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Parking Availability Identification System in Urban Areas of through Image Processing Lima - Peru

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***Abstract*— A challenge of the automobile is to find a solution to this problem of vehicle parking, since the number of vehicles grows annually and there is no sophisticated system that allows to reduce waiting times and perform this task more efficiently, becoming an important aspect for the best use of the capacity of the existing parking area, being the main focus the increase in the number of vehicles that affect the undistributed filling of the parking lot generating waiting time and in many cases desertion in supermarkets. In our country it is necessary to increase parking spaces since many people have vehicles and the number of vehicles continues to increase every year, although there are companies dedicated to this area, they do not achieve the comfort of people for various reasons such as vehicle safety and the distance in which the vehicle is. In view of this problem, this article made a system of identification of availability in parking lots in urban areas of Lima - Peru through image processing to facilitate the user's search for a parking area that is free. Through the development of the system, the objective of detecting the free spaces so that users can park their vehicles according to a previous complete evaluation conducted by the system with an efficiency of 98.14% was met.**

***Keywords*-- image recognition, MATLAB, image processing.**

I. INTRODUCTION

Technological advancement in the twenty-first century has increased dramatically, revolutionizing modern technologies over the years aiming to minimize the process of service delivery and maximize profits. Due to these[1] types of factors, various tools have been developed that together with image processing helps enormously to develop different types of platforms where variations can be made for the purposes of the use that the consumer requests[2], being widely used by many professionals of various areas due to their set of techniques that are applied to digital images with the aim of improving quality or facilitating the search for information.[3]

Therefore, image processing will be used to face a challenge for motorists looking for a solution to this problem of vehicle parking, since[4] the number of vehicles grows annually and there is no sophisticated system that allows reducing waiting times and performing this task more efficiently.[5]

Parking management has become an important aspect for the best use of the capacity of the existing parking area. The main focus is based on the increase in the number of vehicles that affects the undistributed filling of the parking lot, generating waiting time and in many cases desertion in[6] [7] supermarkets, in addition, people currently buy cars for their private use and thus be able to transport themselves to different places and do not agree not to find parking space [8] .

In Peru, the demand for parking services in Lima has increased, despite the shortage of parking and the lack of parking[9]. While it is true, there are companies that provide this service since there are shortages of places in the streets and that remain operational because they have an influx of the public, but there is no satisfaction on the part of customers in the provision of this service[10].

The objective of this research work is to conduct a Parking Availability Identification System in Urban Areas of through Image Processing Lima – Peru to facilitate the user the search for a parking area that is free. To do this, the surveillance camera will provide us with the images of the parking lot to be analyzed through the processing of images in the MATLAB software and can be viewed through the monitor. MATLAB is software that provides an integrated development environment with its own programming language.

In section II, some research papers were reviewed. In section III, the methodology of the system was conducted indicating the stages that make it up. In the IV section, the results that are generated according to the tests conducted with the system design will be indicated.

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In section V, the discussion of the research work will be indicated and finally, in section VI, the conclusion and future improvements of the application of the system will be presented.

II. Literature Review

The system of identification of parking lots available in urban areas is important because many people are looking for a place to leave their car safely, that is why work has been developed previously. As, for example: In , the authors mention that the lack of good parking management provided to the administrative staff of the company brings as a consequence a dissatisfaction of the drivers to see that they lose time at the time of looking for their parking generating discomfort, that is why they proposed to make a mobile application for parking management in the company Power Tools Peru S.A.C-2018. In this methodology Scrum was used for the development of the software, C# was also used as a programming language and the Ionic, CodeIgniter and Atom libraries. Obtaining as a result an improvement of 83% in the satisfaction of the administrative staff and with respect to the time of finding parking was improved by 14%, concluding that the use of the mobile application improves the parking process both in the effectiveness and in the satisfaction of the personnel of the company Power Tools Perú S.A.C with respect to the traditional method.[11]

In [12], the author mentions that currently in all parts of the city in the world they need to have modern parking lots that allow vehicle users to perform the different activities offered by the city, leaving their vehicle parked somewhere, that is why he proposed to design a vehicular parking for 16 cars with a rotating vertical system in a private university of los Olivos. This methodology consists of a bibliographic search of the parking systems and technologies available in the world market and a case study for the implementation of this type of systems to meet the existing demand. Obtaining as a result an efficiency of 90.99% in improvement unlike conventional parking, concluding that with this system parking spaces are used more efficiently and balanced in the use of airspaces.

In [13], the authors mention that traffic congestion in parking spaces is an important problem facing modern society today, since the number of vehicles increases at a rapid rate without the increase in parking spaces, being important to help solve the problem of traffic congestion, that is why they proposed to carry out an automated system of detection of vehicle parking spaces through deep learning.

