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FAKE AND STOLEN NUMBER PLATE DETECTION SYSTEM

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ABSTRACT
In an effort to combat the growing problem of fake and stolen vehicles, this paper presents a novel Automatic License Plate Recognition (ALPR) application that utilizes a powerful combination of deep learning, image processing and optical character recognition. The system leverages a trained YOLOv8 deep learning model for real-time object detection within video or image streams. This model efficiently detects both license plates and vehicle types, providing crucial data for subsequent processing. Extracted license plate regions are then subjected to pre-processing techniques to enhance image quality and facilitate accurate character recognition. The pre-processed license plate images are then fed into a Kera's-OCR engine, which accurately extracts characters from the license plate. Firstly, the extracted license plate number and corresponding vehicle type are meticulously cross-referenced against a comprehensive registered vehicle database. This step verifies the legitimacy of the plate and ensures it matches the characteristics of the registered vehicle. Any discrepancies or mismatches between the extracted data and the database records trigger an alert, indicating a potential case of a fake license plate. Secondly, the system performs a critical check against a dedicated stolen vehicle database. If a match is found between the extracted license plate number and the stolen vehicle database, another alert is immediately sent to the authorities, allowing for the prompt identification and apprehension of stolen vehicles. To ensure real-world applicability and user-friendliness, the proposed system is implemented as an application using flutter.

Keywords
YOLOv8, Object Detection, Optical Character Recognition, Keras ocr, Computer Vision

I. INTRODUCTION

The transportation landscape in India is undergoing a significant transformation, with a dramatic rise in the ownership and usage of personal vehicles. Recent data reveals that the total vehicle population has surged past an unprecedented 300 million mark, with personal vehicles accounting for a significant majority, estimated at approximately 80% of the total. While this trend reflects increasing prosperity and social mobility, it also presents a major challenge to the nation's infrastructure and public safety. The exponential growth in vehicles has led to congested roads and gridlock, particularly in urban areas. Major cities like Delhi, Mumbai, and Bangalore grapple with daily traffic snarls, with commuters collectively spending an astounding 8.5 billion hours stuck in traffic annually, according to recent estimates. This translates to an average of 72 hours per year per individual, a staggering loss in productivity and quality of life. Statistics reveal that India witnesses over 150,000 road fatalities annually, with millions more sustaining injuries. Higher traffic density leads to a higher risk of collisions, exacerbating the already alarming rate of road accidents in India. These accidents often result in injuries, fatalities, and significant economic losses. Vehicular emissions from personal vehicles contribute significantly to air and noise pollution, negatively affecting public health and the overall environment. The usage of vehicles with fake number plates contributes to the escalation in personal vehicle ownership, exacerbating the challenges faced by India's transportation infrastructure and public safety. This illicit practice not only enables individuals to evade regulatory scrutiny but also hampers efforts to accurately track vehicle ownership and enforce traffic regulations. The proliferation of vehicles with counterfeit number plates complicates law enforcement efforts, making it harder to identify and penalize traffic violators. Moreover, it fosters a culture of impunity, where offenders feel emboldened to flout regulations, further exacerbating congestion, accidents, and pollution on Indian roads. The widespread use of fake number plates thus represents a significant impediment to effective traffic management and underscores the urgent need for stringent measures to curb this unlawful behaviour.

Traditional methods are often inadequate and inefficient in dealing with the sheer volume of vehicles and violations. Therefore, the development and implementation of innovative technology-driven solutions become imperative. In response to this critical need, the Automatic License Plate Recognition (ALPR) system emerges as a promising and innovative solution. This Automatic License Plate Recognition System combines the applications of deep learning, optical character recognition and image processing technologies to accurately detect, extract and verify the vehicle numbers with the database of registered and stolen vehicles, any discrepancies or mismatches between the extracted data and the database records trigger an alert to the authorities.

