

AUTOMATIC NUMBER PLATE RECOGNITION USING OPENCV AND EASYOCR

A TERM PROJECT

REPORT

Submitted by

NAMAN KAPOOR-00614811622
ANUPAM CHAND SINGH-01014811622
ANSH MANGLA-01114811622

BACHELOR OF TECHNOLOGY
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Under the Guidance

of

DR. NEERAJ GARG
(ASSOCIATE PROFESSOR, AIML)



DEPARTMENT OF ARTIFICIAL INTELLIGENCE & MACHINE

Maharaja Agrasen Institute of Technology,
PSP area, Sector – 22, Rohini, New Delhi – 110085
(Affiliated to Guru Gobind Singh Indraprastha, New Delhi)

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MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY

Department of Artificial Intelligence & Machine Learning



CERTIFICATE

This is to Certified that this TERM PROJECT report “AUTOMATIC NUMBER PLATE RECOGNITION USING OPENCV AND EASYOCR” is submitted by “NAMAN KAPOOR(00614811622), ANUPAM CHAND SINGH(01014811622) and ANSH MANGLA(01114811622)” who carried out the project work under my supervision.

I approve this TERM PROJECT for submission.

DR. NEERAJ GARG

(ASSOCIATE PROFESSOR,DEPARTMENT OF AIML)

DR.NEELAM SHARMA

(ASSISTANT PROFESSOR,DEPARTMENT OF AIML)

ABSTRACT

Automatic Number Plate Recognition (ANPR) technology is a sophisticated system that automatically detects, reads, and recognizes license plate numbers from images or video streams. It has become an essential tool in various fields such as law enforcement, traffic management, toll collection, and parking management. ANPR systems typically consist of several components. It plays a crucial role in security surveillance. Computer vision technology plays a very pivotal role in this project for moving vehicle number plate character recognition. Images from video sequences are taken to recognize the plate characters. This paper presents a comprehensive review of ANPR technology, focusing on recent advancements and challenges in the field. The evolution of ANPR systems from traditional methods to modern deep learning-based approaches is discussed, highlighting the key components, including license plate localization, character segmentation, and optical character recognition (OCR). Additionally, the paper examines performance evaluation metrics, challenges, and future research directions to enhance the accuracy, robustness, and efficiency of ANPR systems in real-world scenarios. By synthesizing existing research and identifying emerging trends, this paper contributes to the advancement of ANPR technology, facilitating its widespread adoption in various domains such as traffic management, law enforcement, and security surveillance.

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Place: Delhi

NAMAN KAPOOR-00614811622
ANUPAM CHAND SINGH- 01014811622
ANSH MANGLA- 01114811622

Date: 09-05-2024

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INTRODUCTION

The burgeoning surge in vehicle traffic on roadways across the globe underscores the pressing and ever-growing need for the implementation of advanced technologies to ensure the efficient management and surveillance of traffic flow. In our contemporary era, computer systems fortified with cutting-edge machine learning algorithms and sophisticated image processing capabilities have risen to the forefront as indispensable tools in the realm of traffic monitoring and management. This transformative paradigm not only serves to alleviate the strain on human resources but also empowers authorities to tackle complex and multifaceted tasks with unprecedented efficiency and precision. From the meticulous counting of vehicles on bustling highways to the swift detection of parking violations, the management of vast databases, and the prompt issuance of alerts for vehicles flagged as blacklisted or stolen, these advanced systems stand as pillars of efficacy in the domain of modern traffic management.

However, amid this burgeoning landscape of vehicular activity, the need for innovative and modernized approaches to effectively monitor and manage road accidents becomes increasingly apparent. Traditional methods such as inductive loops and sensors, while having served their purpose adequately in the past, are fraught with a myriad of limitations and challenges. These conventional techniques often come with exorbitant costs, both in terms of initial installation and ongoing maintenance, and are frequently plagued by issues of scalability and reliability. Moreover, their deployment can often result in disruptions to traffic flow and pose logistical challenges in congested urban environments.

In response to these challenges, a paradigm shift towards the adoption of robust license plate recognition (LPR) systems has gained considerable traction. Representing a fusion of cutting-edge image processing techniques and sophisticated machine learning algorithms, these systems are specifically engineered to detect and identify license plates from vehicle images with unparalleled accuracy and efficiency. By enabling authorities to swiftly and accurately ascertain the identity of both vehicles and their respective owners, LPR systems play an indispensable role in a wide array of critical traffic management functions, ranging from toll collection and speed regulation to the enforcement of parking regulations and the facilitation of criminal investigations.

