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An Implementation of Automatic Number Plate Detection and Recognition using AI

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Abstract- The upsurge in automobile use is a result of population expansion. A system that automatically reads license plates is utilized to effectively regulate the security system. In the absence of human help, the system recognizes the vehicle number plate using image processing. Any digital picture on the number plate is instantly recognized by a computer system. There are many applications, including complex security systems, public areas, parking entry, and urban traffic control. A few factors, including light and speed, contribute to the complicated features of automatic number plate recognition (ANPR). The bulk of ANPR systems are developed using specialized software like MATLAB. In this paper we have used open-source tools like Python and the Open Computer Vision Library to provide a new approach for ANPR systems. We have presented a comparison analysis of the existing methods with our proposed method.

Index Terms—Automatic Number Plate, Computer System, Python, Open Computer Vision.

I. INTRODUCTION

Intelligent transportation system research is being carried out in the scientific community, and it has a big influence on people's lives. A computer vision technique called ANPR is used to retrieve car license plates from photographs. It is an embedded system with a wide range of uses and difficulties. Common ANPR systems are expensive because they use proprietary technology. Additionally, this restricted methodology limits the system's continued study and improvement. The development of free and open- source technology has elevated the field of computing to greater levels. In a multi-cultural setting, people from many communities engage to create answers to man's endless challenges. Python is a remarkable example of the open- source community's contributions to science. It is crucial that all laws are followed so that an effective economy may be developed in a democratic nation with as many populations as India. In such situations, manual track moving automobiles on the road becomes very difficult. There will be a loss of time and labor. Even if it is operated manually, it will show. incredibly tough and incredibly mistaken operations. Using machine learning techniques, there are existing systems for tracking automobiles and license plates. The complexity of these algorithms for background processing in real time, however, causes them to fail in practice [1]. Therefore, it is imperative to develop an automated system that would assist in tracking the vehicles by accurately tracing their license plates.

Automatic Number Plate Recognition (ANPR), which is essential for vehicle monitoring, is also necessary for many other systems where authorization is essential, including parking management systems and toll payment processing systems. By automating the procedure, security officials may significantly reduce their workload. We have been able to assure the viability of these regulations without a lot of human implementations in recent decades thanks to the rapidly evolving electronic and software technologies [2]. Automatic license plate recognition has long been the subject of extensive research. This work uses image processing methods, mostly from the OpenCV Python library, to develop an ANPR system. With this technique, the computer reads the series of letters and numbers from a license plate. This system may be used for different purposes like parking and security facilities, charging for excessive speeding, identifying stolen automobiles, etc.

A. Existing Method

ANPR techniques are commonly used in several countries, including Australia, Korea, and others, where strict criteria are enforced for license plates. These techniques utilize typical license plate characteristics such as panel size, borders, color, and letter characters to make it easy to identify the vehicle's license number. However, in India, there are no standard number plate regulations, and the

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font styles, text sizes, positions, and colors of number plates vary widely. Furthermore, the Indian number plate lacks unique elements that could make it easier to recognize numbers, and it may feature additional unattractive designs on the panel [3].

B. Challenges in the Existing System

The characteristics of the car license plate are fully main tined in the developed countries. For instance, specific attention is paid to the size, color, font, size, and spacing of each letter in the text, the number of lines the vehicle number plate has, the script, and other factors. a selection of the images from the common tags used in developed countries. In most academic buildings and parking lots, a security guard must verify membership information by looking for a label that contains information about membership on the windscreen of the vehicle or by looking at the ID card of the driver as part of the registration process of people during entry into the building. In addition to being arduous, time-consuming, and prone to faulty recording, this writing technique makes it challenging to backup and share this car information because it is hard copy [4]. In cities like Bangalore, there are numerous apartment buildings and societies that conduct membership checks by looking for stickers on vehicle windshields. This can cause delays for unfamiliar vehicles or visitors who need to register upon arrival. In many cases, complexes consider this process to be risky since it is challenging to monitor the movements of vehicle occupants once they have entered. Security concerns are a significant drawback, as car thefts are common, particularly when vehicles are left unattended in parking lots, making it challenging to keep track of every vehicle entering and leaving during periods of high usage [5].

