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Abstract.   Open parking facilities can be automated and parking spaces can be easily operated by the implementation of IoT technology (Internet of Things). In this article, we present the evolution and prototyping of the open space smart guidance -parking search system, an IoT-based smart parking search system. The Smart Guidance Parking Searches System consists of i) An IOT module to monitor the availability of a parking slot and to update the parking lot status; and (ii) A web-based software allows users to view parking spaces available for a specific open space area. This paper addresses the existing system, device description, its functional specifications, the methods, and technologies used, the development/deployment of prototypes, along with the findings from the demonstration. This device serves as a guide for the user/driver to search for the parking slot occupancy in open/outdoor environments.

1. Introduction

Seeking a parking slot in cities is a common issue. The condition has worsened particularly during public holidays, promotional promotions, or some other festivities. This dilemma exists because most customers would arrive with their own transport, resulting in an influx of cars competing for few empty parking spaces. The restricted supply of parking would make traffic bottlenecks and raise the number of angry drivers. Besides the shortage of empty parking spaces and creating difficulty for drivers in seeking a parking slot, the lack of well-organized parking infrastructure is also a contributing factor to the crisis. To mitigate the increasing traffic crisis, smart parking solutions have been deployed in several countries. This technology uses innovative technology to solve traffic issue [1].

Seeking parking slots is a difficult challenge for most people. Through the advancement of technology, drivers can easily identify parking spaces with the assistance of it. The continuing study on smart parking is dynamic and multidisciplinary. There is another emerging technology known as the Internet of Things (IOT) linking all these sensors and machines together. A large number of applications have been developed, thanks to the IOT [2]. Parking systems involve

complicated issues about monitoring and notification. With the aid of IOT, and this problem can be solved. The development of IOT based smart parking search system is a perfect way to continue. To fit and initiate the intelligent guide, there should be a smart parking system that uses minimal sensor and current camera or CCTV image for parking to be performed in advance and details sent via IOT. The parking system by this innovation would improve the traditional car parking position because it gives visual-based input to the driver [3]. With a web-based system, drivers are assisted to find a parking slot using a system that is built with IOT device. This innovation is helpful because it includes QR code for the driver to view the position map of the parking slot and it is convenient to use for the localizing and determining the parking slot manually, especially for the administrator of the system. This technology automatically uses regular cameras or CCTV camera to locate the parking slot and will be connected to the IOT network and interact instantly.

2. Existing System

Many parking areas have been implementing smart parking technologies, on which display the number of parking spaces accessible in a public area. In this new approach, drivers can check for parking spaces with little knowledge by looking at the sign but with restricted visual toward the driver and expensive placement of detection devices. At parking slots, driver unable to know the position of the occupancy-parking lot [1][4][5].

Smart parking structures can be divided into several different groups based on their technologies of finding parked vehicles. Previously, various technique has been proposed, such as Wireless Sensor Network, Bluetooth, Zigbee, RFID, Wi-Fi, etc. [6]. But, many current solutions utilizing IOT [1][2][3][4] for parking space detection.

Article from [9] proposed an IOT-based parking system uses an integrated component called parking meter and provides parking facility availability information and parking slot reservation system. Article from [8] also presented the IOT based parking-sensing system for outdoor parking area, which able to localize and recognize the vehicle for the billing purposed. Similar to [8] and [9],proposal from [7] used IOT with cloud as a solution to guide the user to the nearest parking slot available. UParking is another example system that applies the concept of IOT by using justified hardware and sensor to locate parking availability and inform the authorities of guest entry [10].

In addition to the above IOT system, the visual sensor plays a leading role in processing of the parking scene so that the IOT system can be worked perfectly. The image processing algorithm proposed by [11] use the features of detected slots to verify the availability of the parking slot. Each slot is categorized as a slot available or unavailable by using a naive Bayes classification. While [12] applies camera nodes to extract local features specifically designed for the task and transmit them to the central controller for retrieving the occupancy information.