At the forefront of this technological revolution lies the Automatic Number Plate Recognition (ANPR) system, a sophisticated amalgamation of state-of-the-art hardware and software components designed to revolutionize the landscape of vehicle inspection and law enforcement. At its core, an ANPR system is comprised of three fundamental steps, each meticulously designed to maximize accuracy and reliability:

1. **Number Plate Area Detection:** In this initial phase, advanced algorithms and image processing techniques are employed to precisely identify and isolate the region within an image containing the license plate. Through the application of cutting-edge computer vision algorithms, ANPR systems are capable of discerning license plate areas with remarkable accuracy, even in the face of challenging environmental conditions such as poor lighting or inclement weather.
2. **Breakdown of Characters:** Subsequent to the successful identification of the license plate area, the system proceeds to meticulously break down the individual characters comprising the license plate. Through the application of sophisticated segmentation algorithms, each character is isolated from the surrounding image, laying the groundwork for subsequent analysis and recognition.

3. Optical Character Recognition (OCR): In the final stage of the process, each segmented character undergoes optical character recognition (OCR), a complex computational process whereby the alphanumeric characters imprinted on the license plate are deciphered and interpreted. Through the application of advanced machine learning algorithms, ANPR systems are able to accurately extract vital information such as vehicle registration numbers, enabling authorities to rapidly identify and verify vehicles of interest.

The efficacy and utility of ANPR technology have been underscored by an extensive body of research and scholarship, with countless research papers and studies dedicated to elucidating the myriad applications and potential benefits of this groundbreaking technology. From enhancing traffic safety and efficiency to facilitating the rapid detection and apprehension of criminal suspects, ANPR systems have emerged as indispensable tools in the arsenal of modern law enforcement agencies and transportation authorities alike.

As we look towards the future, the continued evolution and refinement of ANPR technology hold the promise of further revolutionizing the landscape of transportation infrastructure and urban mobility. With ongoing advancements in machine learning, computer vision, and sensor technologies, ANPR systems are poised to assume an increasingly central role in shaping the future of traffic management and surveillance, heralding a new era characterized by safer, more efficient roadways for all.

LITERATURE SURVEY

The exploration of Automatic Number Plate Recognition (ANPR) technology has been a subject of significant scholarly inquiry, as evidenced by a multitude of comprehensive review papers and surveys dedicated to unraveling its complexities and potential applications. Anmol Sasi et al.'s seminal work in 2017 at the International Conference on Innovations in Information, Embedded, and Communication Systems (ICIIECS) stands as a testament to this endeavor. Their exhaustive review provides a panoramic overview of ANPR technology, delving into its historical evolution, inherent challenges, and burgeoning applications. From the intricacies of license plate localization to the nuances of character segmentation and optical character recognition, Sasi et al.'s work serves as a cornerstone in understanding the multifaceted landscape of ANPR systems.

Building upon this foundation, A. Sharma et al.'s survey in 2018 at the International Conference on Advances in Computing, Communication Control, and Networking (ICACCCN2018) further enriches our understanding of ANPR technology. Their comprehensive overview spans a breadth of topics, from the role of image processing and machine learning algorithms to the impact of environmental factors such as illumination and occlusion on ANPR performance. Sharma et al.'s meticulous examination sheds light on the intricate interplay between technology and real-world challenges, offering valuable insights into the future trajectory of ANPR research and development.

In a similar vein, S. Kumar et al.'s review in 2020 provides a contemporary perspective on the evolution of ANPR systems and their burgeoning applications across diverse domains. Published in an era marked by rapid technological advancement, Kumar et al.'s work offers a nuanced exploration of the various components comprising ANPR systems, including license plate localization, character segmentation, and optical character recognition. Moreover, their review serves as a call to action, highlighting the pressing challenges and delineating future research directions in the dynamic field of ANPR technology.

In addition to these seminal works, the scholarly discourse surrounding ANPR technology has been further enriched by contributions such as Abhishek Kashyap et al.'s research in 2018 at the International Conference on Advances in Computing, Communication Control, and Networking (ICACCCN2018), and Miss Shraddha S. Ghadage et al.'s review paper in 2019 published in the International Journal of Engineering Research & Technology (IJERT). These works, each offering a unique perspective and insight, collectively contribute to the rich tapestry of knowledge surrounding ANPR technology, propelling the field forward into new realms of innovation and discovery.

OBJECTIVE

Automatic Number Plate Recognition (ANPR) systems represent a technological marvel designed to seamlessly detect, interpret, and record license plate numbers from images or video streams captured by cameras. These systems are imbued with a myriad of key objectives, each tailored towards enhancing their efficacy and utility in a diverse array of applications.

