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Drone based Automatic Number Plate Detection and Database Updating using IoT

Dr. BRB Jaswanth[1]; K. Yasaswi[2]; B. Kamachari[3]; M. Venkata Sai Manoj[4]; P. Bharavi[5]

[1,2,3,4,5]Department of Internet of Things Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru, Andhra Pradesh, India

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Abstract: The increasing number of vehicles on the road has led to a rise in traffic congestion, parking challenges, and security concerns. Manual number plate detection and database updation methods are time-consuming, prone to errors, and often incomplete. Moreover, the lack of real-time updates in the database hinders efficient traffic management, law enforcement, and vehicle tracking. The existing systems for number plate detection rely on manual entry or outdated technologies, resulting in low accuracy rates and limited scalability. Furthermore, these systems do not provide real-time updates, making it challenging for authorities to track and manage vehicles effectively. There is a need for an automated, IoT-based system that can accurately detect number plates, update databases in real-time, and provide valuable insights for traffic management and law enforcement. The proposed project aims to design and develop an Automatic Number Plate Detection and Database Updation System using IoT. The system will utilize computer vision and machine learning algorithms to accurately detect number plates, and IoT protocols to update the database in real-time. The system will also provide a user-friendly interface for authorities to access and manage vehicle data, enabling efficient traffic management, law enforcement, and vehicle tracking.

Keywords: *License Plate Detection, Optical Character Recognition(OCR), Computer Vision, Machine Learning, Landing.AI, Video Processing, Image Processing, Object Detection, Text Recognition, Surveillance Systems.*

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I. INTRODUCTION

The primary aim of this project is to design and develop an end-to-end pipeline for automated license plate detection and recognition from video data. The proposed system will utilize the Landing AI framework to integrate computer vision and machine learning techniques, enabling accurate and efficient detection and recognition of license plates. The project aims to address the challenges of processing video data for real-time vehicle monitoring and identification. By developing a robust and efficient pipeline, this project will provide a reliable solution for various applications, including traffic management, security surveillance, and law enforcement. 13 Automatic Number Plate Detection and Database Updation Using IOT 2024-25 Accurately detect license plates in video frames using a dedicated machine learning model. Crop the detected license plate regions from each frame to focus on the area of interest. Extract readable text from the cropped license plate images using Optical Character Recognition (OCR).

II. BACKGROUND

The rapid growth of urbanization and transportation has necessitated the development of intelligent systems for vehicle monitoring and identification. Automated license plate detection and recognition (ALPR) have emerged as crucial components of modern traffic management and surveillance systems. ALPR technology enables the accurate and efficient identification of vehicles, facilitating applications such as traffic law enforcement, parking management, and security surveillance. However, processing video data in real-time and extracting relevant information poses significant challenges. These challenges include detecting license plates under varying lighting conditions, handling different plate formats and orientations, and ensuring accurate character recognition To address these challenges, this project aims to develop an end-to-end pipeline for automated license plate detection and recognition. Leveraging the LandingAI framework, the proposed system will integrate computer vision and machine

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learning techniques to detect license plates, crop detected regions, and extract readable text using Optical Character Recognition (OCR). The successful implementation of this project will provide a robust and efficient solution for real-time vehicle monitoring and identification. With its potential applications in traffic management, security surveillance, and law enforcement, this project contributes to the development of smarter and safer transportation systems.

III. MOTIVATION AND OJECTIVES

A. Motivation

The increasing number of cars in both urban and rural regions has heightened the need for more intelligent and effective traffic monitoring tools. Traditional surveillance systems, such as static CCTV cameras, are restricted by their fixed locations and limited field of view. They often require manual intervention for number plate recognition and database updates, which leads to delays, inaccuracies, and inefficiencies. The integration of drone technology into traffic surveillance introduces a game-changing solution. Drones offer aerial mobility, wider coverage, and real-time video capture, making them ideal for monitoring moving vehicles in diverse environments — including highways, remote regions, crowded areas, and emergency zones. By combining drones with automatic number plate recognition (ANPR) and IoT-based database systems.

B. Objectives

The automated license plate detection and recognition system developed in this project has the potential to revolutionize traffic management and surveillance. By integrating this system into real-world traffic management systems, cities can enable efficient and accurate vehicle monitoring and identification. This can lead to improved traffic flow, enhanced security, and better enforcement of traffic laws. Additionally, the system's real-time processing capabilities make it an ideal solution for applications requiring rapid and accurate vehicle identification. The project's significance extends to the broader field of computer vision and machine learning, demonstrating the effectiveness of deep learning-based approaches in solving complex computer vision problems. The project's findings have the potential to impact various industries and applications.

