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Automated Vehicle Detection and License Plate Recognition Leveraging YOLOv7 and EasyOCR

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ABSTRACT: Due to the increasing demand in intelligent transportation systems, various research and development work occurred in the field regarding automated vehicle detection, tracking, and license plate recognition. This paper proposes a robust framework applying the YOLOv7 algorithm for real-time vehicle detection, counting, tracking, and license plate recognition. It is considered a modular pipeline where it determines and classifies the vehicle, tracks it in frames of the video to make correct counts, and later applies EasyOCR for recognition of license plates. It has also been experimentally tested over varied datasets, examining how the system performs with changing environmental factors like lighting conditions and traffic. The approach has a high accuracy, precision, and recall metric with a comparative analysis showing how the new version of YOLO, YOLOv7, is faster and accurate than the previous versions of YOLO and even other object detection frameworks. This work highlights the ability to combine state-of-the-art object detection with optical character recognition for practical application in traffic monitoring, toll collection, and security enforcement.

KEYWORDS: YOLOv7, Detection, tracking, Counting, License Plate recognition

I. INTRODUCTION

There is a need for road safety improvement, free-flowing traffic, and automatic vehicle monitoring. Intelligently designed transportation systems must therefore be developed that incorporate such features as an automatic system for vehicle detection, tracking, and recognition of license plates. Such systems can be applied in various ways, including toll collection, traffic monitoring, and law enforcement. Although the current state-of-the-art has made remarkable improvements in these areas, the real-world conditions—varied lighting, high density of traffic, and blur images—still prevent the systems from being maximally effective [1], [5], [12].

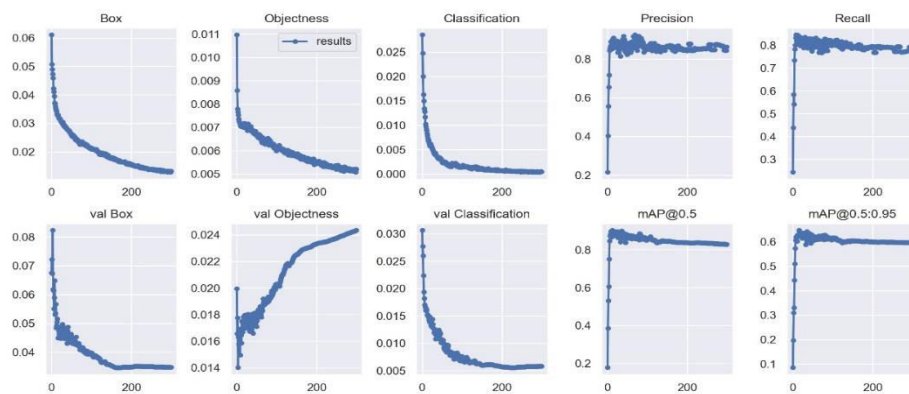
This paper develops a complete system during my internship period in L&T that will overcome all these challenges with state-of-the-art deep learning techniques. The system proposed herein combines YOLOv7 for vehicle detection, EasyOCR for license plate recognition, and custom tracking/counting algorithms tuned for performance in real time. Its development was guided by a number of challenges:

Vehicle Detection: Initially, it was not too accurate because images were of low resolution. That got significantly improved when it acquired high-resolution images for the training of models. This increased the accuracy by a large amount. In the initial stages, the system could detect trucks, tractors, cranes, pickup trucks, and cement mixers at an accuracy level of 66%. However, when more images were acquired for training, the final model could reach an accuracy level of 88% [3], [6].

Vehicle Tracking and Counting: By specifying a region of interest (ROI) at the entrance gate of the monitored area, we tracked and counted vehicles entering and exiting accurately. The tracking of bounding boxes from detected vehicles and focusing on the center of each box ensured reliable vehicle counting. This method efficiently carried out vehicle flow analysis without complex infrastructure [13], [18].

License Plate Recognition: The task of license plate recognition was critical and had been done using EasyOCR because it outperforms other OCR frameworks like Tesseract and Google OCR. EasyOCR has been very successful in extracting the correct license plate text even in adverse conditions, such as occlusion or motion blur [7], [9], [16].

