License Plate Recognition System Using Open-CV and Tesseract OCR Engine

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Abstract -- While technological advancements have made life easier for people, they have also had unintended repercussions. Among these is traffic control, which has grown to be a significant problem in the twenty-first century. Because of the advances in automotive technology, it is now very easy for someone to break traffic laws, and it is nearly impossible for anyone to stop or record a vehicle's license plate when it is moving at a faster pace. This is a significant issue that emerging nations must deal with, and our study will address a workable solution. An information processing system called "license plate recognition" (LPR) uses a digital image of the license plate with alpha-numeric letters on it to perform optical character recognition (OCR). Three stages of a license plate recognition system based on text recognition, picture processing, and illumination are presented in this work.

Character segmentation, character recognition, and license plate identification are all included in the Open-CV and Tesseract OCR engines. In order to enable the camera to take pictures at any time of day, the system typically uses infrared (IR) illumination. License plate recognition or LPR is a crucial part of contemporary security, traffic, and surveillance systems. This work shows a novel approach to LPR, combining the strengths of Tesseract OCR (Optical Character Recognition) with OpenCV (Open Source Computer Vision Library). We aim to create a reliable and effective system that can precisely recognize and extract license plate information from complicated photos by synergistically combining these technologies.

Keywords - License plate recognition (LPR), Open-cv, tesseract OCR engine, character segmentation, character recognition.

I. INTRODUCTION

The world is moving toward a brighter future every day, and people's reliance on technology—particularly that of transportation—is growing at a rapid rate. A significant part of today's world is transportation. As time goes on, people search for quicker ways to save time in day to day lives. The 21st century has seen a significant advancement in transportation technology that is available to every individual on the earth. Since it is accessible to the public, it is imperative that everyone abide by the stringent traffic laws in place to protect their safety. LPR system is one of the applications by which a post disaster calamity can be prevented, basically any person breaking the rule cannot get away with it easily.

Computer vision is essential for helping us recognize license plates on automobiles. Our ultimate outcome is facilitated by OpenCV, a computer vision library subdivision. Every car in this globe [2] has a unique number that is used for vehicle identification.

The vehicle's primary means of identification and the only identity assigned to it is its unique number. The license plate, which is assigned a unique number, will be registered at the transportation department closest to the car. On the other hand, our technology has a wide range of uses, including the ability to detect highway speed, identify stolen cars, gather data on both human and non-human losses, and much more. The system consists of two main parts:

A. locating licence plates
B. identifying licence numbers

In the first step, the localisation of the licence plate takes place based on features of the licence plate. Symmetry, shape, height to width [3] ratio, colour, texture greyness, and many other characteristics are among the characteristics.
There are two main activities happening in the second stage.

- character separation
- character recognition

In this case, the characters are split to allow for the identification of each unique alpha-numeric value [4]. The character is then passed via an optical character recognition (OCR) engine in the second phase to successfully recognize the character or number.

II. OPENCV

Artificial intelligence includes computer vision, which allows people to comprehend image and video storage formats. Additionally, data manipulation and retrieval from these photos are done with it.

The well-known open-source library for image processing, computer vision, and machine learning is called OpenCV. It is essential to the real-time functioning of contemporary systems.

With the help of this open-source framework, objects, faces, and even handwritten text may be recognized in images and videos. When Python is integrated with several additional libraries, such NumPy, it may process the OpenCV array structure for analysis.

