing parking location decisions of individual trip makers to provide data concerning the impacts of alternative parking policies on such decisions in an urban area. A microsimulation approach was utilized in [4] to capture the adaptation of individuals' travel patterns to policies. Land use and transport in the city of Rotterdam were examined by illustrating hypothetical scenarios. A new model has been presented for modelling private vehicle ownership in India [5]. Variable behaviours between men and women in responding to traffic information was studied in [6], which also considered advanced in-vehicle systems in order to deal with congestion. Driving range limits and alternative travel cost compositions were considered in [7], together with route and parking choices. Park-and-ride stations, bus rapid transit schedules and parking spaces were considered in [8], in which a linear integer programming model was used to formulate the capacity of parking spaces, alongside a network design problem.

The progressive occupancy of parking capacity on the street was examined in [9] within the paradigm of user equilibrium. Kerb parking involving dynamic traffic was studied in [10], along with the formulation of traffic management measures for providing traffic safety. To predict occupancy at the destination, a real-time occupancy model was presented in [11]. Meanwhile, traffic seeking parking spaces can be found in the inner districts of towns because of a deficiency in reliable data on the fullness rates of on-street parking places. A real-time occupancy model was proposed to predict occupancy at the destination. In this paper, traffic flow volumes were considered with regard to a number of car parks. A street parking occupancy detection system, based on video, was proposed in [12]. Many challenges were taken into consideration when designing this system, such as rain, occlusions and illumination changes in motion and vehicle detection, by using computer vision and video processing. In the future, we can expect to consider the implementation of artificial intelligence methods, which are already widely used in various tasks, including image analysis [13-16].

2. SYSTEM OVERVIEW

In our evolving and varying world, technology is improving and supporting our lives in all areas. Today, technology is found in every part of daily life with smartphones, smart cars, smart homes and smart clocks. Thus, these smart systems and devices play a major role part in humans' lifetime. To be defined as smart, the program or system should have some of the characteristics below:

- Making decisions
- Sensing
- Learning
- Problem-solving
- Reasoning
- Figure or picture recognition
- Natural language understanding

The capacity to perform different jobs and applications simultaneously makes smart systems indispensable. Smart portable systems can achieve almost all of the applications that are provided by a stationary computer system.

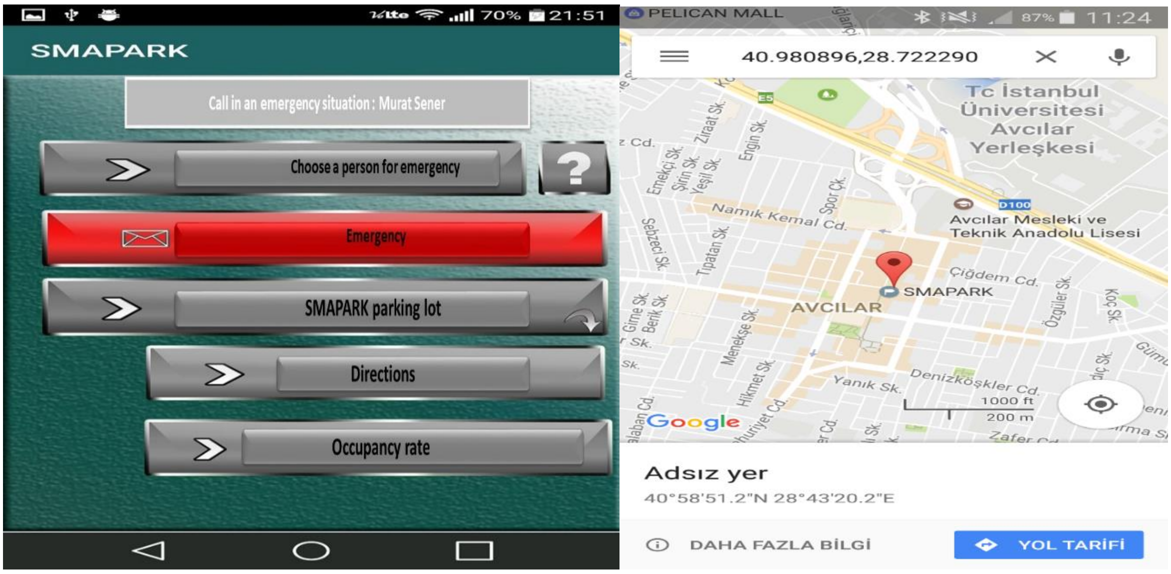
Responding to the main requirements of customers in a car park, we have considered an automatic barrier system, empty/occupied area sensing and monitoring. The proposed system is composed of an Arduino Mega 2560, which is an ATmega2560 base circuit board. It is programmed over Arduino IDE. To detect empty parking spaces, CNY 70 konstrat sensors are used. We decided to use Bluetooth over Wi-Fi and NFC communication systems.

