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Outdoor Parking Control System using Image Processing and Light Fidelity (Li-Fi) Communication Technology

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Abstract:- **In this paper, a fully automated system is introduced which allows drivers to effectively locate and reserve the vacant parking spaces. The system will use image processing to periodically scan the parking status in parking lots and locate the vacant spaces; the reservation service will be affected by the change of physical parking status. The collected data at the parking spaces will be transmitted to the main controller using Light Fidelity technology to ensure high and efficient data transmission. A programmed radio frequency identification system is used to scan the user card to check if he/she has a permission to enter or not. A Raspberry Pi module is programmed and used to capture, communicate, and analyze data. The main advantage of this system is high communication speed.**

Keywords: Li- Fi, RFID, Raspberry Pi, Smart parking, and Image processing.

I.INTRODUCTION

As the population around the world is growing, the number of motor vehicles used is increasing rapidly, so the need of new car parking places is required. To avoid these problems, recently many new technologies have been developed to help in solving the parking problems to a great extent. The traffic generated by cars' drivers searching for parking spaces takes up to 40% of the total traffic, with a huge impact on the mobility and quality of life of residents (Fraifer and Fernström, 2004; Mateo et al., 2009; Yan et al., 2009).

In the past two decades, the concept of intelligence in terms of smart parking systems became more popular in the most vibrant cities, especially in malls and shopping centers. In the mid-80s, the systems used for parking relied mainly on the traditional method of pushing a button in the device next to the checkpoint to get a parking ticket and on exiting, the driver must pay before inserting their ticket in order for the barrier to rise (Chou et al., 2008). This was the method used to determine how many cars came in and out the system each day, and it was used to count the number of vacant spaces available (Longfei et al., 2009; Adler et al., 2005; Khoukhi, 2010; Li et al., 2004; Yeh et al., 2016; Pham et al., 2015). It began by utilizing different methods such as sensors or barriers to be able to know the status of parking lots. All these methods developed dramatically further until recently the term 'smart city vision' emerged. So, a new method to mange the parking systems automatically is needed (Lee et al., 2016; Mahmud et al., 2013; Sharafi and Nikpoor, 2010).

There are a lot of similar works to the work presented in this paper. However, they used different techniques. For example, Nammoon and et. al. introduced a system that gives drivers real time information about the parking and direction guide. The system uses Visible light communication (VLC) technology to give smart parking information, which leads saving in time and fuel. The system was validated through indoor experiments (Nammoon et al., 2014).

Lee and et.al. introduced a system to reduce the time needed for finding a parking spot by using image processing. The system is designed to provide information about the available parking spaces and for registered users it provides an automated payment system. This system can be applied everywhere because it is easy to use and effective (Lee et al.,2016).

Bhor and his team introduced a system that uses vehicle number plate recognition for automatic parking and electronic fee collection. The goal of this system is to increase the accessibility and security of the parking lots. The system also has a parking guidance to guide users to parking lots. The system recognizes the vehicle plate number using image processing for operation of the parking and payments (Bhor et al.,2016).

Finally, Soundarya and Sumithra proposed a system that uses image processing for parking solutions. The system uses a camera that is placed overhead the parking lots; the camera captures an image of the parking lots and a microprocessor is attached to the camera for processing the image to give the number of empty slots. Also, the system sends SMS to the driver about the number of empty spaces (Soundarya et al., 2018).

The system presented in this work will guide drivers to the available parking spaces and their location in an efficient and fast way. Hence, different technologies have been used in the introduced system such as (Sharma et al., 2011; Kianpisheh et al., 2012; Geng and Cassandras, 2012).

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Light Fidelity (Li-Fi) is a wireless communication technology that enables the wireless data transmission through Laser source. This means when Laser is used, lighting bulbs can bring not only the light, but also wireless data transmitted at the same time.
Radio Frequency Identification (RFID) tags are small transponders that respond to queries from a reader by wirelessly transmitting a serial number or similar identifier. They are heavily used to track items in production environments and to label items in supermarkets. They are usually thought of as an advanced barcode.

