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PALESTINE AUTOMOTIVE LICENSE IDENTITY RECOGNITION FOR INTELLIGENT PARKING SYSTEM

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Abstract

Providing employees with protection and security is one of the key concerns of any organization. This goal can be implemented mainly by managing and protecting employees' cars in the parking area. Therefore, a parking area must be managed and organized with smart technologies and tools that can be applied and integrated in an intelligent parking system. This paper presents the tools based on image recognition technology that can be used to effectively control various parts of a parking system. An intelligent automotive parking system is effectively implemented by integrating image processing technologies and an Arduino controller. Results show that intelligent parking is successfully implemented based on car ID image capture to meet the need for managing and organizing car parking systems.

Keywords: License identity, Parking area, Recognition, Car ID, Vehicle plate number.

1. Introduction

An automotive license identity is considered as a unique form of identification that is assigned independently to each vehicle. Therefore, a license identity number can be used as a key in applications implemented in parking systems to provide access security and monitoring.

All companies and institutions offer protection and security to their employees and their automobiles through proper managing and organization of parking areas. Such a project mainly aims to manage the entrance of cars into a parking area through a car plate recognition (CPR) security system and to manage the number of cars inside this area [1, 2].

The characters of vehicle plate numbers in Palestine are usually arranged in a single row. All car license plates consist of a combination of letters and numbers.

Abbreviations

CPR	Car Plate Recognition
JPEG	Joint Photographic Experts Group
LPR	License Plate Recognition
RGB	Red, Green, Blue
TTL	Transistor–Transistor Logic
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus

The alphabet is fixed for all cars in Palestine, given that it refers to the state identification that uses a single letter of the alphabet. The location of the plate is also fixed in the middle of the front part of all private cars.

2. Literature Review

Intelligent parking is commonly defined as an electronic networking technology that integrates devices and appliances to monitor and control an entire parking area as a single machine. Other terms with equivalent meaning are also used in the literature, such as parking automation, smart parking, digital parking, or electronic parking. Intelligent parking is the term commonly used to define a parking area that is equipped with a special system that performs intelligent actions in response to a specific state. All intelligent parking systems are used to provide customers with security and protection [1-8].

Bakar [5] discussed the implementation of double-edge detection to find the location of a vehicle plate number. Edge detection is applied at the filtering stage to convert an original colored image into either white or black. Further edge detection is used to remove an unwanted object and a white spot image in a picture. Chang [2] proposed license plate recognition (LPR) algorithm, which consists of two modules, namely, one for locating license plates and one for identifying license numbers. Soft computing techniques rooted in fuzzy and neural disciplines are introduced to compensate for uncertainties caused by noise, measurement error, and imperfect processing.

Reference [3] addressed the operation of an automated vehicle license plate recognition system in terms of software and hardware aspects. The author divided this operation into two phases: license plate segmentation phase and license plate processing and character recognition phase. The operation was addressed by implementing a sliding concentric window method.

The proposed intelligent parking system includes the use of computer algorithms to perform image processing on digital images. A subcategory of digital signal processing is digital image processing, which has many advantages compared with analogue image processing. Digital image processing allows the application of a considerably wide range of algorithms to input data. It can also avoid problems such as noise buildup and signal distortion during processing.

3. Methodology

The project consists of a controller provided with a camera. The camera captures an image when a car stops in front of the parking gate. Then, the image is sent for

processing. The basic steps of plate detection after the camera captured an image are shown in the flowchart in Fig. 1. First, the image is segmented into parts with statistical region merging algorithm; the car plate is recognized and each number of the plate is segmented [9]. Then, each part is compared with all the images in the database by calculating the image feature vector for the taken image and the feature vector for all images in the database. Thereafter, each part is converted to a text. The result of the converted text of a car plate is then compared with all the numbers stored in the database.

