International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 11 | November - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Automatic Number Plate Recognition System (ANPRS)- A Review

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***Abstract*— Automated number plate recognition (ANPR) is a technology that is gaining increasing attention due to a variety of applications including traffic control, crime detection, and stolen vehicle detection This system uses image processing to capture and analyze vehicle license plates . It uses a camera that takes pictures of the plates, then uses an algorithm to extract the alphanumeric characters. The database is used to identify vehicle owners or related information. The ANPR system has three main components: plate extraction, color separation, and color detection. Plate extraction separates plates from vehicle models, classification separates individual letters, and presentation uses pattern recognition algorithms to determine their ANPR for a variety of applications with high efficiency and accuracy, especially tolls system automation. This paper discusses state-of-the-art technology that is essential in law enforcement, parking and traffic management.**

Keywords—ANPR Technology, Image Processing and Recognition, Vehicle Number Plate Extraction, Toll System Efficiency

I. INTRODUCTION

Automatic Number Plate Recognition is a computer vision technology that has gained significant attention and importance in various applications such as traffic monitoring, crime detection, and stolen vehicle detection. With the advancements in technology, researchers have become increasingly interested in studying the computer vision techniques used in ANPR systems.

This technology has revolutionized various fields, from traffic enforcement to vehicle anti-theft and unattended parking lots. The ANPR system functions by collecting license plate images using cameras or other video devices and processing them through algorithms to obtain recognition results. ANPR systems are widely used for traffic detection, electronic toll collection, and vehicle identification. The ANPR system consists of three main stages: number plate localization, character segmentation, and optical character recognition. ANPR systems have become an essential tool in many surveillance applications, including security systems, highway road tolling systems, and parking management systems. These systems are

designed to detect and recognize the license plates of vehicles, providing valuable information about the vehicle properties. Automatic Number Plate Recognition has emerged as a crucial technology in various surveillance and management applications. The integration of ANPR technology in these applications has significantly improved their efficiency and effectiveness. Automatic Number Plate Recognition systems have become an integral part of various applications, including traffic enforcement, vehicle anti-theft, and unattended parking lots. The ANPR system plays a vital role in these applications by accurately identifying and processing license plate information. Automatic Number Plate Recognition systems have become increasingly important in various applications over the past few decades. These systems have proven to be highly effective and reliable in detecting and recognizing license plates, even under challenging conditions such as low-high lighting, rain, and limited day-night lighting.

II. LITERATURE REVIEW

1. Automatic number plate recognition by Vanshika Rai and Deepali Kamathania [1] presents an automatic number plate detection and recognition system for Indian vehicles. The system detects vehicles, captures images, and extracts number plate regions using image segmentation and optical character recognition. It handles various challenges like noise, low light, and nonstandard fonts. Pre-processing involves morphological transformation and Gaussian techniques. Number plate segmentation uses contour filtering, and character recognition employs the K-nearest neighbour algorithm. The system demonstrates high accuracy and is applicable for e-challan surveillance, stolen vehicle detection, and diverse applications, making it a versatile solution for real-world scenarios.

2. Automatic number plate recognition using deep learning by V Ganaprakash , N Kanthimathi and N Saranya [2] addresses the challenge of tracking fast-moving vehicles using roadside surveillance cameras. It proposes an automated vehicle tracking system employing the You Only Look Once (YOLO) deep learning model for object detection. The process involves converting video footage into images, detecting cars, identifying license plates, and recognizing number plate characters. The model achieves high accuracy: 97% for car detection, 98% for number plate localization, and 90% for character recognition. The system offers an efficient solution for real-time vehicle tracking, ensuring enhanced security and fulfilling the demand for secure travel in the rapidly growing vehicular sector.

3. A Review paper on automatic number plate recognition system using machine learning algorithms by Sharddha S. Ghadage and Sagar R. Khedkar [3] discusses the implementation of Automatic Number Plate Recognition (ANPR) system using various machine learning algorithms. It addresses challenges in vehicle tracking and traffic management, emphasizing the role of computer vision and deep learning techniques. The system employs methods like Otsu, K-nearest neighbour, Support Vector Machine (SVM), and Extreme Learning Machine (ELM) for image processing, character recognition, and feature extraction. The proposed ANPR system effectively handles issues like different font sizes, colours, and environmental conditions, ensuring accurate recognition of number plates. The system's robustness is demonstrated through real-world scenarios, making it a valuable solution for intelligent transportation systems and enhancing security in parking areas.