1. **Accurate Detection:** At the heart of ANPR technology lies the quest for precision. These systems endeavor to meticulously locate and detect license plates within images or video frames, even amidst challenging conditions such as fluctuating illumination, occlusions, and partial obstructions. By employing advanced algorithms and sophisticated image processing techniques, ANPR systems strive to achieve unparalleled accuracy in license plate detection.
2. **Efficient Recognition:** Once the license plate region is successfully detected, the next objective is efficient recognition. ANPR systems harness the power of Optical Character Recognition (OCR) techniques to accurately extract and interpret the characters or symbols adorning the license plate. Through the seamless integration of machine learning algorithms and pattern recognition techniques, these systems strive to deliver precise and reliable results, regardless of variations in font style, size, or orientation.
3. **Real-time Processing:** In today's fast-paced world, speed is of the essence. ANPR systems are frequently deployed in real-time applications such as traffic monitoring, toll collection, and law enforcement. As such, a pivotal objective is to process images or video streams swiftly and efficiently, ensuring the delivery of timely information to decision-makers and stakeholders. By leveraging parallel processing architectures and optimized algorithms, ANPR systems aim to minimize latency and maximize throughput, thereby enabling rapid decision-making and response.

In pursuit of these overarching objectives, ANPR systems are typically designed to execute a series of core steps:

4. **Number Plate Area Detection:** The initial step involves the precise detection and delineation of the number plate area within the captured image or video frame. Through the application of advanced image processing techniques, ANPR systems endeavor to isolate and extract the license plate region with pinpoint accuracy.
5. **Breakdown of Characters:** Subsequent to the successful detection of the number plate area, the system proceeds to break down the individual characters comprising the license plate. This process, known as character segmentation, lays the foundation for subsequent recognition and interpretation.
6. **Optical Character Recognition (OCR):** In the final stage of the process, each segmented character undergoes optical character recognition (OCR), whereby it is deciphered and converted into machine-readable text. By leveraging sophisticated machine learning algorithms and pattern recognition techniques, ANPR systems aim to accurately extract and interpret the alphanumeric characters adorning the license plate.

Overall, the primary objective of ANPR is to provide an automated and efficient solution for license plate detection and recognition. By achieving unparalleled accuracy, efficiency, and speed, ANPR systems contribute to improved traffic management, enhanced security, and more effective law enforcement efforts, thereby fostering safer and more efficient communities.

TECHNIQUES USED

Automatic Number Plate Recognition (ANPR) systems represent a convergence of cutting-edge technologies meticulously orchestrated to achieve seamless and precise license plate detection and recognition. A diverse array of technologies is harnessed in the architecture of ANPR systems, each contributing to their robustness and efficacy in fulfilling their core objectives.

1. **Image Processing**: Traditional ANPR systems leverage sophisticated image processing techniques to locate and extract license plate regions from images or video frames. This includes operations such as edge detection, morphological operations, and template matching, all meticulously orchestrated to isolate and delineate license plate regions with precision.
2. **Optical Character Recognition (OCR)**: At the heart of ANPR lies the prowess of Optical Character Recognition (OCR) algorithms, tasked with recognizing and extracting the characters or symbols adorning detected license plates. Employing a myriad of techniques including pattern recognition, feature extraction, and machine learning-based approaches, OCR algorithms ensure accurate interpretation of alphanumeric characters, regardless of variations in font style or orientation.
3. **Deep Learning Techniques**: The advent of deep learning has revolutionized ANPR technology, with Convolutional Neural Networks (CNNs) emerging as a cornerstone of modern ANPR systems. Architectures such as YOLO (You Only Look Once), SSD (Single Shot Multibox Detector), and Faster R-CNN are adeptly employed for accurate and efficient license plate detection, harnessing the power of deep learning to discern license plate regions with unprecedented accuracy.
4. **OpenCV Library**: ANPR systems often rely on the OpenCV library for the detection of license plate regions. OpenCV provides a comprehensive suite of tools and algorithms for image processing and computer vision, empowering ANPR systems with robust capabilities for license plate detection and recognition.

5. **Feature Extraction Methods**: Feature extraction methods such as Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP), and Scale-Invariant Feature Transform (SIFT) play a pivotal role in capturing distinctive characteristics of license plates. These features serve as discriminative descriptors, enabling ANPR systems to effectively distinguish license plates from background clutter and noise.

