AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM

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DECLARATION

We declare that

a. the work contained in this report is original and has been done by us under the guidance of our supervisor.
b. the work has not been submitted to any other institute for any degree or diploma.
c. we have followed the guidelines provided by the institute to prepare the report.
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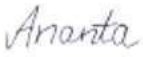
Signature of the student 
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CERTIFICATE

This is to certify that the project Report entitled, **"Automatic Number Plate Recognition System"**submitted by **Akarsh Tomar, Ananta** and **Geetika Titoria** in the Department of Information Technology of KIET Group of Institutions, Ghaziabad, affiliated to Dr.A. P. J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh, India, is a recordof bonafide project work carried out by them under my supervision and guidance and is worthy of consideration for the award of the degree of Bachelor of Technology in Information Technology of the Institute.

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Abstract

In order to manage vehicle data for a variety of uses as there are more cars on the road, automated solutions are needed.Automatic number plate recognition, or ANPR as it is more often known, is a developing field of study in smart cities and the Internet of Things.This research offers a trustworthy algorithm for reading Indian licence plates in environments with noise, bad illumination, cross-angles, and strange fonts. The proposed method uses many image processing methods for preparation, such as morphological transformation, Gaussian smoothing, Gaussian thresholding, and Sobel edge detection. The programme then segments the licence plate, uses contour following, geographic localization, character-based contour filters, and contour following.

state of the plates, non-standard formats, complex scenes, camera quality, camera mount position, tolerance for distortion, motion blur, contrast issues, reflections, processing and memory limitations, environmental factors, indoor/outdoor or day/night shots, as well as software tools or other hardware-based restrictions, can all affect how well number plate recognition systems perform.

The Tesseract Optical Character Recognition (OCR) engine is used to recognise the extracted characters, and the resulting texts are then stored in a database, sorted, and made searchable. The suggested method works well for typical use cases, but because it doesn't make use of advanced machine learning or deep learning techniques, it has some limitations.

CONTENTS

CHAPTER 1

Introduction

1.1 Identification of Need

This project offers a digital image processing-based prototype for recognising licence plates. The system comprises image collection, image pre-processing to enhance image quality, image segmentation to extract the number plate, and use of optical character recognition (OCR) to recognise and record the number plate number as text. According to the OCR principle and the Pytesseract and Tesseract engines, the plate number is shown as text on the terminal in the ANPR system shown in Figure 1[1]. The OCR engine makes use of Tesseract and Pytesseract technology to convert a picture to text. Law enforcement and authorities frequently struggle to apprehend vehicles that violate traffic laws on busy parking lot days or manually record vehicle numbers. By putting a device that scans the road for illegally driving cars, takes a photo of the licence plate, and stores the information in a database for the purpose of fining the owners, this process can be automated. Using a similar method, photos of vehicles in parking lots may be taken and their licence plate numbers can be automatically entered into a database.

A number plate detection method was developed by Heo [2] using a group of lines that came together to form a rectangle at the plate boundary. The second step, the vertical edge density approach, establishes the plate area. To locate the licence plate, Ozbay et al [3] created a smearing method. This technology greatly outperforms people on every busy day by eliminating the need for taxing physical activity, cutting labour costs, and increasing labour productivity. A vehicle's number can be displayed, stored in the database, or used to do a full database search once it has been converted to text. First, Faradji et al. used Sobel vertical edge detection on the picture [4]. An examination of vertical projection was then performed to pinpoint the plate region.

The use of automatic number plate recognition (ANPR) tools by law enforcement and governmental organisations is pervasive worldwide. With a projected CAGR of 9.74% from 2017 to 2023, the market for ANPR is expected to grow from its estimated value of USD 1.78 billion in 2016 to USD 3.57 billion by 2023. The prognosis period is from 2017 to 2023, and the study utilises 2016 as its base year[8]. The automatic number plate recognition industry is anticipated to grow rapidly in the future years. It is projected that factors including the expanding adoption of smart parking technology in developed and developing nations as well as the rise of infrastructure in emerging economies would fuel this trend.The development of a shared platform for the sharing of data from diverse sources, however, is one of the market's future trends for automatic number plate recognition throughout the course of the forecast period[9].Figure 2 shows the ANPR flowchart, which includes

character recognition, number plate extraction, pre-processing, and character segmentation.

1.2 Preliminary Investigation

Numerous security organisations and governmental organisations throughout the world have found success with automatic number plate recognition systems. With a CAGR of 9.74% from 2017 to 2023, the market for automatic number plate recognition (ANPR) systems is projected to increase from its 2016 valuation of USD 1.78 billion to USD 3.57 billion by 2023. The prognosis period is from 2017 to 2023, and the study utilises 2016 as its base year[8].Collecting secondary research information on top vendor revenue is the first phase in the research methodology used to evaluate and predict the market for ANPR systems. When segmenting the market, vendor offerings are taken into consideration. In this analysis, the market for ANPR systems is in-depth examined based on type, component, application, and geography. Following the calculation of the market's overall size, the market has been segmented into a variety of groups and subgroups, as seen in Figure 1. Through primary research, which entailed conducting in-depth interviews with people in high-ranking positions including CEOs (Chief Executive Officers), VPs (Vice Presidents), directors, and executives, these categories and subsegments have been verified. Market breakdown and data triangulation techniques were employed to complete the whole market engineering process and ascertain the precise statistics for all segments and subsegments. The distribution of the primary candidate profiles is shown in Figure 1.1:

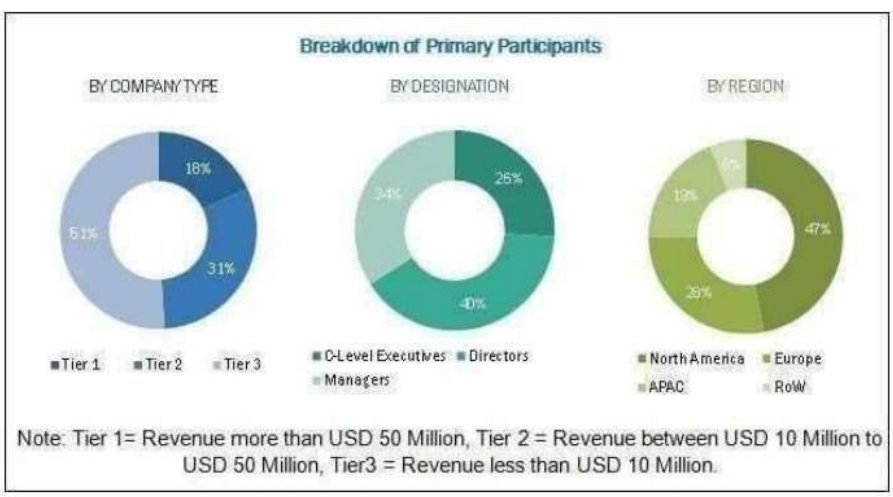


Figure 1.1. Breakdown of primary participants

The traffic management app had the largest market share in 2016. The demand for ANPR systems is developing in urban regions because of the severe traffic congestion, which is driving up the demand for ANPR systems for traffic control applications. According to Figure 1.2, between 2017 and 2023, the market for electronic toll collection applications is expected to grow at the quickest rate. Increased vehicle use and stringent government regulations for the adoption of electronic toll collection systems in various countries are driving the market for ANPR systems to grow.

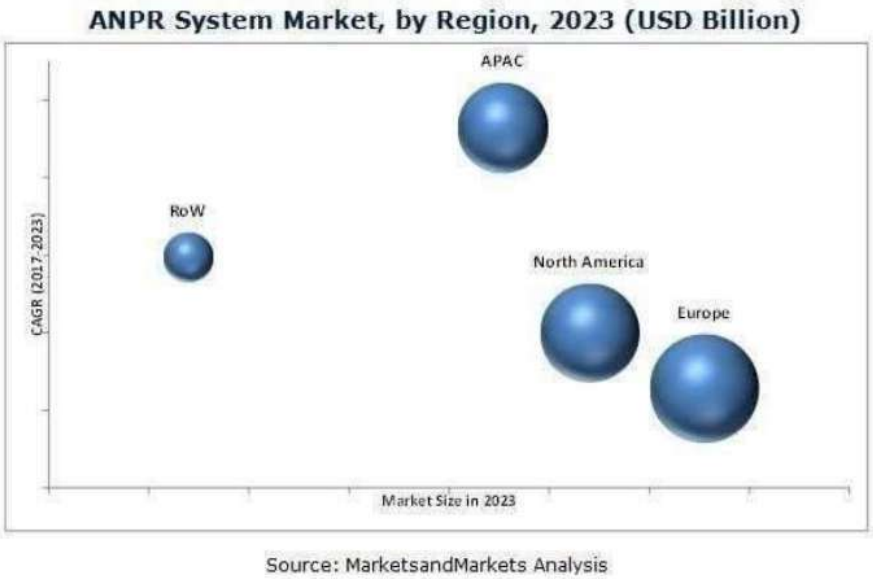


Figure 1.2. ANPR system market

In 2016, Europe accounted for the biggest market share for ANPR systems, and between 2017 and 2023, it is anticipated to expand at a moderate CAGR. During the projected period, the market in APAC (Asia-Pacific) is anticipated to develop at the fastest rate. Highway and public infrastructure expansion in APAC is anticipated to increase demand for ANPR systems. The market for ANPR is constrained by the inconsistency in number plate designs. Everywhere in the world, number plates have different sizes and typefaces, making it challenging to create an algorithm that could read all fonts consistently.