The proposed methodology uses artificial neural networks to provide a better solution to traffic congestion, using a surveillance camera to extract frames and introduce it into the system where free and reserved parking spaces are identified. Resulting in improved robustness by achieving a mask recognition rate above 92.33% and a limit recognition rate of 98.4%, concluding that this system works in the best way and helps avoid traffic.

In [14], the authors mention that the smart car industry is increasing in a surprising way and that it is necessary to implement smart parking so that everything is automated, that is why they proposed to realize a smart parking system based on a cooperative vehicle infrastructure system. The methodology is based on a vision on road, computing, and network Vehicle-to-Road (V2R)," using ArUco beacon and road cameras to establish the coordinate system of the garage and obtain the position of the intelligent vehicle, to track the parking reference path, use a P increment control and pure chase algorithm controlling longitudinal speed and steering angle. Obtaining as a result an efficiency of 93.75% of detection of parking spaces, concluding that in this work an intelligent parking system is designed based on the innovative technology.

In [15], the authors mention that, in recent years, with the increasing number of vehicles, the efficient parking management system has become necessary for large buildings where there are many people who require this service for their vehicles, which is why they proposed to conduct a robust parking occupancy monitoring system using random forests. The proposed methodology consists of using a vehicle detection algorithm based on parts and machine learning because there are many obstacles in the parking area, such as a great diversity of car models, occlusion by another car, people on the move, garbage, and distortion of the camera lens, all this makes it difficult to detect a vehicle. Resulting in 95.39% efficiency due to it performing well on a large set of indoor parking data, concluding that your parking occupancy monitoring system can automatically decide whether a vehicle is parked or empty in each parking space.

III. Methodology

The proposed module will perform image processing in matlab software, using various techniques that allow us to analyze the images of the parking lot of vehicles. These techniques that will be executed in the program consists of 5 steps; this procedure that will be given for the development of the program can be seen in the following figure 1.

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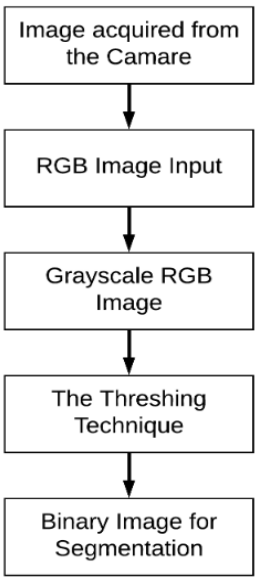

Fig. 1. Block diagram for system design.

A. System Initialization

In this part, the procedure of figure 1 is implemented. In the execution, the image is made available, a process that can draw the corresponding parking number, so that it is useful to identify the empty parking area. The main purpose of this system is to identify parking and verify empty zones without interruption.

For the procedure to succeed, the camera must be stopped during system startup. Therefore, when the camera stops, the image obtained can be processed to show the parking spots, as well as shown in Figure 2.

Parking Spot 1	Parking Spot 2	Parking Spot 3	Parking Spot 4
Parking Spot 5	Parking Spot 6	Parking Spot 7	Parking Spot 8

Fig. 2. Parking sampling.

B. Image acquisition

As the system starts up and achieves its goal, it moves on to the next stage of execution which is image acquisition, from which the image processing technique is used.

In the step of acquisition of images, the camera of the vehicular station will take the corresponding images, for this, the image obtained is preferably taken with high resolution cameras for efficient image processing. The captured image can be taken from different angles, both side and front, the angle captured with the best design for image processing is a panoramic view of the parking area, so this research work used a panoramic view image. Figure 3 shows the panoramic form.

Fig. 3. Panoramic view of the Car Park

C. Image segmentation

In the process of segmentation of images, the following procedure is presented as seen in the diagram. Image segmentation is one of the fundamental steps in image processing for image identification and analysis. For image segmentation, it is required to perform some processes. Figure 4 shows the flowchart

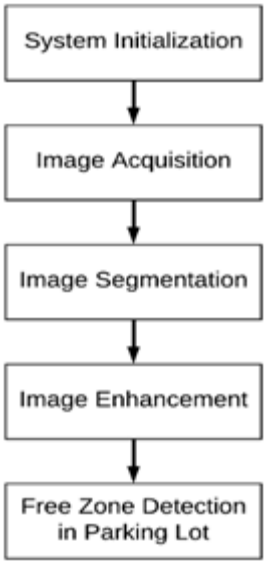

Fig. 4. Flow diagram of the image.

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D. Image segmentation

In this part, the image has been processed to eliminate the noise obtained during the conversion of the binary image. This process is used to draw the edge of the detected image as shown in Figure 5. Being the digital camera the one that takes pictures of different places with little noise.

