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A Robust Texture Descriptor for IdentifyingLicense Plates in Challenging Vehicle ImageConditions using SVM Algorithm

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***Abstract*—The implementation of licenceplate detection in smart transportation systems is discussed in this study paper. The suggested system makes use of character detection techniques as well as an unique method for eliminating shadows. The invention of an enhancedbinary approach for shade elimination that blends the Bernsen approach withGaussian filter and the incorporation of a character detection method utilising the Support Vector Machine (SVM) technique are the paper's two significant contributions to the area. The SVM approach concentrates on the whole licence plate rather than individualcharacters and obtains characterattributes from a stretchy mesh. The research also presents new methods forimprovinggrayscale photos and correcting image tilt. The proposedalgorithm is resilient to variations inlighting, viewing angles, position, size, and colour of license plates, making it suitable for use in complex environments.**

I. Introduction

An image is a column- and row-organized array, or matrix, of square pixels (picture elements). The most popular and practical method of sharing or distributing information is through images. There are a thousand words in a picture. Images clearly communicate information about the positions, dimensions, and connections between items. They depict geographical data that humans may identify as objects. Because of our natural visual and cerebral capacities, humans are good at extracting information from such images. Humans get about 75% of their information in visual form. Picture compression, image amplification and revival, and dimensionretrieval are the three main types of image processing operations. Many individuals are familiar with the idea of picture compression, which seeks to utilise less memory.

II. Literature Survey

[1] An intelligent strategy for checking the annualinspection status of motorcyclesbased on: license plate recognition

Techniques for recognisinglicence plates have beeneffectively used to manageparking lots, track down stolen vehicles, andregulate traffic. This study suggests alicence plate-based method for determininga motorcycle's annual inspection status usingphotos taken at authorized inspection locations and along the roadside. Ashardware platforms, a desktop PC and an UMPC (Ultra Mobile Personal Computer)with a web camera are both employed. A search window is used to scan integratedhorizontal and vertical projections, which are used to locate licence plate locations in photos. Additionally, a character recoverytechnique is used to increase the success rate. Both a back propagation artificialneural network and feature matching are used to recognise characters. Then, using the specified licence plate.

[2] An Efficient Method of License Plate Location in Natural_scene Image

This work proposes a novel and effectivealgorithm for the placement of automobile license plates. This method's goal is to efficiently locate license plates in spite of restrictions on LP distance, angle of view, lighting, and background complexity. This approach's contribution is that it combines the mathematical morphology method with the sliding concentric windows (SCWs) method to create a faster, more reliable method. Our method utilizes the colorinformation of LP toaccurately locate it. It iscapable of identifying multiple LP inanimage,and is less restrictive than other LP locationtechniques. Furthermore, it has a quickerprocessingtime,taking only 0.1 second, makingit suitable for real-timeapplications. 200 natural-scene car photos with various backdrops and ambient lighting were used totest the system.

[3] License Plate detection of movingvehicle

This study proposes an Egyptian license plate recognition system for moving automobiles. The suggested method takes an image from a digital video camera and extracts the distinctive elements of a plate from it. The suggested method detects the numbers and letters on a license plate usingamultilayer neural network. The system is split into two primary phases: the first is the training stage, during which a dataset is produced and the neural networks are taught for recognition. The second is the recognition procedure, which includes segments for words and numbers, detecting vehicles from a stream of frames, estimating plate positions, and plate recognition.

[4] Enhancement of license plate recognition performance using Xception with Mish activation function

The research's goal is to offer a reliable and efficient method for reading characters on license plates under challenging environmental situations. The proposed method was tested using four benchmark datasets, which are, FZU Cars, Stanford Cars, Application-Oriented License Plate(AOLP) and HumAIn 2019 Challenge.

[5] A Method for Identifying Specific Vehicle Using Template Matching

A novel recognition method is proposed in this work to overcome the concerns brought up by the identification strategy that makes use of the previously discussed template- matching process. In order to further verify the algorithm's accuracy in object recognition, we applied it to a real road. Thefindings revealed a 99.6% accuracy rate, which is sufficient for practical application.

[6] Automated new license plate recognition in Egypt

The functional use of license plate recognition (LPR) is utilized by Automatic Vehicle Identification (AVI) systems. This research offered an original and simple technique for the LPR system of Egyptian automobiles. Database communication, plate region extraction, and plate characteridentification are the three key parts of the proposed method. A video stream was one of this system's most important advantages. Real-time functionality could be used without the need of extra sensors, such as infrared ones. Automated New License Plate

[7] A Survey on License Plate Recognition Systems

This study proposes an Egyptian licenseplate recognition system for moving automobiles. The suggested method takes animage from a digital video camera and extracts the distinctive elements of a plate from it. The suggested method detects the numbers and letters on a license plate using a multilayer neural network. The system is split into two primary phases: the first is the training stage, during which a dataset is produced and the neural networks are taught for recognition. The second is the recognition procedure, which includes segments for words and numbers, detecting vehicles from a stream of frames, estimating plate positions, and plate recognition.