Globally, the market for automatic number plate recognition is predicted to grow rapidly in the near future. Some of the key factors fueling this expansion include the growing acceptance of the idea of smart parking in both developed and developing nations, as well as the expansion of infrastructure in emerging economies. However, some prospective trends of the automatic number plate recognition market during the projected period include the creation of a shared platform for the interchange of data from various sources and technological advancements[9].The notion of automatic number plate recognition emerged with a primary focus on vehicle surveillance. Crimes of many kinds occur in different parts of the world, and vehicular crimes have increased because it is so simple to flee in a car. Because it was now vital to stop these crimes, ANPR systems built into security systems have proven to be quite helpful.

1.3 Feasibility Study

It has undoubtedly been beneficial to understand the technical, operational, and financial viability of different software and hardware components as well as the overall project model. So in every aspect, this idea is feasible.

CHAPTER 2

Literature Review

2.1 Previous Work

Several enhancements in digital image processing have been implemented in a range of industries as a result of advancements in optical character recognition technology. In recent years, digital image processing has been used in a range of applications. In the 2000s, OCR was made available as a service (WebOCR), as well as in cloud computing settings and mobile applications such as real-time smartphone translation of foreign-language signs. The best use of this technology would be the development of a reading machine for the blind, which would allow blind people to have a computer read text to them aloud. A number of commercial and free source fonts are available for the majority of common writing systems, including Latin, Cyrillic, Arabic, Hebrew, Indic, Bengali (Bangla), and Devanagari, Tamil, Chinese, Japanese, and Korean characters.

The OCR engine used here is Tesseract OCR. Tesseract is an optical character recognition engine for several operating systems. It is free software that complies with the Apache Licence. Hewlett-Packard developed it as proprietary software in the 1980s, rendered it open source in 2005, and has been maintained by Google since 2006[10].

In 2006, Tesseract was rated as one of the most exact open-source OCR engines. Between 1985 and 1994, Hewlett Packard labs in Greeley, Colorado, and Bristol, England developed the Tesseract engine as private software. Additional enhancements were made in 1996 to allow the engine to be transferred to Windows, and additional C++ code was converted in 1998. The majority of the code was written in C, with a few sections in C++. Since then, all of the code has been updated to use a C++ compiler for compilation at the very least. Over the next ten years, very little progress was made. Later, in 2005, Hewlett Packard and the University of Nevada, Las Vegas (UNLV) declared it open source. Google has been a supporter of the Tesseract since 2006[11]. Tesseract was one of the top three OCR engines in 1995. It is available for Microsoft Windows, Linux, and Mac OS X. Due to limited resources, developers have only properly tested it on Windows and Ubuntu.

2.2 Existing System

In one of their articles, Anisha Goyal and Rekha Bhatia of the Department of CSE Punjabi University Regional Centre for Information Technology and Management in Mohali, Punjab, India, argued that all LPR systems up to this point have used neural networks. They suggested employing the Gabor filter, OCR, and Vision Assistant to develop the system faster and more effectively. Using diverse recognition algorithms, number plate recognition systems are now used in a variety of transportation and security applications, such as parking, access and border control, or the monitoring of stolen vehicles.

According to a different paper by Amr Badr, Mohamed M. Abdelwahab, Ahmed M. Thabet,

and Ahmed M. Abdelsadek, automatic recognition of car licence plate numbers has become crucial in our daily lives due to the unstoppable growth of vehicles and transportation systems, which makes it impossible for humans to fully manage and monitor them. Examples abound and include managing parking tolls, red-light infraction enforcement, border and customs enforcement, tracking stolen vehicles, and more. This work's main contribution is an Automatic Number Plate Recognition (ANPR) system that localises plates and segments characters using morphological operations, histogram manipulation, and edge detection algorithms. Artificial neural networks are used for character categorization and recognition [12].

In his third paper, Hamed Sanghaei makes a suggestion for an automated system for identifying number plates and number plates that can extract the number plate number of a passing vehicle using image processing techniques. The acquired data is compared to database records. According to experimental findings, the presented method correctly detects and recognises the car number plate on genuine pictures. This strategy can be used to manage traffic as well as security.

In addition to eliminating the aforementioned issue, our suggested method also provides the following unique benefits:

1. An automated structure that saves labour.
2. A number is shown and, after some modification, can be managed, searched, or stored in a database.
3. Extremely economical.

CHAPTER 3

Dataset of Images

Image 1:

Figure 3.1. Test data Car_1

Image 2:

Figure 3.2. Test data Car_2

Image 3:

Figure 3.3. Test data Car_3

Image 4:

Figure 3.4. Test data Car_4

Image 5:

Figure 3.5. Test data Car_5

Image 6:

Figure 3.6. Test data Car_6

Image 7:

Figure 3.7. Test data Car_7

Image 8:

Figure 3.8. Test data Car_8

Image 9:

Figure 3.9. Test Data Car_9

Image 10:

Figure 3.10. Test Data Car_!0

Image 11:

Figure 3.11. Test Data Car_11

CHAPTER 4

Proposed Methodology

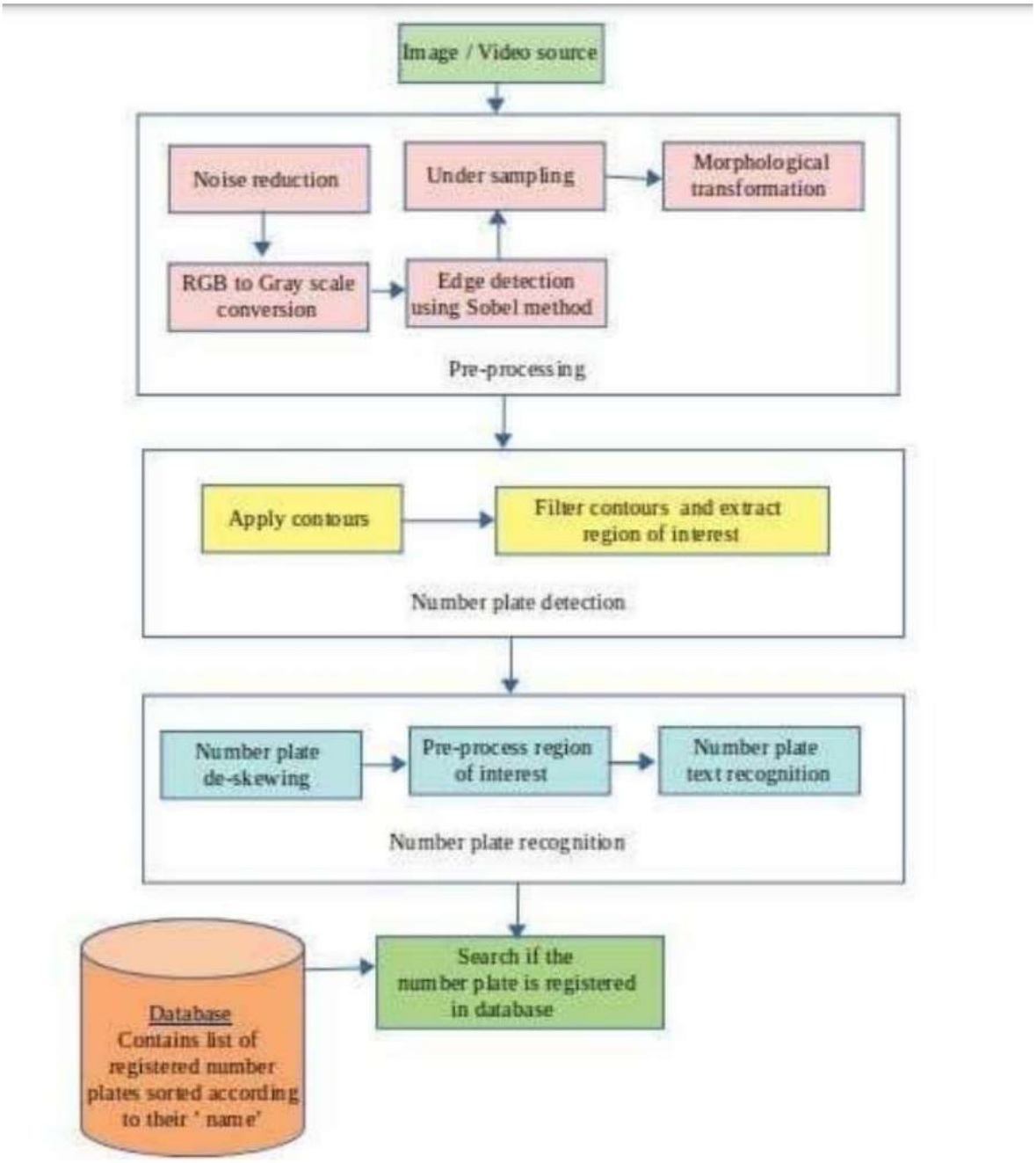


Figure 4.1. Methodology Flowchart

4.1 Pre-processing of Images

Although geometric transformations of images (such as rotation, scaling, and translation) are classified here as pre-processing methods because similar techniques are employed, the goal of preprocessing is an improvement of the image data that suppresses unintentional distortions or enhances some image features necessary for further processing.