C. Importance of Study

Added Security: Deterrence is ANPR's principal effect. The knowledge that their license plate is being recorded and confirmed usually serves as a sufficient deterrent to prevent illicit action in advance. The police can study the data gathered and look for suspicious vehicles or vehicles that have been associated with criminal activity, which is another benefit of ANPR. Because ANPR system data must be retained for a short time, it is possible to use it to support defenses and as evidence. In open workplace parking, where it can handle staff parking permits or identify a car that has previously been forbidden from entering your site, ANPR also provides less security. An additional layer of security is provided by ANPR for both private and public use.

Automated Service: Using ANPR cameras to monitor parking solutions is a cost-effective and efficient option. They eliminate the need for parking wardens in parking lots and are more productive, providing a reliable service with their nonstop operation and highly accurate readings. Moreover, ANPR cameras offer a non-intrusive parking option, which has been found helpful by some when citing motorists. In traffic and parking enforcement, parking management teams usually find that both traffic officers and ANPR cameras work well together, with staff relying on ANPR to provide the necessary information. As a result, employees spend less time on the streets. These issues can be solved by the use of different machine learning algorithms as discussed in [6].

Advantages in real time scenarios: ANPR is useful in many industries because it offers real-time images. Number plate capture used to take a while, and it took much longer to inform violators of traffic laws of their punishments. Yet, number plates may be immediately recognized and checked against the database with ANPR. After this, a penalty notice could be issued in as little as 48 hours. Due to the speed of these cameras, criminal activity may be responded to quickly, preventing any bad behavior from going unnoticed.

II. Literature Review

The review of previous works was done on the basis of the use and development of Automatic Number Plate Detection in the past.

In [7] the behavior of the system was evaluated on a model after successfully installing the hardware and configuring the software components. An IR sensor was used for identifying the movement of the autos. When a car with very fast speed approaches the first sensor, the second and then the third PIR will immediately initiate the USB camera to snap photographs of the car as it is presumed to be over speeding. After this was done, image processing and optical character recognition were applied to the captured image. This is made possible by the Python-written OpenCV codes. A very effective, affordable, VRPN system was created in this effort.

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In order to identify moving objects, this system employs a smart IR sensor, a camera, text extraction software, and text saving software. Technology is unquestionably one of the most affordable ways to implement traffic control in a smart city.

In [8] the suggested design is based on the regulations put out by the NCT Government in Delhi, which were put into effect from January 1 through January 15, 2016, with the main goal of lowering air pollution brought on by the nine million registered automobiles in the area. The four-wheelers used in passenger and private vehicles are subject to this scheme, which emphasizes the odd-even motor vehicle number. Once the relevant picture, such as the car's license plate, has been collected, OCR may be used to extract the characters from the image. The collected text is saved in a text file and used as input by a Python program to carry out the odd/even regulation set in place by the Delhi Government. The main goal of this article was to develop a very effective system that can recognize a license plate automatically and function under a variety of circumstances. Multiple perspectives are used to capture the image. We determine a reasonable and approximate distance, making our technique more accurate than others. The program can recognize many character styles and fonts. The study in [9] investigates the effects of aspect ratio variations, brightness.variations between the car body and the license plate, and the number of positive and negative learning instances on the results of the license plate identification process in pictures with and without license plates. This technique has been proven effective, with a reported 90% success rate in detecting license plates. The methods used to identify and recognize the car number plate using free and open-source software are discussed in this study. To accomplish different image processing algorithms, Python and OpenCV are employed. There are a variety of techniques, including OCR and Tesseract, for removing numerals from the license plate.