The very first OpenCV library released was the OpenCV version 1.0. Since it is distributed under a BSD licence, both academic and commercial [5] uses are free. It supports all of the popular interfaces, including Python, C, C++, and Java. It is compatible with several os, including Windows, Linux, MAC OS, iOS, and Android. To achieve computational efficiency for real-time applications, OpenCV was created. Applications of OpenCV are

1. Automated inspection and surveillance.
2. Facial Recognition.
3. Vehicle Street detection, tracking and counting view image stitching.
4. Medical image analysis.
5. Object detection and tracking.
6. Robot detection and tracking and autonomous car navigation and control.
7. Open CV Interface
8. I/O, processing, and display of images and videos (core, Image processing, highs) • Feature extraction and object detection (object detect, features 2d, nonfee)
9. Monocular stereo computer vision based on geometry (calib3d, stitching video stable)
10. Super resolution photography (picture, video)
11. Clustering and machine learning (ml, flann)
12. Acceleration using CUDA (gpu)

III. TESSERACT-OCR

An optical character recognition engine called Tesseract-OCR is used to identify alphanumeric characters in pictures. Hewlett-Packard (HP) developed it initially in the 1980s. Google has been funding the development of this engine since 2005, and it is available as open-source software.

It is compatible with several operating systems, including as Mac OS, Linux, and Windows.[6] When Tesseract's second version was developed, it could only identify English. In addition to English, Tesseract was able to recognize six other western languages. Language support, including ideographic and right-to-left languages, was greatly expanded in version 3. Japanese and Chinese are the ideographic languages; Arabic and Hebrew are the languages of the right to left. A version known as v3.04, which was published in 2015 [7], included 39 more languages, bringing the total to 100. Up to 116 languages can be recognized by version 4. Long short-term memory, or LSTM, is the foundation of version 4. LSTM is a kind of artificial neural network that is applied to data processing and classification. Deep learning problems also employ its application.

Tesseract's output is dependent on the photos. Inadequate pre-processing of the photos could lead to low quality. Low-frequency brightness fluctuations must be high-pass filtered, rotation or [8] skew must be corrected, and images must be magnified such that text has a minimum of 20 pixels in height.

IV. METHODOLOGY

The basis of the license plate recognition method includes the histogram, texture, edge detection, morphological processing, and transformation. In the steps that follow, we have provided a quick introduction to these tactics.

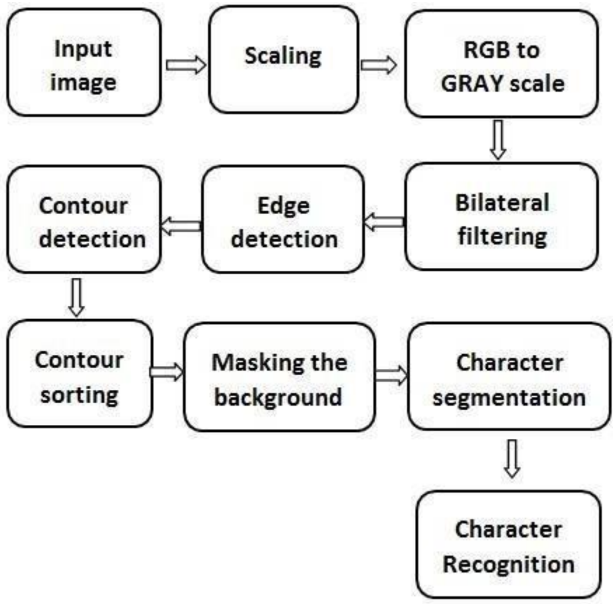

Fig A: Block diagram for licence plate identification

A. CAPTURING THE INPUT IMAGE

Our high-resolution camera (Logitech 720p, 30fps) takes the input images. [15] The camera's quality and resolution are dependent on the vehicle's placement as well as the camera itself. It is necessary to transform the received image to a greyscale image because it is in RGB format.

Fig. B: captured input image

B. SCALING

Resizing the acquired image is a vital step since it allows us to prevent unnecessary difficulties that could occur from a higher quality image. Here, our method reduces the captured image to the desired frame while also ensuring that the licence plate remains in the frame. This procedure is also known as digital image scaling.

C. GRAY SCALE CONVERSION

The RGB format of the image is transformed to grayscale. The RGB image will contain a lot of data that is not needed for image processing; thus, this conversion is crucial. [9] The fact that RGB images include three channels and differing intensity labels is another reason they are converted from RGB to grayscale. As a result, a colour image will contain a wide range of intensities, which will either directly store or alter a large amount of data in the background.

