

Deep Learning for Vehicle Classification and Identification for Security

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Abstract – With the adding demand for intelligence business monitoring and enforcement, deep learning has emerged as an important tool for vehicle classification and identification in security applications. This system presents a comprehensive approach toward processing and recording traffic video footage for vehicle detection, classification, tracking, and identification. This system leverages deep knowledge models for object detection and optical character recognition (OCR) to extract vehicle attributes, including type and license plate number. speed estimation technique caters the tracking of vehicle with accuracy.

Keywords: CV; OpenCV; Segmentation; Video Detection; Image analysis, YOLOv8, YOLO v4

I. INTRODUCTION

In today's urban areas, maintaining vehicle security necessitates the implementation of advanced identification and detection systems. Deep learning has become a formidable tool for automated vehicle recognition, facilitating applications like surveillance, access control, and traffic monitoring. This study presents the findings. A cutting-edge security system, utilizing advanced deep literacy models for vehicle identification and detection, has been developed to bolster security measures [1,4].

Vehicle identification and detection play a vital role in making sure that ensuring security in modern transportation systems. One of the go-to approaches for vehicle recognition is License Plate Recognition which utilizes Optical Character Recognition (OCR) to extract vehicle registration details from license plates [3].

Vehicle counting and classification using open cv and Yolo is an advanced computer vision project that seeks to transform surveillance systems through innovative technology. This advanced system utilizes state-of-the-art technology to identify, quantify, and categorize vehicles in real-time, either

from video feeds or camera streams. At its core, open cv (open- source computer vision library) serves as the fundamental framework for working with images and computer vision tasks. It offers a complete range of tools for analyzing images and videos, making it an excellent choice for managing the intricate visual data involved in vehicle tracking. The process starts by collecting video recordings from security cameras or traffic sensors [1,2].

II. LITERATURE SURVEY

1) *YOLO Based Vehicle Detection and Counting for Traffic Control on Highway (2024)*: This system by Rakesh Kumar and team (2024) introduces a smart, low-cost system that uses CV and AI to detect and count vehicles on highways. It works by analyzing video footage to separate moving vehicles from the background, then classifies them into types like cars, trucks, or bikes. This approach helps improve traffic management and planning without needing to interrupt road operations.[1].

2) *Vision-based vehicle detection and counting system using deep learning in highway scene (2024)*: Huaiyu Li and colleagues (2024) developed an AI-powered system that smartly detects and counts vehicles on highways. They first split the road image into near and far areas to boost accuracy, especially for smaller vehicles. Using YOLOv3 and the ORB algorithm, the system identifies vehicle types, tracks their movement, and even figures out their driving direction. Tests on real highway footage showed impressive results.

III. METHODOLOGY

A. System Architecture

This system of classification and identification of vehicles for security purposes collects video data of

the traffic scene and then extracts and divides the road surface area. Rephrase Deep learning-based approach for detecting objects in images or videos is employed to determine the presence of vehicles in a highway traffic scene [1,4]. Finally, ORB feature extraction is applied to each detected vehicle to help with multi-object tracking and to collect detailed traffic information. To better understand vehicle movement, the system also separates the road area from the rest of the scene using a road surface segmentation method. Based on the camera's viewpoint, the road is then divided into two zones — one closer to the camera (nearby area) and one farther away (remote area) [1,4].

This system of classification and identification of vehicles for security purposes collects video data of the traffic scene and then extracts and divides the road surface area. Rephrase The Yolov8 Deep Learning object detection method is employed to determine the presence of vehicles in a highway traffic scene [1,4]. Finally, the process of extracting the orb feature is carried out on the detected vehicle box to complete multi-object tracking and gather information about vehicle traffic. The road surface segmentation method isolates the road area within the highway. The road area is divided into two sections based on the camera's location: remote and nearby areas. Then, the vehicles in the two road areas are identified using the Yolov8 object detection algorithm [1,4].

This system also contains the tracking system of the vehicles from the video feeds uses multi object tracking of vehicles using ORB(Oriented Fast and Rotated BRIEF) which is used for feature extraction [1]. Finally, it draws output in the form of analysis

and reports from the video feeds and algorithms used in the projects. it gives reports such as vehicle model, vehicle tracked, etc.

B. Object Detection(YOLO model)

Yolo, or you only look once, is a widely used real-time object detection algorithm. Rephrase Yolo make the task easier by utilizing a single Neural network for accomplish both object classification and estimation of bounding boxes for detected objects. Therefore, it is highly optimized for object detection and can work much more quickly than running two distinct neural networks for detection and classification. Yolo divides the resized image into a grid, usually consisting of a 7x7 or 13x13 grid, depending on the specific version of yolo being utilized. [1,4].