In [10] a specific item was extracted and recognized using the object recognition technique, which combines elements like category classification and detecting these using some algorithms. Next Preprocessing is carried out further. This processing enhanced the recovered characteristics by employing techniques such as shrinking the image and balancing the contrast and brightness effects. So, this model allows for the detection of many items. From this point forward, the Easynet model is straightforward to construct and put into use, and it may be expanded to detect moving objects. In order to build a better city, traffic surveillance is a vital requirement. Using disciplines such as machine learning in image processing simplifies it. Riders of motorcycles who don't wear helmets can be fined using equipment that can detect motorcycles and helmets as well as identify license plates. The development of online tools and several built-in models that can be used for a number of applications has been aided by the swift development of machine learning and image processing techniques. In [11], the idea of recognizing the color and characters of the car's surrounding license plate in various lighting conditions while utilizing the well- known Bayes' rule and comparing them to the database is presented. This study also discusses the application of information-fused enhanced color identification technology for the detection of stolen vehicles. This system's methodology is based on the idea of comparing the seta database of registered automobiles while also analyzing a vehicle's identification panel letters and other characteristics like its color and model variant. The algorithm used to identify the car as possibly stolen flags any mismatches [12]. The method can benefit the police department for a variety of safety reasons, it is decided. For a more precise search, they may just input the stolen car number or the engine number. This technology features a built-in digital signature-based ECU that can broadcast the coordinates of the fake automobile in order to prevent theft. The major goal is to keep this simpler and more affordable without sacrificing dependability. This model's construction typically costs between $100 and $150.

In [13] any language's automobile license plate may be detected and recognized by the suggested technology. This method uses machine learning to train all alphabetic letters from the number plate in order to recognize each character.

It is simple to recognize most countries in the world since their number plate characters run from A to Z and 0 to 9. In contrast, because of the intricate alphanumeric letters, it is extremely difficult to identify and recognize Bangla number plates. In this study, a technique is suggested for detecting and identifying Bengali-written automobile license plates in Bangladesh. The number plate areas are retrieved from the vehicle photos in this system using the template matching technique. Following that, each

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character is segmented. A convolutional neural network (CNN) is utilized to select attributes from all characters on the number plate in order to recognize the characters and classify the vehicle city, sort, and number.

In [14] the method for reading a vehicle's license plate from a picture using mathematical morphological processes is covered in this work. The major goal is to properly identify vehicle number plates by utilizing a variety of morphological techniques. This is based on a variety of techniques, including picture augmentation, morphological modification, edge detection, and number plate extraction from vehicle photos. This project is based on automatic car license plate recognition, where it has been shown that current methods do not give any thought to reducing the system's power usage. Implementation of the software algorithm has produced encouraging results. As the goal of our proposed design is to reduce the system's power consumption, with its successful application it will play a significant role in traffic management and safety systems such as car theft prevention, parking lot management, etc.

In [15] MATLAB is used to recognize a license plate. The method for detecting and identifying vehicle license plates that is proposed in this study will aid in the detection of license plates. The method presented in this research uses the Sobel edge detection method and a straightforward yet effective morphological procedure. There are two main parts to how the entire NPR system operates. both the software and hardware components. The specifics of each component's operation are provided below. This thesis describes many recognition approaches, their benefits, and disadvantages, and recommends the best of all of them to choose a user- friendly, effective system that operates unaffected by climatic circumstances. Speed, light, text size, and style should not affect that system in any way.

In [16] the study offers a thorough analysis of ANPR algorithms that have been suggested and evaluated in recent pertinent studies. Based on the features needed for each degree of recognition, we categorized these algorithms. Each stage is presented in full as a performance summary, along with any concerns or challenges that may arise. But, as will be explained later, a consistent evaluation and comparison are not possible if the dataset is not widely used. The extensive optical, processing, and digitalization capabilities used by ANPR devices may cause the plate identification procedure.

to be slow. The ANPR solutions currently available do not offer a standardized set for nations around the world; rather, the companies must be given a optimized system for use in different corners of the world. This is so that the system can be adapted to the location in which it will be utilized, taking into consideration all contributing circumstances, as the system as it was built is insufficient. OCR software frequently has regional variations. The installed library or engine on the camera must be evaluated to see if the needed nations are supported. Every vendor's ANPR solution system has a unique mix of advantages and disadvantages. The one that best satisfies the region's needs within a set framework and has an impact on the local conditions is the best of them.