4. Number Plate Recognition Using Criminal Complementary Hulling Algorithms by Kiran Sonavane [4] focuses on Automatic Number Plate Recognition (ANR) systems, crucial for tracking stolen vehicles in cities. The proposed method tackles challenges like poor illumination and noise in images captured by CCTV cameras. Utilizing the Crimmins Speckle Algorithm, the study effectively removes salt and paper noise, enhancing image quality. The system's flow involves image capture, noise removal, Region of Interest (ROI) extraction, and Optical Character Recognition (OCR). The research aims to optimize processing time by exploring parallel programming methods like OpenMP in the future.

5. An Automatic Number Plate Recognition System under Image Processing by Sarbjit Kaur [5]showcases that the Automatic Number Plate Recognition (ANPR) system, a vital component of Intelligent Transportation Systems, uses computer vision and image processing techniques to extract vehicle number plate information. The system comprises four phases: Acquisition of Vehicle Image and Pre- Processing, Extraction of Number Plate Area, Character Segmentation, and Character Recognition. The accuracy of ANPR depends on the quality of the captured vehicle image. Existing methods work well for dark and bright images but struggle with Low Contrast, Blurred, and Noisy images. To address these challenges, a proposed approach enhances input images using iterative bilateral filtering and adaptive histogram equalization, followed by morp.

6. Automatic Number Plate Recognition System in Real Time by Aditya Trivedi , Dhruv Shah , Rishabh Shetty and Nitin pujari and [6] aims to capture vehicle images via video surveillance, employing real-time processing with MATLAB software to segment and recognize number plates. Automatic vehicle identification aids traffic control and security, especially for access control and tracking. Number Plate Recognition (NPR) systems face challenges due to varying plate aspect ratios and lighting conditions. The proposed approach utilizes spectral analysis, character segmentation with SVM feature extraction, and OCR for successful recognition of moving vehicles. Techniques such as edge detection, morphological operations, and fuzzy logic are employed. The system captures images using a 5.0-megapixel camera, converts them to grayscale, applies edge detection algorithms, and identifies potential license plate regions. The ANPR technique, with potential enhancements like GSM modules for authorities' alerts, proves to be a feasible solution for future vehicle identification despite challenges like broken number plates.

7. Automatic Number Plate Recognition System Using Optical Character Recognition by Monika Arora , Anubha Jain , Shubham Rustagi and Tushar Yadav [7] showcases that the Automatic Number Plate Recognition System (ANPR) is vital due to the surge in vehicle numbers. ANPR, employing Optical Character Recognition (OCR) and neural networks, enables smartphone applications for efficient traffic monitoring. It simplifies toll payments, enhancing overall traffic management. The system faces challenges, including uniform character height and precise vertical edge detection, requiring consistent standards for global applicability. ANPR's development has influenced automatic parking systems, emphasizing the need for advanced, uniform recognition algorithms.

8. An Automatic Number Plate Recognition System using OpenCV and Tesseract OCR Engine Andrew S. Agbemenu , Japthah yankey and Franest O. Addo [8] showcase that the proposed Automatic Number Plate Recognition (ANPR) system for Ghanaian plates uses C++ and OpenCV. It employs edge detection and feature techniques with Tesseract OCR for character recognition. The system detected 397 plates (79.4%) using edge detection and 454 plates (90.8%) using feature detection, with an average processing time of 0.2s. Character recognition achieved 60% accuracy. Challenges included faded characters, plate decorations, and noise affecting segmentation. Further training is expected to enhance accuracy. The study extends gratitude to vehicle owners and contributors like Jeffery Hooper.

9. Helmet, Number Plate Detection and Stolen vehicle recognition using Machine Learning by Vinaya Kulkarni , Dhanashree Pawar , Sanskruti talwekar , Rupali Bharambe and Akshata Mahadik [9] showcased that the proposed system utilizes Convolutional Neural Networks (CNN) and YOLO algorithm for real-time detection of motorcyclists without helmets from CCTV images. It automates the process of monitoring riders,

retrieves their license plate numbers, and compares them with a database to identify stolen vehicles. The system ensures accuracy through deep learning and object detection techniques, enhancing traffic safety and law enforcement.

III. METHODOLOGY USED IN EXISTING SYSTEMS

Many of the existing systems follows methodology as shown below:

A. Image Acquisition

In the initial phase of methodology, the process commences with the capture of an image employing a high-definition (HD) camera. This acquired image is pivotal, as it constitutes the foundational input for all ensuing processing steps, thus warranting the meticulous preservation of precise specification integrity throughout the entire procedure.

B. Converting to Grayscale

In this subsequent step of methodology, the color image undergoes transformation into a grayscale rendition. This conversion is essential due to the enhanced suitability of grayscale images for specific tasks, simplifying subsequent processing and analysis.