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II. RELATED WORKS

P. Prabhakar, Anupama. P., & Resmi. S. R.has proposed an "Automatic Vehicle Number Plate Detection and Recognition" model. This paper on car license plate detection (CLPD) utilizes a unique methodology that involves a fast vertical edge detection algorithm (VEDA) based on grayscale contrast, adaptive thresholding (AT), and an unwanted line elimination algorithm (ULEA) . This approach aims to efficiently extract license plate information by enhancing the speed of the detection process through the use of these algorithms. The system also incorporates automatic number plate recognition (ANPR) techniques such as character recognition, Hough transform, horizontal projection profile, and image preprocessing methods like median filtering. The technology employed in this system includes image manipulation, character recognition, and real-time processing capabilities for license plate extraction and recognition . By combining these technologies, the system is designed to be efficient, fast, and cost-effective for real-time applications. The proposed methodology also focuses on reducing computation overhead and introducing parallelism into the design to enhance efficiency.[1]

C. N. E. Anagnostopoulos, I. E. Anagnostopoulos, V. Loumos, and E. Kayafas has proposed "A license plate-recognition algorithm for intelligent transportation system applications". The paper discusses the development of a new algorithm for vehicle license plate identification using adaptive image segmentation and neural network character recognition. The authors tested the algorithm on natural-scene vehicle images and achieved an 86% success rate. The algorithm involves steps for license plate detection, character segmentation, and character recognition, utilizing a novel adaptive segmentation technique called SCWs and implementing neural networks for character recognition. Connected components analysis (CCA) is used for license plate segmentation, and a Probabilistic Neural Network (PNN) is employed for character recognition. The system was tested on various sample sets with different lighting conditions, showing high accuracy but facing challenges with character misclassification and varying environmental conditions. The algorithm was implemented in Visual C++ with low computational requirements. The paper also discusses errors in neural network recognition performance and suggests incorporating rule-based methods for accuracy improvement. The technologies used in the paper include adaptive image segmentation, neural networks, image processing techniques, connected components analysis, and Probabilistic Neural Networks (PNN).[2]

H. Karwal and A. Girdhar has proposed a "Vehicle Number Plate Detection System for Indian Vehicles". The Vehicle Number Plate Detection (VNPD) System algorithm presented in the paper utilizes template matching with modified Otsu's method for threshold partitioning to reduce scale variance . The system consists of several modules, including image pre-processing, candidate area extraction, and character recognition. In the image pre-processing module, the input image is converted to grayscale and noise is removed using a median filter . The image is then cropped to the region of interest and irrelevant information is removed to prepare it for further processing. The candidate area extraction module locates and extracts the number plate area from Indian vehicles. This is achieved by detecting components in the image and identifying the exact number plate area for further analysis. The components are detected by scanning the pixels from left to right in a top-down fashion and storing the information of connected pixels of similar intensity in a set.The character recognition module utilizes template matching with Normalized Cross Correlation for accurate character recognition with an impressive accuracy rate of 98.07% . This module is crucial for identifying and retrieving characters from the number plate area. While neural networks can also be used for character recognition, they require extensive training and expertise for satisfactory results.[3]

Thapliyala, T., Bhatt, S., Rawat, V., & Maurya, S.had proposed an “Automatic License Plate Recognition (ALPR) using YOLOv5 model and Tesseract OCR engine”. This paper presents a comprehensive study on the implementation of Automatic License Plate Recognition (ALPR) utilizing the YOLOv5 model and Tesseract OCR engine for the identification of vehicle owners and the enforcement of traffic laws. The methodology outlined in the research involves a systematic approach encompassing data collection, preparation, character recognition, and integration to enable real-time license plate identification. Through simulation results, the effectiveness of the system in successfully identifying license plates under diverse lighting conditions is demonstrated. The study also delves into the development of an automatic car plate system that leverages license plate recognition technology. By employing a range of image processing techniques, the system is capable of detecting and identifying vehicles based on their number plates. Extensive testing has validated the system's proficiency in detecting and identifying license plates across varying lighting conditions. [4]

Poorani, G., Krishnna, B. R. K., Raahul, T., & Kumar, P. P has proposed “Number Plate Detection Using YOLOV4 and Tesseract OCR”. The paper presents a system for automatic license plate recognition using YOLOv4 and Tesseract OCR. It achieves high accuracy rates of 92% in plate detection and 81% in character recognition. Unlike previous studies limited to controlled environments or specific plate formats, this system aims to handle various plate designs and fonts, including non-standard Indian plates. The system comprises three main phases: compiling a dataset, image processing and segmentation, and character recognition. The character recognition process involves neural networks and statistical classifiers to address challenges such as incorrectly segmented characters and missed characters. The proposed system utilizes YOLOv4 for plate detection, which involves a backbone architecture and a neck and head structure for feature extraction and prediction . The system also includes preprocessing steps such as gray scaling to reduce image complexity and improve processing efficiency. [5]

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III. METHODOLOGY

This section details the methodology employed in developing a system for detecting fake and stolen number plates using deep learning, video processing, and image processing techniques.

