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ParkingKS: Parking Management System Using Open Automatic License Plate Recognition

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***Abstract*—This Computer Vision is one of the most research fields in data science and is being applied in Autonomous vehicles, Machine Vision, Military, etc. Computer Vision is also used for license plate recognition and can be integrated with various projects such as toll points on highways, border points, exceeding the speed limit, car parking, etc. In this paper, we proposed a system for car management parking lots. The system is web-based and developed with Python programing language and Flask web framework. In this project, we have used OpenCV to receive images from the camera and OpenALPR to recognize license plates and analyze them. System running in Linux and Raspbian operating system. The experiments show that our system can be used for car parking and can recognize 85% of images captured from the camera.**

Keywords— OpenALPR, OpenCV, parking system, License Plate Recognition

I. INTRODUCTION

Automatic license plate recognition (ALPR) is a technology that recognizes a vehicle's license plate from an image and provides it in a text format for further processing [1].

Different methods and libraries can be used for license plate recognition. The library which we used to recognize the plate is OpenALPR. OpenALPR is a library that enables the analysis of images and video streams to recognize vehicle license plates. Each country uses license plates to identify vehicles and has them designed according to their format. Many license plate systems have been developed for specific countries by training OpenALPR with their state license plate to improve license plate recognition accuracy. OpenALPR supports European-style license plates. Since Kosovo has license plates similar to European countries, so OpenALPR also recognizes Kosovo license plates.

In Kosovo, the number of cars is quite large compared to the number of inhabitants. According to Eurostat [2] data for 2018, Albania, Kosovo, and Turkey were 160 passenger cars per 1,000 inhabitants. The number of large vehicles and limited public parking spaces has led to an increase in private parking lots, where most of these parking lots do not have an automatic parking management system. The purpose of the work is to create a fast, low-cost system for reading vehicle license plates, which will be implemented in auto parking. Will facilitate parking management work by maintaining vehicle entrances and exits, customer subscriptions, automatic calculation of payment for the time of stay, etc.

This system is implemented to work on Linux 18.04 system and the Rasberian operating system with Raspberry Pi microcontroller. The system was developed with the Python programming language, and the web part was created with Flask. The database is designed in MySQL while for recognizing license plates and analyzing them, we have used the OpenALPR library and OpenCV software library. Our system is designed to manage parking lots by recognizing vehicle license plates. The application receives images from the camera using OpenCV technology and extracts license plate numbers from the photos. To extract these numbers; the application uses the OpenALPR library, which is open source and has high precision even in low-quality images. The vehicle parking system works in such a way that when the vehicle passes in front of the entrance, just before the obstacle, the camera automatically recognizes it and records the license plate number, date, and time of entry into the system. Automatically calculate the parking fee to be paid by the driver and register the captured image, license plate number, and time of the vehicle through registration in the database.

This paper is organized as follows: in section II we discuss the related work. In section III, we proposed our system. Section IV demonstrates how system work. In section V we show the result and analysis of our application, and in section VI we discuss the conclusion and future work.

II. RELATED WORK

Many researchers have developed systems using ALPR (automatic license plate recognition) with different methods. In the following, we will introduce some of them. The authors [3] developed a system that detects Indian license plates, using the OpenALPR software and the RaspberryPi microcontroller. The methodology has been evaluated by 1300 positive images with variations in capturing distance, angle, and light intensities, and 4786 negative samples were obtained from the online database for training its cascade classifier to localize license number plates. After training is completed, the generated file is used by