C. Image Enhancement

As a pivotal phase in the process, the focus is on enhancing the image's quality through the elimination of undesirable noise artifacts. This critical noise reduction procedure is executed employing a Median filter, which effectively refines the image by reducing irregularities and distortions. This step significantly contributes to the overall clarity and visual fidelity of the image, ensuring its optimal condition for subsequent analytical and processing tasks.

D. Plate Extraction

In this pivotal phase, the focus is on specific area within the image housing the license plate. To achieve this, Sobel edge detection technique is employed, which adeptly discerns the plate's edges. Following edge detection, one meticulously enlarge and isolate the plate region, meticulously eliminating any extraneous objects that are not part of the plate. This meticulous process culminates in the successful extraction of the desired license plate region, a crucial step in our image processing workflow.

E. Character Segmentation

In this phase, the focus shifts to the characters residing on the license plate. Employment of a method that involves the creation of bounding boxes around each individual character is done. Each character is meticulously enclosed within its own defined region, and subsequently saved as an independent image. This meticulous segmentation process effectively dissects the license plate's characters, setting the stage for further analysis and recognition within our image processing workflow.

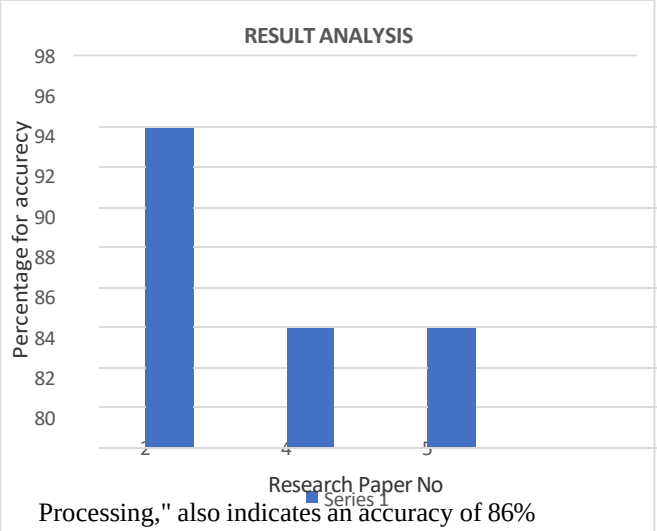
F. Character Recognition

In this pivotal stage, the focus turns to character identification. The segmented characters are systematically compared against a predefined set of known templates. When a character aligns with one of these templates, a corresponding image representing that character is retrieved. This recognition process enables the mapping of segmented characters to their respective identities, playing a fundamental role in the successful interpretation and extraction of information from the license plate within our image processing workflow.

As a result, the recognized characters are converted into text. The system retrieves the stored license plate number from a database. Apply a technique called super resolution to enhance the image quality of the license plate. Utilize Optical Character Recognition (OCR) to identify and extract the characters from the license plate. If the content is not clear enough for the OCR, continue applying super resolution until the content is recognized. The recognized text is then stored in a database for further use.

IV. RESULT ANALYSIS

The reported accuracies in the respective research papers are as follows: In the study titled "Automatic Number Plate Recognition using Deep Learning" by V. Ganaprakash, N. Kanthimathi, and N. Saranya, the accuracy is documented as 96%. Kiran Sonawane, in the paper "Number Plate Recognition Using Criminal Complementary Hulling Algorithms," reports an accuracy of 86%. Similarly, Sarbjit Kaur, in the paper on "An Automatic Number Plate Recognition System Image Processing," also indicates an accuracy of 86%



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V. CONCLUSION

From the above rigorous study we conclude that the Automatic Number Plate Recognition (ANPR) system has become a valuable tool for traffic monitoring, security, and surveillance applications. Current ANPR systems are congestion control. Advancements in machine learning and artificial intelligence can further improve pattern recognition and accuracy in ANPR systems. The future of ANPR systems holds promise, with the potential for increased efficiency, accuracy, and reliability. These systems may integrate with smart transportation initiatives, aiding law enforcement, crime prevention, urban planning, parking management, and transportation services. Despite significant progress, ongoing research and development are essential to optimize ANPR systems for diverse traffic scenarios, ensuring their continued growth and enhancement.

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[3] Ghadage, Shraddha S., and Sagar R. Khedkar. "A review paper on automatic number plate recognition system using machine learning algorithms." International effective under various conditions, but there is still room for improvement. Future developments should focus on handling poor image quality by advancing camera technology and image processing algorithms, ensuring accurate license plate recognition even in challenging situations. Integrating ANPR with other smart transportation systems can enable real-time data sharing and analysis, enhancing traffic management and Journal of Engineering Research & Technology (IJERT) 8.12 (2019).

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