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Real-time Automatic License Plate Recognition Using Color Features

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ABSTRACT

Various researchers presented various solutions for license plate detection but real-time performance is still a challenge in the field. In this paper, we propose a fast license plate detection method to work correctly in a real-time environment. In the first step, we locate or detect the license plate in the image sequences. We used color-based methods to detect the license plate. The method consists of computing image contours, later, we analyzed the contours to localize the license plate in the image sequences. After detecting the license plate, in the second step, we perform segmentation using a character recognition model. Finally, we propose the license plate format checking model to verify the detected license plate is the correct license plate. For the tools, we used OpenCV (open computer vision library) and tesseract for character recognition.

Keywords: Color segmentation; visual methods; license plate localization; character segmentation; optical character recognition; region of interest; contours.

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INTRODUCTION

The vehicle license plate detection method detects the vehicle registration number which is still a challenging task to work in a real-time environment. Vehicle license plate detection was introduced in 1976. The license plate detection system checks the detected license plate number with the database.

The CCTV cameras can only record videos and on need, we can see record frame by frame but vehicle license plate detection is the fastest and most efficient and real-time method. The license plate of different countries has different color, formats, and logo. There are many methods have been explored for license plate detection by using different techniques of computer vision.

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Vehicle license plate detection and recognition have an important role in many applications which includes security, and traffic control. It may be for government or private organizations. License plate recognition (LPR) is a process in which license plates are detected with the available computing speed. It can be the license plate of cars, motorbikes, and trucks. It's a very difficult task in heavy and speedy traffic vehicle license plate detection has used many approaches with different results. Generally, license plate detection has three steps first detecting the license plate, second segmentation, and third character recognition of the license plate.

Our contribution to this study is as follows:

- We proposed a method that first captures images with a high-resolution camera for better input. After capturing the image, pre-processing is applied to remove noise and prepare the image for the detection of the license plate area.
- We convert RGB (Red, Green, Blue) image format into grayscale image format. After that, we find the contours for localizing the license plate.
- We used tesseract to recognize the character extracted from the image as a license plate. We use Open CV free software with visual studio, see Fig. 1.

Figure 1: The proposed method allows for the identification of license plates on diverse automobiles. The procedure was carried out under various lighting and vantage points.

The rest of the paper is laid out as follows: In section II, we discuss in detail the existing methods for license plate detection. The proposed method and its details are discussed in section III. In section V, we discuss the experiments and results, finally, the conclusion and future work is provided in section VI.

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LITERATURE REVIEW

In this section, we go over the research that has already been done on visual approaches for detecting license plates. For many nations and cities, numerous strategies and approaches have been presented in the field of computer vision. The model is suggested in accordance with a country's background, character, or logo. Distinct license plates have varied backgrounds, characters, and colors because it is harder to read license plates with different backgrounds, logos, colors, and languages.

Feature-Based Methods

Jia et al. [1] proposed a region-based method for detecting a license plate. the first step of this method filters the image and segmentation by using the mean shift algorithm to find the desired portion of an image. After that classification and analysis, the desired part is the license plate or not.

Zhou et al. [2] suggested a three-step approach. To create the Principal Visual Word (PVW) for each character, they first gather the features from the training photos. The features of the test photos are compared to those of the generated PVW in the following stage, and then the license plate is located using the matching.

Lee et al. [3] proposed a method for Korean license plate detection. They proposed a local structure patterns algorithm. In the proposed method, license plate detection is done by using a local structure feature with MCT and kernel. To remove false positives using the post-processing of the detector.

Machine Learning-based Methods

Various researchers explored machine learning and deep learning-based methods for license plate detection. They used object detection methods such as Single Shot Multi-box Detector (SSD) [4], You Only Look Once (YOLO) [5], and R-CNN (Region-based Convolutional Neural Network),

[6].Iqbal et al.[7] used the inception model with SSD framework for the utility meter reading detection. The images of utility meters were collected in real-time environments with different tilt angles and then annotated the images with a labeling tool. The labeled images were saved as eXtensible Markup Language (XML) files and claimed improved results both in terms of accuracy and computing speed. Naseer-u-Din et al. [8] used MobileNet with SSD to diagnose tumors in the MRI-scanned images.