OpenALPR to detect Indian license plates. This method has a success rate of more than 98 percent. The presented system at [4] runs a Raspbian operating system on the Raspberry Pi microcontroller for automated gate powered by an automatic license plate recognition system. The license plate recognition is performed using the OpenALPR library, and the entire automated gate system is built using the Node-RED software. Their analysis results show that the system can achieve a recognition rate of 87.50–90.90% on images with a specified height and angle. Another work [5] used OpenALPR software to create a prototype for an automatic portable car detection system that included a Thai license plate and car logo recognition. To check if the image contains the car logo, they use tiny YOLO v3, if the logo is detected the image will be sent to OpenALPR for license plate recognition and to the tiny YOLO v3 for logo detection. With an overall processing time of 15.71 seconds, the system can recognize car license plates with 70% precision inside the top three ranks and 100% precision in detecting car logos. The approach presented in this paper [6] is an Electronic Road Pricing system based on a Raspberry Pi with RFID and image processing capabilities based on OpenALPR. The system photographs the image of the license plate then reads the RFID tag and will then be transmitted to the server. After training with 1000 Indonesian license plates, the OpenALPR can recognize nine out of ten that are given randomly. Authors [7] developed a low-cost system for recognizing Myanmar license plates through the OpenALPR library. They collected license plate data and trained them. Their system showed 90% accuracy in recognizing characters and approximately 100% in recognizing license plates. The proposed Automatic License Plate Recognition system that is based on YOLOv3 and CRNN [8] employed a methodology for License Plate classification and detection that advances the results through the use of post-processing rules. On the AOLP datasets used for the experimentations, the average recognition accuracy is 96.1 %. The authors in [9] propose an automatic recognition method for Western Australian license plates. The proposed ALPR algorithm was written in MATLAB and is divided into three phases. Identify the license plate in phase one and extract an image that contains the entire license plate with a minimal background scene. All characters are segmented from the license plate in Stage Two, and the final task is to recognize those characters in the Third Stage. According to the experimental results, success rates of 97 percent, 97 percent, and 98 percent were achieved for Stages 1, 2, and 3, respectively. The authors' [10] approach for recognition of Indian License Plates is k-NN, OpenALPR and CNN. They collect 200 static images and 250 video frames. They compare the accuracy of OpenALPR, k-NN, and Convolutional Neural Networks (CNN) techniques. The result shows that CNN achieves the best result compared to other techniques used. Authors in [11] for Automatic License Plate Recognition used the YOLO model, and ResNet model to classify the Indonesias plate numbers. Their tests showed that the YOLO can recognize plate numbers with a high level of success. Based on the test dataset, the ResNet model achieves an accuracy of 80%. Based on the analyzed papers, we developed a system to recognize Kosovo license plates, is low-cost, and will be implemented in auto parking.

III. PROPOSED SYSTEM

The system will open the camera with OpenCV and captured image. OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products [12] . Captured images send to OpenALPR as input for license plate recognition. These images will go through the OpenALPR processing steps to return possible plate numbers, finally we check plate numbers and save to database.

Our proposed system is divided into three stages: captured image, OpenALPR stages, system analysis (see Fig.1).

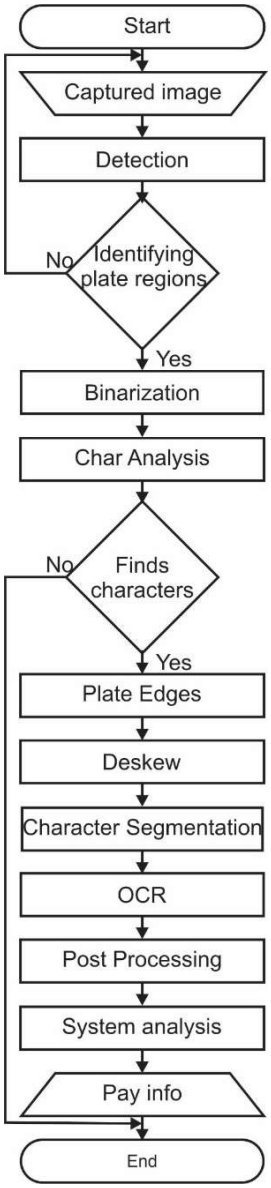

Fig. 1. System stages for plate recognition

These three stages are described in the following.

A. Captured image stage

In our system, image capture is done with the OpenCV library. We can perform this process in 3 different ways in our system. OpenCV library examines with the picture. In addition, frame-by-frame images can be taken on video and live broadcasts and examinations can be made on frames. We do the license plate recognition system by examining the frames on the live broadcast with a webcam camera.

B. OpenALPR stage

OpenALPR: is a library written in C++ and supports bindings to other programming languages such as Python, Java and C#. It processes images and video streams and makes the results available to another subsequent system [Automatic Vehicle License Plate Recognition System for Smart Transportation].

OpenALPR operates as a pipeline. The input is an image, various processing occurs in stages, and the output is the possible plate numbers in the image. The pipeline stages occur in the following order: [13]

Detection

In this phase input image analyzed with LBP(Local Binary Pattern) algorithm to identifying license plate regions and to sent to Binarization phase for processing

Binarization

In this phase creates multiple binary images (black and white) for each plate region. In this phase Wolf-Jolien and Sauovola method for binarization. Each of the binary images are processed in subsequent phases.