In YOLO (You Only Look Once), every grid cell on the image doesn't just predict one thing—it actually generates multiple bounding boxes (usually 2, 3, or 5 per grid cell). Each of these boxes is described using coordinates: the center point (x, y), along with the width and height of the box then comes the smart part—YOLO uses a confidence score to figure out whether there's actually an object inside that grid cell or not. If it thinks there is, it assigns a probability to it. The bounding box values (bx, by, bw, bh) help define how big the object is and exactly where it sits in the image. When it comes to identifying what the object is (like a car, person, or bike), YOLO uses class probabilities. For example, if it's a car, it might set $c_2 = 1$, while c_1 and c_3 (other object types) would be 0—meaning YOLO is confident it's a car and not something else.

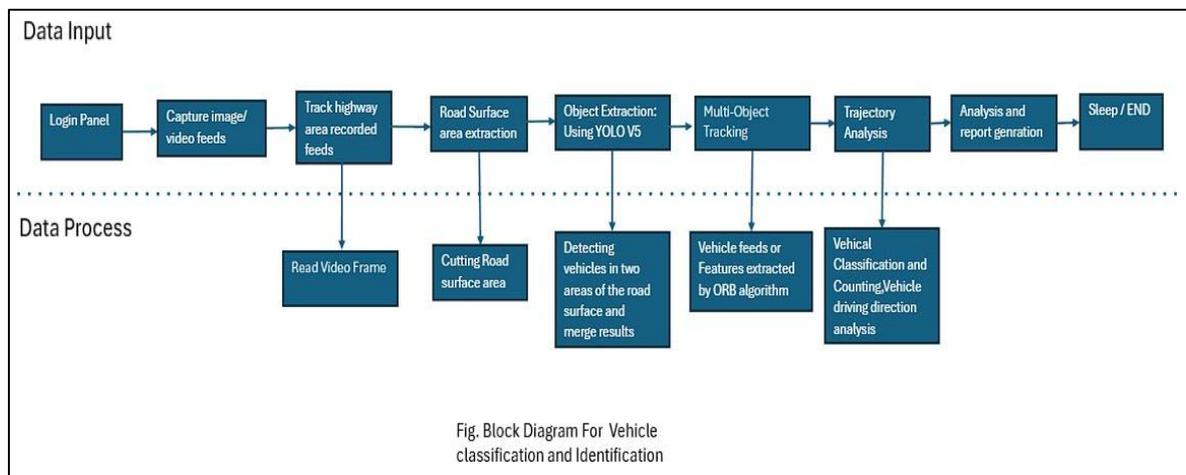


Fig. Block Diagram For Vehicle classification and Identification

C. System flow

The system flow is categorized into 2 phases User and Admin phase. User phase is inactive and keeps the video feeds and admin phases comprises various sub modules they are:

Data Collection: Gather diverse vehicle images and videos from surveillance cameras or public datasets. Ensure data includes various vehicle types, angles, and environmental conditions.

Data Preprocessing: Extract frames from video feeds. Normalize and augment the data (e.g., resizing, color adjustments) to enhance model training.

Model Selection: Choose appropriate deep learning models for vehicle detection (YOLO) and classification (CNN). Research and select OCR technology for license plate recognition if applicable. [1,2].

Model Development: Prepare the model to recognize object to identify vehicles in images and videos. Develop and train the classification model to categorize detected vehicles.[2].

Vehicle Detection Module: Leverage pre-trained Deep neural models such as YOLO or Faster R-CNN for vehicle detection. These models will detect all vehicles within each frame and output bounding boxes around the detected vehicles.[2].

Vehicle Classification Module: Utilize CNN-based models (e.g., ResNet, VGG) to classify the detected vehicles into predefined categories. Vehicle types such as Cars, Trucks, Buses, Motorcycles, Vans, etc. Once vehicles are detected, the system will classify them in batches, assigning a label (category) to each detected vehicle. [1,2].

Vehicle Identification Module: Using a Deep neural model trained to detect vehicle make and model built upon visual cues (e.g., logos, shapes, and structural features).The identification process is applied after classification to each batch of detected vehicles.[3]

Vehicle Tracking Module: The tracking module links the vehicles identified in several frames to track their movement over time. Deep SORT or Kalman Filter algorithms can be used to track vehicles across batches of frames. This ensures that the same vehicle detected in multiple frames is

assigned a consistent identity, even when moving through different parts of the footage [3].

Analysis and Report Generation: It includes all the details regarding vehicles passing in the video feed and analyze the feed and generate the report based on video feed such as (vehicles passed, vehicle models, tracks the vehicle etc...