Lekhana et al. [9] authors proposed a method to extract a license plate with combine two approaches one is connected component analysis and another is the spectral analysis approach. Character component analysis was done by using connected component analysis. A support vector machine (SVM) was used for character recognition. This method provides a good result

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for feature extraction as compared to the principal component analysis (PCA) and linear discriminant analysis LDA methods. Wu et al. [10] proposed a neural network based on the SSD model for and implement on Tensor Flow. ResNet has used the place of VGG as a basic framework. They used the Sobel detector for edge detection. Morphological analysis was used to find the candidate area after that connected component is used for the analysis candidate region. Finally, the license plate was located in the image.

Sajjad et al. [11] proposed a method for Indian license plates using two software Python and OpenCV. In their method, they first captured the image with a high-resolution camera. The other step was to pre-process the image to remove the noise. Thresholding technique used for pre-processing. The third step was to identify the character by using connected component analysis. Finally, OCR was used for character recognition.

Castro et al. [12] claimed improvements by using a single shot detector with MobileNet for the identification of license plates. The original SSD framework used VGG16 to extract meaningful features deeply. The proposed strategy created bounding boxes of varying sizes and also generates XML files for the detection of target objects.

Silva et al. [13] used a deep learning technique-based approach Fast-YOLO for license plate tracking and recognition. The technique used region proposals rather than, image pyramid and sliding window technique. Finally, character recognition techniques were applied for the recognition of characters consisting of 0–9 and A–Z.

LPR with Optical Character Recognition

Kumar et al. [14] mentioned and show that the maturity of open-source software and technologies. The author proposed a method using OpenCV and neural networks for license plate recognition. The training sets are of different sizes like 6 × 8, 8 × 13, and so on. They use different tools in this method the name of tools are net Beans, OpenCV library, and MySQL.

Palekar et al. [15] proposed a method based on tesseract and OpenCV. First, captured the image with a cell phone camera. Pre-processing was carried out by using the OpenCV library used with python language. Text extraction from the image was accomplished using tesseract. To remove the extra text as comas and columns removed with ASCII filter from a license plate.

Agbemenu et al. [16] proposed a methodology for the Ghanain number plate using C++ with OpenCV library. Locating the license plate was done by using an edge feature with mathematical morphology. Tesseract OCR was used for character recognition. The methods we have discussed above are not accurate enough to be deployed in the real environment. Whereas, the deep learning methods are very slow to meet the real-time performance challenge.

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In this paper, we present a fast feature-based method that is fast enough to be workable in a real-time environment. The method also showed remarkable accuracy in a complex environment. After extracting the license plate, we used the optical recognition model to segment the license plate characters and recognize them for further processing.

OUR METHOD

In the suggested methodology, we first use the generic pre-processing technique to the input image to reduce noise, tweak resolution, and crop the image before feeding it to the model. In the proposed method, we first locate the various possible regions that may contain the license plate. We use the contours to find the regions. In the next step, we count the number of contours inside every region, we throw the regions with no contours. Later we apply the character recognition tesseract to segment and recognize the characters inside the regions. Finally, we apply the format checking to select the correct
license plate, see Fig. 2.