Furthermore, image segmentation and enhancement using MATLAB as a software platform been recommended by [13] as a new approach to identify the free empty parking area. [14] also used MATLAB to a perform morphological operation in image processing. This approach has been claimed that able to estimate the maximum capacity of parking slots, and then estimate an occupancy factor at given hour.

Besides, the usage of around view monitor (AVM) with IOT is well completed. The combining image captured by AVM used to detect the empty slot is presented by [15].While, [16] used AVM images with motion sensor-based odometry to recognize the positions and occupancies of various types of the parking slot.

Some IOT based smart parking used a proximity sensor to recognize if the car is present in the parking slot or not [17]. However, method [18] used IOT with a single bit light sensor for detecting the availability of parking slot dan claimed that have better energy consumption with low-cost costing. In addition, the infrared sensor also been chosen as the sensor to work with

IOT in developing an android-based application to monitor the availability of idle parking slot and guides the vehicle to the nearest parking slot [19].

The integration of IOT and visual sensors has experimented a lot with indoor parking, but the experiment with outdoor parking is limited. Moreover, none of the proposed system above that have the ability for the administrator to design and define the parking slot manually due to the placement of CCTV camera.

3. System Overview

This project is intended to direct users to locate the parking slot by checking the QR code for their vehicle. The invention provides a web page for the user to view the parking occupancy. Advantageously, this system and method use a standard camera or CCTV camera to identify parking slot, which will connect to IOT network and inform the user about parking slot availability through provided web page.
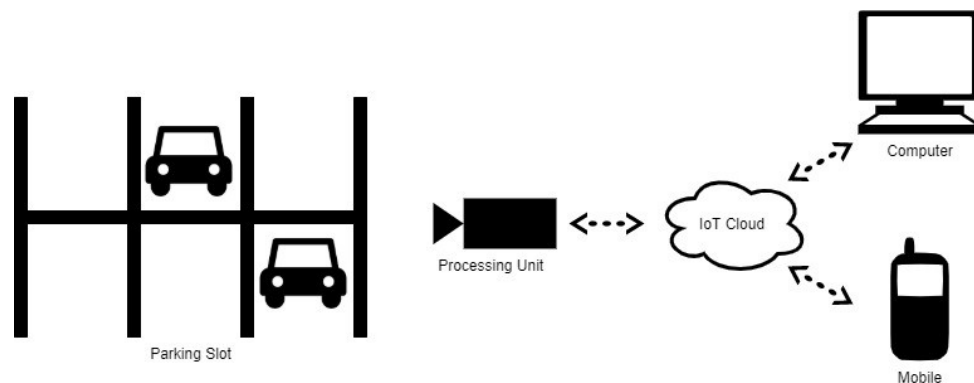

Figure 1. The smart parking system module

Figure 1 shows the system module required. The processing unit plays an important role in capturing and processing the data before informing the user/driver the availability of the parking slot. User information is kept in a database and server will update the information on the webpage.

Cameras play an important role in the system and connectivity or the IOT network is represented as the main connectivity between webpage, monitoring center and the camera. As the camera plays an important role as a sensor, the processing unit requires processing of the image of the parking spaces/slot as shown in Figure 2.

The system start is the first thing needed to be done when this system is started. The purpose of this procedure is to uniquely identify location of every parking slot in the image. Therefore, masking technique is used to crop and setup the parking slot boundary. The coordinates and the area value of the desired parking slot are to be stored in the database.

As for the video, the original image will be transformed into a gray-scale image in which the picture is now black and white. To minimize the noise of a scene, the gray image is then transformed into a blur. The reason is that blur image makes the color transition from one side of the image to another seamlessly.