IV. PROPOSED METHOD

The initial step in this project involves preparing the development environment by installing the essential Python libraries. This includes executing !pip install landingai and !pip install gdown, which are necessary for utilizing LandingAI's machine learning capabilities and for retrieving files from Google Drive. These tools form the backbone of the license plate detection and recognition workflow. Once the environment is set up, video footage captured using the DJI Mini 4 Pro drone is imported into the system. This footage provides the input data required for further processing. The drone's ability to capture stable, high-resolution video from elevated perspectives is advantageous for identifying and tracking vehicles in motion or across larger areas.

A. System Architecture

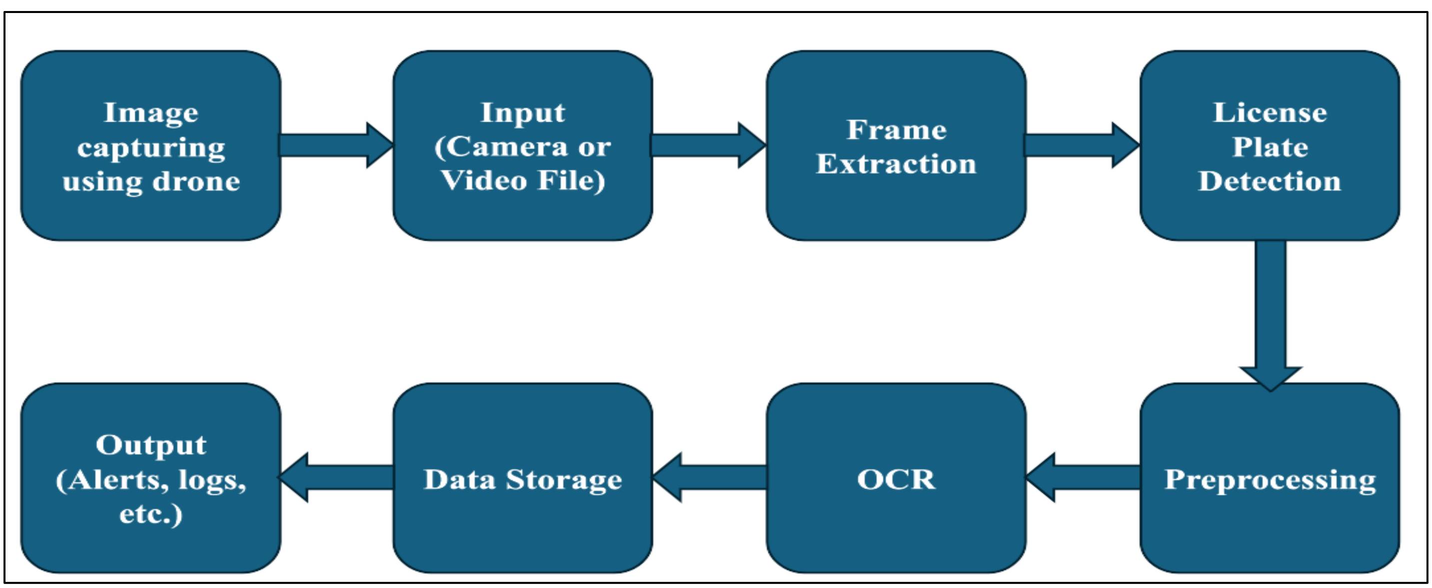

Fig 1: Block Diagram

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Following data acquisition, individual frames are extracted from the video. These frames are analyzed using OpenCV to detect and isolate the number plate region from the rest of the vehicle. After the region of interest is segmented, Optical Character Recognition (OCR) is performed using libraries like Tesseract or EasyOCR to convert the detected characters into digital text. To improve the reliability of the detection, LandingAI is incorporated into the pipeline. It assists in accurately identifying number plates, even under challenging conditions such as varying angles, lighting, or motion blur—common in aerial footage.

Finally, the recognized number plate data is transmitted to a cloud platform, enabling real-time storage and access as part of an IoT-based system. This cloud integration supports applications like vehicle tracking, automated access control, and traffic data analytics.