Fig. C : RGB to Gray scale conversion

D. BILATERAL FILTERING

After the image has been resized as necessary, a crucial phase known as bilateral filtering occurs. This step will assist us or the system store only the necessary information by removing the extraneous details from the image.

Fig. D: Bilateral filtering

Bilateral filtering helps reduce noise in the image while also preserving the image's borders, essentially smoothing the final product. Noise in an image is the undesirable information.

E. EDGE DETECTION

A crucial stage in image processing is edge detection, which aids in locating the borders of the object [13] (license plate) in the picture. Edge detection functions by identifying brightness discontinuities. In particular, data extraction and image segmentation are done with it. For edge detection in this code, we'll be using the OpenCV canny edge function.

F. CONTOUR DETECTION

The process of connecting all of the continuous points in an image or picture that have the same colour or intensity is known as contour detection. To find the continuous rectangular-shaped items in the image, we will use contour detection in this application. Finding the boundaries of the items in the picture and easily localizing them is the primary objective.

Fig. E: Finding all contours in the image

G. CONTOUR SORTING

After contour detection is completed, sorting of rectangular objects [11] should occur, which is necessary because the rectangular seize of a car is much larger than the rectangular seize of a license plate, and our concern here is only the license plate, so contour sorting is a critical step in our algorithm.

H. MASKING THE BACKGROUND

As we now have the required object in the image, the other information in the background is pretty much useless.

Fig. F: Masking the background

In order to preserve the necessary portion of the image—the license plate—we conceal the background. The remaining information in the image is useless once the contour sorting has located the required object. Consequently, all of the image's superfluous information has been obscured.

I. CHARACTER SEGMENTATION

Segmenting the license plate is the next stage of our algorithm and is essential for character recognition. Our code separately crops and saves the pertinent image [14]. Character segmentation is the process of breaking down an image of a sequence of characters into smaller images representing individual symbols after the required image has been cropped. We will talk about using Tesseract OCR for character recognition in the next phase.

Fig. G: Character segmentation

J. CHARACTER RECOGNITION

The [12] number plate's character identification is the last stage, when the most crucial procedure occurs. In this case, the Tesseract OCR engine is used to recognize characters. To recognize characters in an image, OCR uses artificial intelligence, whereas Tesseract is used to detect templates in words, letters, and pixels.

Fig H: Character recognition

PROCEDURE FOLLOWED IN ALGORITHM:

1. BEGIN
2. Input the captured image
3. Output contains the characters in the image
4. Method: OpenCV and tesseract OCR engine.
5. LP: - licence plate

A license plate is basically defined as a vehicle which is displaying its registration details.

6 RGB to grayscale conversion

We change the RGB image to various shades of grey in this stage. There are three variations: complete black, complete black, and complete white.

7 Morphological transformations

Morphological transformations are just some simple transformations based on the shape of an image which is usually performed on a binary image.

8 Gray scale image to binary image

This method converts a grayscale image into a binary image (black and white) by substituting each pixel in the input image with one that is brighter than the original image.

9 Bilateral filtering

Bilateral filtering is used to smoothen images and reduce noise while preserving the edges.

10 Gaussian filtering for blur image

Gaussian filtering is basically mean filtering which performs a common function which is used to reduce image noise and reduce detail.

11 Finding contours in the image Essentially, contours are points that connect all of the continuous points in an image.

12 Recognition of all possible characters in the rectangular plate

13 Crop LP from the image

14 Apply steps from 6-12 on cropped image

15 Print the characters in LP

16 END

V. RESULTS

A total of 100 images were used to test the LPR system prototype which included images taken from varying distances, different illumination conditions and different camera angles. We faced problems with images which was taken from a long distance and our system was not able to detect the licence plate while the vehicle was in motion.