The presence of the car in the parking slot is tracked with edge detection. Edge detection is an image processing algorithm that helps locate the object's borders within an image. The edge detector operates by identifying the discontinuities in luminosity. Laplacian is used on the parking slot for seeking the edges. By integrating the image threshold approach into the code, the threshold is used to separate two regions from the Laplacian average. If the average value is
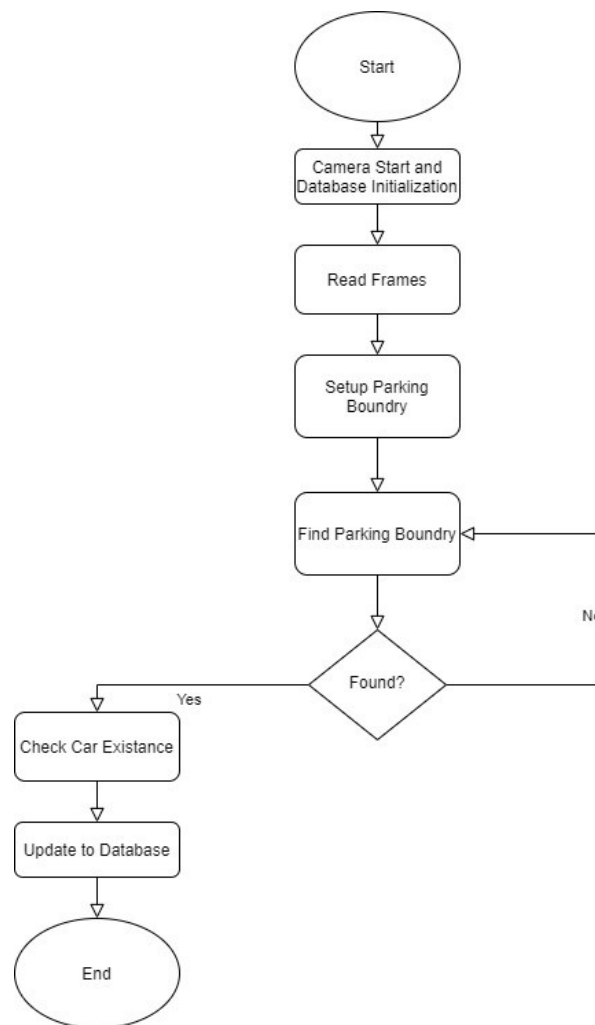
Figure 2. Flowchart of Smart Guidance Parking Search System

below the threshold, the system can sense the car on the parking lot and vice versa. Furthermore, before publishing to the web page, the system will update the parking slot availability to the database.

Figure 3. Parking Slot Viewing Processes

The QR code was created to extend the barcode technology. Driver/user can scan the QR code with their smartphone camera. The short address of the web page linked with the QR code would be shown. The driver/user can view the parking area on the webpage given. Figure 3 illustrates the parking-viewing process for the driver as they reached the parking slot.

4. Result And Discussion

The system has been experimented using a video captured from CCTV in an outdoor parking area. The scene of the captured video is presented in Figure 4. In this experiment, only six parking slots from many of them were checked and the result is shows only available or unavailable parking slot.

Figure 4. Screenshot of the outdoor parking lot

For each parking slot, the administrator can use the system to set the boundary. The parking slot is set to 4 points (shown in Figure 5 and Figure 6) before the system detects the parking slot occupancy.
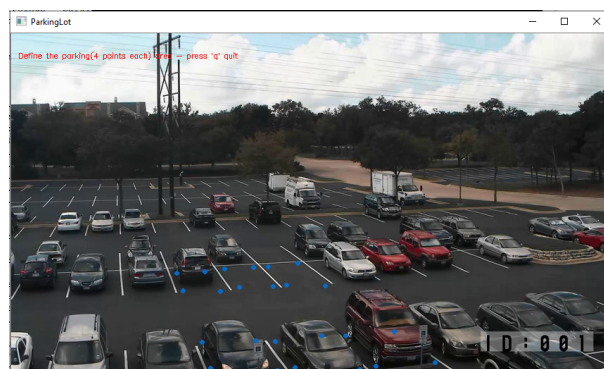
Figure 5. Parking Slot's Boundary Setup