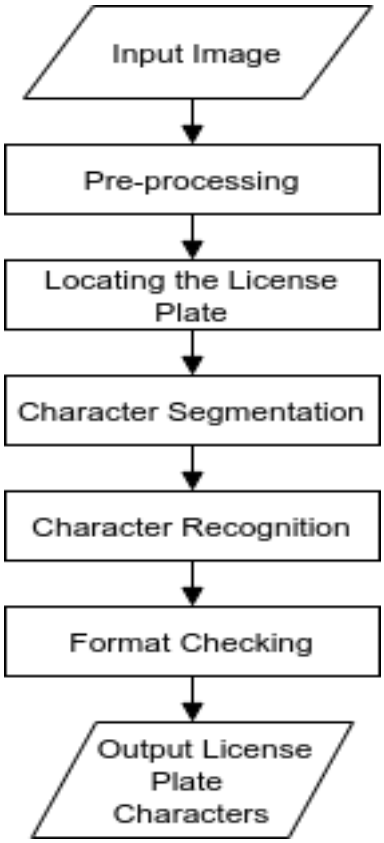

Fig. 2. Algorithm flow diagram of the proposed method.

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Input Image

We first captured the image from the video stream and feed it to the proposed method. The video stream would be the CCTV cameras installed on the roadside in an outdoor environment.

Pre-processing

The input image is first pre-processed to remove the noise in the image. After that, we convert the RGB input image into a greyscale image. The pre-processing also include resizing, cropping, and a Gaussian smoothing algorithm to prepare the image for further processing. Python is an object-oriented language that has standard libraries. Python is a mature, embeddable, and scalable language. By using this language, we have carried out all the experiments.

Localizing the License Plate

In our method, we first convert the image into a binary image using the Otso method. In the next step, we apply morphological operators Erode and dilate to remove the unwanted blobs. Later we compute the contours in the image in the image. The contours create multiple regions containing license plates. We analyze every contour and count the contour in every detected region. We remove the regions that contain zero contours and carry further processing on the possible regions containing license plates.

Character Segmentation and Recognition

We have used the character recognition tool tesseract to segment the characters in the detected region. We also used the tool to recognize the text in that region.

Format Matching

In this step, we matched the format of the detected characters with the standard license plate formatting. The formatting matching helped us to find the correct region if multiple regions were detected by the proposed method and threw the false positives.

TOOLS USED

We have used various tools to carry out experiments with the proposed method. In this section, we describe the details of each tool.

OpenCV

OpenCV has good open-source libraries for computer vision algorithms. OpenCV is written in various languages such as Python, C++, and C language. It is portable on different platforms.

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Python

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Google Colab

Google Colab is a free cloud-based service for machine learning. It is the best platform for machine learning. It is used to train machine learning models. We wrote the python programming in Google Colab.

EXPERIMENTS AND RESULTS

In this section, we made the experimental setup and carried out a number of experiments to test the proposed method.

Performance Evaluation

In the experiment, we collected the dataset of various vehicles and carry experiments to test the robustness of the proposed method. We collected various images of vehicles online and applied the proposed method. The method correctly located the license plate in the images and recognize the text in it, see Fig. 3. After locating the license plate, we also applied the character recognition tool that is tesseract to recognize and segment the detected license plate.

After locating the license plate, we also applied the character recognition tool that is tesseract to recognize and segment the detected license plate.

Fig. 3. Various images of the vehicles containing license plates. The method correctly localized the license plate in the images. The method first localizes the license plate and also applied the character recognition tesseract to segment and recognize the characters

Testing Accuracy

We also carried out experiments to test the accuracy of the proposed method. We tested the three different video streams. They showed reasonably improved results over the datasets, see Fig. I.

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Table 1: Accuracy test: Experiment for testing the accuracy of the proposed method

Chapters	# of Vehicles	True Positive (TP)	False Positive (FP)
Video set I	40	38	4
Video set II	35	32	5
Video set III	30	25	3

CONCLUSION

In this paper, we proposed a visual-based model to detect and recognize the license plate in the image scene. We first locate various possible regions containing the license plates. We used the image contours to find the possible regions. Later, we correctly locate the license plate by analyzing those image contours.

In the next stage, we apply the character recognition model to recognize and segment the characters. We used the tesseract to recognize the characters. Finally, we check the format of the recognized characters and declare it as the correct license plate or mark it false license plate.

In future work and recommendations, we can optimize and replace the visual method with a deep learning module such as CNN or single shot detector (SSD).

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