In our project, the user starts to use the application by activating Bluetooth via a connection to the HC-06 Bluetooth module. To provide the connection between the MAC address of the user's device and the device itself, a socket is formed, with received data processed together along with sending data to Arduino. The Firebase RealTime Database is also utilized on the project, which allows us to stored project data as JSON in real time.

3. PROPOSED SYSTEM IMPLEMENTATIONS

In the last 20 years, increasing energy costs, the need for greater efficiency, competition and developing technologies have led to the emergence of and improvements in smart car parking systems in line with customer needs.

For this reason, we considered the main needs of customers in terms of parking spaces: an automatic barrier system, empty/occupied area sensing, and monitoring. On the project, we designed a system for two types of users. If the user has already reached the car park, s/he will be informed at the entrance of the available spaces. But, if the user is on the way to the car park, s/he will be informed via our system over his/her smartphone before arriving about the fullness rate.



(a) (b)

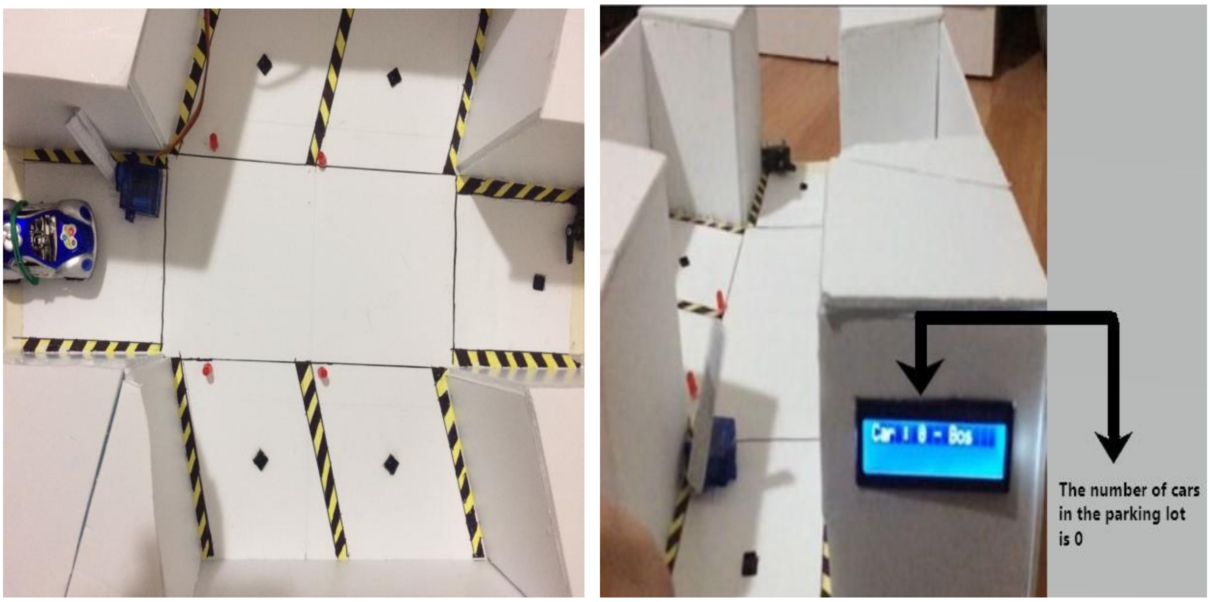
Fig. 1. User interface of the presented car parking system (a) and location of the closest parking space (b)

On the project, we designed four parking areas, each one containing four parking spaces. In each area, empty parking spaces are monitored with sensors, which are placed in the parking space at floor level. The number of empty parking spaces is then shown at the entrance of the car park, meaning that, if there is no empty parking space, the customer decides to leave, rather than enter the multilevel parking garage. Thus, the customer saves time and money. When a customer leaves a parking space, the availability will be noticed by the system; however, until s/he leaves by the exit, its place will not show as empty in order to prevent a queue. Thus, at the entrance and exit, possible congestion is prevented.