Character Analysis

In this phase find characters in the plate region. After find characters, the characters region is saved and further processing takes place

Plate Edges

In this phase find the edges of the license plate. The plate edges tries to find the precise top/bottom/left/right edges of the license plate.

Deskew

In this phase remaps the plate region to a standard size and orientation. Ideally this will give a correctly oriented plate image

Character Segmentation

In this phase tries to isolate all the characters that make up the plate image.

OCR (Optical Character Recognition)

The OCR phase analyzes character and computes all possible characters and their confidences.

Post Processing

Post processing phase determines the best possible plate letter combinations.

C. System analysis stage

When OpenALPR plate recognition results are obtained, these results are arranged according to their plate similarity success percentage. We get the most successful rate, if this rate is higher than 70%, we save this plate result in the database.

The customer entering the parking will bring their car next to the camera. The camera takes an image of the license plate and transmits it to the OpenALPR library and the results are obtained. If the plate recognition result provides the required success rate, the entry time and information of this plate are recorded in our system. In the same way, when the car will exit, the camera again transmits the license plate images of the car to the OpenALPR library, the success results are checked. In this case, it is checked whether the car has already entered the parking lot or not. If the car has entered before, the exit time and information of the car is recorded in our system.

IV. DEMONSTRATION

ParkingKS is a very convenient web application and its aims are to facilitate and simplify the work of auto parking. ParkingKS is developed with a Python programming language and Flask web framework, while the database is developed in MySQL. After opening the web application, a login web page appears where the username and password must be entered.

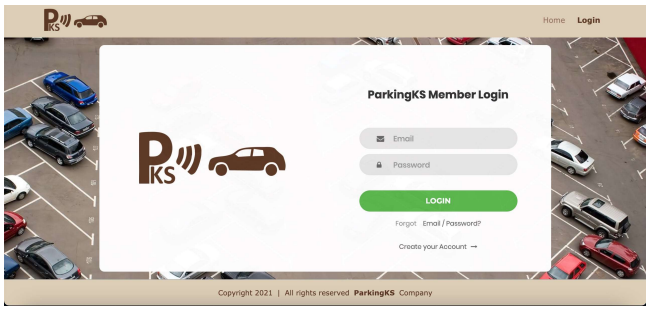

Fig. 2. The login web page of ParkingKS system

After filling in the required fields by clicking the submit button we access the web application. If login is successful in the application, the main page of the application is displayed.

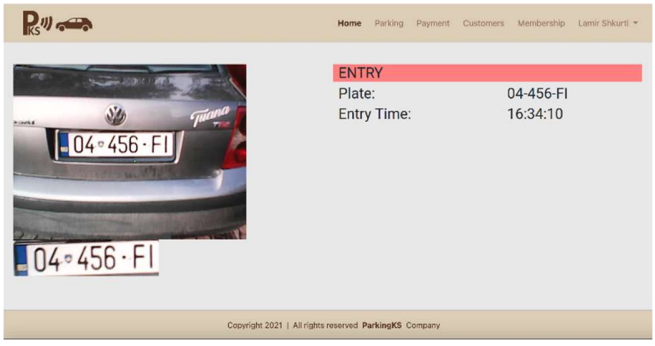

Fig. 3. The main web page, where show entering car to the parking lot

At the top of the window are the menus included in the web application. On the left side, you can see the camera which constantly looks for a license plate. At the moment the vehicle passes in front of the entrance, the camera will detect the license plate, the photo of the vehicle and the extracted license plate will be displayed on the left side of the window, while on the right side are displayed the vehicle information such as license plate and time of entering the parking lot.