4.1.1 Noise reduction

Smoothing and Gaussian filtering are used to reduce noise and detail. The later steps of picture processing will benefit from this. A gaussian filter for an image can be expressed mathematically as indicated in Eq(1).

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{-(x^2+y^2)}{2\sigma^2}} \quad (1)$$

The input image is made to convolve with this 2-D 'G' matrix in order to produce a smoothed image.

To apply Gaussian smoothing in OpenCV, use the following function:

$cv2.GaussianBlur(image, (5,5), 0)$

where (5,5) refers to the filter size and '0' indicates the model to find the value of standard deviation (sigma) itself.

4.1.2 RGB to Grayscale conversion

Since we only need to perform convolution of the image with sobel filter over a single 2D matrix rather than a complicated RGB image with three channels, converting RGB images to grayscale saves a significant amount of time. Another reason is that when doing image edge detection, our attention is drawn to the shift in intensity, which is simpler to examine in a grayscale image.

4.1.3 Edge detection using sobel method

This method used by Sobel edge detection is to compute the gradient of picture intensity at each pixel inside the image. It specifies the direction and rate of change, as well as the highest rise in darkness from light. The Sobel edge detection method uses the equations Eq(2) and Eq(3).

Run filter over image

$$\frac{\partial f}{\partial x} = S_x \otimes f \qquad \frac{\partial f}{\partial y} = S_y \otimes f \tag{2}$$

Image gradient

$$\nabla f = \left[\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right] \tag{3}$$

In OpenCV, cv2.Sobel(img2,cv2.CV_8U,1,0,ksize=3) is used to perform edge detection using kernelsize of 3.

4.1.4 Under-sampling

A preset frame rate is included into the algorithm for number plate recognition and identification. It is not surprising that image processing algorithms take longer to process high-resolution photos. In reality, it is unnecessary to contemplate photographs of such high quality. If it increases beyond a predetermined limit, the resolution is reduced in this stage.

4.1.5 Morphological transformation

Examples of morphological adjustments are Top-hat and Black-hat filters. The black-hat operation, often referred to as bottom-hat, is used to emphasise dark objects of importance in a relatively bright background. The top-hat operation is used to stress brilliant things of interest in a relatively dark background. Figure 4 shows the initial image after top-hat results have been added to it and after black-hat results have been subtracted from it. Figure 4.2 depicts the many stages of morphological change.

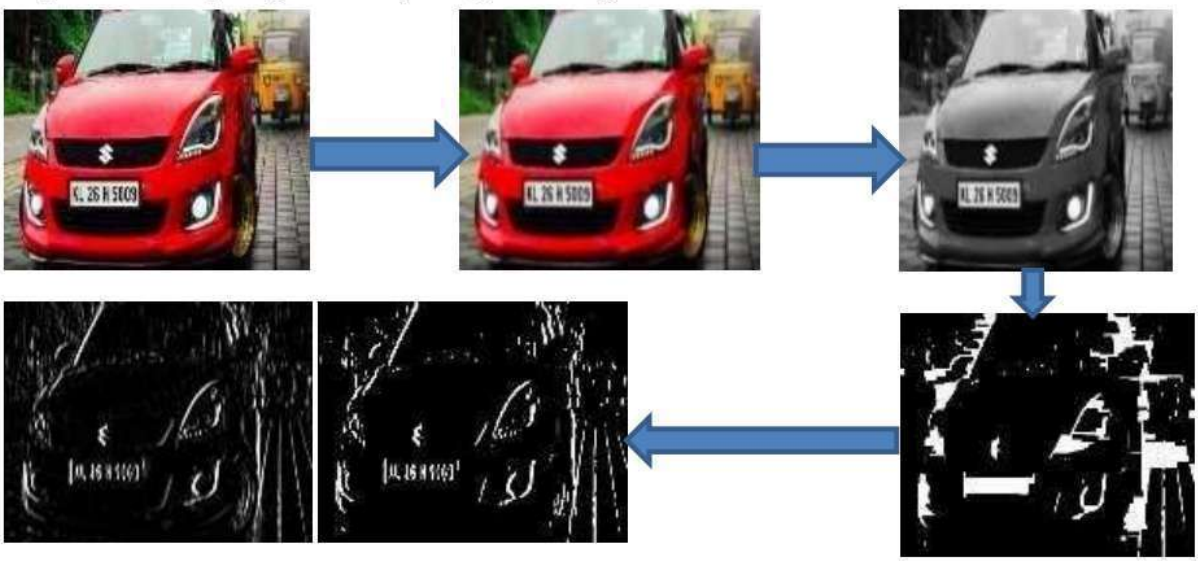


Figure 4.2. Morphological Transformation

4.2 Number plate detection

The ANPR technology is therefore capable of recognising licence plates. Tesseract OCR or MaskOCR algorithms are used in image processing techniques to recognise individual characters, verify their order, and convert the number plate image into text.

4.2.1 Apply Counters

The algorithm used to construct contours is known as border following, sometimes known as contour tracing.
The boundary is defined by a contour, which is a collection of points with equal intensities. Because contour identification in OpenCV is similar to finding a white object on a dark backdrop, inversion operation must be used during the adaptive gaussian thresholding stage.

4.2.2 Filter the contours and the precise region of interest.

Contours are employed for narrow areas, such as cutting edges and noise outliers. Although a programme must take this into consideration, the human eye can immediately perceive that such contours are superfluous. Each contour was initially given bounding boxes. Next, for each contour, the minimum and maximum possible aspect ratios as well as the minimum and maximum contour area and width and height were considered.As a result, the vast majority of unnecessary contours were filtered out, which helped us get closer to realising our objective—the detection of the number plate as shown in Figure 4.3.

Figure 4.3. Extracted Number Plate

4.3 Number Plate Recognition

The next phase of the process is required for number plate detection in an ANPR system.

4.3.1 Number plate de-skewing

Skew is the amount of rotation needed to align an image both horizontally and vertically. Skew is measured in terms of degrees. Skew is removed during the de-skewing process by rotating an image by the same amount as its skew but in the opposite direction.
As a result, rather from being tilted, the text runs straight across the page, resulting in a picture that is aligned both horizontally and vertically. In this stage of our project, ratio_and_rotation() is used.

4.3.2 Pre-process region of interest

It is feasible for two or more contours to entirely overlap one another if they are discovered while contouring. This conduct can cause both contours to be recognised throughout the recognition process as different characters. Before starting the recognition procedure, we additionally resize the image if necessary.

4.3.3 Number plate text recognition

An optical character recognition (OCR) tool for Python is called Python-tesseract. In other words, it will identify and "read" any text that is contained in photos. Finally, we used this tool to extract the text from the filtered, de-skew contour as shown in Figure 4.4.

Figure 4.4 Plate Recognition

4.4 Searching unknown image

Finding a specific element within a group of components is the definition of searching. If an element is present in the collection or not is determined by the search result. If it is, we may also determine where that element is in the specified collection if it is present. A key method in computer science is searching.

4.4.1 Create database

After deleting any other special characters, use Steps 1, 2, and 3 to register each car in the dataset and save them in a database.

4.4.2 Sorting

We are sorting the identified texts in order to improve the efficiency of the search process. A rapid sort algorithm is used to do this. Divide and conquer is an algorithm used in quick sort. It sorts in-place and is not stable. The Quicksort Efficient Flowchart is displayed in Figure 4.5.

Quick sort:

Flowchart:

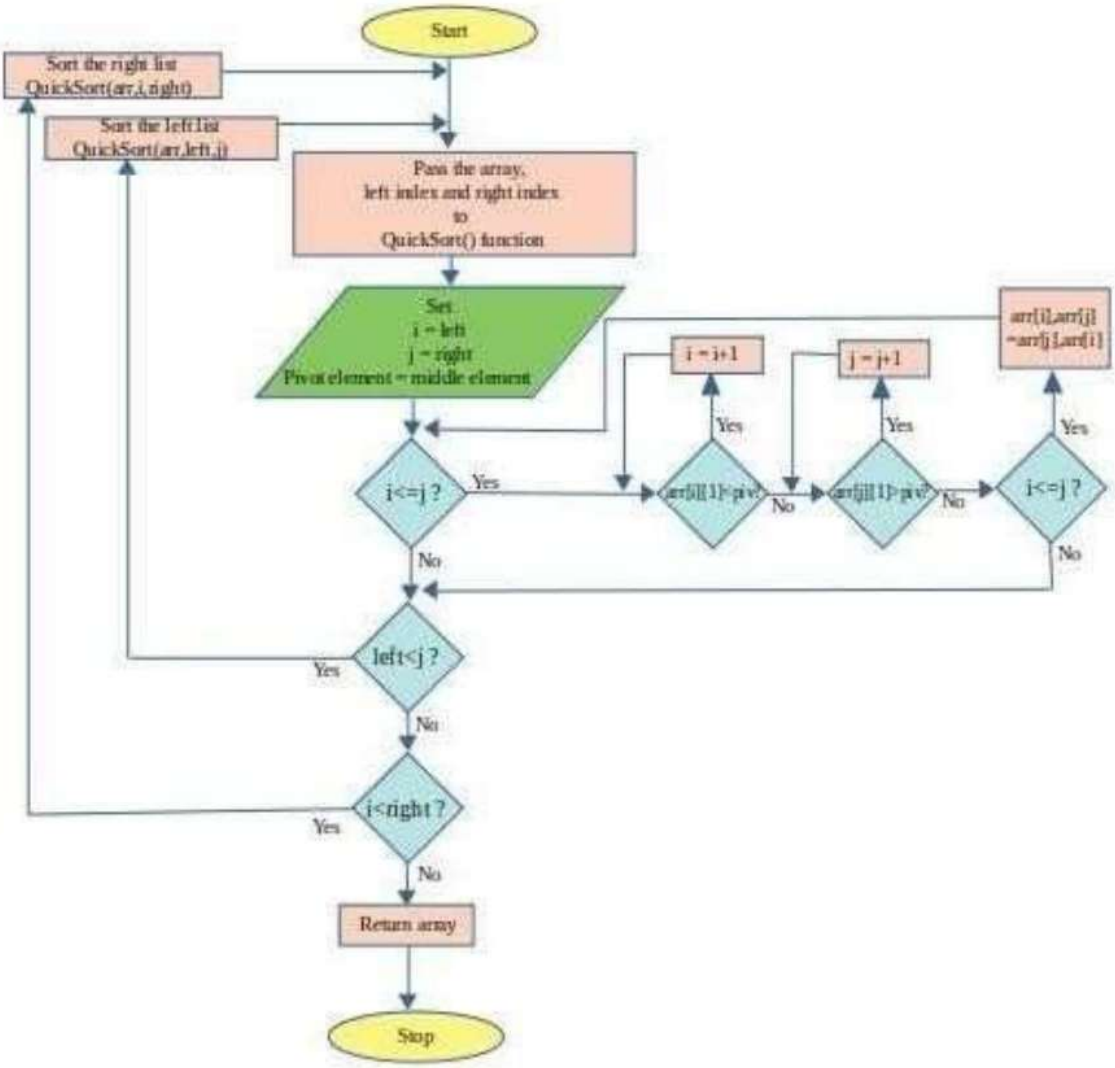


Figure 4.5. Quicksort flowchart

Time complexity:

Best case: O(n log(n))

Average case: O(nlog(n))

Worst case: $O(n^2)$

Space complexity:

Best case: O(log(n))

Worst case: O(n)

4.4.3 Searching

Follow steps 1, 2, and 3 for a fresh image. Obtain the new vehicle's registration number, then use the binary search method to see if it is already present in the database. A sorted array or list is subjected to a straightforward divide and conquer method known as binary search. When there are more photos in the collection, it performs better than linear search. The Searching Flowchart is displayed in Figure 4.6 below.

Binary search:

Flowchart:

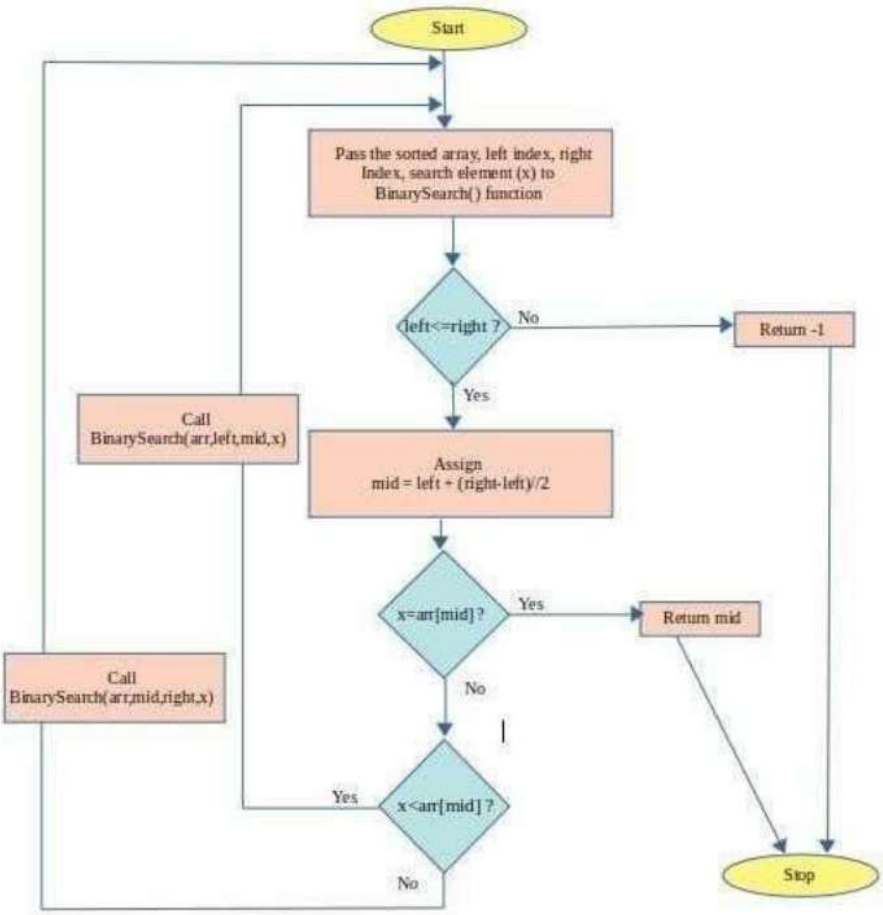


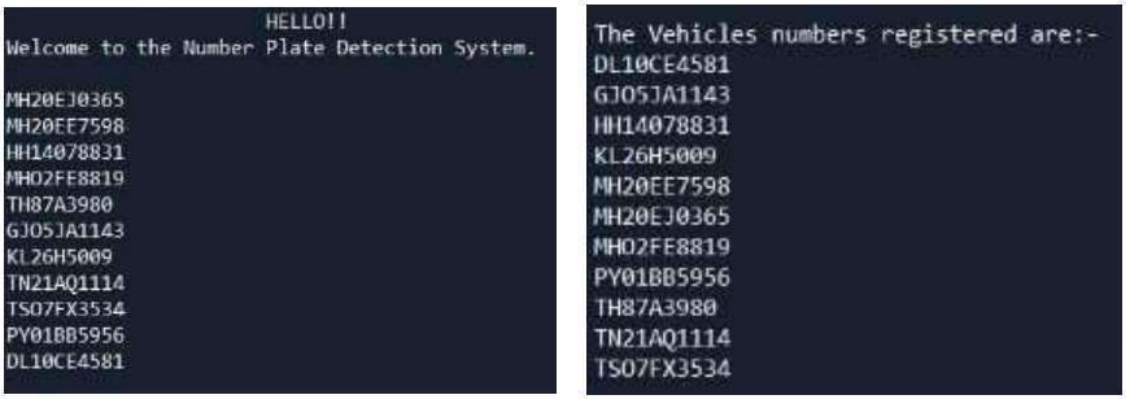
Figure 4.6.Searching Flowchart

Time complexity:

It takes O(log(n)) time complexity, which when compared with linear search is much better, especially when the array size gets larger.

Space complexity:

O(1)



a) b)

Figure 4.7 Number Plates Output which contain Figure a): Number Plates and Figure b): Sorted Number Plate

CHAPTER 5

Result and Discussion

5.1 Result

This effort completes four essential responsibilities. The first duty, which is to input an image of the car, will be aided by the webcam on the prototype computer. Whenever the image is fed, the quality improves. Improvements are made to the thresholding and resolution. The image is forced into a predetermined image frame size. After augmentation, the image is processed using the mathematical model of the rectangle to isolate the number plate from the background.

The goal of the project is to better understand the technology that powers optical character recognition (OCR) systems and automatic licence plate readers (ALPRs), which are currently used in the majority of industrialised countries, including Singapore, Germany, France, and Japan. This project has some limitations because we didn't use advanced machine learning and deep learning algorithms, but it will work well when used in housing societies, apartments, or other institutions to let residents' vehicles inside. Almost all of the challenges we faced while solving the problem have also been successfully resolved. The test situations for automatic licence plate recognition displayed below in Figure 5.1


```
The car number to search is:-  MH20EJ0365

The Vehicle is allowed to visit.
```

a)

```
The car number to search is:-  TN21AQ1114

The Vehicle is  not allowed to visit.
```

b)

Figure 5.1. Test Cases which contain Figure a) Case 1 and Figure b) Case 2

5.2 Discussion

Some ANPR systems may use simple image processing techniques to identify popular licence plate designs. Specialised object detectors, such HOG, CNN, SVM, and YOLO to name a few, are used by advanced ANPR systems. Identifying number plates is made more difficult by the requirement that any ANPR system operate in real time. Because of this, ML, CV, and AI techniques can successfully enhance ANPR. The proposed approach has some limitations because we didn't use highly developed machine learning and deep learning algorithms, but it will function well if applied to housing societies, apartments, or other institutions to allow residents' vehicles inside, and nearly all of the challenges we faced while solving the issue have been successfully resolved. There are many businesses that provide ANPR solutions, but not all of them provide the same services or are as user-friendly as the others. In order to obtain the required level of recognition accuracy and avoid unwanted consequences like inaccurate number plate identification or no recognition at all due to the complexity of the scene or the deployment of ineffective algorithms, the appropriate software must be employed. In order to choose the most effective ANPR system, one needs evaluate software providers based on the aspects of cost, working environment, vendor assistance for developers, free trials, and data accuracy testing.