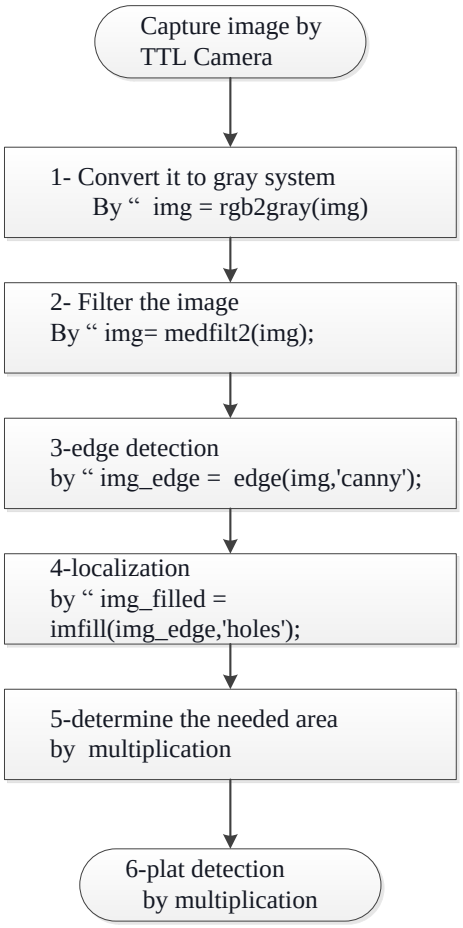

Fig. 1. Basic steps of plate detection.

The comparison output of the car plate number is used to generate an order to either enable or prevent the car parking gate from opening. The feature of this system, that is, recording the time and date of the entry of each car, can also be beneficial in reporting cars that log into the parking area. Therefore, the main aim of the project, which is to control a parking system by implementing CPR algorithm with the aid of electronic tools, can be fulfilled.

The images are defined over two-dimensional (or higher) digital image processing, which may be modeled in the form of multidimensional systems [10].

One of the features of a 2D object pattern is the area, which can be measured by counting pixels. Similarly, the shape of an object may be characterized by its border. Some of the attributes that characterize the shape of an object pattern are Fourier descriptors.

MATLAB Support Package for Arduino (also referred to as Arduino IO Package) allows the user to communicate with an Arduino Uno over a serial port. It consists of a MATLAB API on the host computer and a server program that runs on Arduino. Together, they allow a user to access Arduino analogue input/output (I/O) and digital I/O ports.

The captured image is processed with an MATLAB image processing toolbox. The first step in designing an image analysis system is digital image acquisition via a TTL camera, as shown in Fig. 2.

Fig. 2. Car plate number.

After being obtained from the TTL camera, the image goes through enhancement processes. These processes can consist of a collection of techniques that seek to improve the visual appearance of an image or to convert an image into a form that is suitable for human or mechanical analysis, as shown in Fig. 3. The digital images are adjusted through image enhancement. Thus, the images become suitable for display or for further image analysis. Before the next stage occurs, the image in Fig. 3 is converted from an RGB (i.e., red, green, blue) color image to a grayscale image.

Fig. 3. Image enhancement.

After image enhancement, the next step is determining the plate numbers. At this stage, a continuous rectangular shape is searched to detect the plate number area. The detection process consists of a collection of techniques that improve the visual appearance of an image to determine the plate. These techniques are performed with an image toolbox. The image is initially converted to a gray model to simplify the analysis. Then, edge detection is performed on the numbers, as shown in Fig. 4.

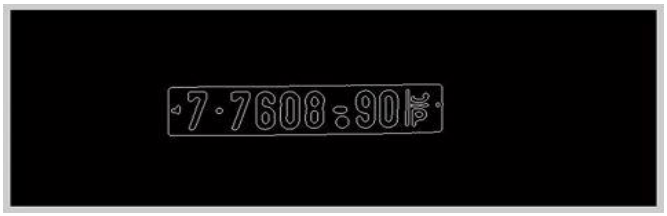

Fig. 4. Detection of a plate.

Plate number segmentation is the process through which an image is divided into several consistently identical areas. In other words, image segmentation is defined by a set of regions that are connected and non-overlapping. Thus, each pixel in a segment in the image acquires a unique region label that indicates the region to which it belongs. In this paper, each number in the plate is segmented, as shown in Fig. 5.

Fig. 5. Segmentation of numbers.

Plate number recognition can be obtained after the process of pattern recognition. It is also an integral part of machine vision and image processing, as shown in Fig. 6. One of the features of a 2D object pattern is area, which can be measured by counting pixels. Similarly, the shape of an object may be characterized by its border. Some of the attributes used to characterize the shape of an object pattern include Fourier descriptors. Each segmented number is compared with the database of the numbers, and each one is converted to a text. The detection of each segment is based on the specific shape of the Arabic number, which is most likely characterized by the shape of Arial font. This style of numbering is a mandatory regulation for all plates.

Fig. 6. Recognition of numbers.