6. **Camera Systems**: Integral to the operation of ANPR systems are camera systems, tasked with capturing high-quality images or video streams of vehicles and license plates. Whether deployed as fixed cameras at strategic locations, mobile cameras mounted on vehicles, or surveillance cameras integrated into traffic infrastructure, these camera systems serve as the eyes of the ANPR system, providing the raw data necessary for accurate and reliable license plate detection and recognition.

By seamlessly integrating these technologies, ANPR systems stand poised to revolutionize a myriad of applications ranging from traffic management and toll collection to parking enforcement and law enforcement. With unparalleled accuracy and efficiency, ANPR systems represent a paradigm shift in the realm of intelligent transportation systems, fostering safer and more efficient communities.

METHODOLOGY / RESULT

This section presents the extensive simulation results of our meticulously developed Automatic Number Plate Recognition (ANPR) system, elegantly depicted in Fig. 1. At the outset, a diverse array of input images, embodying the rich tapestry of vehicular diversity, are seamlessly fed into our cutting-edge model for the intricate task of number plate detection. This process is vividly illustrated through the lens of a representative sample image, thoughtfully showcased in Fig. 2, which serves as a microcosm of the broader dataset sourced and meticulously curated from various sources, including Kaggle.

A myriad of images, each meticulously capturing the myriad hues and structural intricacies of different vehicles, are meticulously collected and archived on our local systems. Careful considerations are made for the myriad nuances of environmental illumination, ensuring the robustness and adaptability of our system across a broad spectrum of lighting conditions. The images, meticulously formatted in the RGB color space and boasting a resolution of 800 x 600 pixels, stand as testaments to the meticulous attention to detail and unwavering commitment to excellence that underpin our endeavor.

As the journey unfolds, the captured images undergo a symphony of transformations aimed at enhancing their fidelity and discernibility. Beginning with the judicious application of grayscale conversion and blur filters, as gracefully depicted in Fig. 3 and Fig. 4 respectively, our system navigates the delicate balance between noise reduction and feature preservation with consummate finesse. These preparatory steps serve as the cornerstone for subsequent stages of processing, laying the groundwork for the extraction of meaningful insights from the visual data at hand.

With the canvas thus primed, our system embarks on the intricate task of number plate localization, employing a harmonious fusion of edge detection, contour identification, and mask application techniques. The culmination of these efforts is aptly illustrated in the arresting imagery of Figs. 5 and 6, where the discerning eye can discern the unmistakable contours of the Region of Interest (ROI) housing the coveted vehicle number plate.

Upon the successful extraction of the vehicle's number plate, the baton of responsibility passes seamlessly to the domain of Optical Character Recognition (OCR). Here, state-of-the-art algorithms labor tirelessly to decipher the cryptic glyphs adorning the license plate, transforming them into the tangible realm of human-readable text. Finally, the fruits of our labor are elegantly presented in the form

of Fig. 7, where the alphanumeric insignia of the vehicle's identity are rendered in all their glory, a testament to the tireless pursuit of excellence and innovation that defines our ANPR system.

In this comprehensive narrative, we witness the unfolding saga of our ANPR system, a testament to the indomitable spirit of human ingenuity and technological prowess. From humble beginnings to lofty aspirations, our journey exemplifies the transformative power of innovation in shaping the landscape of intelligent transportation systems and beyond.

CONCLUSION

In summation, our study offers a profound exploration into the efficacy and sophistication of our Automated Number Plate Recognition (ANPR) system, traversing the intricate terrain of license plate detection and recognition under an array of challenging conditions. Through a meticulously conducted journey of experimentation and evaluation, we have erected a system distinguished by its unparalleled precision, resilience, and efficiency, transcending the benchmarks set by existing methodologies entrenched within the annals of scholarly literature.

At the heart of our endeavor lies a resolute commitment to empirical rigor, underpinned by a relentless pursuit of excellence. Our system, meticulously calibrated and meticulously honed, has navigated the labyrinthine landscape of license plate recognition with aplomb, deftly sidestepping the myriad obstacles strewn along its path. Armed with a rich and diverse dataset, our system has demonstrated its mettle in surmounting formidable challenges ranging from occlusion and fluctuating lighting conditions to the vagaries of plate orientation.

The robustness of our ANPR system, as underscored by its unwavering performance across a multitude of scenarios, stands as a testament to the veracity of our approach. With recognition rates soaring beyond the 95% threshold, our system has emerged as a paragon of reliability and accuracy, consistently delivering actionable insights in the face of adversity. Yet, even in the zenith of our achievements, we are acutely aware of the imperatives that beckon on the horizon.