B. Components:

➢ *DJI Mini 4 Pro Drone*

In this project, the drone functions as a vital component for aerial monitoring and real-time data acquisition. Its ability to move freely and cover wide areas makes it far more versatile than stationary CCTV or traditional ground-based systems. This mobility allows drones to effectively observe vehicles in diverse environments and terrains.

Equipped with a high-definition camera, the drone captures continuous video footage of vehicles, whether they are in motion or parked. These visual inputs are then analyzed using computer vision models either on the drone itself or via connected edge devices. The elevated vantage point helps bypass common limitations such as visual obstructions, tight spaces, or traffic congestion that often restrict the performance of fixed surveillance systems.

➢ *The Drone's Main Roles in this System Include:*

- **Aerial Monitoring:** Routinely patrolling roads, parking areas, and secure zones to gather visual data on vehicular activity.
- **License Plate Recognition:** Acquiring sharp images of license plates from varying heights and angles, aiding accurate detection.
- **Data Transfer:** Sending collected visuals or extracted information wirelessly to a central processing unit for further analysis and storage.
- **IoT Connectivity:** Working in tandem with IoT devices to automatically update a cloud-based or centralized database with recognized vehicle information.

By acting as a dynamic aerial observer, the drone significantly improves the system’s coverage, flexibility, and efficiency. It is particularly valuable in places where permanent infrastructure is unavailable or in situations requiring rapid deployment, such as public events or emergencies. This approach also lays the groundwork for future enhancements like autonomous drone fleets, scheduled patrol routes, and integration into broader smart city ecosystems.

Fig 2: Dji Mini 4 Pro Drone

In this, the DJI Mini 4 Pro drone is used as the primary device for video data acquisition. This compact yet powerful drone is equipped with a high-resolution camera, making it well-suited for capturing detailed footage of vehicles and their number plates from an aerial view. The drone's ability to fly at various altitudes and angles allows it to record video across wide areas, which is essential for real-time surveillance and traffic monitoring in both urban and remote environments. The DJI Mini 4 Pro provides exceptional video stability and clarity, which are crucial for the later stages of number plate detection and text recognition. It captures smooth footage even while in motion, reducing motion blur and improving frame quality. This significantly boosts the accuracy of object detection and OCR processing. The drone can be flown manually or pre-programmed to follow a specific route, depending on the target monitoring area.

Using a drone offers major advantages over traditional, fixed surveillance cameras. It allows for dynamic monitoring across multiple lanes or large parking zones and can be easily deployed to new locations as needed. This flexibility makes the system highly scalable and practical for real-world applications like law enforcement, traffic regulation, and smart city projects. After recording, the video is transferred from the drone and uploaded to the project’s custom-built web application. The footage is then processed for vehicle detection and theft plate identification. By using the DJI Mini 4 Pro, the system benefits from lightweight portability, long flight time, and precise camera control, all of which contribute to better overall performance.

Furthermore, the drone's integration with the AI-powered backend ensures that data captured in real time is quickly converted into actionable insights. This helps authorities or system users respond immediately if a stolen vehicle is detected. The drone essentially acts as the mobile eye of the

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system, feeding accurate, high-quality data into the IoT-connected platform.

C. Software Implementation

The entire development process for the project was executed using **Visual Studio Code (VS Code)** — a modern, feature-rich code editor known for its speed, extensibility, and developer-friendly tools. VS Code served as the primary environment for coding, debugging, and testing the extension throughout the project lifecycle.

➢ *Why Visual Studio Code?*

- **Highly Extensible**: VS Code allows for seamless development of custom extensions through its robust API, making it ideal for building tailored functionalities directly into the editor.
- **Platform Independence**: Since VS Code runs efficiently across Windows, macOS, and Linux, it ensured that the extension could be built and tested on any system.
- **Integrated Terminal and Git Tools**: Built-in support for terminal operations and version control through Git helped streamline the development process without the need for external tools.
- **Advanced Debugging Features**: The editor includes built-in debugging capabilities, such as breakpoints and variable watchers, which made troubleshooting and fine-tuning the extension more efficient.