II.MATERIALS AND METHODS

Proposed System Overview

The introduced system will consist of two main parts a transmitter and a receiver as shown in Fig. 1. The camera will take images from the parking lot for each spot and send it to the microcontroller. The microcontroller will analyze the images and find available parking spots and their locations. This information will be sent to the receiver using LI-FI.
This procedure will be updated every five seconds. The RFID system is connected to a Raspberry pi, which is easy and flexible to use. The IDs of the RFID are stored in the database to be able to add and remove IDs. To make the

The Raspberry Pi is a small, barebones computer developed by The Raspberry Pi Foundation with the intention of providing low-cost computers and free software to students. The Raspberry pi Camera Module v2 has a Sony IMX219 8-megapixel sensor. The camera module can be used to take high-definition video, as well as stills photographs.
In this paper, the full details of the design and implementation of the Li-Fi communication and image processing is presented, including the use of RFID tags and the Raspberry pi system at an outdoor parking control system.
system even smarter, a screen is installed in the system that can show how many parking spots are available in the parking area, and it can communicate to the driver the nearest parking available. Indirectly with a Raspberry pi camera, information about the selected parking area will be updated every 2.3 seconds. This camera can detect all kinds of cars with high quality images. These data will be sent fast through light to the original Raspberry pi. This is where LI-FI technology takes place and it is efficient. In the entrance gate of the parking lot, there is a screen that tells this information about parking searching procedure. The gate will open once the system authorize the ID card and finds available parking.

III.THE RESULT

AND DISCUSIOON

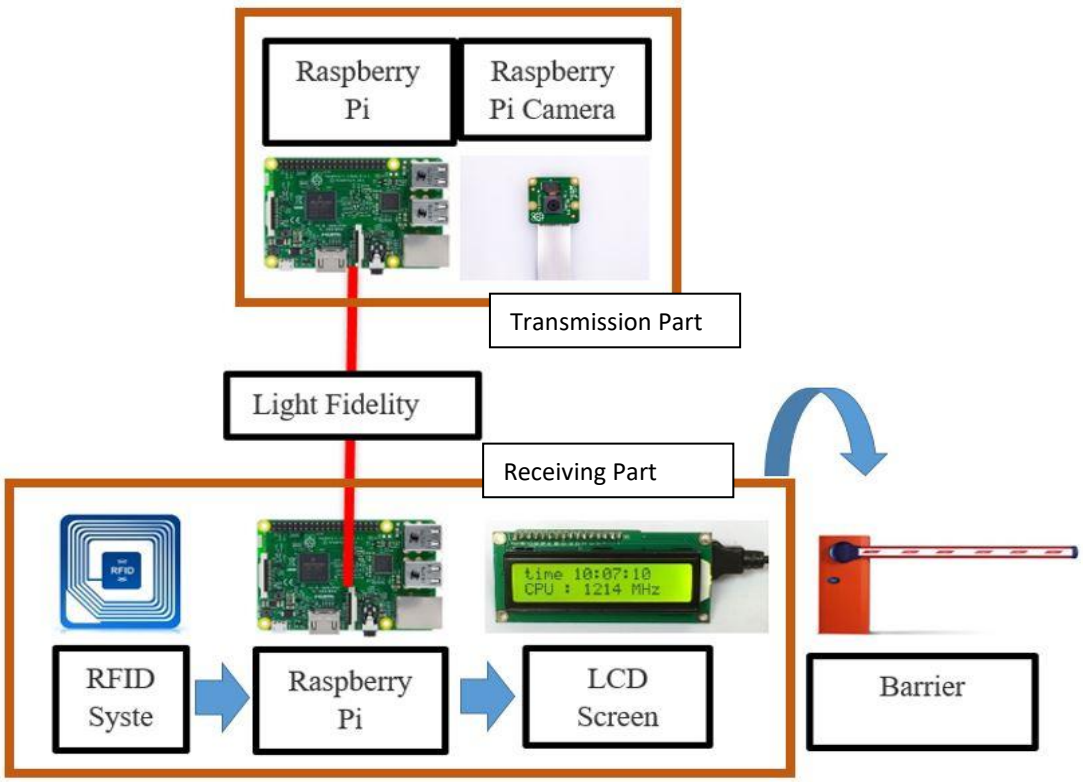

FIGURE 1. PROPOSED SYSTEM OVERVIEW

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Receiving Part

The receiver is responsible for sending a signal to the gate to open or not. In this part a passive RFID tag that works on high frequency range (10-15 MHz) is used. The main role of the RFID system is to provide a tag number that allow the Raspberry pi controller to check if the tag number is already registered in the data base or not. So, if the tag number is not registered the LCD screen will display that this tag number is not available, and the user is not allowed to enter. On the other hand, If the tag number is registered the Li-Fi solar cell receiver will receive data coming from the transmitter about the number and location of available parking spots. Fig. 2 shows the flow chart of the receiving part of the system.