III. Proposed System And Algorithms

The software requires seven core algorithms for identifying.

- Plate localization- responsible for locating and isolating the plate on the image using 'cv2.imread'.
- Plate orientation and sizing - correct for plate skew and adjusts dimensions to needed size using 'imutils. resize'.
- Normalization- It is the process of adjusting the brightness and contrast of an image using 'cv2.cvtColor' and reduce noise using 'cv2.bilateralFilter'.
- Character segmentation- It identifies the various characters on the plates, we will use the pytesseract package.
- Recognition of optical characters
- Syntactical/geometrical analysis - Verify that characters and placements adhere to any applicable national laws.
- Average the recognized value across several fields or photos. This might produce a more accurate or confident result, particularly when each given image might have a light flare, be partially obscured, or have other obscuring factors. a license plate:

The Automatic License Plate Recognition system uses Pytesseract, a powerful OCR engine, and extensive OpenCV libraries for image processing.

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As we have demonstrated, ANPR can effectively address most of the issues we have identified. We want to emphasize the project's scalability and potential for expansion, as the main challenge in number plate detection is the noise added during image capture or environmental factors. Our system can operate in all environments, even in low light or rainy conditions. The integration of new features into existing infrastructure can be a major concern for clients considering a new system. However, we are confident that our system can be seamlessly integrated with the majority of clients' pre-existing infrastructure.

By using a web crawler, the system can process number plate recognition and retrieve vehicle data from the official website vahan.nic.in for further analysis. However, we recognize the privacy concerns associated with government websites and acknowledge the potential security flaws. The Indian license plate system consists of two types: black characters on a white plate and black characters on a yellow plate for personal vehicles and for commercial vehicles respectively.

Our system focuses on recognizing these two types of plates.

Capture: A camera of high-definition quality was used to capture the image of the car. This picture is saved in the system. The skew is often quite sensitive to character identification. The obliqueness of the camera might cause the legible text to distort. A better camera with more clarity and resolution will improve the system's success rate.

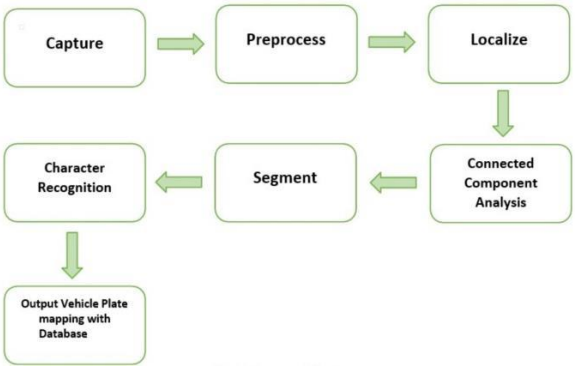

Fig. 1. Proposed System.

Fig. 2. Captured Image (Original image).

Pre-Processing: The method of pre-processing employs backdrop lighting circumstances and number plate location algorithms. The major goals of this step are to minimize background noise and improve contrast. Two procedures are used in the system preprocessing: Resize - In this part, we must adjust the object's size in accordance with the specifications. Convert Color Space: Camera images are either captured in raw format or encoded according to a specific multimedia standard. These graphics will primarily be in RGB mode, which stands for red, green, and blue. OpenCV functions should be used during the pre-processing stage.

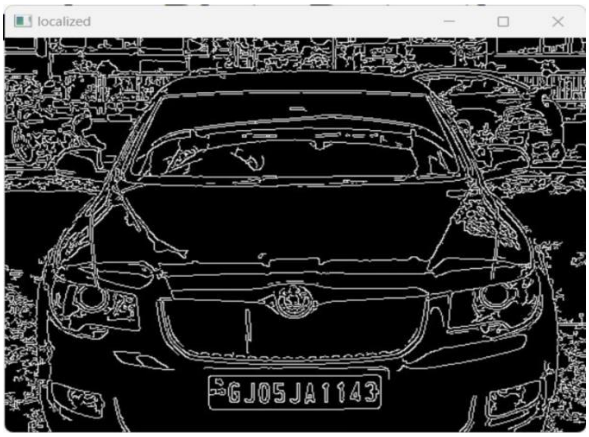

Fig. 3. Localization (Threshold image).