Figure 6. The Point's Position for Each Parking Slot

When the system begins, the machine will display which parking slot is available by using green frame while the unavailable parking slot is highlighted with red frame. The figure shown in Figure 7 is only available for administrator.
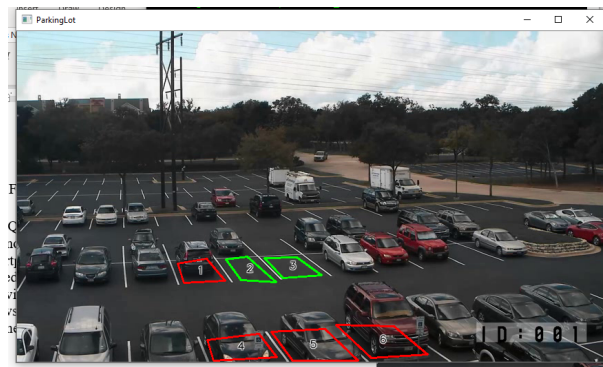
Figure 7. Parking Slot Availability View by Administrator

When the driver/user scans the QR code and opens the URL given, driver/user is directed to the website display the parking id number with parking slot indicator. The website interface is depicted in Figure 8. The number of available parking slot on the website has been proven to be the same as shown in the system. The use of the website makes it easy for users to find and park their car without having to check every row of the parking slot.

Figure 8. Webpage Interface

When one of the cars drives out of the designated parking slot, the administrator will be able to see the changes in the color of the frame. The result of the car driving out the designated parking slot is shown in Figure 9, while Figure 10 displays the results changed.

5. Conclusion

This outcome indicates an efficient usage method of an intelligent parking search system to reduce and overcome the common problem of allocating and guiding free parking spaces in large areas, especially in outdoor parking spaces. The smart parking guidance search system provides a safer and more effective solution for parking management. It can assess the availability of parking space by using the image processing system. A smart parking guide search system is
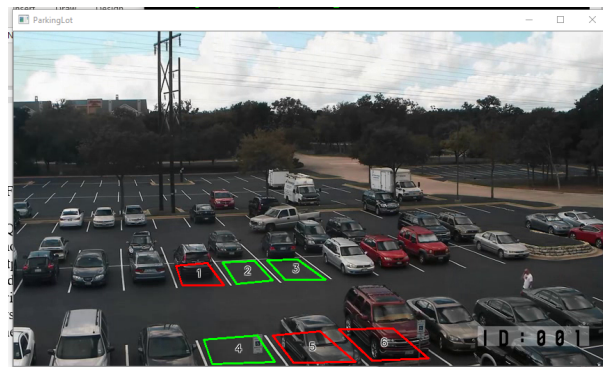
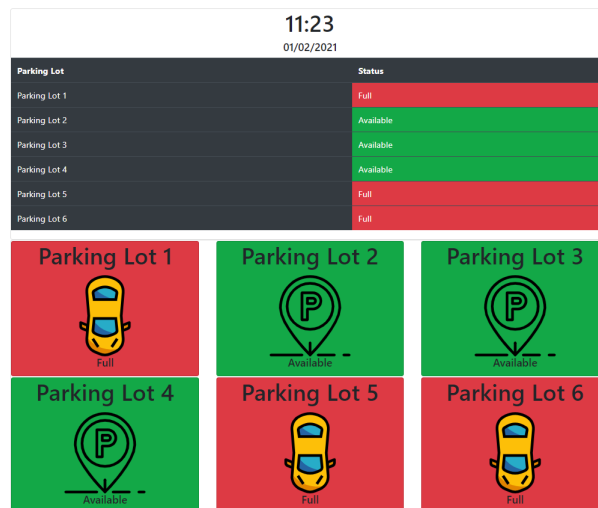**Figure 9.** Result When the Car Drives Out

Figure 10. Screenshot of the Updated Website as the Car Came Out.

user-friendly to both administrators and consumers. It is easy to set up the designated parking slot and easy to see the parking status only via QR code scan.

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