

# Techniques used in Automatic Number Plate Recognition

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**Abstract**—The Automatic Number Plate Recognition (ANPR) systems typically consist of a camera, image processing software, and a database system. When a car passes by, the camera snaps a picture of its license plate. The image processing software then uses OCR technology to retrieve the license plate number from the picture. The extracted plate number is then compared against a database of registered vehicles, and any relevant information associated with the plate number is retrieved. This information can include the vehicle's make and model, owner information, and any applicable fines or penalties. By automatically capturing license plate numbers, ANPR can help identify stolen vehicles, track the movements of known criminals, and enforce traffic violations such as speeding and running red lights. In addition, ANPR can also be used for parking enforcement, enabling authorities to enforce regulations. ANPR is also widely used in the toll collection industry, where drivers can be automatically charged for using toll roads without the need for physical barriers or manual inspection of license plates. Overall, ANPR technology is a valuable tool for improving road safety, reducing crime, and increasing efficiency in a variety of applications. However, like all technologies, ANPR has the potential to be misused, and its use must be balanced against privacy concerns and the right to protect personal information.

**Keywords**—Automatic number plate recognition, License plate detection, Character recognition, Character segmentation, Traffic sensing

## I. INTRODUCTION

ANPR, or automated number plate recognition, is a technique that reads licence plates to automatically identify automobiles. ANPR can offer useful information for traffic control and analysis by keeping track of all cars that enter and exit a specific region. In some countries, ANPR is used in conjunction with toll road systems to collect toll fees automatically. The technology eliminates the need for human intervention and reduces the possibility of human error. In addition to its commercial applications, ANPR is also used by law enforcement agencies to track stolen vehicles, enforce traffic laws, and monitor vehicles that have been flagged as suspicious. ANPR systems can quickly scan thousands of license plates per minute, making it an efficient tool for monitoring large areas[1]. In some countries, ANPR is integrated with criminal databases and can instantly alert authorities if a flagged vehicle is detected. ANPR technology is constantly improving, with new algorithms and hardware being developed to increase accuracy and speed.

However, the widespread use of ANPR raises concerns about privacy and the use of personal data. Some people are concerned that ANPR systems can be used to monitor individuals' movements and track their location without their

consent. To address these concerns, some countries have enacted laws and regulations to govern the use of ANPR and ensure that personal data is protected. ANPR is a powerful technology that is widely used for various purposes. It provides a fast, accurate, and efficient way to identify vehicles and monitor traffic. While there are privacy concerns associated with its use, the benefits of ANPR are widely recognized and it is likely to continue to play an important role in the future. ANPR systems are becoming increasingly sophisticated, with the ability to recognize license plates from different countries and even the different font styles used on plates. This makes ANPR a versatile technology that can be used in a variety of settings, including border control, security and surveillance, and even in private parking lots[2]. Another benefit of ANPR is that it can help reduce congestion and improve traffic flow. By collecting data on vehicles and their movements, ANPR systems can provide valuable insights into traffic patterns and help identify bottlenecks and areas of congestion. This information can then be used to optimize traffic management strategies and improve road networks. Despite its benefits, there are some limitations to ANPR technology.

One of the main limitations is the cost of implementation, as ANPR systems can be expensive to install and maintain. In addition, the technology is dependent on good quality images of license plates, which can be difficult to obtain in certain conditions such as low light or in the case of heavily-tinted license plates [3]. Finally, it is important to note that ANPR systems require proper maintenance and regular updates to ensure they continue to work effectively. This includes updating the software to fix bugs and improve accuracy, as well as cleaning and calibrating the cameras and sensors. Regular maintenance will help to ensure the system remains reliable and effective over the long term. Another application of ANPR is in fleet management, especially for companies that operate a large fleet of vehicles. By using ANPR, fleet managers can monitor the location and movements of their vehicles, track fuel consumption, and monitor the usage of company vehicles[4]. This information can help companies optimize their fleet operations and reduce costs by reducing fuel consumption, improving maintenance schedules, and reducing unauthorised vehicle use. ANPR systems can also be used in smart cities to manage parking and enforce parking regulations. By using ANPR cameras installed at parking spots, the system can automatically detect the presence of vehicles and calculate the amount of time they have been parked. This information can be used to enforce time limits, manage parking fees, and improve the availability of parking spots for residents and visitors.