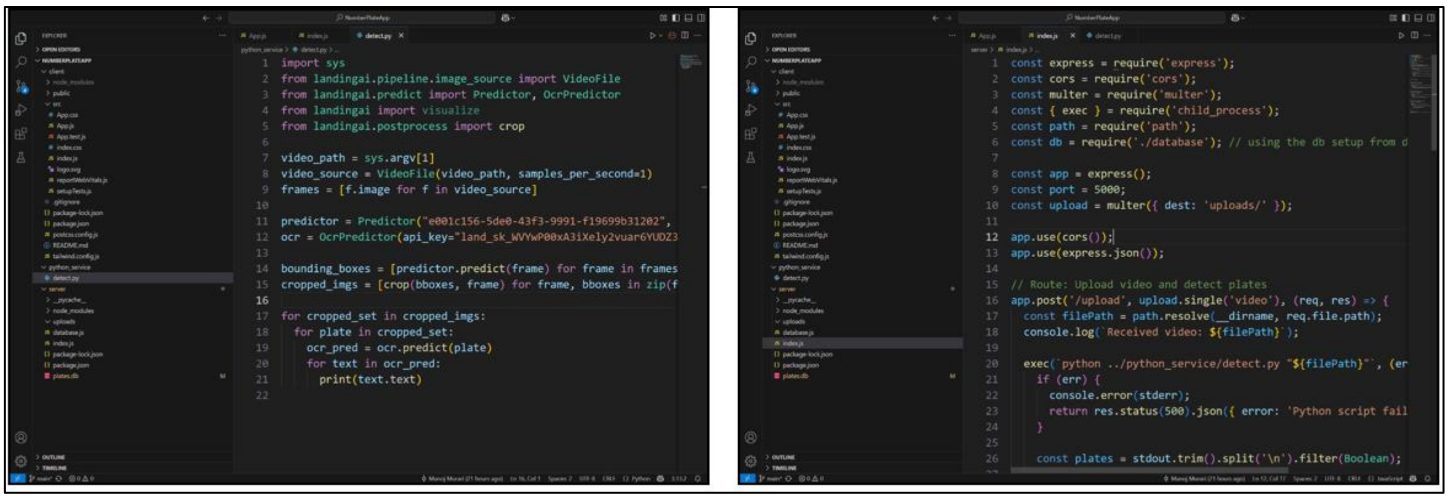

Fig 3: Code

➢ *Project Workflow and Process Explanation*

The core process of this project begins with the acquisition of video data using a drone-mounted camera. The drone captures aerial footage of vehicles on roads, providing a wide view that is ideal for surveillance and traffic monitoring. This video footage is then uploaded to a web-based platform that handles further processing. The uploaded video acts as the main input for detecting and identifying vehicle number plates. The system is built to automate the extraction of useful data from these videos using a combination of software tools and machine learning techniques.

Fig 4: Vehicle Identification

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Once the video is uploaded, it undergoes video processing, where the footage is split into individual frames using Python. Each frame is analyzed separately for vehicle detection. This step is important because object detection and text recognition typically operate on static images rather than continuous video. During this phase, techniques from image processing are applied to enhance frame quality, reduce noise, and highlight relevant features like the vehicle and its number plate. Filters and edge detection algorithms help isolate number plates from the rest of the frame.

After isolating the vehicle and its number plate, the system uses object detection algorithms to identify and extract the region containing the license plate. This is achieved using pre-trained models based on deep learning, such as YOLO (You Only Look Once) or similar frameworks. These models are capable of detecting vehicles and their plates with high accuracy. Once the license plate area is detected, it is passed on to the next step for character recognition.

Fig 5: Recongnised Number Plates

At this stage, Optical Character Recognition (OCR) plays a critical role. OCR techniques are used to read and extract the alphanumeric characters from the detected license plate region. Tools like Tesseract OCR or advanced AI-powered platforms like Landing AI are integrated to ensure accurate text recognition even under challenging conditions such as low lighting, blurred plates, or unusual angles. The recognized text is then formatted and stored as a detected number plate. The extracted plate numbers are automatically compared with a list of pre-registered theft vehicle numbers stored in a SQLite database. Before the video upload, users have the option to mark any vehicle number as "theft" using the interface. During the matching process, if any detected plate matches an entry in the theft list, the system triggers an alert. This alert appears as a popup notification on the website, and the matched plate is highlighted in red to draw immediate attention. This real-time alerting is vital for practical applications like law enforcement and public safety.