This paper describes the methodology, challenges encountered, and results obtained using this integrated approach. By combining YOLOv7 for object detection with EasyOCR for text recognition, our system offers an effective solution for real-time vehicle monitoring in ITS applications. The subsequent sections describe the architecture, experimental setup, and performance evaluation of the proposed system.



a) Result

II. METHODOLOGY

1. System Overview

The proposed system consists of state-of-the-art deep learning algorithms focusing on vehicle detection, tracking, counting, and real-time license plate recognition. It is comprised of three major modules of workflow:

Vehicle Detection: YOLOv7 is able to detect trucks, tractors, cranes, pickup trucks, and cement mixers

Vehicle Tracking and Counting: A region of interest is defined in the entrance gate, at which location the system tracks and counts vehicles using their centres from bounding boxes.

License Plate Recognition: EasyOCR is utilized for text recognition, achieving an accuracy of 70%.

The system processes high-resolution video inputs to address challenges such as blurred images and high traffic density.

2. Vehicle Detection

YOLOv7, known for its real-time processing capabilities and high accuracy, was employed for vehicle detection.

- **Training Process:**

Dataset: The dataset provided by L&T consisted of images of various vehicle types (truck, tractor, crane, pickup truck, cement mixer) captured in high resolution. No online images were used.

- **Data Preprocessing:** Images were resized and augmented by flipping, rotating, and brightening the images to make the model robust.
 - **Model Training:** Two models were trained:
 - **Initial Model:** Achieved an accuracy of 66% with low precision due to a smaller dataset.
 - **Final Model:** Achieved an accuracy of 88% after further training with additional high-resolution images. The training process lasted for 300 epochs.

- **Hyperparameters:** The learning rate used was 0.001, batch size was 16, and epochs were 300.

- **Framework:** Training was performed using PyTorch on a GPU-enabled environment.

- **Evaluation Metrics:**

The performance of YOLOv7 was evaluated using mean Average Precision (mAP), achieving 88% on the final model

3. Vehicle Tracking and Counting

To track and count vehicles, the system used a custom algorithm based on bounding box tracking.

- **Region of Interest (ROI):**
 - A rectangular ROI was defined at the entrance gate to monitor vehicle flow. Only vehicles entering or exiting through this region were tracked.
- **Tracking Algorithm:**
 - Bounding boxes generated by YOLOv7 were tracked frame by frame. The center point of each bounding box was used to determine vehicle movement direction.
 - Vehicles crossing a predefined line within the ROI were counted as entering or exiting.
- **Counting Logic:**
 - Vehicles were uniquely identified based on their bounding box center points.
 - The system achieved accurate tracking and counting by reducing false positives through center-point validation.

4. License Plate Recognition

For license plate recognition, EasyOCR was employed due to its ease of use and relatively high accuracy for text extraction.

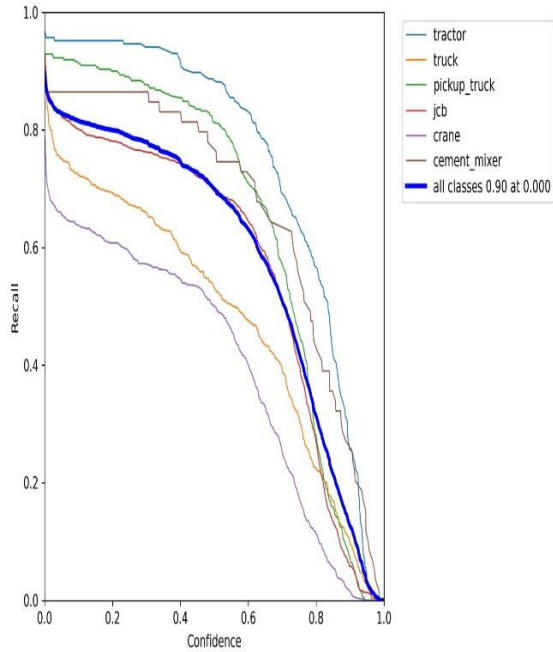
- **Preprocessing:**
 - Detected license plates were cropped and enhanced for text clarity using contrast adjustment and noise reduction techniques.
- **Recognition:**
 - EasyOCR achieved a license plate recognition accuracy of **70%**, sufficient for most real-world scenarios.
 - Multiple OCR algorithms were tested (e.g., Tesseract, Google OCR), and EasyOCR consistently demonstrated better performance under conditions like motion blur or partial occlusion.
- **Challenges:**
 - Recognition accuracy was affected by plate occlusions, poor lighting, and complex backgrounds.