Fig. I: Capturing the input image and scaling process

Fig. J: Conversion of RGB format to grey scale format

Fig. K: Character Recognition

VI. CONCLUSION

Our paper's primary goal is to create a license plate recognition system that is effective and produces few errors while identifying the number plate. For testing, 1000 photos were used. We could successfully identify the license plates. We can further improve our system's efficiency by integrating neural network technology with image processing techniques. Ensuring that our technology operates accurately in a variety of lighting and environmental circumstances is another primary goal.

First off, our research has demonstrated the effectiveness of current ALPR systems in accurately identifying and detecting license plates under various driving conditions and speeds. This suggests that widespread application in traffic control, law enforcement, and other domains will be bright in the future.

But despite these advancements, ALPR still has several shortcomings. It is necessary to find solutions for issues like occlusions, poor image quality, and privacy concerns in order to increase the accuracy and utilization of ALPR technology. In addition, the potential for exploitation or abuse of ALPR data highlights how important it is to have robust privacy safeguards and ethical considerations in all ALPR model applications.

Future work on ALPR should focus on finding solutions to these problems while exploring opportunities for innovation and progress. This could include incorporating complementary technologies like computer vision and machine learning along with the development of more intricate algorithms to increase speed and accuracy. Furthermore, interdisciplinary cooperation between researchers, policymakers, and industry stakeholders are essential to ensure that ALPR technology is used in a morally sound, sensible manner that respects people's civil liberties and privacy rights.

VII. FUTURE WORK

The technology used to track and resolve issues with traffic and transportation management should progress in tandem with the automotive industry. Since LPR systems are well-known for their ability to conduct mass surveillance, issues with traffic clearing, transportation management, vehicle tracking, and many other issues would be resolved if they were implemented in developing nations.

Future developments and applications in a wide range of fields are highly promising for Automatic License Plate Recognition (ALPR) technology.

1. Enhanced Accuracy and Speed: The goal of upcoming research and development projects should be to increase the speed and accuracy of ALPR systems. To do this, more intricate algorithms would need to be developed in order to accurately read license plates in challenging situations like low light, inclement weather, or moving cars.

2. Integration with Emerging Technologies: ALPR technology can be used with other state-of-the-art technologies, such as artificial intelligence (AI), machine learning, and computer vision, to enhance its capabilities. For example, AI-powered algorithms may improve the accuracy with which ALPR devices identify and recognize license plates.

3. Real-Time Data Analysis and Insights: Real-time data analysis and insights generation are possible with ALPR systems. Through the use of ALPR technology, license plate data may be processed and analyzed in real-time, providing valuable insights for law enforcement, traffic management, and urban planning. For example, it can be used to identify traffic patterns, monitor parking violations, or track the movement of vehicles across an urban area.

4. Integration with Smart Cities Initiatives: 1. The emergence of smart cities can be greatly aided by ALPR technology, which provides valuable data for urban planning and management. Combining ALPR systems with parking meters, traffic lights, and security cameras can help smart cities maximize resource allocation, enhance traffic flow, and boost public safety.

5. Mobile and Wearable apps: Future ALPR technology may heavily rely on the development of wearable and mobile applications. Mobile ALPR systems installed on smartphones or wearable technology may enable law enforcement officers, parking enforcement officers, and private security specialists to perform license plate recognition tasks while on the go, increasing their efficiency and productivity in the field [1].

6. Solutions that Preserve Privacy: The widespread adoption and usage of ALPR technology depends on resolving privacy concerns associated with it. Future research should focus on developing privacy-preserving techniques to safely process and retain sensitive license plate data while yet allowing for the effective use of ALPR technology. These tactics include, for instance, anonymization, encryption, and decentralized systems.

7. Regulatory Frameworks and Ethical Guidelines:

Regulatory frameworks and ethical standards will be needed to regulate the use of ALPR technology as it advances and spreads. Together, legislators, business stakeholders, and privacy activists must create rules and guidelines to guarantee that ALPR systems are implemented and maintained responsibly, and that their use respects people's rights and liberties.

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