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AI-Driven No Parking Violation Detection and Fine Management System

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Abstract*— Illegally parked cars are a prominent cause of road safety issues as well as metropolitan traffic jams. This paper presents an artificial intelligence-based parking violation detection and fine collection system that employs object detection using YOLO-based and OCR technology for automatic plate number recognition. The system scans real- time camera feeds employing an integrated database to detect illegal parking, acquire vehicle details, and levy penalties. In addition to this, people can take and upload photos of illegally parked vehicles via a citizen-supported reporting system, which police agencies verify prior to issuing penalties. To maintain equity, the framework imposes a limitation that a vehicle is penalized just once per day for the same spot. The extensive database facilitates law enforcement's ability to find repeat violators and implement harsher penalties by following previous offenses. By combining AI and community outreach, the strategy improves traffic flow, alleviates congestion, and promotes correct parking behavior. In the end, this ingenuous enforcement tactic promotes safer and more effective urban mobility.

Keywords*—YOLO object detection, Optical character recognition (OCR), Traffic congestion reduction, Smart urban mobility, Illegal parking monitoring.

I. INTRODUCTION

Illegal parking is one of the common issues in cities, which generates traffic jams, congestion, and safety hazards. The human traffic police observation employed in the most traditional parking enforcement methods is time-consuming, labor-intensive, and subject to inefficiencies. The proposed study offers an AI-based Parking Violation Detection and Fine Collection System capable of automatically detecting and penalizing cars parked illegally in an effort to bypass such constraints. The system can automatically levy fines by identifying license plates from video feeds and fetching vehicle owner data from a database by harnessing cutting-edge technologies such as optical character recognition (OCR) and object detection with YOLO.

The system has a citizen-reporting capability that enables users to photograph illegally parked vehicles and submit them, along with the date and place of the occurrence, as well as real- time tracking. The reports are confirmed by law enforcement before fines are imposed. To avoid double fines for the same vehicle at the same spot on the same day, the system is programmed to avoid such occurrences. By utilizing a central database for tracking repeat offenders, the authorities can act against them more sternly.

By integrating artificial intelligence with community participation, this novel methodology improves traffic law enforcement, streamlines traffic, and encourages safe parking. By using automated observation and community participation, the suggested method offers a scalable and effective alternative to managing urban traffic, ultimately enhancing road mobility and safety.

II. LITERATURE SURVEY

In cities, illegal parking results in traffic jams and safety hazards, frequently necessitating a manual review of security footage. An automated approach for reliable vehicle identification utilizing YOLOv3 is presented in this research. Template matching and IoU computations to establish stationary time are used to accomplish movement tracking. License plate information is extracted by OpenALPR for the purpose of enforcing violations. High accuracy in detection, tracking, and plate recognition under a variety of situations is demonstrated by empirical results[1].

This solution ensures proper vehicle management in public spaces such as offices and institutes, even in the presence of increasing car traffic and unauthorized parking. It informs authorities through SMS when it finds unauthorized parking in restricted

zones and differentiates between authorized and non-authorized vehicles at gateways. Parking charges are made before leaving, and violations are penalized with fines. Also, when a vehicle approaches a designated parking lot, the parking lights illuminate [2].

This research applies an LSTM model to predict and compare parking infractions with real data in an attempt to examine how smart parking systems (SPSes) influence the mitigation of parking infractions. Based on the findings, there has been a significant reduction in violations since SPS went into effect, suggesting that monitoring in real-time has increased adherence. Policymakers and urban planners can enhance parking management strategies with the assistance of this research's findings [3].

Instead of costly permanent sensors, this paper proposes a data-driven crowdsensing system for detecting parking violations with mobile users. Although a deep reinforcement learning-based scheduling model tells users to monitor high- risk areas, a generative model predicts parking violation hotspots. The framework's accuracy and effectiveness in predicting and responding to parking violations are confirmed by simulations on real-world datasets [4].