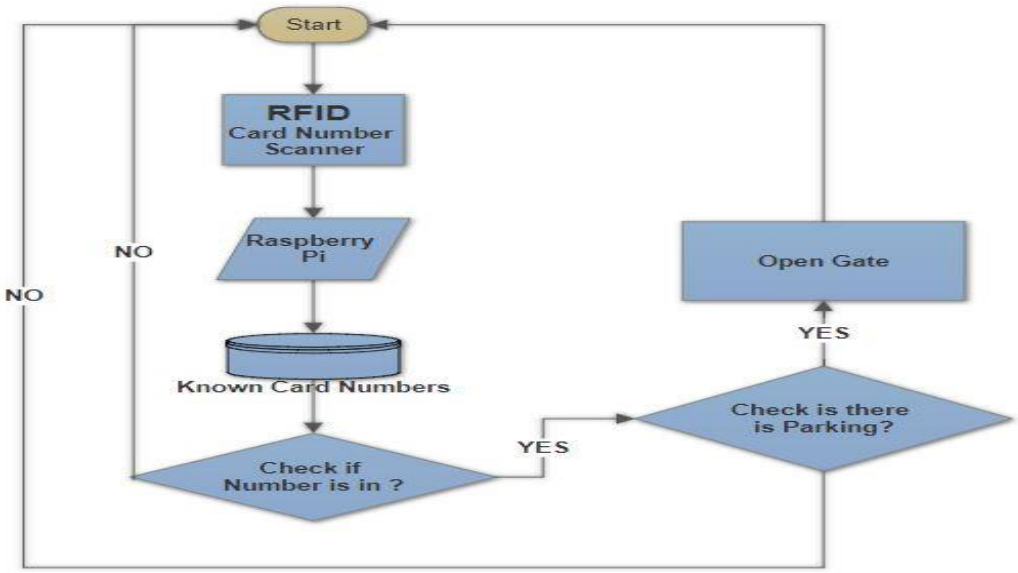

FIGURE 2. FLOW CHART OF THE RECEIVING PART

TABLE (1) ILLUSTRATES THE HARDWARE COMPONENT OF THE RECEIVING PART THAT USED IN THE PROPOSED SYSTEM.

Name/part number	Description
RC 522	RFID transceiver
Raspberry Pi B3	Microcontroller
LCD 16*2	LCD screen 16 bit
Servo Motor	Gate Barrier
Solar Cell	Li-Fi receiver

Transmission part

The transmitter is responsible to take the information about the available parking slot and their location from the microcontroller and send it to the Receiving Part. The Transmission part consists of Camera, Raspberry pi, and Laser. Fig. 3 shows the flow chart of the transmitter part of the system. So, the Camera will take images of the location every 5 seconds and save them in the microcontroller. Then, the open CV library will take the saved images and convert them to Numby Array. Array will be compared with Cascade Classifier. The Comparison is made to find how many cars detected in images and will draw red squares on the cars found (called Frames). For detecting the location of the cars, by dividing the horizontal pixels, this will create zones. So, the system will make another comparison between the Frames location and the divided horizontal pixels of the image.