Localize: The front or back of the vehicle is photographed. The photograph has additional details of the car and its surroundings, but the system does not require them. As the license plate is the part of the picture that interests us, it must be differentiated from the background noise. Localization is essentially the process of binarizing the image. As seen in Fig. 3, the image has been converted to black and white. Characters are highlighted in this

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procedure, while background information is suppressed. Thresholding is an image processing method that performs localization. Depending on the threshold setting, the image's pixels are reduced to two values. Pre-image analysis is necessary for threshold in order to determine the ideal threshold value.

Connected Component Analysis: To remove undesirable picture regions from the binarized plate candidate, a connected component approach is initially used. Connected component analysis is used to identify the characters in the image. The basic concept is to search the picture for related pixels by moving across it. All the linked parts (blobs) have labels and have been removed as shown in Fig. 4.

Fig. 4. Connected Components (Blobs).

Segmentation: Character segmentation is a method for separating out the various characters that are included in a picture. Every character in this is checked out separately.

Character Recognition: Alphanumeric characters must be recognized by an automatic license plate recognition system. The training set and the character picture are compared, and the degree of similarity that yields the best recognition is determined.

Fig. 5. Recognized Vehicle plate.

Output Vehicle Plate Mapping with Database: The training set's character is further mapped by the database we had created using MySQL tools.

Fig. 6. Generated Output.

A. Tools:

Python: Python is a dynamic, object-oriented programming language that is extremely sophisticated and widely used in a variety of application fields. It has extensive standard libraries as well as good integration support for a variety of languages and technologies. Python's abundance of flexibility encourages users to think in terms of problems rather than languages. Python is the greatest alternative for scientific computing because of these qualities.

MYSQL: The information of the registered owner of the license plate is filled up using MySQL tools. We create tables here.

OpenCV: An open-source computer vision library is called OpenCV. More than 2500 efficient algorithms can be found in the collection. These algorithms are frequently used. to find and recognize faces, locate items, identify landscape, create markers to overlay photos using augmented reality, and other tasks.

Table I Analysis of Alternative Methods and Performance Indicators.

ANPR Techniques	Main Methods	Accuracy	Adaptiveness on a larger scale	Noise Effective	Processing Time
Character segmentation using the K-Means algorithm for recognizing	K-Means Algorithm Modifying by Filtering SIFT key Points OCR,	94.03%	Low	Low	10–20 ms

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license plates	LPR				
Intelligent System for Vehicles Number Plate Detection and Recognition using CNN	CNN	95.20%	Low	Low	21.31 ms
Real-Time Automatic Plate Recognition System using OCR and WSN	An adaptive parking service called Smart Parking Service makes use of optical char- acter recognition (OCR) and (SPANS)	96.70%	High	Low	12 ms
An Adaptive Method for Multi-National Vehicle License Plate Recognition Using Multi-Level Deep Features and a Foreground Polar ity Detection Model	Two important LPR stages: 1) (LPCS) 2) (LPCR)	96.04%	Low	Low	12 ms
Proposed System	ANPR system using OpenCV and Python.	98.20%	High	Low	3.78 ms

B. Implementation:

1. We have collected various number plate data in our database.
2. The scanning process begins with the capture of the data on the license plate.
3. We used the implemented OpenCV feature to refine the number plate and its data.
4. The data from the license plate is extracted in several processes before reaching the final result. It has several processes, including turning the image to greyscale using 'cv2.cvtColor', changing it to negative, and finally reducing noise to obtain clear data at the end by using 'cv2.bilateralFilter'.
5. Following the extraction of the number plate data, the resulting data is compared to the data contained in the database.
6. The character comparison takes place.
7. Finally, if the retrieved data matches any instance of database, it is a success in granting specific permission.
8. The extracted data in temporary is deleted, and a system log file is updated to reflect the present event.