A real-time video-based parking occupancy detection system reducing fuel consumption and traffic jam is demonstrated in this work. While integrating traffic law enforcement features, it effectively detects cars despite obstructions such as weather changes, occlusions, and illumination changes. Experimental results in a wide range of real-world situations exhibit more than 90% accuracy at 5 frames per second [5].

This initiative employs OpenStreetMap's geo-location information and footage captured via car windshield cameras to examine parking violations in Germany. Per 100m violations are forecast by a zero-inflated negative binomial model, which shows that shopping routes and areas with a higher number of points of interest have greater rates. For the purpose of improving urban planning as well as enforcement, the results indicate significant factors influencing illegal parking [6].

The paper outlines an on-line technique for the detection of illegally parked vehicles in outdoor environments. The technique applies one-dimensional image transformation to vehicle detection, thus simplifying detection and minimizing computational complexity. The method is effective in vehicle segmentation and tracking regardless of the weather and light conditions. The method was validated on video data sets and proven suitable for use in the field [7].

This article describes how IoT can be used in combination with cloud computing to avoid illegal parking. The system takes real-time geolocation data from the cars and reminds drivers of available or no-parking areas. There is smoother traffic flow through cloud processing, and the model keeps no- parking areas well-covered with low manual enforcement [8].

This research suggests an image-processing system for automatically detecting illegally parked vehicles. The system captures images of parked vehicles, extracts license plate numbers through Optical Character Recognition (OCR), and alerts the authorities. Real-time data transmission allows for rapid response time and enhances city parking enforcement. The solution is economical and scalable to illegal parking cities [9].

This paper suggests an automatic issue of vehicle-parking fines for vehicles parked at unauthorized locations. The system makes use of computer vision methods for vehicle detection and OCR to read the number plate details. The system cross-verifies the number plate with a database and issues an automatic fine to violators. The system is designed to make traffic control automatic and reduce human intervention in parking control [10].

III. METHODLOGY

No Parking Violation Detection and Fine administration System applies a systematic method combining computer vision, deep learning, optical character recognition (OCR), and database management to detect vehicle owners, detect parking offenses, and impose fines automatically. The approach includes a number of important steps: video input processing, database checking, text extraction through OCR, license plate and vehicle detection, and automated enforcement of fines. Each phase is required for the system to function correctly and optimally in real time.

3.1 VIDEO INPUT PROCESSING

The system is first provided with a live or tape feed from security cameras installed in no-parking zones. The cameras sweep the area to pick up live shots of parked or stationary vehicles. The video being fed in is scrutinized frame-by- frame to look for vehicles which have been motionless for a specified amount of time. To limit processing burden and ensure precise detection, the video processing method called frame extraction takes samples of frames at regular intervals. As needed, the frames are reduced in size or converted to grayscale to prepare for further processing.

3.2 VEHICLE AND NUMBERPLATE DETECTION

In order to detect vehicles in no-parking areas correctly, the system utilizes a YOLO object detection model, which is renowned for its real-time object detection. Due to the fact that the YOLO model had been trained on a specific set of cars and license plates, it is able to identify and detect cars and their license plates correctly within an image.

After a vehicle has been detected, the number plate bounding box coordinates are retrieved. The detected number plate area is clipped and handled independently for text recognition. Since license plates can be of any size, shape, and clarity, image preprocessing methods such as contrast enhancement, noise filtering, and edge detection are applied to enhance the accuracy of detection. The model is also altered to consider variations in lighting conditions, occlusions, and styles and fonts.

3.3 OPTICAL CHARACTER RECOGNITION FOR LICENSE PLATE EXTRACTION

OCR is used to convert alphanumeric characters to machine- readable text after successful extraction and detection of license plates. Tesseract OCR or EasyOCR, which have high accuracy in text recognition based on images, are both used in this method. For enhancing the performance of OCR, some of the preprocessing techniques are used to the cropped image of the license plate. While thresholding and binarization improve contrast between character and plate backgrounds and are hence more detectable, grayscale conversion simplifies images and removes colour-based noise.