[8] An edge:basedcolor:aided method forlicense plate detection

Detecting licence plates is a challenge that isexamined in this research. Some commonissues include poor imagequality brought onby poor lighting, moving vehicles, shifting viewpoints and distances, complex backgrounds, etc. It is suggested to use edge density and intensity variance to improveimages in two separate ways.

[9] CarLicensePlateDetection

This study examines automobile licence plate detection (CLPD) technology, whichuses car license plates to identify vehicles (CLP). Due to several applications, including crime prevention, electronic toll collection, intelligent traffic management, etc., car license plate detection (CLPDS) is a growing field of study. The suggested system employs adaptive thresholding to produce the binary picture after converting the colour input image to grayscale. The undesirable lines are then eliminated using an algorithm for unwanted lines (ULEA).Finally, the Sobel operator detects vertical edges to identify the license plate. For the purpose of detecting license plates in both the front and back views, experiments were performed. The experimental evaluation is done on 60 photos that were obtained from parking lots and the sides of roads.

[10]Autonomous Vehicular Surveillance using License Plate Recognition over Cloud Computing Architecture

For the purposes of vehicular surveillance, these cameras are inefficient, as a lot of them will be required to monitor vehicles effectively. These cameras capture meaningful images of license plates from their video feed, and upload these images to the cloud using a Vehicular Cloud Computing architecture. The cloud compares them to a database of license plates that are flagged by law enforcement. If the license plate is found to be flagged, then the respective law enforcement authorities are notified of the location of the car.

[11]Vehicle plate number localization using a modified GrabCut algorithm

A key stage in any vehicle plate number recognition system is to first locate the vehicle plate number. In this paper, they presented a modified GrabCut algorithm for localizing vehicle plate numbers. In contrast with the traditional interactive GrabCut technique, a modified GrabCut algorithm was designed to identify and extract vehicle plate numbers in a completely automatic manner. Finally, to evaluate the performance of the proposed technique, the localization accuracy is tested with a dataset of 500 vehicleimages with vehicle plates from different countries.

[12]Region-based license plate detection

In order to recognize a license plate efficiently, however, the location of the license plate, in most cases, must be detected in the first place. Due to this reason, detecting the accurate location of a license plate from a vehicle image is considered to be the most crucial step of an ALPR system, which greatly affects the recognition rate and speed of the whole system. In this paper, a region-based license plate detection method is proposed. These candidate regions are then analyzed and classified in order to decide whether a candidate region contains a license plate.

[13]Towards aMultinationalCarLicensePlateRecognitionSystem

A full-fledged image-based car license plate recognition system is described in the paper. The localization stage of the CLPR yields a plate clip followed by character segmentation and recognition. The recognition scheme combines adaptive iterative thresholding with a template-matching algorithm. Promising results have been obtained in the experiments with Israeli and Bulgarian license plates including images of poor quality.

[14]Vehicle license plate character segmentation

Auxiliary lines are added into the image to make the separated parts of each Chinese character to be an interconnected region. The noise regions will be eliminated after two fusing images are merged according to the minimum principle of gray values. Then, the characters are segmented by projection method and the final character images are obtained. The experimental results show that this method features fast processing and good performance in segmentation.

III. PROPOSED METHOD

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Our proposed method focuses on a solution for image disturbance brought on by varying outdoor conditions including shadow and exposure, as well as uneven illumination,which are typically difficult to successfully handle using conventional binary methods. We discussed the method of extracting features from alphanumeric characters, and applied a Support Vector Machine (SVM) to classify those features. The system's overall performance along with the effectiveness of every single element were also evaluated.

This paper presents several newcontributions to the field of image processing. Firstly, a novel technique for eliminating shadows from images is proposed, which combines an advancedversion of the Bernsen algorithm with theuse of Gaussian filter. Secondly, an algorithm for character recognition is presented, which uses Support Vector Machines (SVMs) to recognize characters in an address string, rather than just a single character.

Additionally, the most effective character feature extraction are evaluated in order to determine which ones are most useful in practical contexts. The paper also includes techniques for correcting image slant and enhancing image quality. Furthermore, the paper proposes an image tilt correction method for license plate pre-processing. Finally, the paper presents the results of experiments evaluating the performance of the proposed techniques.

IV. Implementation Modules

1. *License plate preprocessing*

In license plate recognition (LPR),preprocessing the image of the license plate is a crucial step. This process includes identifying the location of the license plate, correcting any distortions in the image, and segmenting the elements on the plate. The objective of recognition is to find regions of the image that resemble a number plate. However, variations in the image's orientation can result in skewed or distorted images. Therefore, adjusting the image tocorrect these issues before attempting to segment the characters is an essential step inthe process.

2. *License plate detection*

The connected component analysis (CCA)technique is used in the search for binary images that are connected in an eight- neighborhood relationship. Using theConnected Component Analysis (CCA) method, the picture is examined and its pixels are arranged into distinct clusters based on their connectedness.