Artificial intelligence (AI) and machine learning algorithms are the newest advances in ANPR [5]. AI can assist ANPR systems recognise licence plates more accurately and under difficult lighting circumstances. AI can also help ANPR systems to identify patterns and anomalies in traffic data, providing valuable insights into traffic patterns and trends. In conclusion, ANPR technology is a versatile and powerful tool that can be used for a wide range of applications. From traffic management and security to fleet management and parking enforcement, ANPR offers many benefits to various industries and organizations. With the integration of AI and machine learning, ANPR is set to become even more advanced and sophisticated in the future.

#### A. Why ANPR?

Automated Number Plate Recognition (ANPR) technology has become a widely used tool in various industries and applications due to its numerous advantages and benefits. One of the primary reasons for its popularity is its speed and efficiency[6]. ANPR systems use cameras and computer vision algorithms to scan and recognize license plates in real-time, making it a quick and effective way to identify vehicles. This is especially useful in high-traffic areas, such as border crossings, where manual methods of license plate recognition would be too time-consuming and inefficient. Another benefit of ANPR technology is its accuracy[7]. With the use of advanced algorithms and computer vision techniques, ANPR systems can accurately recognize license plates even in challenging conditions, such as low light or glare. This helps to reduce the risk of errors and improves the reliability of the technology. ANPR systems can also recognize license plates from different countries, allowing for cross-border traffic monitoring and management.

In addition to speed and accuracy, ANPR also provides valuable data and insights that can be used for various purposes. For example, ANPR data can be used for traffic management and analysis, to track the movements of vehicles, and even to enforce traffic laws and regulations[8]. This information can be extremely useful for government agencies and private companies alike. For example, ANPR data can be used to monitor and control traffic flow, reducing congestion and improving road safety. Another application of ANPR technology is in fleet management, especially for companies that operate a large fleet of vehicles. By using ANPR, fleet managers can monitor the location and movements of their vehicles, track fuel consumption, and monitor the usage of company vehicles. This information can help companies optimize their fleet operations and reduce costs by reducing fuel consumption, improving maintenance schedules, and reducing unauthorised vehicle use. ANPR technology also has the potential to greatly improve public safety[9]. By automatically tracking vehicles that have been flagged as stolen or linked to criminal activity, ANPR can help law enforcement agencies to quickly locate and apprehend suspects. This can greatly enhance public safety and reduce crime.

Finally, ANPR technology is becoming increasingly sophisticated, with the integration of artificial intelligence (AI) and machine learning algorithms. With the help of AI, ANPR systems can improve their accuracy and ability to recognize license plates even in challenging conditions. AI can also help ANPR systems to identify patterns and anomalies in traffic data, providing valuable insights into

traffic patterns and trends [10]. In conclusion, ANPR technology offers many benefits, including speed, accuracy, versatility, and the ability to provide valuable data and insights. With the integration of AI and machine learning, ANPR is set to become even more advanced and sophisticated in the future. This technology will continue to play a critical role in various industries and applications, such as traffic management, security, and fleet management.

#### B. Objectives of ANPR

The objectives of Automated Number Plate Recognition (ANPR) technology can be further divided into several specific goals, each of which contributes to the overall goal of improving efficiency, security, and safety.

- **Accurate and Reliable Vehicle Identification:** ANPR systems recognise vehicles fast and precisely by reading their licence plate numbers using cameras and computer vision algorithms. The tracking of vehicle movements, enforcement of traffic laws and regulations, and management and control of traffic flow are only a few uses for this data. [11].
- **Improved Public Safety:** By automatically tracking automobiles that have been reported as stolen or associated with criminal activities, ANPR technology can significantly enhance public safety. In order to reduce crime and improve public safety, law enforcement agencies can utilize this information to locate and apprehend suspects promptly. [12].
- **Effective Traffic Management:** ANPR data can be used for traffic management and analysis, providing valuable insights into traffic patterns and trends. This information can help governments and private organizations to optimize traffic flow and reduce congestion, improving road safety and reducing travel time for drivers[13].
- **Efficient Fleet Management:** ANPR technology can be used for fleet management, allowing companies to monitor the location and movements of their vehicles, track fuel consumption, and monitor the usage of company vehicles. This information can help companies optimize their fleet operations and reduce costs by reducing fuel consumption, improving maintenance schedules, and reducing unauthorised vehicle use[14].
- **Enhanced Border Security:** ANPR can be used for border control, helping to monitor cross-border traffic and improving border security. This information can be used to track the movements of vehicles, monitor trade and commerce, and enforce immigration and customs laws[15].
- **Improved Parking Management:** ANPR technology can be used in private parking lots, helping to control access, monitor usage, and enforce parking regulations. This information can be used to optimize parking lot operations, reduce congestion, and improve safety and security[16].
- **Advanced Technology Integration:** ANPR technology is becoming increasingly sophisticated, with the integration of artificial intelligence (AI) and machine learning algorithms. With the help of AI, ANPR systems can improve their accuracy and ability to