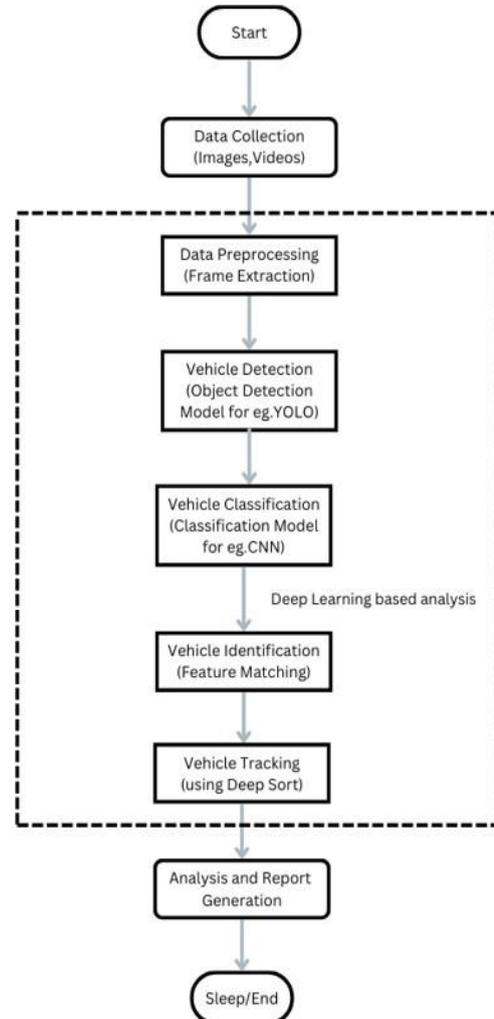


Fig System Flow for vehicle identification and classification

IV. RESULT ANALYSIS



Fig .Login panel

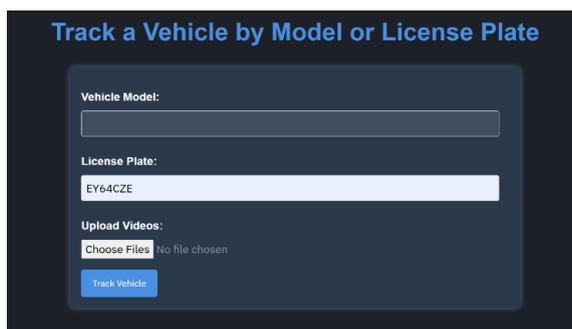


Fig. License plate tracking

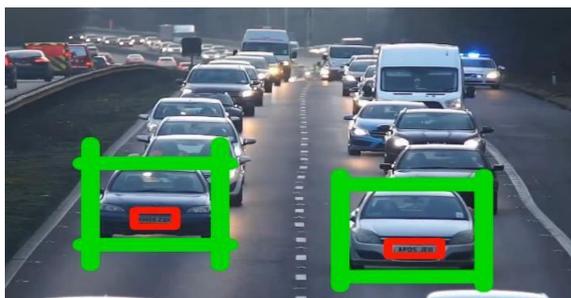


Fig. Vehicle identification

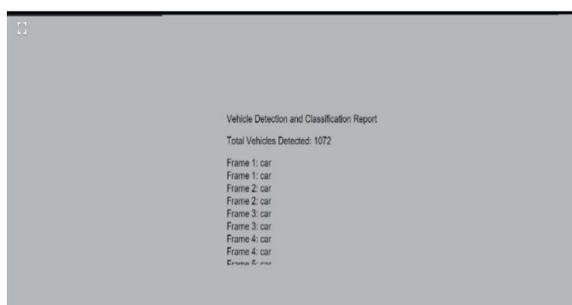


Fig. Report Genration

V. CONCLUSION

For vehicle classification and identification to enhance traffic monitoring and security enforcement. By leveraging the YOLOv8 object detection algorithm and ORB-based multi-object tracking, the system effectively detects, classifies, and tracks vehicles from recorded traffic footage. The integration of convolutional neural networks (CNNs) for vehicle model classification and speed estimation further enhances its capabilities. We have collected videos of traffic to feed of the system. The tracking system in this model helps to build security in the project. It can tracked vehicles continuously over several video frames of the car from the given video feeds and can give the report of the specific car from the video feed. The system of Deep Learning for vehicle classification and identification in security systems presents a powerful and scalable solution that significantly improves the efficiency.

VI. FUTURE SCOPE

The future of deep learning-powered vehicle detection systems is full of exciting possibilities, especially for improving security. As the technology becomes smarter and more efficient, it'll be able to handle tough conditions like heavy traffic or changing lighting. Adding features like anomaly detection could help spot unusual vehicle behavior in real time. By combining video with data from GPS or RFID, these systems could track vehicles more accurately over large areas. With edge computing, they can even run smoothly on devices without needing constant cloud access—making them faster and more reliable in real-world situations. Since it is deep learning based system we are trying to get buffer included system in the future.

VII. REFERENCES

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