CHAPTER 6

Conclusion and Future Scope

6.1 Conclusion

There are four main purposes for this project. For the prototype, the webcam on the computer will be utilised for the first task, which is to input an image of the car. As it is fed, the image's quality gets better. Improvements have been made to the thresholding and resolution. The picture has to fit in a certain size image frame. After improvement, the number plate is extracted from the background using the mathematical model of the rectangle. In a new window, the segmented plate with all of the characters is shown in binary format.

All the characters in the enhanced segmented plate are separated into text after being processed for optical character recognition (OCR), which can then be saved in a database or displayed as in this prototype. The initiative is designed to help us understand contemporary technologies. The vast majority of developed countries, including Germany, France, Singapore, Japan, etc., use automatic licence plate readers and optical character recognition (OCR) systems. This project has some limitations because we didn't use advanced machine learning and deep learning algorithms, but it will work well if implemented in housing societies, apartments, or other institutions to allow residents' vehicles inside. In addition, nearly all the issues we ran into while solving the problem have now been substantially resolved.

6.2 Future Scope

The created method would focus on improving the precision of text localization and graphics removal in caption text images as future development. It can be assessed using a variety of different classifiers and other picture data bases that are readily available. The suggested approaches can be improved upon and used for automatic mixed mail sorting.

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Annexure 1

Outcome

By putting a device that searches for vehicles breaking the law, takes a photo of the number plate, and stores the number in a database for the purpose of fining the owners, this process can be automated. Our study report includes a prototype for digital image processing-based licence plate recognition. The method needs taking pictures, pre-processing the pictures to improve image quality, segmenting the pictures to get rid of the number plate, and then utilising optical character recognition (OCR) to read and save the number plate number as text. Figure depicts an ANPR system that displays the licence plate number as text on the terminal using the OCR concept, Pytesseract, and Tesseract engines. When converting an image to text, the OCR engine employs pytesseract and tesseract technology. On busy days in parking lots, law enforcement and authorities frequently struggle to stop vehicles that break the law or manually record vehicle numbers. Similar techniques can be used to picture cars in parking lots and automatically enter their licence plate numbers into databases. Heo created a method for detecting licence plates that made use of a collection of lines that joined to form a rectangle at the plate boundary. The vertical edge density technique, which establishes the plate area, is the next phase. A smearing method was developed by Ozbay and colleagues to find the licence plate. Since it eliminates the need for physically strenuous work and reduces labour expenses, technology is far more efficient than people on a busy day. Following that, the text equivalent of a vehicle's number can be read aloud, saved in the database, or used to do a comprehensive database search.

Around the world, law enforcement and governmental entities frequently employ ANPR technologies to identify licence plates. The market for ANPR is anticipated to increase from an estimated value of USD 1.78 billion in 2016 to USD 3.57 billion by 2023, with a predicted CAGR of 9.74% from 2017 to 2023. The analysis uses 2016 as its base year and makes projections for the years 2017 through 2023. It is projected that the automatic number plate recognition market would expand quickly in the next years. The rising use of smart parking technology in both developed and developing countries, as well as the development of infrastructure in emerging economies, are predicted to fuel this trend.

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Automatic Number Plate Recognition System

Abstract
The increase in the number of vehicles necessitates au- tomated systems to manage vehicle information for various purposes.Automatic Number Plate Recognition (ANPR), also known as License Plate Recognition, is an emerging field of research in smart cities and the Internet of Things.This study proposes an effective algorithm for recognizing Indian vehicle number plates, even in noisy, low-light, cross-angled, and non-standard font environments. The proposed method utilises a combination of image processing techniques, such as morpho- logical transformation, Gaussian smoothing, Gaussian thresh- olding, and Sobel edge detection, in the preprocessing stage. The algorithm then segments the number plate, applies contour following, and filters contours based on character dimensions and spatial localization.
The performance of number plate recognition systems can be affected by several factors such as the condition of the plates, non-standardized formats, complex scenes, camera qual- ity, camera mount position, tolerance to distortion, motion-blur, contrast problems, reflections, processing and memory limita- tions, environmental conditions, indoor/outdoor or day/night shots, as well as software tools or other hardware-based con-straints. The Tesseract Optical Character Recognition (OCR) engine is employed to identify the extracted characters, and the resulting texts are stored in a database, sorted, and made avail- able for searching. However, the proposed approach has its lim- itations, as it does not employ advanced machine learning or deep learning algorithms, but it performs efficiently for typical use cases.

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Automatic Number Plate Recognition System

Akarsh Tomar, Ananta, Geetika Titoria

*KIET Group of Institutions, , , ,

1. Abstract

With the increasing number of vehicles on the roads, automated systems are necessary to manage vehicle data for various purposes. One emerging area of research in smart cities and the Internet of Things is automatic number plate recognition (ANPR), commonly known as number plate recognition. This study proposes a robust algorithm for reading Indian license plates in challenging conditions such as noise, poor lighting, angled views, and non-standard fonts.

The suggested method involves several image processing techniques in the preparation phase, including morphological transformations, Gaussian smoothing, Gaussian thresholding, and Sobel edge detection. The program then segments the license plate, applies contour following, incorporates geographical localization, and utilizes character-based contour filters.

Several factors can affect the performance of number plate recognition systems, including the condition of the license plates, non-standard formats, complex scenes, camera quality, camera mounting position, tolerance to distortion, motion blur, contrast issues, reflections, processing and memory limitations, environmental conditions, indoor/outdoor or day/night shots, as well as software tools or hardware constraints.

The extracted characters are recognized using the Tesseract Optical Character Recognition (OCR) engine, and the resulting texts are stored in a database, sorted, and made searchable. While the proposed method performs well for common use cases, it has certain limitations as it does not employ advanced machine learning or deep learning techniques.

Keywords: Automatic Number Plate Recognition , Image Processing ,Optical Character Recognition (OCR) ,Edge Detection , Number Plate , Motion Blur ,Image Segmentation

2. Introduction

This research provides a prototype for licence plate recognition based on Digital Image Processing. The system entails the collecting of images, The images undergo pre-processing to enhance their quality, followed by segmentation to extract the number plate. Optical character recognition (OCR) is then applied to identify and save the number plate number as text. Figure 1 illustrates an ANPR system where the OCR principle, along with the pytesseract and Tesseract engines, is utilized to present the plate number as text on the terminal[1].To turn an image into text, the OCR engine employs pytesseract and Tesseract technology. On crowded days in parking lots, law enforcement and authorities frequently confront difficulties catching automobiles that break traffic regulations or manually documenting vehicle numbers.This procedure can be automated by installing a device that looks for vehicles that are breaching the law, snaps a photo of the number plate, and saves the number in a database for the purpose of fining the owners. A similar technique can be used in parking lots to take pictures of cars and automatically register their licence plate numbers in the database Heo [2] used a collection of lines that formed a rectangle at the plate boundary to create a number plate detecting method. The vertical edge density method is the next stage, which determines the plate area. A smearing algorithm was developed by Ozbay et al [3] to find the licence plate. This technology eliminates the requirement for laborious manual work, reduces labor costs, and proves to be significantly more efficient than human efforts, particularly during busy days. Once the vehicle's number is extracted as text, it can be displayed, stored in a database, or used for searching the entire database to retrieve relevant information. The image was initially subjected to Sobel vertical edge detection by Faradji et al [4]. Next, the plate area was located using a vertical projection analysis.

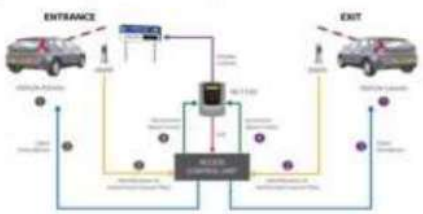

Figure 1: Introduction to ANPR

The use of automated number plate recognition (ANPR) devices by security forces and governmental bodies is widespread around the world. The market for ANPR was estimated to be worth USD 1.78 billion in 2016 and is anticipated to increase to USD 3.57 billion by 2023, with a predicted CAGR of 9.74% from 2017 to 2023. The study uses 2016 as its base year, and the prediction period is from 2017 through 2023[8]. In the upcoming years, it is projected that the global market for automatic number plate recognition would expand significantly. This growth is anticipated to be fueled by elements like the rising use of smart parking technologies in both developed and developing countries and the development of infrastructure in emerging economies. However, among the future trends of the automatic number plate recognition market during the forecast period[9] are the creation of a shared platform for the exchange of data from various sources. The ANPR flowchart is depicted in Figure 2 and includes pre-processing, number plate extraction, character recognition, and character segmentation.