3. *Character segmentation*

Character segmentation is a multi-step process that includes the following steps: 1) creating a white backdrop with black text on the licence plate picture, 2) resizing the plate to 100x200, 3) applying tilt correction and image enhancement techniques, 4) dividing the numberplate into two portions using a projective approach, then separating theelements from each area and, 5)standardizing the size of the characters.

4. *Character Recognition Algorithm*

The peripheral direction contributive density(PDC), the local direction contributive density (L-DCD), and the global direction contributive density (G-DCD) are examples of characteristics of the stroke direction that are used in a statistical procedure. The steps taken to achieve the G-DCD and L-DCDcharacteristics are described in thistechnique.

IV. Proposed Method Diagram

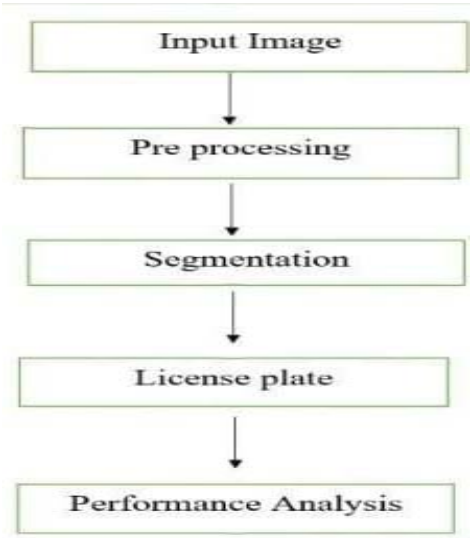

Fig.1 Proposed Method

5. *Experimental analysis*

The process of extracting features from binary characters is found to be simple and efficient, in comparison to grey-value characters. Oursystem, which can acquire images under various lighting conditions and environments, achieved an accuracy of 90.98%.

Image gray equilibrium results of the different methods.

Fig.2 Image gray scale results

The performance of the system in terms of location, segmentation,recognition and overall performance was 96.96%, 98.23%, 98.01% and 93.45% respectively. To ensure optimal image quality, a step of grey equilibrium is included in the segmentation stage. In this study, we utilized a gray statistical method (GSA) to improve image quality.

V. Advantages

The License Plate Recognition (LPR) system operates as follows: When the system receives an input image, the initial step is pre-processing which includesactions such as making the image binary andeliminating noise. Then, using either frame location or character location methods, potential number plates are obtained fromthe picture. If the system is unable to locate any license plates, it will generate a "refusedrecognition" outcome. However, it ispossible for

multiple license plates to be detected. After that, the system advances to the detection and segmentation phases. The segmentation step of the licence plate willbe completed if it can be recognised. If not, the system will consider a different possible licence plate.

Two assessments areperformed during the segmentation phase:one for a plate with a single huge number ona bright-white background and another for a binary alteration procedure. The first assessment concerns plates with a single big number on a white background. When the present approach fails to appropriately segment the plate, a different binary method is used in the second evaluation. While, text detection includes classifying characters into4 distinct categories.

The end result of the detection process is determined by selecting the best recognition method among the different methods used. To generate a legitimate licence number, all characterrecognition results are taken intoconsideration, as long as they conform to thestructural rules of license numbers outlined previously.

VI. Discussions

For a variety of reasons, including car park operations, surveillance systems in secured areas, and road system, its capacity to recogniselicence plates (LPR) is crucial. The many plate formats and the variable illumination.Outsideduring photogrammetry, including backdrop, lighting, speed limit, and camera-vehicle distance, might make this work challenging. Consequently, many techniques are confinedto specific situations such as constant lighting, predefined paths, and unchanging backdrops.

The identification and division ofthelicence plate, segmenting and normalising the characters, and character recognition make up the four key elements of an LPR system. For the whole system, thesuccess of the locating operation is essential since it directly affects the precision and effectiveness of the succeeding processes, however, this step is challenging to accomplish due to different lighting conditions and complex backgrounds.

VII. Conclusion

The three primary aspects of the license plate recognition (LPR) method presented in this work are: identifying the registration plates, dividing the tokens, and recognizing the licence tokens. The overall performance of the algorithm is 95.8%. The performance of identifying the plate, segmenting the characters and recognizing the characters individually are 96.96%, 98.23%, and 98.01%, respectively. Our system achieved satisfactory results for individual rates and overall performance. Even though the suggested method isdesigned to work with number plates from a certain nation, many of its components may be readily changed to work with licence plates from other nations. The improved binary algorithm is particularly useful in dealing with uneven illumination, a commonissue in plate detection, and can be adapted to various surrounding conditions. As license numbers are commonly composed of numerals and Roman letters, the suggested algorithm is suitable for any number plates that follow a similar composition.

VIII. Result

Fig.3. Output

As observed in the above diagram as shown the image of the vehicle is the input that was provided to the model andwegotthe number plate of the vehicle asthe output and the accuracy received was 95.8. The heat map represents confusion matrix.

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