For obtaining the proper and clean text extraction, subsequent to that morphological operations are used to refine character segmentation and remove undesired artifacts. Edge detection and contour analysis also help identify and separate individual characters to improve recognition accuracy. The image is processed and then forwarded to the OCR engine, which translates it into text carrying the registration number of the vehicle. To minimize errors, correct incorrectly classified characters, and ensure accuracy, a post-processing technique matches the recognized text against a database of known license plate classes.

3.4 VEHICLE OWNER IDENTIFICATION USING MongoDB.

After the license plate number has successfully been read, it is matched against a pre-existing MongoDB database that holds details of vehicles registered in the system. This database centrally stores the vehicle make and model, FASTag account details, owner name and contact details, violation history, and vehicle registration number. The system retrieves the relevant owner data from this database in real-time. When a match is obtained, the system acquires the information needed to continue with fine enforcement.

The car is flagged as unregistered and the accident is recorded for authorities to manually check when a license plate is not available in the database. By making sure that even cars not included in the database can be traced and dealt with accordingly, this minimizes the loopholes in violation detection. MongoDB facilitates smooth integration with automated fine management systems and allows rapid and efficient data retrieval. For the concerned authorities to further act on it, the system may also include notifications for recidivists.

3.5 AUTOMATIC FINE IMPOSING AND OWNER NOTIFICATION

Once the vehicle owner is determined, the system automatically triggers the fine enforcement process to maintain an uninterrupted penalty collection process.
If the vehicle has a FASTag account with enrolment, the penalty amount is automatically deducted from the corresponding FASTag balance.

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The owner is informed through email or SMS as soon as the automatic transaction has been recorded. This leads to immediate and secure processing of fines without any intervention from humans. But if the vehicle is not FASTag- enabled or there is a low balance in the FASTag, the system

defaults to another mode of notification. Under these situations, the registered owner is automatically sent a notice through WhatsApp, Telegram, or SMS specifying the parking violation and demanding payment of the penalty.

The notice has vital information such as the date and place of the offense, a picture of the car from the CCTV camera, the amount of the fine and payment date, and a secure link to an online payment portal for a prompt settlement. This dual enforcement system ensures that all those who violate the law are notified and taken to task by making payment centres easily accessible to those who violate the law.

3.6 VIOLATION TRACKING HISTORY

To provide for proper record maintenance for enforcement purposes, the system maintains a comprehensive database that logs every parking offense that it detects. Date, time, location, and the license plate number of the vehicle are all part of every entry. It also maintains a record of fine status, indicating whether the fine has been paid or not. The technology also tracks repeated violations by the same vehicle, helping law enforcement to identify repeat violators. Law enforcement can punish repeat violators more harshly by using this information, thus discouraging reckless parking. The stored violation history helps authorities identify areas of high risk that experience a lot of violations with the help of policy- making and predictive analysis. Through the assessment of patterns of violations, urban planners and law enforcement agencies can enact improved parking legislation and infrastructure development, hence decreasing instances of illegal parking and enhancing urban traffic control.