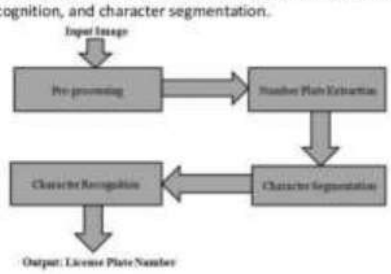

Figure 2: Process for ANPR

3. Existing System

Optical Character Recognition (OCR) technology is one of the important developments in digital image processing that has been widely adopted in a variety of areas. Various techniques have been established as a result of recent advancements in digital image processing. OCR was first made available as a service online in the 2000s, and it is currently used in cloud computing settings and mobile applications, such as cellphones that can translate signs in real-time into different languages. The creation of a reading machine for those who are blind is one of the most advantageous uses of OCR technology. With the use of this technology, a computer can read material aloud to the blind. There are a number of commercial and open-source OCR programmes that can read the most popular writing systems, including Latin, Cyrillic, Arabic, Hebrew, Indic, Bengali (Bangla), Devanagari, Tamil, Chinese, Japanese, and Korean characters. In this instance, Tesseract OCR is the name of the optical character recognition (OCR) engine used. The OCR engine is free and open-source, and it can work with several operating systems. Tesseract OCR is offered without charge and is made available under the Apache Licence. It was initially created by Hewlett-Packard as proprietary software in the 1980s. It was made available as open source in 2005, and Google has been funding its development since 2006[10]. continual intervention of people. hefty price, More workers are needed.

4. Proposed System

The proposed approach resolves the aforementioned drawbacks and offers the following advantages in addition to them: automated framework needing less labour. A number is shown and, with some adjustment, can be stored in a database, searched, or processed. The featured licence plate is automatically cropped and shown individually. The system can extract the licence plate from the input image using either Edgedetection or Template matching together, and Tesseract OCR does the character recognition. Methodology Figure 3 depicts a flowchart with several ANPR system components.

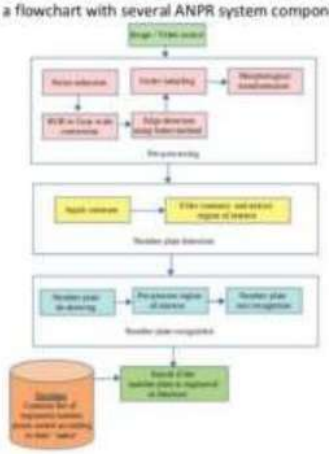

Figure 3: Flowchart for the methodology

4.1. Image pre-processing

Geometric transformations, including rotation, scaling, and translation, are considered preprocessing methods in this context due to their similarity in techniques employed. However, the primary objective of preprocessing is to enhance the image data by suppressing unintended distortions and highlighting important image features that are essential for subsequent processing.

4.1.1. Noise reduction

To lessen noise and detail, Gaussian filtering and smoothing are used. This will be useful for later stages of picture

processing. Mathematically, a gaussian filter for an image can be written as:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

To generate a smoothed image, the input image undergoes convolution with a 2-D matrix represented as 'G'. The following function in OpenCV can be used to implement Gaussian smoothing: where

'0' denotes a model to determine the standard deviation (sigma) value itself and (5,5) denotes the filter size.

4.1.2. Grayscale conversion from RGB

Since we only need to perform convolution of the image with sobel filter over a single 2D matrix rather than a complicated RGB image with three channels, converting RGB images to grayscale saves a significant amount of time. Another reason is that when doing image edge detection, our attention is drawn to the shift in intensity, which is simpler to examine in a grayscale image.

4.1.3. Edge detection using the Sobel method

Top-hat results to the original image and the subtraction of Black-hat results from it Sobel edge detection operates by computing the intensity gradient at each pixel within the image. This process determines the direction and magnitude of the steepest change from light to darkness. When performing edge detection using the Sobel method, the equations Eq(2) and Eq(3) are used:

$$\frac{\partial f}{\partial x} = S_x * f \qquad \frac{\partial f}{\partial y} = S_y * f$$

$$\nabla f = \begin{bmatrix} \frac{\partial f}{\partial x} & \frac{\partial f}{\partial y} \end{bmatrix}$$

4.1.4. Under-sampling

The contour tracing algorithm, also referred to as border following, is employed to generate contours. A contour represents a sequence of points with equal intensity, defining the boundary. In OpenCV, contour detection is similar to identifying a white object against a black background. Consequently, during the adaptive Gaussian thresholding stage, an inversion operation is necessary.

4.1.5. The Morphological transformation

Morphological transformations involve the application of filters such as Top-hat and Black-hat filters. The Black-hat operation, also known as bottom-hat, is utilized to enhance dark objects of interest against a relatively bright background. On the other hand, the Top-hat operation is employed to highlight bright objects of interest against a relatively dark background. Figure 4 demonstrates the addition of Top-hat results to the original image and the subtraction of Black-hat results from it.

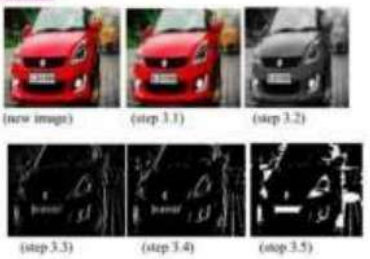

Figure 4: Transformation of Morphology

4.2. Detection of licence plate numbers

Consequently, the ANPR system can recognize license plates, enabling the identification of individual characters and the confirmation of their order. To achieve this, image processing methods such as Tesseract OCR or MaskOCR algorithms are utilized to convert the number plate image into text.

4.2.1. Apply Counters

The algorithm used to produce contours is known as contour tracing, or border following. The boundary is defined by a contour, which is a series of equal-intensity points. In OpenCV, locating contours is analogous to locating a white object against a black background; as a result, inversion operation must be used during the adaptive gaussian thresholding stage.

4.2.2. Filter the contours and extract the region of interest

Contours are utilized to identify small regions, specifically for sharp edges and noisy outliers. While these contours may appear unnecessary to the human eye, it is crucial for a program to consider them. To address this, bounding boxes were initially applied to each contour. Subsequently, minimum criteria such as contour area, width, height, and allowable aspect ratios were applied to filter out unnecessary contours. This filtering process brings us closer to our objective of accurately detecting the number plate.

4.3. Number Plate Recognition

In ANPR system, The number plate detection involves the following step of process.

4.3.1. Number plate de-skewing

Skew refers to the degree of rotation needed to align an image horizontally and vertically. During the deskewing process, the image is rotated by the same degree but in the opposite direction to eliminate the skew. This ensures that the text appears straight across the page rather than at an angle, resulting in a horizontally and vertically aligned image. In our project, the ratio and rotation() functions are utilized to perform this deskewing phase.

4.3.2. Preprocess region of interest

During the contouring process, it is possible for two or more contours to completely overlap each other. This situation can lead to the recognition process treating both contours as separate characters. Additionally, prior to the recognition process, we may resize the image if required.

4.3. Number plate text recognition

An optical character recognition (OCR) tool for Python is called Python-tesseract. In other words, it will identify and "read" any text that is contained in photos. Finally, we used this tool to extract the text from the filtered, de-skew contour.

4.4. Searching unknown image

Finding a specific element within a group of components is the definition of searching. If an element is present in the collection or not is determined by the search result. If it is, we may also determine where that element is in the specified collection if it is present. A key method in computer science is searching.

4.4.1. Create database

After deleting any other special characters, use Steps 1, 2, and 3 to register each car in the dataset and save them in a database.

4.4.2. Sorting

To enhance the search process efficiency, we are organizing the identified texts in a sorted manner.A rapid sort algorithm is used to do this. Divide and conquer is an algorithm used in quick sort. It sorts in-place and is not stable. The Quicksort Efficient Flowchart is displayed in Figure 5.

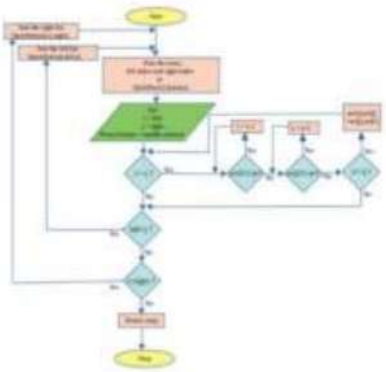

Figure 5: Flowchart for Quicksort

4.4.3. Searching

Follow steps 1, 2, and 3 for a fresh image. Obtain the new vehicle's registration number, then use the binary search method to see if it is already present in the database. A sorted array or list is subjected to a straightforward divide and conquer method known as binary search. When there are more photos in the collection, it performs better than linear search. The Searching Flowchart is displayed in Figure 6 below.

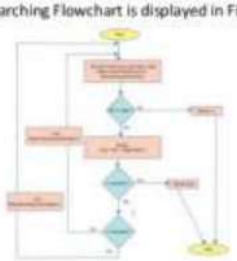

Figure 6: Flowchart for Searching

5. Discussion

Certain ANPR systems utilize simple image processing algorithms to recognize standard license plate designs. However, advanced ANPR systems utilize specialized object detectors, including HOG, CNN, SVM, YOLO, and others, to improve recognition accuracy.The need for any ANPR system to operate in real time makes identifying number plates even more challenging. As a result, ML, CV, and AI approaches can effectively empower ANPR. The proposed methodology has some limitations because we didn't use sophisticated machine learning and deep learning algorithms, but it will work

effectively if implemented in housing societies, apartments, or other institutions to allow residents' vehicles inside, and almost all of the difficulties we encountered while solving the problem have been effectively overcome.There are a lot of companies offering ANPR solutions, but not all of them offer the same services or are equally user-friendly. The suitable software must be used in order to achieve the needed level of recognition accuracy and prevent undesirable outcomes like inaccurate number plate identification or no recognition at all because of the complexity of the scene or the usage of inefficient algorithms. One must assess software suppliers based on the factors of pricing, working environment, vendor support for developers, free trials, and data accuracy testing in order to select the better performing ANPR system.

