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# Abstract

Many facets of human life are being improved by smart vehicles and Intelligent Transportation Systems (ITS) technologies and services. ANPR (Automatic Number Plate Recognition) is a well-studied topic with a number of viable solutions. Image segmentation is used to extract important information from each image for easier analysis. These solutions are often customized for a certain environment and special template due to differences in number plate features around the world. Because these parameters are used in number plate recognition algorithms, a universal solution would be impossible to acquire because the image analysis methods used to construct these algorithms do not guarantee 100% accuracy. This study focuses on a proposed strategy that is designed to work with specific car license plates. The program, which is written in Python-Jupyter Lab using the OpenCV library, uses edge detection and feature detection techniques, as well as mathematical morphology, to locate the plate. The identified characters on the plate were recognized using the Tesseract OCR engine. By mentioning developers' work, reviewing and presenting a review of extraction, segmentation, and recognition approaches, and providing guidance on future trends in this sector, this study aims to improve the position in ITS(ANPR) based on CV algorithms.

**Key words**: Automatic Number Plate Recognition (ANPR), Image segmentation, template matching, OpenCV, Jupyter-lab, Tesseract OCR engine

# 1.Introduction

An image is a data-transporting medium that includes a lot of information. Understanding the image and collecting data from it to accomplish tasks is a key area of application for digital image technology, and image segmentation is the first step in that process (Yuheng & Hao, 2017). Image segmentation is also a major challenge in image recognition, according to Song Yuheng. It separates an input image into a number of comparable classes based on particular standards in order to extract the region of interest to humans. It also acts as the foundation for image analysis, as well as image feature detection and extraction. Image segmentation is also the process of drawing lines between distinct semantic aspects in an image. From a technical standpoint, image segmentation is the process of assigning a label to each pixel in an image so that pixels with the same label are linked together based on some visual or semantic property (Ghosh et al., 2019).

Image segmentation can be accomplished using a variety of approaches. In the classification of approaches, traditional methods and soft computing techniques have been classified into two categories. The standard ways are simple to implement conventional methods. They gain and produce real solutions to the segmentation issue. Traditional segmentation approaches are usually divided into four groups based on how they work: (a) region-based segmentation, (b) clustering, (c) edge-based segmentation, and (d) thresholding (Chouhan et al., 2018). In contrast to classification and object identification, it is typically a low-level or pixel-level vision task since the spatial data of an image is very important for semantically segmenting a variety of regions. The goal of segmentation, as previously stated, is to extract usable information for easier analysis. The image pixels are labeled in this scenario so that each pixel in the image has the same color, intensity, texture, and other qualities (Zaitoun & Aqel, 2015). Image segmentation is achieved by generating a 'object matrix' using the 'connected pixel' approach, in which the value of each pixel indicates which object that pixel belongs to.

In automated traffic regulation enforcement, automatic number plate recognition (ANPR) technology has played a critical role. An ANPR system is a means of collecting data from an image file and identifying a vehicle number plate using image processing technologies. Image capture, image preprocessing, determining and identifying the region of interest (ROI), and employing optical character recognition to interpret the pixels into numerically readable letters are all common steps in the technique (S Fakhar et al., 2019). Plate detection, plate segmentation, and character recognition are the three stages of the ANPR process (Sarbjit Kaur, 2016).

# 2.Problem statements

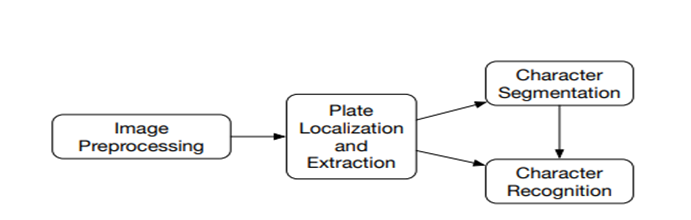
Automatic license plate recognition and identification is a topic in image processing and a vital method in most traffic-related technology. For license plate identification and recognition, a variety of methodologies, tactics, and algorithms have been developed. Researchers are interested in ANPR because of its unreliability, difficult conditions, and other issues. The number plate situation, non-standardized formats, complicated scenes, distinct colors, digital camera quality, camera mount position, tolerance to distortion, motion-blur, contrast problems, reflections, processing and memory limitations, environmental conditions, or other hardware-based constraints can all obstruct it. The image segmentation technique proposed in this paper is widely utilized in the field of ANPR and has shown to be effective.