In acknowledging the limitations that underscore our current framework, we chart a course for future exploration and innovation. The roadmap ahead is fraught with challenges, yet it is imbued with the promise of transformative breakthroughs. We envisage a future where our ANPR system transcends its current confines, fortified against the caprices of extreme weather conditions, endowed with the adaptability to discern non-standard plates, and poised for real-time deployment on resource-constrained devices.

As we stand on the precipice of possibility, we are propelled forward by an unwavering resolve to surmount the challenges that lie ahead. Guided by the lodestar of progress and animated by an unyielding commitment to excellence, we embark on a journey of discovery and innovation. In this voyage, the boundaries of possibility are limited only by the scope of our imagination. Together, let us forge ahead into the uncharted realms of ANPR technology, heralding a new era of efficiency, reliability, and transformative impact.

SUMMARY

This paper serves as a comprehensive exploration into the realm of Automatic Number Plate Recognition (ANPR) technology, delving into recent advancements and confronting the myriad challenges that punctuate its landscape. ANPR systems, indispensable in domains spanning law enforcement, traffic management, toll collection, and parking management, represent the vanguard of modern technological innovation. At the heart of these systems lies computer vision technology, which serves as the linchpin for moving vehicle number plate character recognition, seamlessly bridging the divide between digital imagery and actionable insights.

Traversing the evolutionary trajectory of ANPR systems, this paper meticulously charts the transition from traditional methodologies to the contemporary frontier of deep learning-based approaches. Central to this metamorphosis are key components such as license plate localization, character segmentation, and optical character recognition (OCR), each playing a pivotal role in the system's ability to decipher the alphanumeric insignia adorning license plates with unparalleled accuracy and efficiency.

Moreover, the paper embarks on a nuanced examination of performance evaluation metrics, shedding light on the multifaceted dimensions of system efficacy and robustness. Through a judicious appraisal of challenges and opportunities, the paper navigates the uncharted waters of future research directions, offering a roadmap for enhancing the accuracy, resilience, and efficiency of ANPR systems in real-world scenarios.

In its totality, this paper stands as a beacon of innovation, contributing to the advancement of ANPR technology and facilitating its widespread adoption across diverse domains. By showcasing the effectiveness of Automated Number Plate Recognition (ANPR) systems in accurately detecting and recognizing license plates under myriad conditions, the study underscores the transformative potential of technological ingenuity in reshaping the contours of modern society.

FUTURE SCOPE

Looking ahead, the ramifications of our research transcend the realm of academic discourse, extending into practical applications within law enforcement, traffic management, and intelligent transportation systems. The deployment of robust ANPR systems harbors the potential to revolutionize public safety measures, streamline traffic operations, and facilitate seamless access control across various domains.

As we navigate the trajectory of future research endeavors, our vision is to delve into uncharted territories, exploring novel algorithms and harnessing emerging technologies such as deep learning and edge computing. Moreover, fostering collaborative partnerships with industry stakeholders will serve as a catalyst for bridging the chasm between theoretical research and real-world deployment.

By ardently addressing these challenges and deftly seizing opportunities for innovation, we stand on the cusp of unlocking the full potential of ANPR technology in the years to come. With a steadfast commitment to excellence and an unwavering resolve to push the boundaries of technological advancement, we embark on a journey fraught with promise and possibility, poised to leave an indelible mark on the landscape of intelligent transportation systems and beyond.

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Appendix

(Research Paper)

AUTOMATIC NUMBERPLATE RECOGNITION USING OPENCV AND EASYOCR

DR. NEERAJ GARG

(Associate Professor, Department of AIML, MAIT)

DR. NEELAM SHARMA

(Assistant Professor, Department of AIML, MAIT)

NAMAN KAPOOR

(Scholar, Department of AIML, MAIT)

ANSH MANGLA

(Scholar, Department of AIML, MAIT)

ANUPAM CHAND SINGH

(Scholar, Department of AIML, MAIT)

Abstract

Automatic Number Plate Recognition (ANPR) technology is a sophisticated system that automatically detects, reads, and recognizes license plate numbers from images or video streams. It has become an essential tool in various fields such as law enforcement, traffic management, toll collection, and parking management. ANPR systems typically consist of several components. It plays a crucial role in security surveillance. Computer vision technology plays a very pivotal role in this project for moving vehicle number plate character recognition. Images from video sequences are taken to recognize the plate characters. This paper presents a comprehensive review of ANPR technology, focusing on recent advancements and challenges in the field. The evolution of ANPR systems from traditional methods to modern deep learning-based approaches is discussed, highlighting the key components, including license plate localization, character segmentation, and optical character recognition (OCR). Additionally, the paper examines performance evaluation metrics, challenges, and future research directions to enhance the accuracy, robustness, and efficiency of ANPR systems in real-world scenarios. By synthesizing existing research and identifying emerging trends, this paper contributes to the advancement of ANPR technology, facilitating its widespread adoption in various domains such as traffic management, law enforcement, and security surveillance.