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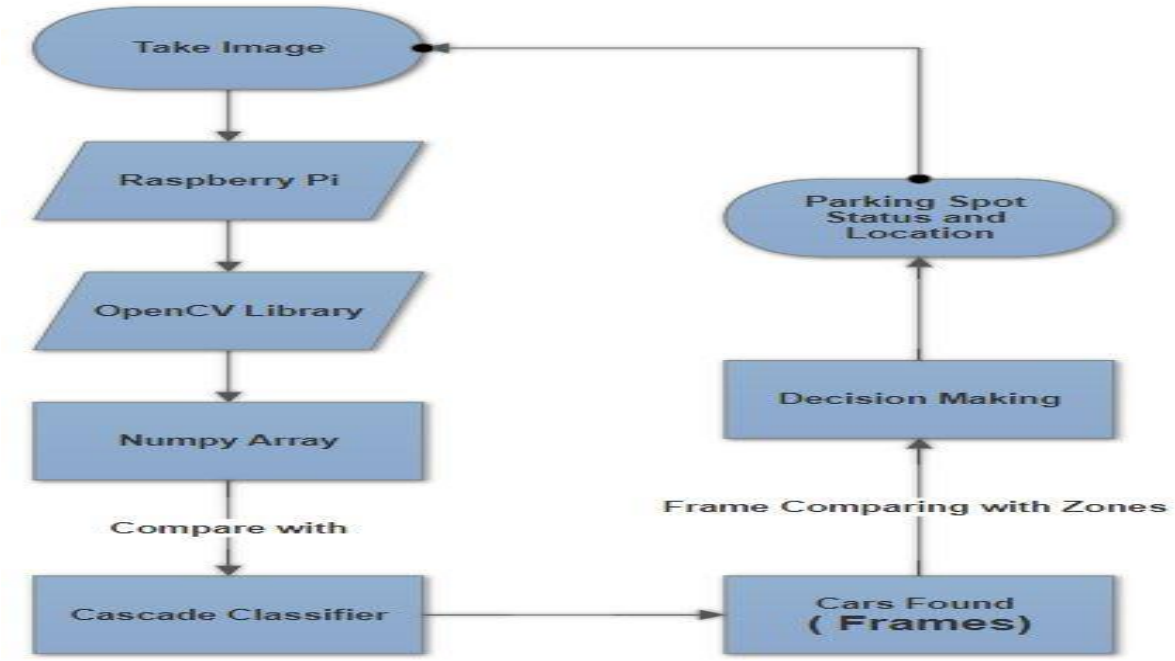

FIGURE 3. FLOW CHART OF THE TRANSMITTER SECTION

TABLE 2 ILLUSTRATES THE HARDWARE COMPONENT OF THE TRANSMISSION SECTION THAT USED IN THE PROPOSED SYSTEM.

Name/part number	Description
Pi Camera 8MP	Camera
Raspberry Pi B3	Microcontroller
Laser 200mw	Li-Fi sender

The results from the comparison of the whole process will be sent as an Array explaining the parking spot status where "1" indicates the parking is taken, and "0" indicates otherwise. This information will be sent to the receiver through a laser. Fig. 4 shows the resultant Array.

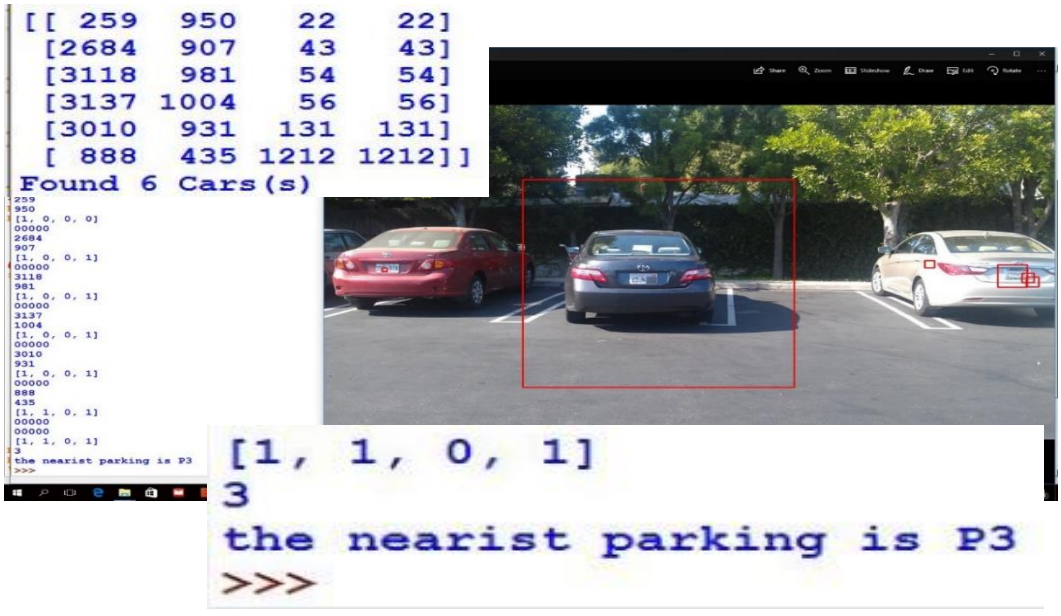

FIGURE 4. THE RESULTS FROM THE PROPOSED SYSTEM

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IV.CONCLUSION

In this paper a fully automated system was introduced that allows drivers to effectively find available parking spot and reserve the vacant parking spaces number. Image processing technique is used to periodically recognize the parking status in the parking lots where the reservation service is affected by the change of physical parking status. Li-Fi is used for to provide high communication speed.

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