The user can monitor the parking area with the presented application as shown in Figure 1a. According to his/her location, the application will look for the closest parking area in the system. Then it will examine the fullness rate of the parking area. If it detects that the parking area is full, it will look for the next closest parking area. When it notices a suitable one as presented in Figure 1b, the system provides the user with directions and the fullness rate. If the user does not want to go to this location, the system will look for another suitable space for the user.

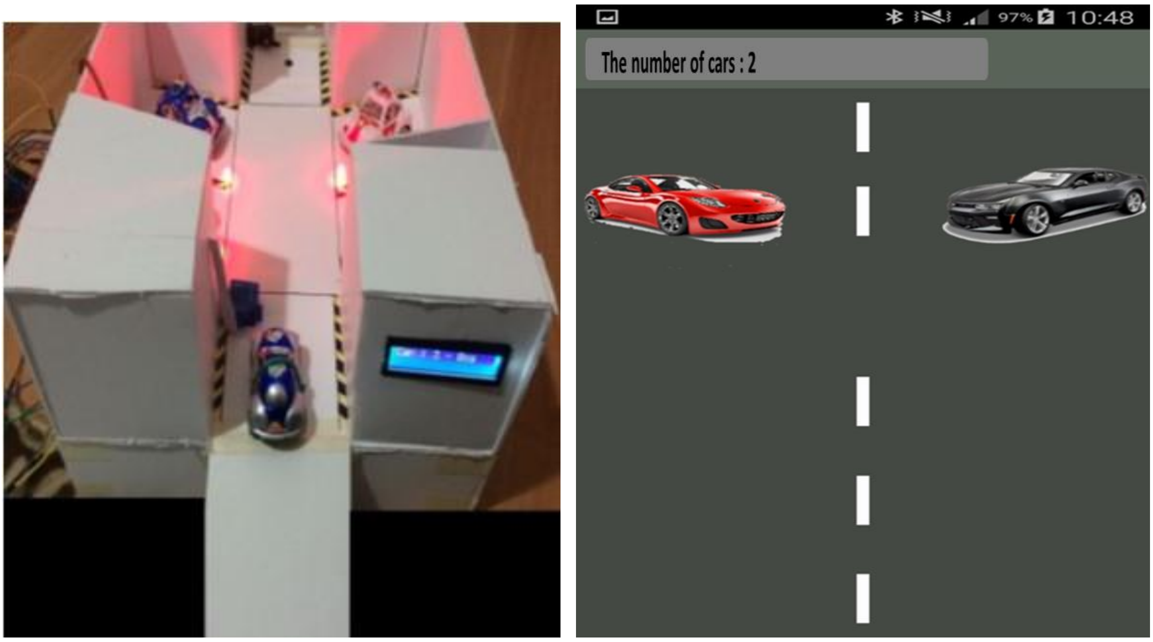
We used an Arduino Mega 2560, which is an ATmega2560 base circuit board. It is programmed over Arduino IDE. CNY 70 konstrat sensors are utilized to detect the empty parking spaces as shown in Figure 2a. On our project, when there is no car to trigger the sensors, the screen displays “Car : 0” to show that the parking space is empty, as shown in Figure 2b.

When a car reaches the entrance, the driver is informed about the fullness rate of the parking area in terms of the number of cars inside. If there is an empty parking space, the screen also displays “Empty”. In Figure 3, two cars are sensed in the parking area, which means that there are two empty parking spaces. Thus, an automatic barrier system opens to allow the waiting car at the entrance to enter the parking area. The user who monitors the parking system over his/her smartphone will also receive the information as shown in Figure 3b.