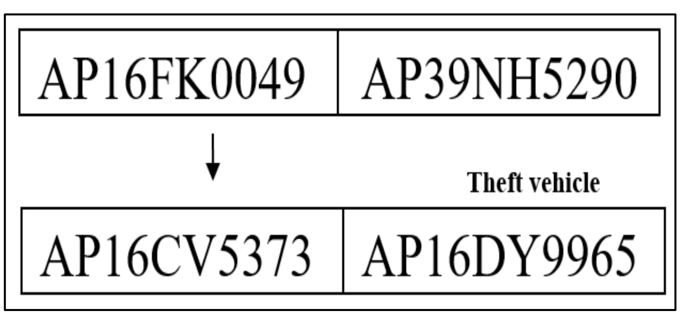

Fig 6: Final Number

Finally, the user interface, built using JavaScript, HTML, and CSS, presents all the results in a clean and interactive format. Users can view the uploaded video, check the progress of detection, and see a history of all identified plates. They also have control over the database, with options to remove or mark vehicles. This full-stack solution effectively combines drone technology, AI-based image analysis, and IoT data management to create a robust and practical system for automated vehicle monitoring and theft detection.

V. RESULTS

The implemented project presents an efficient system for automatic number plate detection using drone-captured footage, integrated with a web-based platform for real-time processing and theft vehicle identification. Initially, a drone records video footage of moving traffic, which is then uploaded to a custom-built website for further processing. This website, developed using Visual Studio Code, utilizes Python and JavaScript to handle both backend and frontend functionalities. The input video is processed on the platform to detect vehicle number plates using computer vision techniques. The high-resolution camera mounted on the drone successfully captured clear video footage of vehicles from various altitudes and angles. Using computer vision techniques and OCR, the system accurately detected and recognized number plates in real time, even under varying lighting conditions and backgrounds. The integration with IoT enabled seamless transmission of the recognized data to a centralized database, allowing for instant updates and easy access for monitoring purposes. The system demonstrated efficient performance in both static and moving

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vehicle scenarios, validating its effectiveness for real-world applications such as traffic monitoring, security surveillance, and vehicle tracking. Overall, the results confirm that the proposed approach is both feasible and reliable for enhancing automated vehicle identification and real-time data management.

Once the video is uploaded, Python handles the detection of number plates frame-by-frame, and the results are dynamically displayed on the website. Each detected plate is instantly shown in the "Detected Plates" section, allowing users to view all numbers captured from the video. These plate numbers are then automatically stored in a local SQLite database, which serves as the system's storage backend. Users have the ability to search, remove, or monitor these plate numbers from the database via the website interface, enhancing data control and management.

A key feature of the system is its ability to identify stolen or theft-marked vehicles. Before processing any video, users can input known stolen vehicle numbers into the system via the "Mark Theft Vehicle" field. These entries are stored securely in the SQLite database. During video processing, the system cross-checks all detected plate numbers against this list. If any theft vehicle number is detected, the system immediately triggers a visual red highlight and a popup alert on the interface to notify the user—ensuring prompt attention and response.