# 3.Objectives

To extract data from an image that is represented in the form of data, image segmentation, function measurement, and object representation are all used. The success of feature extraction determines the purpose of image segmentation. Image segmentation is a computer-aided system component as well. There is also a trend for integrating several methods in the segmentation process to achieve outstanding outcomes. The paper is divided into six sections. Sections 3 and 4 present the problem description and recommended approach for number plate identification, respectively. Sections 5 and 6 and 7 contain experimental data, fundamental evaluation, conclusions, and future work, respectively.

# 4.Proposed System Model (Method)

The four aspects of the proposed ANPR system are depicted in Figure 1. Our system can employ edge detection, template matching, and mathematical morphology to extract the number plate from the input image. The open-source Tesseract OCR engine is required to recognize characters.



In addition to the Python programming language inherent to the Raspberry Pi environment, this system will use OpenCV, an Intel computer vision simulation for image pre-processing. OpenCV was created with a focus on resource efficiency, low power usage, and increased speed. When using an ensemble of distinct methodologies, there is a tendency for numerous optimization and decision-making strategies, therefore multiple validity assessments should be used (Chin-Wei & Rajeswari, 2010).

## 4.1. Algorithm of image preprocessing

Pre-processing has the primary purpose of enhancing the contrast of the input image, reducing image noise, and so speeding up processing while also improving the visibility and quality of the input image. The RGB image is first transformed to grey scale, then a bilateral iterative filter is used to remove noise from the gray scale image, and finally the filtered image is enhanced using the Adaptive Histogram Equalization (AHE) technique, as described in the suggested ANPR approach (Sarbjit Kaur, 2016). The CvtColor function in OpenCV is used to convert color images to grayscale, and the effect of this function is shown in(S Fakhar et al., 2019).

A red car on a road

Description automatically generated

A car driving on a road

Description automatically generated with medium confidence

## 4.2. Algorithm of licence plate location

The detection of edges is the first step in image segmentation (Farhad, 2017). It divides an image into two sections: the object and the background. Edge detection divides an image by analysing modifications in its intensity or pixels. For image segmentation, edge detection, the gray histogram and gradient are the two most regularly utilized algorithms (Yepez, 2018). Edge detection strategies are oftentimes used to extract number plates with the aid of identifying all the rectangles in the image data. A big colour transition between the vehicle body and the number plate is frequent. By finding the edges, side detection filters or algorithms are utilized to figure between the two. Vertical edge detection can be used to obtain vertical lines and horizontal component detection can be used to obtain horizontal lines, or the two can be combined to obtain a whole rectangular shape. Various edge detection filters for ANPR systems are compared, including Sobel, Canny, Gabor, and Log-Gabor filters.

An iterative bilateral filter is used in the proposed method, which decreases noise while preserving edges more effectively than the median filter. When compared to the median filter, the iterative bilateral filter provides significantly less blurring while smoothing an image. In comparison to the image reconstructed with the median filter, the image reconstructed with the iterative filter has a high PSNR and a low MSE value. As a result, the image rebuilt using a median filter had a higher fantastic than the image filtered with an iterative bilateral filter. The image filtered using an iterative bilateral filter is shown in Fig. (Sarbjit Kaur, 2016).

A picture containing graphical user interface

Description automatically generated

## 4.3. Number plate segmentation Method

The character segmentation stage determines whether or not a number plate can be extracted from an image or scene. The isolated number plate may have challenges including contrast issues, fluctuating lighting circumstances, or being orientated at different angles. In such circumstances, pre-processing processes such as de-skewing, de-blurring, or other approaches may be required before segmenting the characters, depending on the number plate's conditions. Depending on the approach used, this step is performed either during the extraction stage or after obtaining an isolated candidate area. The isolated number plate is mapped onto a straight rectangular form to deal with skewed number plate images (Lubna et al., 2021).

In (Busch, 1998), the binary image is scanned horizontally to identify the starting and terminating characters' locations.. The commencement point of the character is when the character-pixel-to-background-pixel ratio exceeds the threshold level after being below the threshold value. The commencement point of the character is when the character-pixel-to-background-pixel ratio exceeds the threshold level after being below the threshold value.