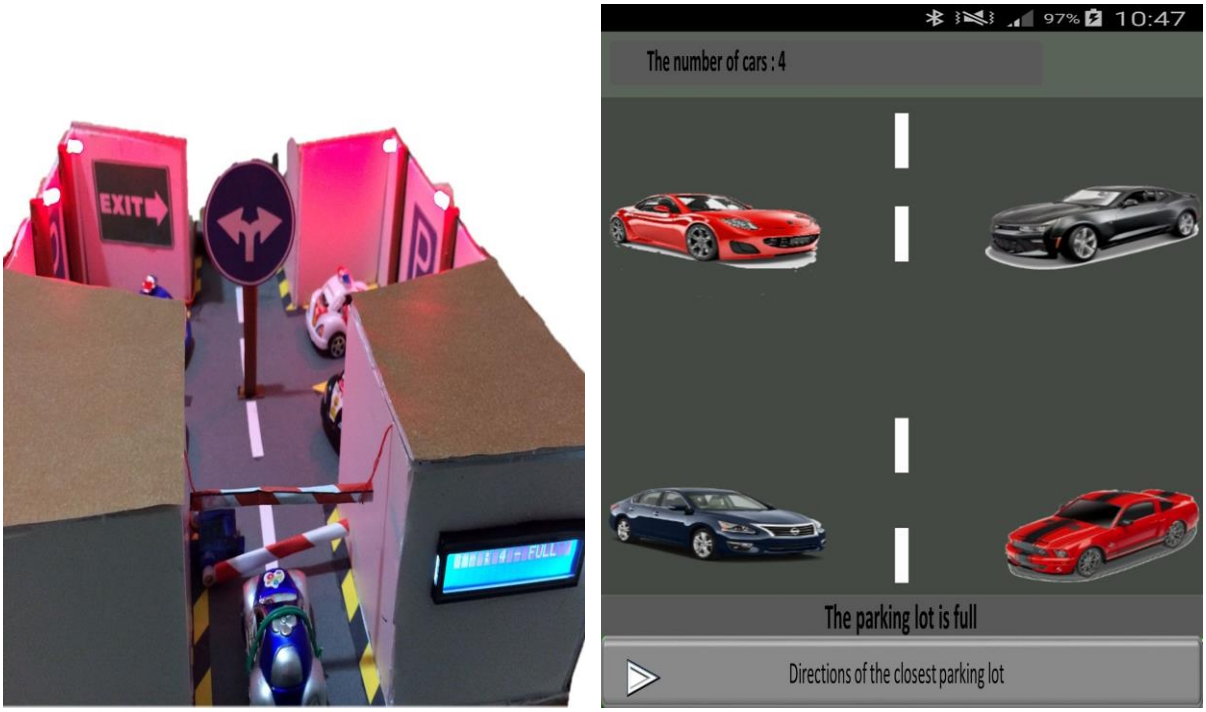
(a) (b)

Fig. 2. The presented smart car parking system (a) and the presented smart car parking system screen (b)



(a) (b)

Fig. 3. The presented car parking system with two cars (a) and the presented car parking system interface with two cars (b)



(a) (b)

Fig. 4. The full smart car parking system (a) and the full smart car parking system interface (b)

The CNY 70 sensor emits infrared signals and produces analogue outputs according to whether or not infrared signals are received back. This helps us to decide whether there is a reflective surface in front of the sensor. If there is a surface in front of the sensor, this means that there is a car parked in the respective parking space. Furthermore, at the entrance, the number of occupied parking spaces is shown as three, while the number of empty parking spaces is shown as one. For this reason, the automatic barrier is opened for the fourth car to enter into the parking area in question. When the fourth car enters the parking area, both the screen as shown in Figure 4a and the smartphone application as shown in Figure 4b indicate that the parking area is full. In addition, the smartphone application offers to find the next closest parking area for the user.

In Figure 5, the sensors that are triggered by cars are represented by red lights, which are on. The parking area in this example is full with four cars; thus, the entrance is closed to waiting cars in order to prevent congestion and queues.

When the parking area is occupied by four cars, but one of them is leaving, and there is another car arriving at the entrance at the same time, in order to prevent congestion and queues, the automatic barrier system will not open until the departing car leaves the parking area as represented in Figure 6. After this car leaves, the automatic barrier system opens to allow the arriving car inside the parking area.