Fig. 5. Binary image of segmentation

The resulting noise can be removed by using a technique called morphology, this current technique as a filter because it denigrates the segmented image. The morphological mechanism has many processes of different characteristics, among all of them, the morphology process of opening and closing is the most used to eliminate noise. The opening process is to remove the small objects in the image and the closing process is to remove the small objects and holes in the segmentation process. Therefore, the morphological mechanism provides the exact boundary and shape of the image without distortion. The exact image boundary is used to detect the free parking [16]. Then, the process called dilation and erosion is used to increase or decrease the pixel area of the image. Dilation is used to increase the pixel area of the image border [16]. Erosion is another process that removes pixels from edges. In the proposed process, if the value of the input pixel of a binary image is equal to "0", the output pixel will be "0"[17][18][19]. Figure 6 shows the image without noise.

Fig. 6. Noise-free image

E. Free parking space detection

The image detection module is developed when the enhancement module arrives at the exact boundaries of the image edges and contours. In this part, the value of the area and perimeter is accurately obtained from the image. This information of the acquired values has to be sent to the drivers so that they can park their vehicle. For these calculations the following formula is used.

$$Shape = (4 * pi * area) / (perimeter^2) \quad (1)$$

Fig. 7. A parking space has been detected.

IV. RESULTS

The results obtained from the Parking Availability Identification System in Urban Areas of through Image Processing Lima - Peru were favorable, as well as the manipulation of the user with the visualization interface.

With the development of the vehicle parking system, the objective of detecting the free spaces so that users can park their vehicles according to a previous evaluation conducted by the system with an efficiency of 98 is met. 14%.

According to the elaborated tests, the video surveillance camera can be widely used beyond its real-time video, also incorporating both hardware and software to electronic devices to make them more functional for the intelligent recognition of parking places, as shown in Figure 8, it has the precision in recognizing empty parking spaces so that the test vehicle can more easily find a place in the parking lot.

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Fig. 8. Vehicle parking system.

Based on the threshold value, the free parking space is visualized through the on-site surveillance camera and can also be displayed by an LED monitor at the entrance of the parking lot. In addition, a horn has been added to the system to make parking easier for the driver.

For the implementation of the system, it is necessary to manage the MATLAB software to be able to analyze the image when applying the image processing techniques. In addition to having the electronic equipment specified above.

It should be noted that this system can be used in various places such as shopping centers, schools, where you want to have greater control in vehicle parking.

The development of this system is ideal, that is, when the driver parks his vehicle correctly, if there is a case in which he does not park correctly, a warning system would have to be implemented to modify the cars that are not parked correctly.

The development of this system is for closed spaces, in case it is a closed space, a group of strategically located cameras is required for the adequate rearrangement.

V. Discussion

Many vehicle identification systems have been developed in urban areas that have been implemented to facilitate access to a free parking area for users. This system has differences with other systems developed previously, for example, the work done by[11] , where the authors proposed to make a mobile application for parking management in the company Power Tools Perú S.A.C-2018. Obtaining a result of 83% in the satisfaction of the administrative staff and with respect to the time of finding parking was improved by 14%, but to use this application the user feels that having access to the internet and does not provide security to vehicles.

The work developed by [12], where the author proposed to design a vehicular parking for 16 cars with a rotating vertical system in a private university of los Olivos. Obtaining a result of 90.99% efficiency, but this vehicle parking system is expensive, in addition to parking few vehicles.

The work developed by [13], where the authors proposed to perform an automated system of detection of vehicle parking spaces using deep learning. Obtaining a result of 98.4% efficiency in limit recognition, but this system alone is a simulation, so its efficiency is not dependable.

The work developed by [14], where they proposed to realize an intelligent parking system based on a cooperative vehicle infrastructure system. Obtaining as a result a 93.75% efficiency, but this system uses the method of V2R or CVIS that are not very efficient in their development.

The work developed by [15], where they proposed to perform a robust parking occupancy monitoring system using random forests. Obtaining as a result a 95.39% efficiency, but this system presents a limitation in its approach, when the vehicles are removed from the parking lot it does not indicate that there is a free space.

VI. Conclusions

It is concluded that the identification of the parking area and the number of empty parking spaces can be determined using an image processing technique, identifying a particular space that can determine that the vehicle is parked in a safe area in a brief period without delay.

It is concluded that this system can be developed for a zone of maximum 8 parking lots, but it can be developed for large parking lots that can propagate the information by means of a GPS that would definitely help drivers through an application for Android.

It is concluded that the proposed architecture will be especially useful for parking the vehicle in the parking area without any distortion.

This system is limited when taking photos of the parking lot at night. For the system to work correctly, the vehicle parking lot must be well lit to capture the images clearly.

The system is limited when there is a rainy season, which is why the parking lot, in addition to having good lighting, must protect the camera so that the rain does not affect the lens and it can take the correct photos of the vehicle parking lot.

The system is limited to giving a warning to drivers who park their vehicle incorrectly, for which an additional warning system has to be implemented.

As work in the future, a mobile application will be added to the system to make it easier for users to park vehicle parking spaces and enter faster and safer.

Readers are advised to choose strategic points from the surveillance camera so that they have a better analysis of the vehicle parking.

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