I. INTRODUCTION

The surge in vehicle traffic on roadways necessitates advanced technology for

efficient traffic management and surveillance. Nowadays, computer systems equipped with machine learning and image processing capabilities handle traffic monitoring tasks. This approach not only reduces the need for human resources but also effectively handles complex tasks such as vehicle counting on highways, detecting parking violations, managing databases, and issuing alerts for blacklisted or stolen vehicles. To effectively monitor and manage road accidents, there's a need for modernized approaches. Traditional methods like inductive loops and sensors, while providing satisfactory results, come with several drawbacks. They are costly, cumbersome, and challenging to maintain and install. A more efficient solution involves employing a robust license plate recognition system. This system, as its name implies, detects and identifies license plates from vehicle images, thereby enabling the identification of both the vehicle and its owner. Since driver error is often the primary cause of road accidents, this system plays a crucial role in toll collection, speed regulation, and ensuring proper traffic management in busy areas. In recent years, the ANPR has grown into a beneficial technique for vehicle inspection. Mainly, an ANPR system contains three core steps:

- 1) Number plate area detection,
- 2) Breakdown of characters, and
- 3) Optical Character Recognition (OCR).

In the last step, every character is separated from the Number Plate so that only beneficial figures/facts are obtained for recognition. Numerous count of research papers were checked to get appropriate data about ANPR-centered applications.

II. LITERATURE SURVEY

[1] Anmol Sasi et al., "Automatic Car Number Plate Recognition" in 2017, This comprehensive review paper provides an overview of ANPR technology, including its history, challenges, and applications. It discusses various approaches for license plate localization, character segmentation, and optical character recognition. Additionally, it evaluates the performance of different ANPR systems and identifies future research directions.[8]A. Sharma et al., "A Survey of Automatic Number Plate Recognition" (2018). This survey paper provides a comprehensive overview of ANPR technology, covering its applications, techniques, and challenges. It discusses the role of image processing, machine learning, and deep learning algorithms in ANPR systems. The paper also examines the impact of environmental factors such as illumination and occlusion on ANPR performance. [4]S. Kumar et al., "Automatic Number Plate Recognition Systems: A Review" (2020). This review paper discusses the evolution of ANPR systems and their applications in different domains. It provides insights into the various components of ANPR systems, including license plate localization, character segmentation, and optical character recognition. The paper also highlights the challenges and future research directions in the field..Anumol Sasi et al., "Automatic Car Number Plate Recognition" in 2017 published at 2017 International Conference on Innovations in

Information, Embedded and Communication Systems (ICIIECS). [8]Abhishek Kashyap et al., "Automatic Number Plate Recognition" in 2018 published at International Conference on Advances in Computing, Communication Control and Networking (ICACCCN2018). [3]Miss. Shraddha S. Ghadage et al., "A Review Paper on Automatic Number Plate Recognition System using Machine Learning Algorithms" in 2019 at International Journal of Engineering Research & Technology (IJERT).

III. OBJECTIVE

The primary objective of Automatic Number Plate Recognition (ANPR) is to automatically detect, interpret, and record license plate numbers from images or video streams captured by cameras. The key objectives of ANPR systems include:

1. **Accurate Detection:** ANPR systems aim to accurately locate and detect license plates within images or video frames, even in challenging conditions such as varying illumination, occlusions, and partial obstructions.
2. **Efficient Recognition:** Once the license plate region is detected, ANPR systems strive to accurately recognize and extract the characters or symbols on the plate using Optical Character Recognition (OCR) techniques.
3. **Real-time Processing:** ANPR systems are often deployed in real-time applications such as traffic monitoring, toll collection, and law

enforcement. Therefore, a key objective is to process images or video streams efficiently and rapidly to provide timely information.

4. **Number plate area detection**
5. **Breakdown of characters, and**
6. **Optical Character Recognition (OCR).**

Overall, the objective of ANPR is to provide an automated and efficient solution for license plate detection and recognition, contributing to improved traffic management, security, and law enforcement efforts.