Many Image Processing capabilities in OpenCV are useful for recognizing edges, reducing noise, and creating threshold images, among other things. The Find Contours method returns all of the contours that it can find in the image. Contours are just a curve that links all of the continuous points of the same color or intensity (along the boundary). The contours are a useful tool for detecting and recognizing objects as well as analyzing forms.

Masking is an image processing technique that involves defining a small 'image component' and using it to change a larger image. Masking is used in several sorts of image processing, including edge detection, motion detection, and noise reduction.

Graphical user interface

Description automatically generated with medium confidence

A picture containing application

Description automatically generated

## 4.4. Number plate Recognition Method

The recognition of segmented characters is the final stage of ANPR systems. Due to zooming and camera distance, the segmented characters may vary in size and thickness. (Zhang, 2003).

### 4.4.1Template matching

The most basic method for character recognition is template matching. It's a cross correlation method that compares or measures the extracted character's similarity to a set of template characters. The character with the most similarities to one of the candidates in the template set is picked. These methods are frequently used for binary images since changes in lighting conditions rapidly impact the gray level intensities in the resulting image (Lubna et al., 2021). The character with the highest correlation value is the best match. Template Matching, on the other hand, can only recognize characters that are not broken, tilted, have no font changes, and have been adjusted to a constant size.(Pan, 2008).

### 4.4.2Character matching

Character Recognition uses an alternate way of feature extraction that decreases processing time and eliminates pixels that aren't as important (Pan, 2008). The alphanumeric characters on the observed plate are recognized using the Tesseract OCR engine. The Tesseract engine used was trained to improve the accuracy of the recognition process. The training included creating images of the characters to be identified, using appropriate fonts, and compiling a dictionary of possible character combinations found on a number plate, such as regional codes, suffixes, and registration numbers. The text displaying the vehicle number is the stage's output.



## 4.5. Render Result

A red car on a road

Description automatically generated with medium confidence

# 5.Experimental results

|  |  |  |
| --- | --- | --- |
| Image2 | Image3 | Image4 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| Image5 | Image6 | Image7 |
| A picture containing text, road, outdoor, car  Description automatically generated |  |  |
| A car parked on a street  Description automatically generated with low confidence |  |  |
| A picture containing diagram  Description automatically generated |  |  |
| Graphical user interface  Description automatically generated |  |  |
| Graphical user interface  Description automatically generated with low confidence |  |  |
| Text  Description automatically generated |  |  |
| A picture containing text, car, outdoor  Description automatically generated |  |  |

# 6.Critical Evaluation And analysis

This study provides a comprehensive review of ANPR algorithms that have been suggested and tested in recent relevant studies. We divided these algorithms into categories based on the features necessary for each stage of the recognition process. Each stage is described in depth for a performance summary, as well as any concerns or challenges that may arise. ANPR systems rely on complex optical, computational, and digitization capabilities, which might cause plate recognition to be delayed. The ANPR solutions on the market do not provide a standardized set for all countries; instead, each company must be provided with a well-optimized system for different parts/regions of the world, as a single system developed is insufficient and must be designed according to the region where it will be deployed, taking all influencing factors into account. OCR engines are often customized for specific countries. Each ANPR solution from a different manufacturer has its own set of pros and limitations. The one that satisfies the region's needs in terms of identified system-effecting conditions is the best.

# 7.Conclusion

Various image segmentation approaches have been covered in this article, and an overview of all related image segmentation techniques has been offered in this paper. This paper presents some recent research in image segmentation algorithms. Following an analysis of numerous image segmentation procedures, it was revealed that the most effective way to solve the problem of image segmentation is to use a hybrid solution that incorporates two or more techniques (Ferdowsi, 2019).

Artificial Neural Network-based recognition algorithms provide higher recognition rates. Future study is needed to emphasize the importance of this technology and strategies to integrate it with other ICT tools that can benefit the transportation system and policymaking. The accuracy of the existing CV algorithm is limited to specific locations and number plate standardization. More research is needed to make the algorithms smart enough to work in a range of situations with non-standardized, heterogeneous number-plate information.

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