A. *Data Acquisition*

To train and evaluate our system effectively, we curated a diverse image dataset containing vehicles with license plates from various regions (e.g., different states/countries) encompassing real-world variations in lighting, backgrounds, and vehicle types. We utilized a publicly available dataset as a foundation. Additionally, we obtained access to databases containing registered vehicle information (license plates, types) and reported stolen vehicles (license plates, descriptions) for real-world verification during the matching process.

B. *Preprocessing*

To prepare the image dataset for optimal YOLOv8 training, we applied a preprocessing pipeline. This included meticulous annotation of both vehicle types and license plates for ground truth data. Additionally, image enhancement techniques (e.g., auto-orientation, resizing) improved dataset quality and consistency. Finally, the pre-processed data was converted to the YOLOv8 format for seamless training integration.

C. *Deep Learning for Core Functionalities*

YOLOv8, a deep learning model suited for real-time object detection, is employed to achieve the system's core functionalities: detecting license plates and classifying vehicle types within images. The pre-processed dataset, containing labelled vehicle types and license plates, trains the YOLOv8 model, enabling it to distinguish these features in real-world scenarios.

D. *License Plate Processing*

To extract vehicle registration numbers, YOLOv8's bounding boxes precisely crop license plates from the images. These cropped images then undergo a multi-step preprocessing pipeline for optimal character recognition. This pipeline may include techniques like normalization, colour conversion, noise reduction, and contrast enhancement to improve the clarity of the characters. Finally, the pre-processed license plate images are fed into a pre-trained Keras-OCR model, which extracts the vehicle registration number from the plate.

E. *Verification and Alert Generation*

Extracted vehicle registration numbers and types are verified against registered vehicle databases to identify inconsistencies (e.g., mismatched details) potentially indicating fake license plates. Alerts for such cases are directed to the motor vehicles department. Additionally, the system cross-references extracted numbers with stolen vehicle databases, triggering alerts for potential stolen vehicles and notifying the relevant law enforcement agency for immediate action.

F. *System Integration and Alert Management*

For real-world deployment, the system integrates the processing steps into a unified pipeline. It handles video inputs by extracting frames and applying the image processing pipeline for real-time analysis of license plates and vehicle types. Additionally, an alert system is designed to communicate potential detections:

1) *Real-time notifications:* In critical cases (e.g., stolen vehicle detection), alerts are sent immediately to relevant law enforcement agencies.

2) *Flagged data storage:* The system can store flagged data (images, extracted vehicle information) for authorized personnel to investigate potential fake license plates or suspicious activity.

G. *Evaluation*

For real-world deployment, the system integrates the processing steps into a unified pipeline. It handles video inputs by extracting frames and applying the image processing pipeline for real-time analysis of license plates and vehicle types. Additionally, an alert system is designed to communicate potential detections:

1) *Metrics:* The performance of the system is evaluated using metrics like precision, recall, and F1 score to assess its accuracy in detecting fake and stolen license plates.
2) *Testing on Unseen Data:* The model's generalizability is tested on a separate dataset not used for training to ensure its effectiveness in real-world scenarios.

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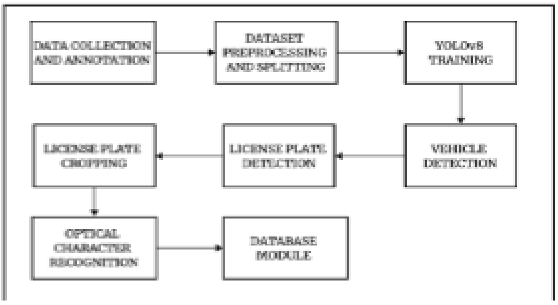

Fig. 1. Flow Diagram

IV. IMPLEMENTATION

This paper introduces an automatic vehicle license plate recognition system designed to detect both theft and fraud. The system leverages two key technologies: You Only Look Once v8 (YOLOv8) for real-time vehicle and license plate detection and Optical Character Recognition (OCR) for character extraction from the detected plates.

A. Data Annotation and Preprocessing

1) *Annotation:* The initial data preparation involves meticulous annotation of the vehicle image dataset using the Roboflow annotation tool. This process creates ground truth data for the YOLOv8 model by manually drawing bounding boxes around both vehicles and license plates within the images.