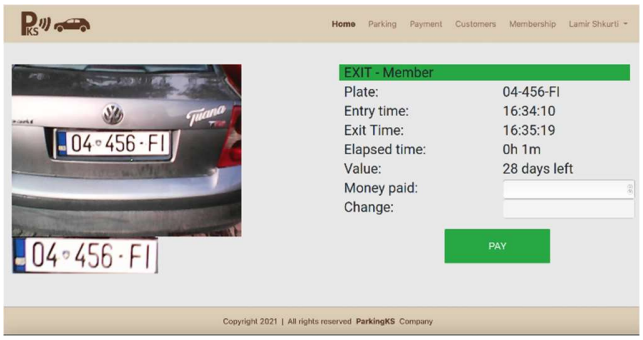

Fig. 4. The main web page, where show exit car to the parking lot

Entered vehicle at the moment of exit, the camera recognizes the plate and the exit page appears, where information is provided on the vehicle license plates, entry time, exit time, elapsed time, and price for pay. After clicking the Pay button, the payment will be registered in the system and the page information will be cleared.

The system also has the possibility of registering customers so that during the entry and exit of the vehicle in the parking lot the customer information is displayed.

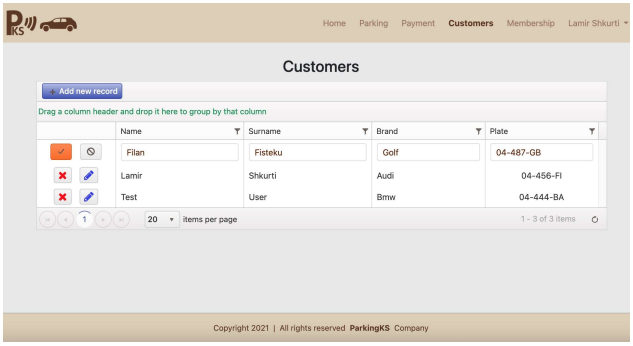

Fig. 5. The customer page

The system also enables the registration of customers' subscriptions on a monthly and yearly basis, where if the customer is registered and enters the parking lot, during the exit the system shows how many days the subscription expires.

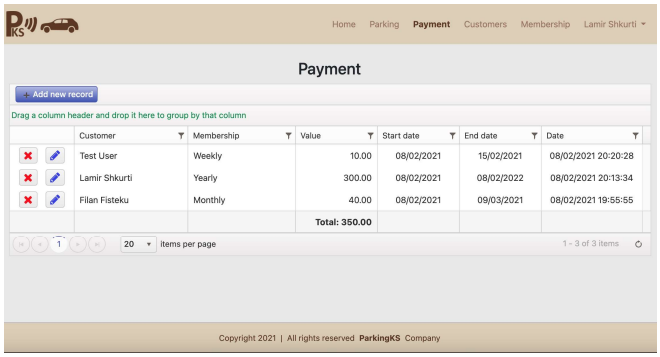

Fig. 6. The payment page

The user of the system can also see through the Parking module all the entrances and exits of the vehicles such as: the photo taken by the system, the time of entry and exit from the parking lot, the amount of money received from each customer, they can also filter and group displayed data.

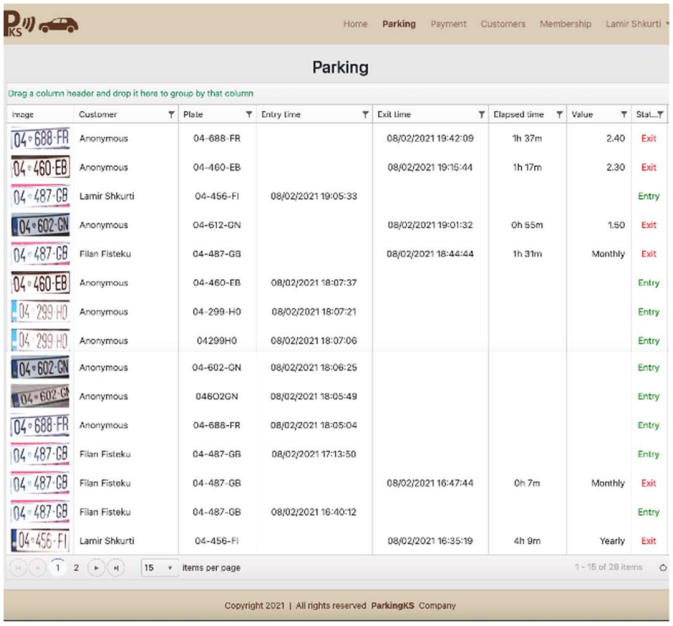

Fig. 7. Entry and exit report of vehicles entering the parking lot

As can be seen from the Fig. 7, the system detects vehicles that have a subscription and others that are not subscribed. In case they have a subscription, the name of the client and the type of subscription are shown, while in case they are not subscribed, the name Anonymous and the total amount they have paid are shown.