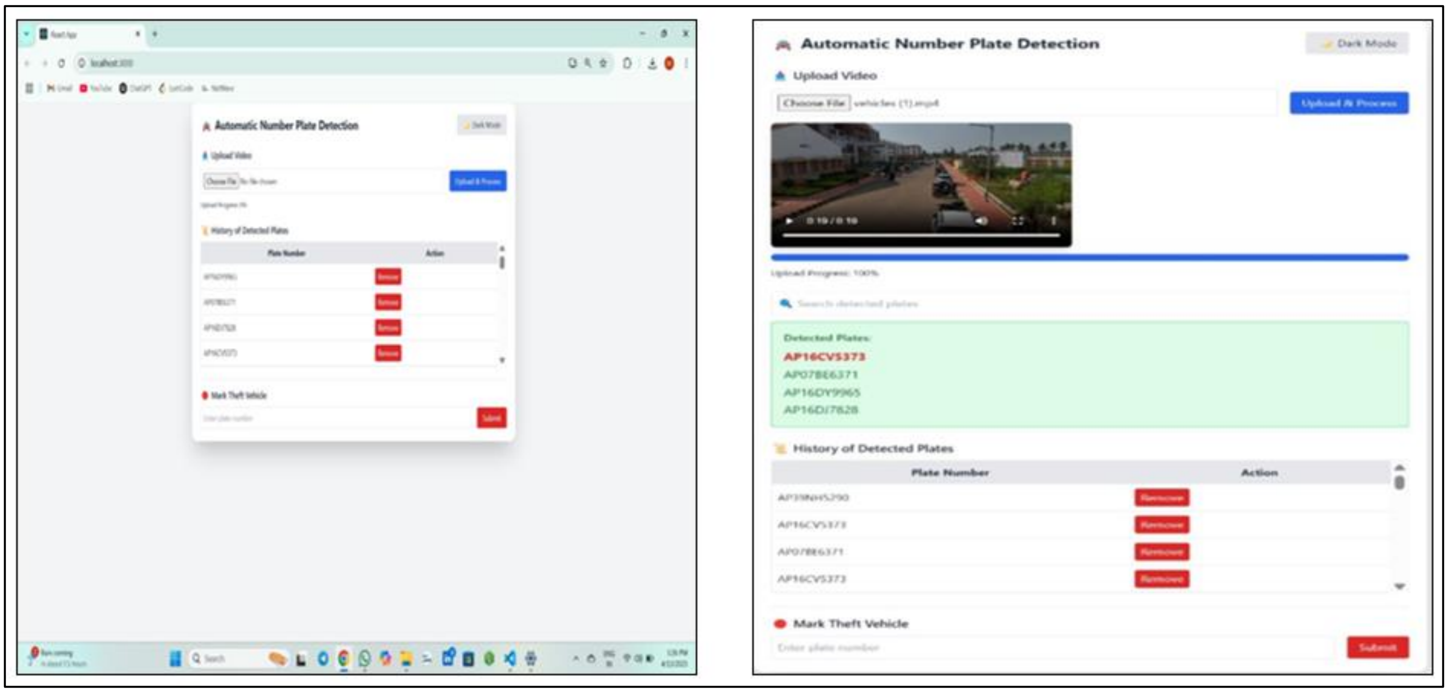

Fig 7: Final Result

Overall, the results demonstrate that the system effectively combines drone surveillance, real-time number plate recognition, theft vehicle detection, and smart database updating using IoT principles. The use of SQLite provides a lightweight yet reliable way to manage data locally. With accurate detection, instant alerts, and an easy-to-use web interface, the project proves to be a practical solution for traffic monitoring, law enforcement, and smart city applications.

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The development of a drone-based automatic number plate detection and database updating system using IoT represents a significant step toward modernizing traffic surveillance and vehicle monitoring. By combining the mobility of drones with the capabilities of computer vision and IoT integration, this project offers a flexible, efficient, and intelligent solution for real-time vehicle identification. The system effectively addresses the limitations of traditional ground-based surveillance by providing wider coverage, faster response times, and automated data handling. Through accurate license plate detection and real-time database updates, it supports various applications such as traffic law enforcement, security monitoring, and intelligent transportation systems. The use of machine learning models and OCR ensures high precision in recognizing license plates under diverse conditions. Overall, this project demonstrates how emerging technologies can be integrated to enhance public safety, improve traffic management, and support the development of smart city infrastructure. With further improvements and scaling, the proposed system holds great potential for real-world implementation and future innovation.

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B. Future Scope

The drone-based automatic number plate detection system integrated with IoT holds immense potential for future development and large-scale implementation. As advancements in artificial intelligence, drone technology, and IoT continue to progress, the system can be further enhanced to achieve greater efficiency and accuracy. In the future, drones can be equipped with onboard processing units to perform real-time number plate detection and recognition without relying heavily on external servers, thereby reducing latency and improving performance in remote or low-connectivity areas. The deployment of multiple drones operating in coordination can also enable wider area coverage, making the system suitable for large cities, highways, or critical zones like border areas and sensitive facilities.Further improvements in computer vision algorithms and machine learning models can lead to better recognition accuracy under challenging conditions, such as poor lighting, high-speed movement, or different license plate formats. Incorporating GPS and location tracking features will allow the system to log the exact location of each detected vehicle, enhancing traceability. Moreover, the project can evolve to include automated alert mechanisms for suspicious vehicles, traffic rule violations, or unauthorized access to restricted zones, enabling quick response by law enforcement authorities.

This system can also be integrated with existing smart city infrastructure, such as automated tolling systems, traffic signal networks, and central traffic control centers, contributing to a more intelligent and responsive urban transportation system. With such advancements, the proposed project has the potential to become a key component in the development of smart, secure, and sustainable cities of the future.

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