In this project, the number captured from the image is compared with the car plate numbers in the database after the image process is completed. If the captured number already exists in the database, the system sends a command for

the Arduino controller to open the parking door. The user interface view of the program is shown in Fig. 7.

Fig. 7. User interface view of program.

4. Hardware Implementation

The Arduino controller is a computer-based tool that can considerably sense and control the physical world more than a desktop computer can. Arduino is an open-source physical computing platform based on a simple microcontroller board and a development environment for writing software for the board. Arduino Mega 2560 is a microcontroller board based on the ATmega2560 shown in Fig. 8. It has 54 digital I/O pins and 16 analog inputs, and it is powered via a USB connection or by an external power supply [11]. The open-source Arduino environment facilitates writing and uploading code to the I/O board. The environment is written in Java and based on processing, avr-gcc, and other open-source software. The Arduino Duemilanove module has several facilities for communication with a computer, another Arduino, or other microcontrollers.

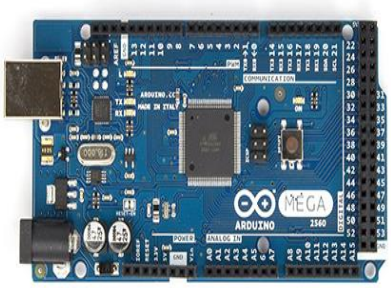

Fig. 8. Arduino Mega 2560.

A photoelectric sensor QT50CM, or photo eye, is a device used to detect the distance, absence, or presence of an object via a light transmitter and

a photoelectric receiver, as shown in Fig. 9. Three different functional types exist: opposed (through beam), retroreflective, and proximity sensing (diffused).

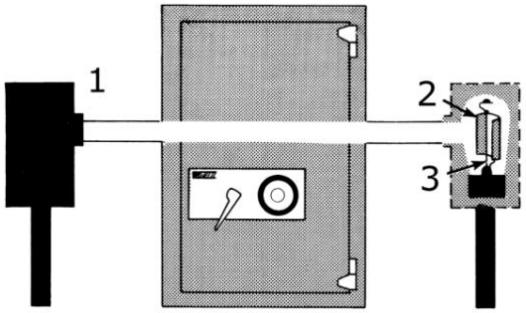

Fig. 9. Photoelectric sensor.

The JPEG TTL color camera allows the user to capture and output JPEG images through universal asynchronous receiver/transmitter (UART), thereby simplifying the integration into an existing design. The features of a TTL camera include 160×120 resolution, JPEG support capture, 32×32 mm size, and 80–100 mA current consumption.

5. Results and Analysis

Figure 10 illustrates how a user deals with the system. This illustration demonstrates that the security officer is the only person who directly handles the program. This person can log in to the system and edit the database of plate numbers. The system also enables the building manager to acquire a car logging report.

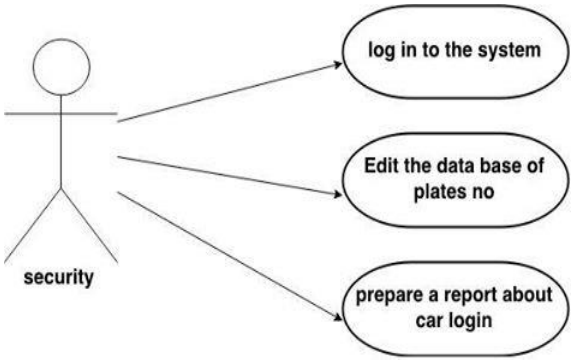

Fig. 10. Case illustration.

The security officer can log in to the system with the user interface window shown in Fig. 11. The security officer enters a user name and password to securely enter the system and log in to any account. The system can be used successfully only if the correct login information is entered. To maintain safety and security, the system cannot be used if incorrect information is entered.

Fig. 11. Login screen.

The edit page of the plate number database can be accessed by the security officer who is authorized to edit the system database. The security officer can add new numbers or delete existing ones from the system, as shown in the window in Fig. 12.

Fig. 12. Screen for adding a new plate number.

Preparing a report on car logging is one of the features of the proposed system. This system records the time and date of each car entry. Thus, the security staff can prepare a report on car logins, as shown in Fig. 13.