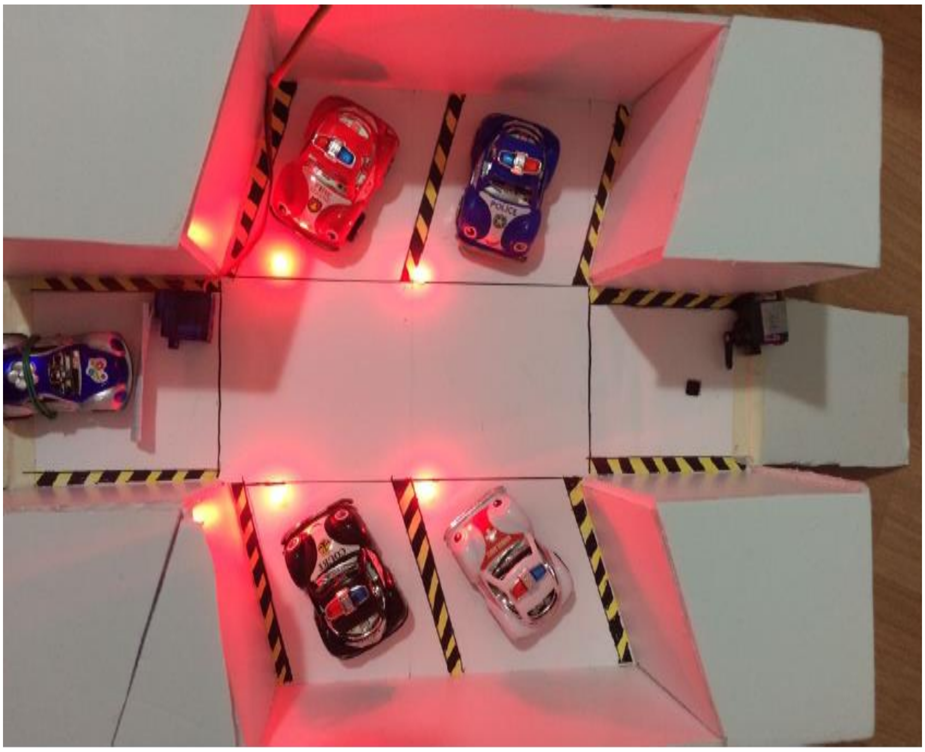


Fig. 5. The full smart car parking system

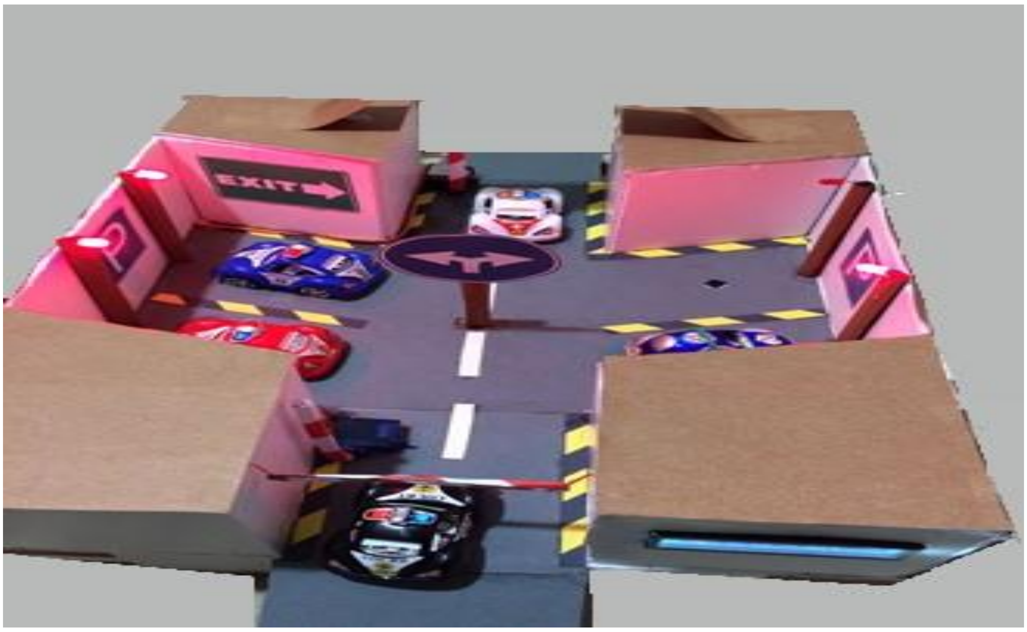


Fig. 6. The full smart car parking system

4. CONCLUSION

We applied sensor technology to identify parking space availability in our proposed car parking system. In the presented work, basic methods are used in order to implement this system at the present time. Our main aim is to minimize both financial and time losses related to finding a parking space by utilizing sensors. The use of sensors in this way allows for the collection and processing of data in a short time period, which in turn will ensure lower costs and less time loss. Utilizing sensors in industry and factories offers many benefits to people, as well as in car parks. We also combined sensor usage with the Android platform found in some smartphones. The user can easily access the presented system with user-friendly interfaces in order to determine the closest and available spaces in a car park in a short time. Thus, the user does not waste time and fuel to look in this search. Future research could develop a system that can be placed in parking spaces found on the roadside in order to provide users with more parking space options.

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Received 22.10.2017; accepted in revised form 02.01.2018