V. RESEARCH RESULT AND ANALYSIS

Depending on the light condition of the camera used in our system, sometimes correct results cannot be obtained in the plate recognition process. When we look at the areas shown with the red line in Fig. 8, the number of the plates was detected incorrectly. If the detected result is not a Kosovo plate, then our system will perform the plate recognition step again.

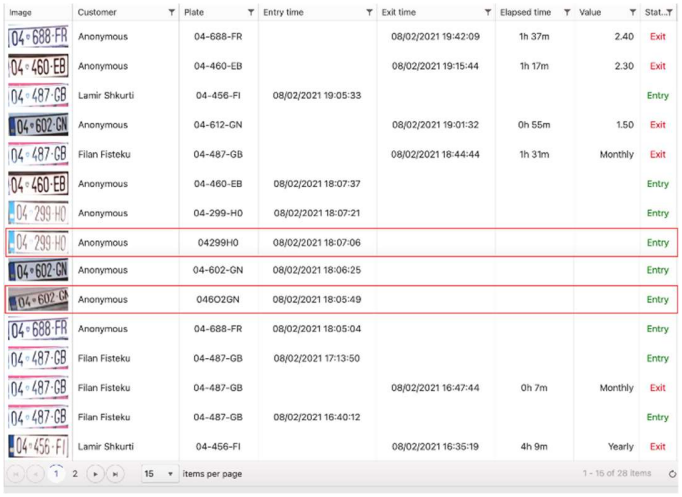

Image	Customer	Plate	Entry time	Exit time	Elapsed time	Value	Stat...
	Anonymous	04-688-FR		08/02/2021 19:42:09	1h 37m	2.40	Exit
	Anonymous	04-460-EB		08/02/2021 19:15:44	1h 17m	2.30	Exit
	Lamir Shkurti	04-456-FI	08/02/2021 19:05:33				Entry
	Anonymous	04-612-GN		08/02/2021 19:01:32	0h 55m	1.50	Exit
	Filan Fisteku	04-487-GB		08/02/2021 18:44:44	1h 31m	Monthly	Exit
	Anonymous	04-460-EB	08/02/2021 18:07:37				Entry
	Anonymous	04-299-H0	08/02/2021 18:07:21				Entry
	Anonymous	04299H0	08/02/2021 18:07:06				Entry
	Anonymous	04-602-GN	08/02/2021 18:06:25				Entry
	Anonymous	046O2GN	08/02/2021 18:05:49				Entry
	Anonymous	04-688-FR	08/02/2021 18:05:04				Entry
	Filan Fisteku	04-487-GB	08/02/2021 17:13:50				Entry
	Filan Fisteku	04-487-GB		08/02/2021 16:47:44	0h 7m	Monthly	Exit
	Filan Fisteku	04-487-GB	08/02/2021 16:40:12				Entry
	Lamir Shkurti	04-456-FI		08/02/2021 16:35:19	4h 9m	Yearly	Exit

1 2 15 items per page 1 - 15 of 28 items

Fig. 8. The results of the report with correct and incorrect plates

In Figure 8, it can be seen that the correct plates have been detected shortly after the defective plate.

When we look at the license plate recognition results, it has been determined that our system has recorded 85% of the registered plate numbers correctly.

VI. CONCLUSION AND FUTURE WORK

We implemented our ParkingKS system on the Linux 18.04 operating system. Also, the system was implemented in the Raspbian operating system on the Raspberry Pi microcontroller. The system has an interface that facilitates the work of the user and extracts reports in various files as Pdf, Excel, Word, etc. The system is low-cost, works quickly, and has approximately 85% accuracy in recognizing license plates. Therefore, we can say that OpenCV and OpenALPR open source can be used for the recognition of Kosovo license plates.

Our system has a limitation on recognition license plates which are not straight on the camera and in the evening when it is very dark and the camera doesn't have light. For this, we need to train the system for better recognition of license plates.

As a future work to achieve greater accuracy in recognizing Kosovo license plates we plan to train the OpenALPR library. We will also connect the Raspberry Pi microcontroller to move the gate automatically, to open the gate in case the vehicle is nearing the gate, and when it exits the parking lot moves the gate to close automatically.

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