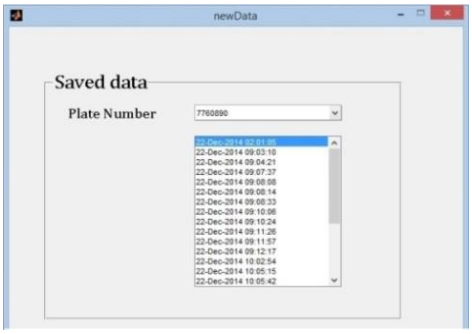

Fig. 13. Plate number report.

Figure 14 shows a flowchart of the project function. The sensor can sense the presence of a car once it is in front of the parking gate, and the camera takes an image of the car. Then, the image is sent to start the image processing, thereby determining whether the plate number is saved in the database or not. This procedure generates a command for the Arduino controller to either open the

parking gate or keep it closed. If the car enters the parking area, the system saves the time of entry in a special database.

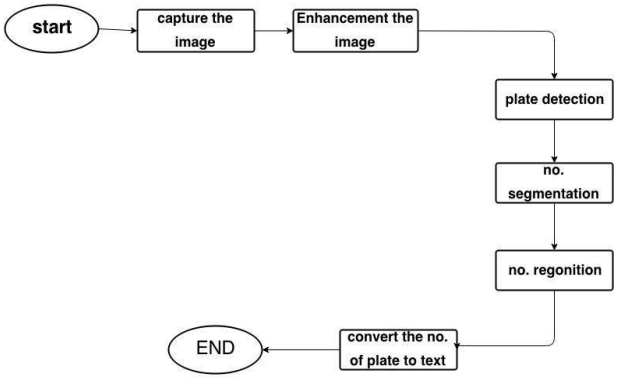

Fig. 14. Flowchart diagram.

A sensor and two lights in each position, namely, red and green, are located inside the parking area. The sensor can sense the car in the position. If a car is present, the red light is illuminated. If not, the green light is illuminated. Meanwhile, an LCD is located outside the parking area, which shows the number of the vacant positions inside the parking. When a car leaves the parking area, the sensor on the tailgate sends a command to open the gate in one direction. In case of an emergency, the front gate can be opened with a switch in the security room, as illustrated in the activity diagram shown in Fig. 15.

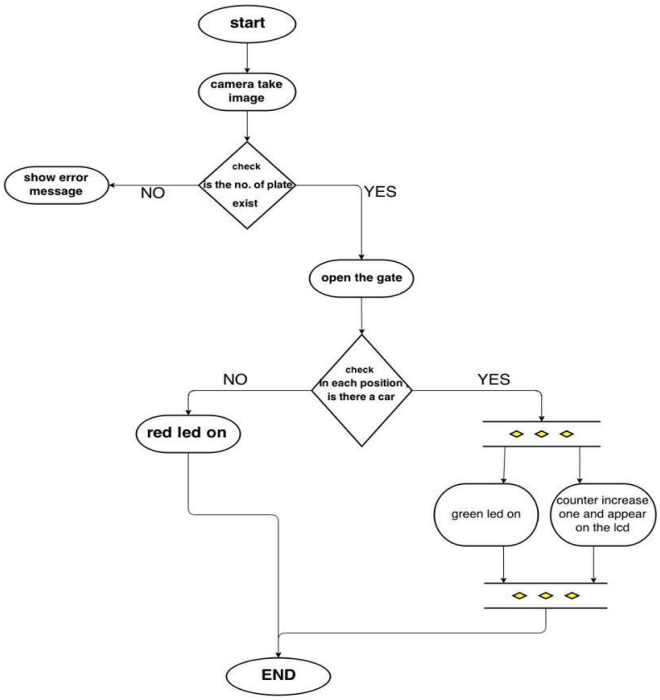

Fig. 15. Activity diagram.

If the car ID is recognized, the system output for the ID check enables the command to open the gate, as shown in Fig. 16. If the car ID is not recognized, the system output for the ID check disables the command. Thus, the gate remains closed, as shown in Fig. 17.

Fig. 16. Positive result of ID check.

Fig. 17. Negative result of ID check.

6. Conclusion

Providing employees and their properties, such as cars, with protection and security is one of the key concerns of any organization. To achieve this goal, the parking area must be managed and organized with smart tools that can be implemented and integrated in an intelligent parking system. Based on image recognition technology, an intelligent automotive tool that controls various parts of a parking system is effectively implemented by integrating image processing technologies and an Arduino controller. The results show the successful implementation of intelligent parking based on capturing car IDs, thereby meeting the need for car parking management.

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