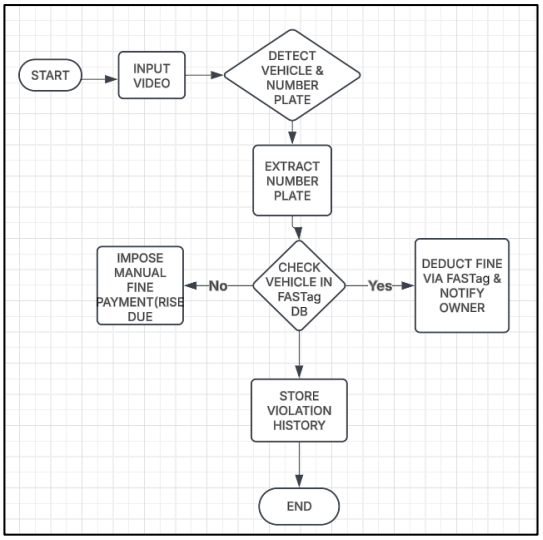

Fig. No. 3.1 Automated parking violation detection & fine enforcement process

3.7 COMMUNITY ASSISTED PARKING VIOLATION REPORTING SYSTEM

The system also features a user-reported parking violation feature via a special web portal, where citizens can assist in traffic discipline. If a user sees a vehicle parked illegally and blocking traffic, they can take a photo of the vehicle and license plate and post it on the website. In addition to a concise outline of the infraction, they also provide the location and time information for verification. Upon submission, police officers inspect the evidence uploaded, confirm the validity of the offense, and assess the information provided for accuracy. The system sanctions a vehicle only once per day for a specific region after verification in order to prevent the imposition of exorbitant fines for a single offense.

This reporting scheme based on citizens enhances public engagement with the law enforcement authority and minimizes the use of surveillance cameras. The solution integrates community-reported violations with real-time AI- based detection to build a more complete and efficient system of controlling parking offenses. The hybrid model guarantees wider coverage, enhances compliance, and enables enhanced traffic regulation and enforcement.

IV. RESULT AND DISCUSSION

The application of the AI-based parking violation detection system has shown remarkable

enhancement in detecting and processing parking violations. The object detection model based on YOLO is effective in detecting vehicles parked within prohibited areas, while the incorporated Optical Character Recognition (OCR) is effective in extracting license plate numbers for subsequent processing. The system is able to cross-correlate the extracted data against the MongoDB database to obtain the vehicle owner information, making possible automated fine imposition using FASTag and integration of RTO databases. The detection accuracy and OCR processing has been tested and certified using several test cases with high precision in actual usage scenarios.

One valuable addition to the system is the Community- Assisted Parking Violation Reporting System, which allows people to help the police by taking and sending pictures of vehicles committing parking infractions. Evidence, including photographs, license plate numbers, and descriptions of infractions, is entered by users through the web-based system. Police officers verify the location and time of the reports entered before they send out fines. To prevent abuse and excessive fines, the technology is such that a particular vehicle is fined only once a day for a particular zone. This citizen-involving method increases the efficiency of the system with greater coverage and instantaneous detection of violation.

Every violation that is detected is tidily logged in the system's centralized database, which also takes note of important details like date, time, place, and fine status. This enables the police to track repeat offenders and penalize frequent offenders more severely in an effort to discourage future violations. Secondly, the data collected makes it easier to perform predictive analytics and allows law enforcers and urban planners to identify high-risk areas where illegal parking is probable. Through analyzing such patterns, local authorities are able to handle traffic flow and infrastructure better to avoid future violations.

When paired with public participation, the AI-based system offers an effective and holistic means of detecting parking violations and imposing fines. It has been shown that combining real-time AI-driven monitoring with public participation is an effective method that increases parking law compliance while minimizing the necessity for manual enforcement. The method improves traffic flow and urban mobility planning as well as road etiquette.

Fig no 4.1: Number plate detection & fine notification

V. CONCLUSION

AI-based parking violation detection systems offer an effective and automated means of enforcing parking regulations when complemented with community engagement. The system correctly detects violations and levies fines instantly using OCR for license plate recognition, YOLO-based object detection, and database integration. The feature of citizen-reporting assisted by the general public to help with maintaining peace adds to the coverage. The application of organized databases to monitor repeat offenders facilitates enhanced compliance and strictly enforces the law. The process significantly minimizes illicit parking, facilitates traffic, and enhances metropolitan mobility alongside simplifying the administration of fines. AI is joined with public engagement to facilitate better road safety and a smoother traffic flow so as to develop a more efficient and organized traffic environment.

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