recognize license plates even in challenging conditions. AI can also help ANPR systems to identify patterns and anomalies in traffic data, providing valuable insights into traffic patterns and trends[17].

In conclusion, ANPR technology has many specific objectives, including accurate and reliable vehicle identification, improved public safety, effective traffic management, efficient fleet management, enhanced border security, improved parking management, and advanced technology integration. These objectives contribute to the overall goal of improving efficiency, security, and safety in various industries and applications.

## II. ANPR

The field of Automated Number Plate Recognition (ANPR) is rapidly evolving and there are still several research gaps that need to be addressed in order to improve the technology and its applications. Some of these research gaps include:

- **Improved Accuracy:** Despite the progress made in ANPR technology, there are still challenges in recognizing license plate numbers in low-light conditions or when license plates are dirty, obstructed, or deformed. Research is needed to improve the accuracy of ANPR systems in such conditions.
- **Integration with Other Technologies:** ANPR technology is typically used in conjunction with other technologies, such as traffic management systems and surveillance systems. However, there is still a need for further research into how ANPR technology can be integrated with these other systems to improve their overall functionality and efficiency.
- **Real-Time Processing:** ANPR systems need to process license plate data quickly and accurately in real-time in order to be effective. Research is needed to improve the speed and efficiency of ANPR systems, particularly in high-traffic environments.
- **Privacy Concerns:** ANPR technology raises important privacy concerns as it tracks the movements of vehicles and collects personal information. Research is needed to address these concerns and ensure that ANPR technology is used in a responsible and ethical manner.
- **Artificial Intelligence:** The integration of artificial intelligence (AI) and machine learning algorithms has the potential to greatly improve the accuracy and efficiency of ANPR systems. However, there is still much research to be done to fully leverage the potential of AI in ANPR technology.
- **Data Management:** ANPR systems generate large amounts of data, which need to be stored and processed effectively. Research is needed to improve data management systems and ensure that ANPR data is stored securely and used responsibly.
- **Cost-Effectiveness:** ANPR systems can be expensive, particularly when deploying the technology on a large scale. Research is needed to improve the cost-effectiveness of ANPR systems, making the

technology more accessible and affordable for a wider range of users.

In conclusion, the field of ANPR technology still has many research gaps that need to be addressed in order to improve the technology and its applications[18]. These include improving accuracy, integrating with other technologies, real-time processing, addressing privacy concerns, leveraging the potential of AI, improving data management, and cost-effectiveness [19]. Addressing these research gaps will help to advance the field of ANPR and ensure that the technology is used to improve safety, security, and efficiency in various industries and applications.

### A. Working of ANPR

Automated Number Plate Recognition (ANPR) is a complex technology that involves several components and processes to recognize license plate numbers accurately and efficiently. Here are more details about how ANPR works:

- **Camera:** The first component of ANPR technology is the camera, which captures images of vehicles and their license plates. These cameras typically use high-resolution imaging sensors and specialized lenses designed to capture clear images of license plates, even at high speeds and in low-light conditions.
- **Illumination:** In some cases, ANPR cameras may also use specialized illumination, such as infrared or ultraviolet light, to capture clear images of license plates. This is particularly important in low-light conditions or when license plates are dirty or obstructed.
- **Image Processing:** Once the image has been captured, the ANPR system uses image processing algorithms to prepare the image for recognition. This includes removing any noise or distortion, correcting the brightness, contrast, and colour, and cropping the image to focus on the license plate.
- **Character Segmentation:** The next step is to segment the license plate number into individual characters. This involves separating the characters from the background and any other elements in the image. The ANPR system may use edge detection algorithms, morphological operations, or other image processing techniques to accomplish this.
- **Optical Character Recognition (OCR):** The optical character recognition (OCR) algorithms built into the ANPR system are then used to identify each character on the licence plate. In order to determine the licence plate number, the segmented characters are compared to a database of recognised characters, such as letters and numbers.
- **License Plate Verification:** The ANPR system then verifies the license plate number against a database of registered vehicles. This database typically includes information such as the make and model of the vehicle, its registered owner, and any outstanding traffic violations or other issues.
- **Data Collection and Storage:** The ANPR system then stores the data collected from the license plate recognition process, including the license plate



number, the date and time of the capture, and the location of the camera. This data can be used for various purposes, such as traffic management, surveillance, and enforcement.

- **Integration with Other Systems:** ANPR technology can be integrated with other systems, such as traffic management systems and surveillance systems, to improve their functionality and efficiency. For example, ANPR data can be used to monitor traffic flow, enforce traffic laws, or identify stolen vehicles.

In conclusion, ANPR technology involves several components and processes, including the camera, illumination, image processing, character segmentation, optical character recognition (OCR), license plate verification, data collection and storage, and integration with other systems. The technology uses a combination of image processing algorithms, optical character recognition (OCR), and database verification to recognize license plate numbers accurately and efficiently.

### B. Related Work

Marzuki et al. 2019 [20] utilised methodology to choose the optimum model for the four-layered CNN architecture that was employed as the recognition method is the primary contribution of this work. This is accomplished by confirming the ideal SDLM learning algorithm (improved Stochastic Diagonal Levenberg Marquardt) learning parameter values and CNN network size. The CNN recognition approach is successfully used to construct the LPR system.

Shafi et al. 2022 [21] described the 53-layer deep convolutional neural network (CNN) architecture based on the most recent iteration of the object detection algorithm, You Only Look Once (YOLOv3). A sizable image data set made up of nine different types of Pakistani licence plates is used to test the proposed methods.

Raj et al. 2022 [22] implemented on a dataset of licence plates with only English alphabets and digits, an ANPR system. For number plate detection, the cutting-edge YOLOv5 object detection model is applied. Using image processing and contouring techniques, the output from detection is then processed and split into individual characters.

Dhont et al. 2022 [23] uses a sophisticated spatio-temporal disaggregation method to wring knowledge from ANPR data. In a dense network of ANPR cameras, the author visualises and analyses spatial and temporal insights from vehicle detections along roadway segments.

Khan et al. 2022 [24] developed ANPR pipeline locates the number plate area utilising YOLOv4 object detection models after detecting the vehicle's front and rear views. The next phase in the pipeline is to identify the number plate label using a deep learning architecture after an algorithm recognises the distinctive plate layout, which can be either a single or double row layout depending on the country.

Al-Hasan et al. 2022 [25] suggested that one way to improve road safety inside residential complexes and institutions is to install an automatic speed radar system. The proposed approach, which is based on Automatic Number Plate Recognition, eliminates the need for human interaction in contrast to various solutions.

### C. ANPR Research

Automated Number Plate Recognition (ANPR) has been the subject of extensive research and development over the past few decades, with many advances in technology and techniques being made. Here are some of the key ANPR research areas and implementations:

- **Image Processing Techniques:** Research in this area has focused on improving the image processing techniques used to prepare images for recognition. This includes techniques for removing noise and distortion, correcting brightness, contrast, and colour, and cropping the image to focus on the license plate[26].
- **Character Segmentation Algorithms:** Research in this area has focused on developing algorithms for accurately and efficiently segmenting characters from license plate images. This includes edge detection algorithms, morphological operations, and other image processing techniques[27].
- **Optical Character Recognition (OCR):** Research in this area has focused on improving the accuracy and speed of optical character recognition (OCR) algorithms. This includes improving the database of known characters, developing algorithms to recognize distorted or degraded characters, and incorporating machine learning techniques to improve recognition accuracy[28].
- **License Plate Verification:** Research in this area has focused on improving the accuracy and efficiency of license plate verification. This includes incorporating machine learning techniques to improve database matching, developing algorithms to recognize license plate numbers in different languages and scripts, and improving the speed of database searches[29].
- **Data Collection and Storage:** Research in this area has focused on improving the data collection and storage capabilities of ANPR systems. This includes developing secure and efficient methods for storing large amounts of data, developing algorithms for data compression and archiving, and improving the speed and accuracy of data retrieval[30].
- **Integration with Other Systems:** Research in this area has focused on improving the integration of ANPR technology with other systems, such as traffic management systems and surveillance systems. This includes developing standards for data exchange and integration, and improving the accuracy and speed of data processing[31].
- **Performance Evaluation:** Research in this area has focused on evaluating the performance of ANPR systems in various conditions, such as different lighting conditions, weather conditions, and vehicle speeds. This includes developing methods for testing and evaluating the accuracy and speed of ANPR systems and developing methods for improving the performance of ANPR systems in adverse conditions[32].
- **Deep Learning Techniques:** With the advancement of deep learning techniques, researchers have started incorporating these into ANPR systems to improve

recognition accuracy. This includes using convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to perform character recognition, as well as using deep learning algorithms for license plate verification[33].

- **Vehicle Recognition:** Research in this area has focused on incorporating vehicle recognition into ANPR systems, which can help to identify the make, model, and colour of vehicles in addition to their license plate numbers. This can be useful in various applications, such as theft prevention and traffic management[34].
- **Real-Time Processing:** Research in this area has focused on improving the real-time processing capabilities of ANPR systems, which is crucial for applications such as traffic management and enforcement. This includes developing algorithms for efficient image processing, character recognition, and license plate verification, as well as improving the speed and efficiency of data retrieval and processing[35].
- **Multimodal ANPR:** Research in this area has focused on incorporating multiple modalities, such as video and audio, into ANPR systems. This includes developing algorithms for recognizing license plates from video and audio streams, as well as integrating these modalities with existing ANPR systems to improve recognition accuracy and performance[36].
- **Privacy Concerns:** With the increasing use of ANPR technology, there have been concerns about privacy and data security. Research in this area has focused on developing methods for protecting the privacy of individuals and ensuring the security of ANPR data. This includes developing methods for data encryption, access control, and data deletion, as well as developing methods for ensuring the privacy and security of ANPR data in cloud computing and other storage systems[37].

In conclusion, ANPR technology has been the subject of extensive research and development, with advances in image processing techniques, character segmentation algorithms, optical character recognition (OCR), license plate verification, data collection and storage, integration with other systems, and performance evaluation. These research areas have contributed to the development of more accurate, efficient, and reliable ANPR systems, which have a wide range of applications in traffic management, surveillance, and enforcement.

### III. CONCLUSION

Automatic Number Plate Recognition (ANPR) is a crucial technology that has various applications in fields like law enforcement, traffic management, and security. In recent years, the ANPR technology has undergone significant advancements and improvements, resulting in more accurate and efficient systems. The research in ANPR has mainly focused on improving the accuracy and speed of license plate detection and recognition. This has been achieved through the use of deep learning algorithms, such as Convolutional Neural Networks (CNNs), and advanced image processing techniques. However, there are still some research gaps that need to be filled to further improve the ANPR technology.

Some of the major challenges include: Plate detection in varying conditions: ANPR systems can have difficulties detecting license plates in challenging conditions such as low light, glare, or when the plate is partially obscured. This can result in incorrect detections or missed detections. Plate recognition accuracy: The recognition accuracy of ANPR systems can still be improved, especially for license plates that are unreadable due to dirt, damage, or when the plate design is non-standard. Integration with other systems: ANPR systems need to be integrated with other systems, such as traffic management or law enforcement databases, to provide real-time information and support decision making. To fill these research gaps, researchers can focus on developing advanced image processing techniques and deep learning algorithms that are more robust to challenging conditions and can better handle non-standard license plates. Additionally, research can be done to improve the integration of ANPR systems with other systems to provide real-time information and support decision making. In conclusion, ANPR is a crucial technology that has undergone significant advancements in recent years. However, there are still some research gaps that need to be filled to further improve the technology and provide better and more accurate results.

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