6. Conclusion

6.1. *Result*

Four key tasks are accomplished by this initiative. The prototype computer's webcam will be used to assist in the first task, which is to input an image of the car.An improvement in quality occurs when the image is fed. In the resolution and thresholding, improvements are made. An established image frame size is imposed on the image. After augmentation, the image is processed in a way that separates the number plate from the entire scene using the rectangle's mathematical model. All of the characters in binary form are displayed on the segmented plate in a separate window.

Figure 7: Output

The objective of this research is to enhance our understanding of the technology employed in automatic license plate readers (ALPR) and optical character recognition (OCR) systems, which are widely used in most industrialized countries., including Singapore, Germany, France, and Japan. This project has some limitations because we didn't use sophisticated machine learning and deep learning algorithms, but it will function effectively if used in housing societies, apartments, or other institutions to allow residents' vehicles inside, and almost all of the difficulties we encountered while solving the problem have been effectively overcome. The Automatic Number Plate Recognition Market Forecasted Value 2032 is shown in Figures 8 and 9.

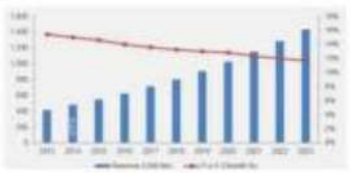

Figure 8: Car Plate Recognition Chart

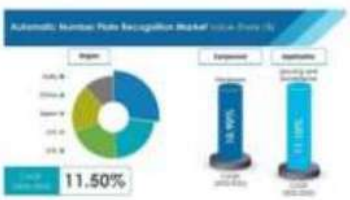

Figure 9: Forecast for the Automatic Number Plate Recognition Market through 2032

6.2. *Future Work*

The created method would focus on improving the precision of text localization and graphics removal in caption text images as future development. It can be assessed using a variety of different classifiers and other picture data bases that are readily available. The suggested techniques can be improved upon and used for automatic mixed mail sorting.

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Annexure 2

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Automatic Number Plate Recognition System

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1. Abstract

With the increasing number of vehicles on the roads, automated systems are necessary to manage vehicle data for various purposes. One emerging area of research in smart cities and the Internet of Things is automatic number plate recognition (ANPR), commonly known as number plate recognition. This study proposes a robust algorithm for reading Indian license plates in challenging conditions such as noise, poor lighting, angled views, and non-standard fonts.

The suggested method involves several image processing techniques in the preparation phase, including morphological transformations, Gaussian smoothing, Gaussian thresholding, and Sobel edge detection. The program then segments the license plate, applies contour following, incorporates geographical localization, and utilizes character-based contour filters.

Several factors can affect the performance of number plate recognition systems, including the condition of the license plates, non-standard formats, complex scenes, camera quality, camera mounting position, tolerance to distortion, motion blur, contrast issues, reflections, processing and memory limitations, environmental conditions, indoor/outdoor or day/night shots, as well as software tools or hardware constraints.

The extracted characters are recognized using the Tesseract Optical Character Recognition (OCR) engine, and the resulting texts are stored in a database, sorted, and made searchable. While the proposed method performs well for common use cases, it has certain limitations as it does not employ advanced machine learning or deep learning techniques.

Keywords: Automatic Number Plate Recognition , Image Processing ,Optical Character Recognition (OCR) ,Edge Detection , Number Plate , Motion Blur ,Image Segmentation

2. Introduction

This research provides a prototype for licence plate recognition based on Digital Image Processing. The system entails the collecting of images, The images undergo pre-processing to enhance their quality, followed by segmentation to extract the number plate. Optical character recognition (OCR) is then applied to identify and save the number plate number as text. Figure 1 illustrates an ANPR system where the OCR principle, along with the pytesseract and Tesseract engines, is utilized to present the plate number as text on the terminal[1].To turn an image into text, the OCR engine employs pytesseract and Tesseract technology. On crowded days in parking lots, law enforcement and authorities frequently confront difficulties catching automobiles that break traffic regulations or manually documenting vehicle numbers.This procedure can be automated by installing a device that looks for vehicles that are breaching the law, snaps a photo of the number plate, and saves the number in a database for the purpose of fining the owners. A similar technique can be used in parking lots to take pictures of cars and automatically register their licence plate numbers in the database Heo [2] used a collection of lines that formed a rectangle at the plate boundary to create a number plate detecting method. The vertical edge density method is the next stage, which determines the plate area. A smearing algorithm was developed by Ozbay et al [3] to find the licence plate. This technology eliminates the requirement for laborious manual work, reduces labor costs, and proves to be significantly more efficient than human efforts, particularly during busy days. Once the vehicle's number is extracted as text, it can be displayed, stored in a database, or used for searching the entire database to retrieve relevant information. The image was initially subjected to Sobel vertical edge detection by Faradji et al [4]. Next, the plate area was located using a vertical projection analysis.

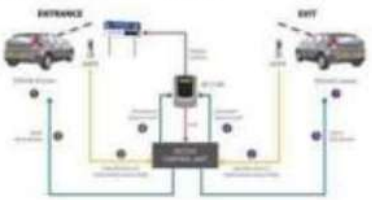

Figure 1: Introduction to ANPR

The use of automated number plate recognition (ANPR) devices by security forces and governmental bodies is widespread around the world. The market for ANPR was estimated to be worth USD 1.78 billion in 2016 and is anticipated to increase to USD 3.57 billion by 2023, with a predicted CAGR of 9.74% from 2017 to 2023. The study uses 2016 as its base year, and the prediction period is from 2017 through 2023[8]. In the upcoming years, it is projected that the global market for automatic number plate recognition would expand significantly. This growth is anticipated to be fueled by elements like the rising use of smart parking technologies in both developed and developing countries and the development of infrastructure in emerging economies. However, among the future trends of the automatic number plate recognition market during the forecast period[9] are the creation of a shared platform for the exchange of data from various sources.The ANPR flowchart is depicted in Figure 2 and includes pre-processing, number plate extraction, character recognition, and character segmentation.

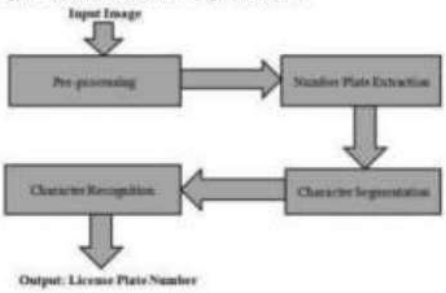

Figure 2: Process for ANPR

3. Existing System

Optical Character Recognition (OCR) technology is one of the important developments in digital image processing that has been widely adopted in a variety of areas. Various techniques have been established as a result of recent advancements in digital image processing. OCR was first made available as a service online in the 2000s, and it is currently used in cloud computing settings and mobile applications, such ascellphones that can translate signs in real-time into different languages. The creation of a reading machine for those who are blind is one of the most advantageous uses of OCR technology. With the use of this technology, a computer can read material aloud to the blind. There are a number of commercial and open-source OCR programmes that can read the most popular writing systems, including Latin, Cyrillic, Arabic, Hebrew, Indic, Bengali (Bangla), Devanagari, Tamil, Chinese, Japanese, and Korean characters. In this instance, Tesseract OCR is the name of the optical character recognition (OCR) engine used. The OCR engine is free and open-source, and it can work with several operating systems. Tesseract OCR is offered without charge and is made available under the Apache Licence. It was initially created by Hewlett-Packard as proprietary software in the 1980s. It was made available as open source in 2005, and Google has been funding its development since 2006[10]. continual intervention of people. hefty price, More workers are needed.

4. Proposed System

The proposed approach resolves the aforementioned drawbacks and offers the following advantages in addition to them: automated framework needing less labour. A number is shown and, with some adjustment, can be stored in a database, searched, or processed. The featured licence plate is automatically cropped and shown individually. The system can extract the licence plate from the input image using either Edgedetection or Template matching together, and Tesseract OCR does the character recognition. Methodology Figure 3 depicts a flowchart with several ANPR system components.

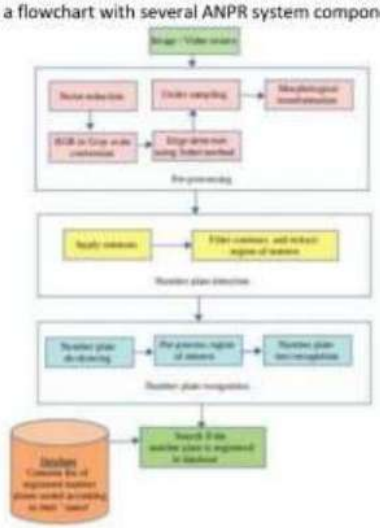

Figure 3: Flowchart for the methodology

4.1. Image pre-processing

Geometric transformations, including rotation, scaling, and translation, are considered preprocessing methods in this context due to their similarity in techniques employed. However, the primary objective of preprocessing is to enhance the image data by suppressing unintended distortions and highlighting important image features that are essential for subsequent processing.