The steps of working of the code are defined as follows:

IV. Comparative Analysis

A comparative analysis of different algorithms is presented in Table I based on following points:

- Main method- a procedure or process used.
- Performance Rate- Used to evaluate individual performance with reference to a normal or reference performance in order to be able to use the determined actual times as target times.
- Adaptiveness on a larger scale- The state or quality of being adaptive; capacity to adapt on a large scale.
- Noise Effective-In photographs, noise creates a grainy veil that hides details and makes the image look sub- spatially worse.
- Processing Time- The duration of the complete procedure running through to completion might be referred to as the processing time.

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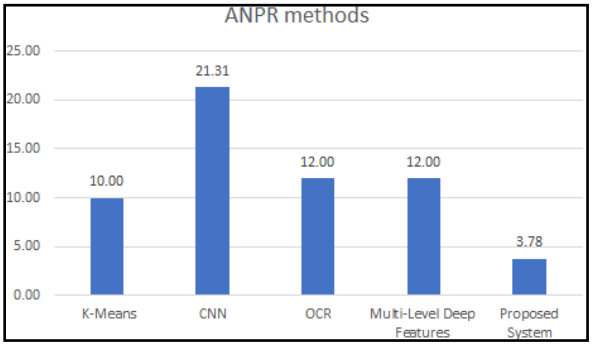

Fig. 7. Comparative Analysis of different ANPR methods based on processing time (in ms).

As shown in Fig. 7, our proposed system is the most efficient one in terms of processing time (in ms).

V. Limitation And Future Work

The study of the results reveals that our ANPR system functioned effectively at times and poorly at others. Additionally, deleting any foreground pixels that contact the edges of the input license plate enhanced license plate OCR accuracy. Sensors at the entry can improve the system. Any car entering the gate is first photographed while its license plate is read. The picture is subsequently transmitted to OPENCV and thereafter to a database for categorization. The gate will open if the license plate matches, else an alarm will be sent. Modern improvements in technology have transformed ANPR systems from complex, costly, fixed-based applications to straightforward mobile ones that support the "point and shoot" technique. This is made feasible by the development of software that operated on less expensive PC-based hardware that does not require specialized hardware and eliminates the requirement for pre-defined directions, angles, speeds, and sizes in which the plate would pass the camera field of view. For maintaining the data web servers are used. These servers may poses some security threats [17]. The foundation of this difficult problem is a mathematical operation that is easy to perform but hard to reverse. Several different categories of hard problems, such as elliptic curve-based and integer-based ones, are used [18]. The Law enforcement personnel may now patrol everyday with the benefit of real-time license plate identification thanks to smaller cameras that can read license plates quickly and processors that are more robust and fit in police cars [19]. In future, we can use web crawler to process the data and submit it to the official website www.vahan.nic.in. However, users may have the privacy concerns on government websites as well as the security flaws in such websites. So, security analytics and a solution for the extracted data can be done in future.

VI. Conclusion

In this paper we proposed a technique in which vehicle registration numbers may be recognized via digital image processing. From this proposed system we have obtained various results such as:

- Whether or not the registered car is on a blacklist.
- One person can now properly watch the traffic and find the offending car thanks to this.
- The data can be readily transported and stored, which increases system efficiency.

The system was created utilizing a modular approach that enables simple upgrading and/or replacing of various sub- modules, possibly making it ideal for a wide range of visual applications. The system's capabilities set it apart from its rivals, particularly in cases when the cost of both the application must be kept within acceptable bounds. Furthermore, it is quite adaptable and versatile due to the modular construction. Because digital image processing was used, which provides an accuracy of 90% under typical conditions, older approaches that had been put into place were not as accurate and effective as the planned Recognition system. This project is based on automatic car license plate recognition, where it has been shown that current methods don't give any thought to reducing the system's power usage implementations of the software algorithm have produced encouraging results. As the goal of our proposed design is to reduce the system's power consumption, with its successful application it will play a significant role in traffic security and management systems such as car theft prevention, parking lot management, etc.

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