2) *Preprocessing:* The annotated dataset undergoes a standardized preprocessing pipeline using the Roboflow platform to ensure optimal training for the YOLOv8 model. This pipeline incorporates the following steps:

   a) *Resizing:* Images are resized to a consistent dimension, such as 640 x 640 pixels. This standardization simplifies data handling and model training.

   b) *Auto-orientation:* Images are automatically oriented to correct for potential skewing or rotation issues. This step improves the consistency of the dataset and avoids introducing biases due to orientation variations. *These preprocessing steps are implemented within the Roboflow environment, leveraging its capabilities for efficient data annotation and management.*

Fig. 1. Annotated images

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B. Dataset Conversion and Model Specification

1) Dataset Conversion: Following preprocessing, the dataset is converted into a format compatible with the YOLOv8 framework. This conversion process involves creating a YAML configuration file that defines essential training parameters. The YAML file specifies:

a) *Number of Classes:* The number of classes the model will be trained to identify. In this case, the value is 19, representing types of vehicles and license plate.

b) *Class Names:* A corresponding list containing human-readable names for each class like "Motorbike", "Sedan", "SUV", "license plate".

This YAML configuration file serves as a blueprint for the YOLOv8 model during the training process.

2) Model Specification: To achieve optimal training efficiency and performance, the preprocessed dataset is further divided into training, validation, and testing sets using a predefined split ratio. A common split is 70% for training, 20% for validation, and 10% for testing. This standard split ensures the model is trained on a comprehensive dataset while reserving portions for validation (monitoring training progress) and testing (evaluating final model performance on unseen data).

C. Training the YOLOv8 odel

The training data is fed into the YOLOv8 model, initiating the training process. During this stage, the model learns to detect the region of interest (ROI) within the images – specifically, the vehicle license plate. The model iteratively analyzes the training data, progressively refining its ability to accurately pinpoint license plates in new images.

D. Vehicle and Number Plate Detection

The YOLOv8 model takes an input image/video containing a vehicle. This input can be captured from a traffic camera, security surveillance system, or any other source. The pre-trained YOLOv8 model swings into action, analyzing the input image. Based on its training, the model identifies objects within the image and predicts bounding boxes around them. Model initially identifies the type of vehicle and then locate the license plate on the vehicle. The model will locate the bounding box corresponding to the license plate in the image. Once the license plate is identified it extracts the cropped image of the detected license plate from the original image. This cropped image becomes the new focus, containing only the license plate for further processing.

E.OCR Character Extraction

The cropped license plate image, often containing variations in lighting, angles, and potentially unclear characters, is fed into an OCR engine. A powerful tool like Keras-OCR is employed to decipher the alphanumeric characters present on the license plate. The OCR engine meticulously analyzes the image, recognizing and extracting each character from the plate. The extracted characters are converted into a text string.

E. Verification against Database

The text string is compared against a database of registered vehicles. This database holds information on all legally registered vehicles. If there's no match between the extracted characters and the registered vehicle database, it raises a red flag, indicating a potential case of a fake license plate.The extracted characters are then checked against a separate database of stolen vehicles. . If a match is found between the extracted characters and the stolen vehicle database, it signifies a critical situation – a stolen vehicle has been identified.

F. Alert Generation

Based on the verification results, the system triggers appropriate alerts. In the case of a potential fake license plate, an alert is sent to the Motor Vehicle Department, enabling them to investigate the vehicle further. For a stolen vehicle match, a critical alert is immediately dispatched to the police department, providing them with valuable information to apprehend the vehicle and potentially recover it.

This real-time license plate recognition system, coupled with intelligent verification and alert generation, offers a powerful tool for enhancing security and streamlining traffic management. By automating the process of license plate identification and verification, the system can significantly improve response times and contribute to a safer environment.

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V. CONCLUSION

The conclusion of a fake and stolen number plate detection system would likely emphasize its effectiveness in enhancing security and law enforcement efforts by accurately identifying vehicles with fraudulent or stolen plates. It would highlight the system's ability to reduce crime rates, improve public safety, and streamline the process of apprehending offenders. This system would reduce the hardship of manually detecting the status of a vehicle.

As for future scope, advancements in technology could further enhance the system's capabilities, such as integrating artificial intelligence for more accurate detection and predictive analysis to preempt criminal activities. Additionally, collaboration with law enforcement agencies and policymakers could lead to the implementation of regulations mandating the use of tamper-proof number plates or incorporating unique identifiers for each vehicle to prevent theft and fraud. Moreover, expanding the system's coverage to include other forms of vehicle identification, such as facial recognition for drivers, could provide a more comprehensive approach to security and enforcement. If the database of stolen vehicles across the country is integrated into one database, then the stolen vehicles which are transferred across the state borders could also be reduced.

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