4.1.1. Noise reduction

To lessen noise and detail, Gaussian filtering and smoothing are used. This will be useful for later stages of picture

processing. Mathematically, a gaussian filter for an image can be written as:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

To generate a smoothed image, the input image undergoes convolution with a 2-D matrix represented as 'G'.The following function in OpenCV can be used to implement Gaussian smoothing: where

'0' denotes a model to determine the standard deviation (sigma) value itself and (5,5) denotes the filter size.

4.1.2. Grayscale conversion from RGB

Since we only need to perform convolution of the image with sobel filter over a single 2D matrix rather than a complicated RGB image with three channels, converting RGB images to grayscale saves a significant amount of time. Another reason is that when doing image edge detection, our attention is drawn to the shift in intensity, which is simpler to examine in a grayscale image.

4.1.3. Edge detection using the Sobel method

Top-hat results to the original image and the subtraction of Black-hat results from it Sobel edge detection operates by computing the intensity gradient at each pixel within the image. This process determines the direction and magnitude of the steepest change from light to darkness. When performing edge detection using the Sobel method, the equations Eq(2) and Eq(3) are used:

$$\frac{\partial f}{\partial x} = S_x * f \qquad \frac{\partial f}{\partial y} = S_y * f$$

$$\nabla f = \left[\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}\right]$$

4.1.4. Under-sampling

The contour tracing algorithm, also referred to as border following, is employed to generate contours. A contour represents a sequence of points with equal intensity, defining the boundary. In OpenCV, contour detection is similar to identifying a white object against a black background. Consequently, during the adaptive Gaussian thresholding stage, an inversion operation is necessary.

4.1.5. The Morphological transformation

Morphological transformations involve the application of filters such as Top-hat and Black-hat filters. The Black-hat operation, also known as bottom-hat, is utilized to enhance dark objects of interest against a relatively bright background. On the other hand, the Top-hat operation is employed to highlight bright objects of interest against a relatively dark background. Figure 4 demonstrates the addition of Top-hat results to the original image and the subtraction of Black-hat results from it.

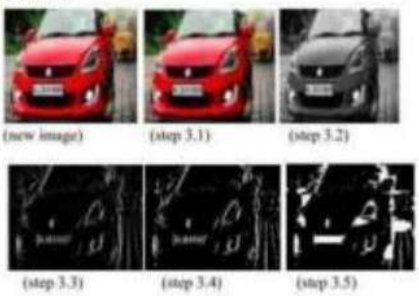

Figure 4: Transformation of Morphology

4.2. Detection of licence plate numbers

Consequently, the ANPR system can recognize license plates, enabling the identification of individual characters and the confirmation of their order. To achieve this, image processing methods such as Tesseract OCR or MaskOCR algorithms are utilized to convert the number plate image into text.

4.2.1. Apply Counters

The algorithm used to produce contours is known as contour tracing, or border following. The boundary is defined by a contour, which is a series of equal-intensity points. In OpenCV, locating contours is analogous to locating a white object against a black background; as a result, inversion operation must be used during the adaptive gaussian thresholding stage.

4.2.2. Filter the contours and extract the region of interest

Contours are utilized to identify small regions, specifically for sharp edges and noisy outliers. While these contours may appear unnecessary to the human eye, it is crucial for a program to consider them. To address this, bounding boxes were initially applied to each contour. Subsequently, minimum criteria such as contour area, width, height, and allowable aspect ratios were applied to filter out unnecessary contours. This filtering process brings us closer to our objective of accurately detecting the number plate.

4.3. Number Plate Recognition

In ANPR system, The number plate detection involves the following step of process.

4.3.1. Number plate de-skewing

Skew refers to the degree of rotation needed to align an image horizontally and vertically. During the deskewing process, the image is rotated by the same degree but in the opposite direction to eliminate the skew. This ensures that the text appears straight across the page rather than at an angle, resulting in a horizontally and vertically aligned image. In our project, the ratio and rotation() functions are utilized to perform this deskewing phase.

4.3.2. Preprocess region of interest

During the contouring process, it is possible for two or more contours to completely overlap each other. This situation can lead to the recognition process treating both contours as separate characters. Additionally, prior to the recognition process, we may resize the image if required.

4.3.3. Number plate text recognition

An optical character recognition (OCR) tool for Python is called Python-tesseract. In other words, it will identify and "read" any text that is contained in photos. Finally, we used this tool to extract the text from the filtered, de-skew contour.

4.4. Searching unknown image

Finding a specific element within a group of components is the definition of searching. If an element is present in the collection or not is determined by the search result. If it is, we may also determine where that element is in the specified collection if it is present. A key method in computer science is searching.

4.4.1. Create database

After deleting any other special characters, use Steps 1, 2, and 3 to register each car in the dataset and save them in a database.

5.1.1. Sorting

To enhance the search process efficiency, we are organizing the identified texts in a sorted manner.A rapid sort algorithm is used to do this. Divide and conquer is an algorithm used in quick sort. It sorts in-place and is not stable. The Quicksort Efficient Flowchart is displayed in Figure 5.

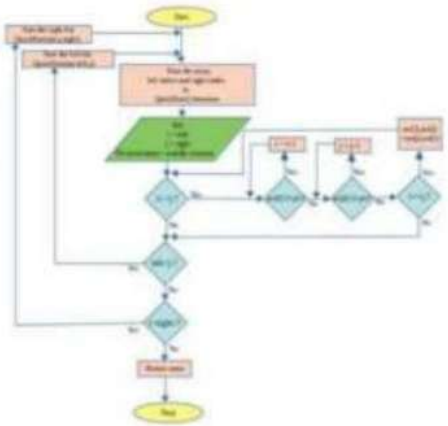

Figure 5: Flowchart for Quicksort

4.4.3. Searching

Follow steps 1, 2, and 3 for a fresh image. Obtain the new vehicle's registration number, then use the binary search method to see if it is already present in the database. A sorted array or list is subjected to a straightforward divide and conquer method known as binary search. When there are more photos in the collection, it performs better than linear search. The Searching Flowchart is displayed in Figure 6 below.

Figure 6: Flowchart for Searching

5. Discussion

Certain ANPR systems utilize simple image processing algorithms to recognize standard license plate designs. However, advanced ANPR systems utilize specialized object detectors, including HOG, CNN, SVM, YOLO, and others, to improve recognition accuracy.The need for any ANPR system to operate in real time makes identifying number plates even more challenging. As a result, ML, CV, and AI approaches can effectively empower ANPR. The proposed methodology has

effectively if implemented in housing societies, apartments, or other institutions to allow residents' vehicles inside, and almost all of the difficulties we encountered while solving the problem have been effectively overcome.There are a lot of companies offering ANPR solutions, but not all of them offer the same services or are equally user-friendly. The suitable software must be used in order to achieve the needed level of recognition accuracy and prevent undesirable outcomes like inaccurate number plate identification or no recognition at all because of the complexity of the scene or the usage of inefficient algorithms. One must assess software suppliers based on the factors of pricing, working environment, vendor support for developers, free trials, and data accuracy testing in order to select the better performing ANPR system.

6. Conclusion

6.1. Result

Four key tasks are accomplished by this initiative. The prototype computer's webcam will be used to assist in the first task, which is to input an image of the car.An improvement in quality occurs when the image is fed. In the resolution and thresholding, improvements are made. An established image frame size is imposed on the image. After augmentation, the image is processed in a way that separates the number plate from the entire scene using the rectangle's mathematical model. All of the characters in binary form are displayed on the segmented plate in a separate window.

Figure 7: Output

The objective of this research is to enhance our understanding of the technology employed in automatic license plate readers (ALPR) and optical character recognition (OCR) systems, which are widely used in most industrialized countries., including Singapore, Germany, France, and Japan. This project has some limitations because we didn't use sophisticated machine learning and deep learning algorithms, but it will function effectively if used in housing societies, apartments, or other institutions to allow residents' vehicles inside, and almost all of the difficulties we encountered while solving the problem have been effectively overcome. The Automatic Number Plate Recognition Market Forecasted Value 2032 is shown in Figures 8 and 9.

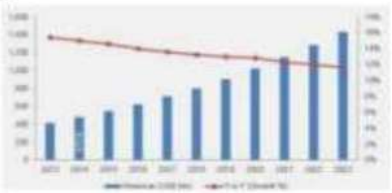

Figure 8: Car Plate Recognition Chart

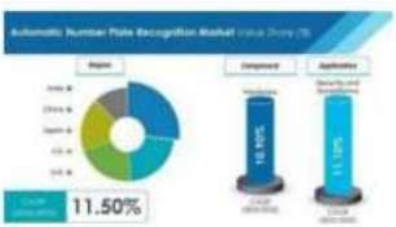

Figure 9: Forecast for the Automatic Number Plate Recognition Market through 2032

6.2. Future Work

The created method would focus on improving the precision of text localization and graphics removal in caption text images as future development. It can be assessed using a variety of different classifiers and other picture data bases that are readily available. The suggested techniques can be improved upon and used for automatic mixed mail sorting.

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