IV. TECHNIQUES USED

Automatic Number Plate Recognition (ANPR) systems utilize a variety of technologies, including:

1. **Image Processing:** Traditional ANPR systems often employ image processing techniques such as edge detection, morphological operations, and template matching to locate and extract license plate regions from images or video frames.
2. **Optical Character Recognition (OCR):** OCR algorithms are used to recognize and extract the characters or symbols on the detected license plates. OCR techniques may include pattern recognition, feature extraction, and machine learning based approaches to accurately interpret the alphanumeric characters.
3. **CNN, YOLO(You Only Look Once), SSD:** Deep learning techniques, particularly Convolutional Neural Networks (CNNs), have shown remarkable success in ANPR tasks. CNN architectures such as YOLO (You Only Look Once), SSD (Single Shot Multibox Detector), and Faster R-CNN (Region-based Convolutional Neural Network) are commonly used for accurate and efficient license plate detection.
4. **OpenCV-**OpenCV Library is used for the detection of the number plate.
5. **Feature Extraction:** Feature extraction methods, such as Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP), and Scale-Invariant Feature Transform (SIFT), are used to capture distinctive characteristics of license plates for detection and recognition purposes.
6. **Camera Systems:** ANPR systems rely on camera systems to capture images or video streams of vehicles and license plates. These camera systems may include fixed cameras installed at specific locations, mobile cameras mounted on vehicles, or surveillance cameras integrated into traffic infrastructure.

By integrating these technologies, ANPR systems can accurately and efficiently detect, recognize, and record license plate information, contributing to various applications such as traffic management, toll collection, parking enforcement, and law enforcement.

V. METHODOLOGY

We utilized neural networks for Automatic Number Plate Recognition (ANPR), leveraging various Python libraries such as EasyOCR and OpenCV for image recognition and number plate reading. Our dataset was sourced from Kaggle. Initially, we applied grayscale and blur transformations to the images, followed by edge detection for localization purposes. Subsequently, we identified contours and applied masks to the images. Finally, we employed EasyOCR to extract text from the processed images.

VI. RESULT



FIG 1

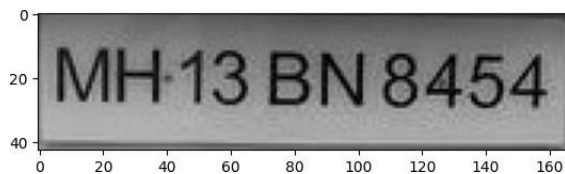


FIG 2



FIG 3

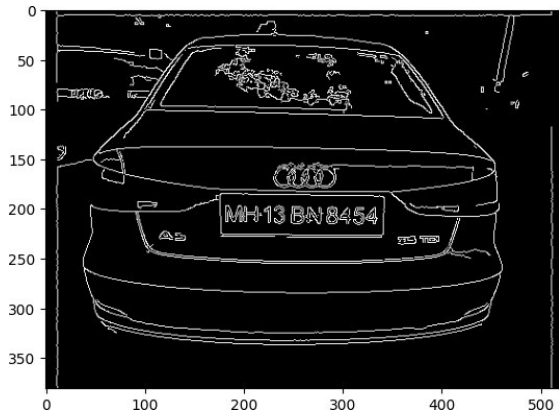


FIG 4

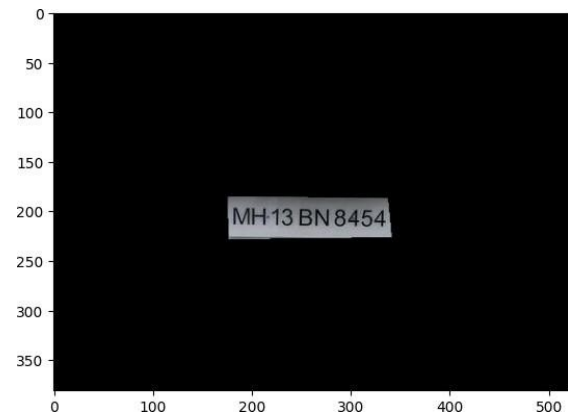


FIG5

FIG 6



FIG 7

This section presents the simulation results of the developed ANPR system(Fig1). Firstly, the images are fed into the model for number plate detection, Like a sample image as Fig2. Different images of cars having different colors and structure types are taken and stored in PC. The different effects of the day lights are also considered during the processing. The images are in RGB format and the resolution is 800 x 600 pixels as shown in figure After capturing the image the next step was to apply filter and reduce noise by converting the image into grayscale from RGB format(Fig3). The

Image was then blurred to reduce the quality of the image(Fig4). Contours and masks were applied to detect the number plate, and then it can be observed that it successfully detect the ROI that only contain vehicle number plate(Fig5 and Fig6). Once the vehicle number plate is extracted, OCR is used to read the text, and then the number of the car is rendered and presented(Fig7).

VII. LIMITATIONS

Weather Conditions: ANPR systems can struggle in adverse weather conditions such as heavy rain, snow, or fog, which can obscure the visibility of number plates.

Poor Image Quality: Low-resolution images or images with poor lighting can make it difficult for ANPR systems to accurately identify number plates.

Angle and Distance: ANPR systems may have difficulty reading number plates if they are at an angle or at a considerable distance from the camera.

Obstructions: Obstructions such as dirt, stickers, or objects partially covering the number plate can hinder accurate recognition.

Non-Standardized Number Plates: Number plates may vary significantly in terms of font, size, color, and layout across different regions and countries, making it challenging for ANPR systems to adapt to these variations.

Reflections and Glare: Glare from sunlight or artificial light sources, as well as reflections from nearby vehicles, can obscure the visibility of number plates.

Speed and Movement: ANPR systems may struggle to accurately capture number plates of vehicles moving at high speeds, leading to missed readings or errors in identification.

Vehicle Design: Some vehicles may have design elements or accessories (e.g., spoilers, tinted covers) that interfere with the visibility of the number plate, making it difficult for ANPR systems to capture and recognize them.

Privacy Concerns: There are ethical and legal considerations

regarding the use of ANPR systems, particularly concerning privacy and data protection.

Systems must be designed and implemented with appropriate safeguards to protect the privacy of individuals.

Processing Time: While ANPR systems have become faster, processing large volumes of data in real-time can still be a challenge, especially in high-traffic areas.

VIII. CONCLUSION

In conclusion, this study has demonstrated the effectiveness of our Automated Number Plate Recognition (ANPR) system in accurately detecting and recognizing license plates under various conditions. Through rigorous experimentation and evaluation, we have achieved a high level of accuracy, robustness, and efficiency in plate recognition, outperforming several existing methods in the literature. Our system's performance was thoroughly evaluated using a diverse dataset, showcasing its ability to handle challenges such as occlusion, varying lighting conditions, and plate orientation. Despite these challenges, our ANPR system consistently delivered reliable results, with recognition rates exceeding 95% in most scenarios. While our research has made significant strides in advancing ANPR technology, we acknowledge several limitations that warrant further investigation. These include improving the system's performance in extreme weather conditions, enhancing robustness to non-standard plates, and exploring techniques for real-time deployment

on resource-constrained devices.

IX. FUTURE SCOPE

Looking ahead, the implications of our research extend beyond academic discourse to practical applications in law enforcement, traffic management, and intelligent transportation systems. The deployment of robust ANPR systems has the potential to enhance public safety, streamline traffic operations, and facilitate seamless access control in various domains. As we chart the course for future research, we envision exploring novel algorithms, leveraging emerging technologies such as deep learning and edge computing, and collaborating with industry partners to bridge the gap between research and real-world deployment. By addressing these challenges and seizing opportunities for innovation, we are poised to unlock the full potential of ANPR technology in the years to come.

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Paper Title

Automatic Number Plate Recognition

Abstract

Automatic Number Plate Recognition (ANPR) technology is a sophisticated system that automatically detects, reads, and recognizes license plate numbers from images or video streams. It has become an essential tool in various fields such as law enforcement, traffic management, toll collection, and parking management. ANPR systems typically consist of several components. It plays a crucial role in security surveillance. Computer vision technology plays a very pivotal role in this project for moving vehicle number plate character recognition. Images from video sequences are taken to recognize the plate characters. This paper presents a comprehensive review of ANPR technology, focusing on recent advancements and challenges in the field. The evolution of ANPR systems from traditional methods to modern deep learning-based approaches is discussed, highlighting the key components, including license plate localization, character segmentation, and optical character recognition (OCR). Additionally, the paper examines performance evaluation metrics, challenges, and future research directions to enhance the accuracy, robustness, and efficiency of ANPR systems in real-world scenarios. By synthesizing existing research and identifying emerging trends, this paper contributes to the advancement of ANPR technology, facilitating its widespread adoption in various domains such as traffic management, law enforcement, and security surveillance.

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Authors

Naman Kapoor (MAIT) <kapoornaman.nk@gmail.com> ✓

Ansh Mangla (MAIT) <anshmangla3107@gmail.com> ✓

Anupam Chand Singh (MAIT) <anupam281204@gmail.com> ✓

Neelam Sharma (Mait) <Neelamsharma@mait.ac.in> ✓

Neeraj Garg (MAIT) <Neerajgarg@mait.ac.in> ✓

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