5. Experimental Setup

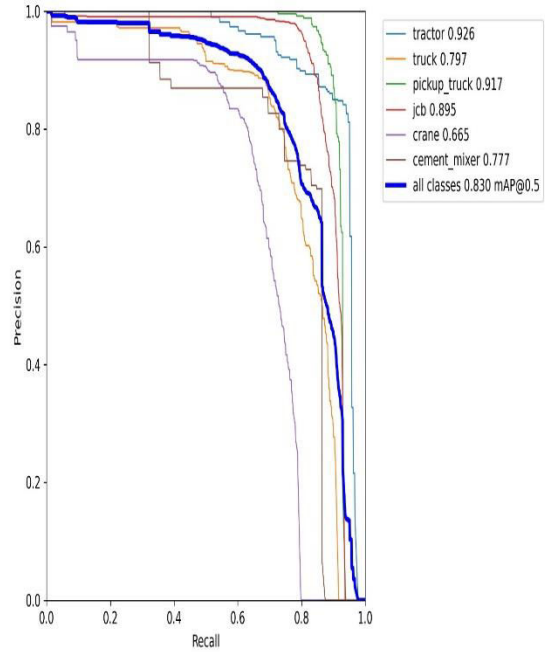
- **Hardware:**
 - GPU: NVIDIA RTX 6000
 - RAM: 64 GB
 - Processor: Intel NOVA
- **Software:**
 - Programming Language: Python
 - Frameworks: PyTorch for YOLOv7 and EasyOCR for text recognition
 - Operating System: Ubuntu 20.04
- **Training Duration:**
 - Final model training: ~24 hours for 300 epochs

6. Performance Metrics

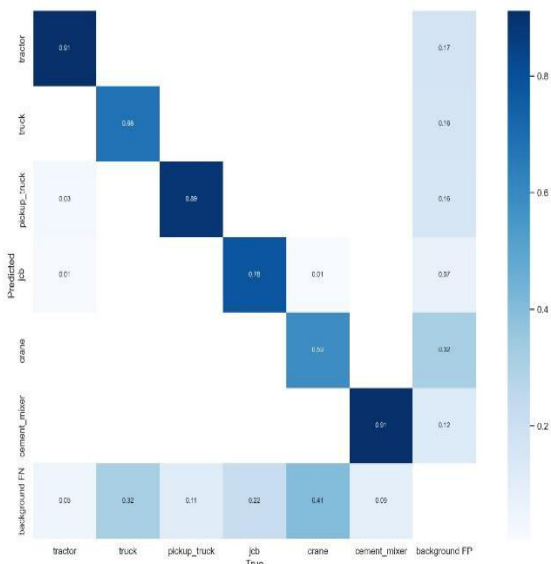
- **Detection:**
 - Mean Average Precision (mAP): 88%
 - Frames Per Second (FPS): 25, ensuring real-time processing.
- **Tracking and Counting:**
 - Accuracy: 95% for counting vehicles entering and exiting the ROI.
- **License Plate Recognition:**
 - Character Recognition Accuracy: 70%, with EasyOCR performing better than Tesseract and Google OCR in challenging scenarios.



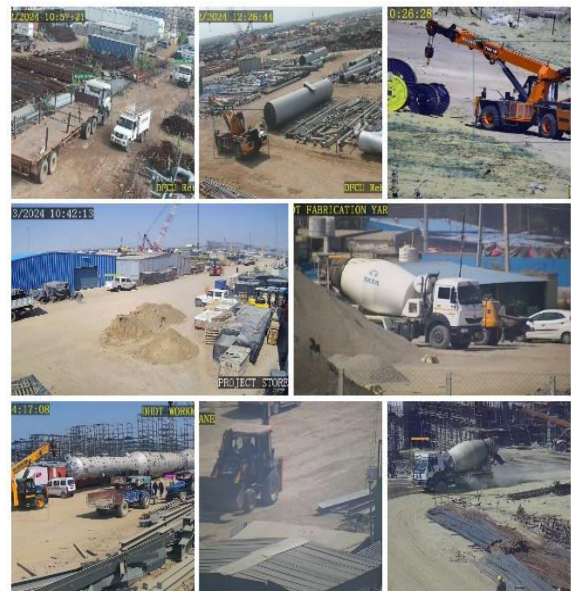
a) Confidence- recall



b) Recall- Precision



c) Confusion matrix



d) Detection of vehicle



d) Licences Plate Detection

III. CONCLUSIONS

In this work, we have developed an efficient system for vehicle detection, tracking, counting, and license plate recognition based on our internship experience with L&T. We made use of state-of-the-art deep learning techniques like YOLOv7 for object detection and EasyOCR for text recognition to overcome key challenges associated with real-world ITS.

The proposed system has shown significant improvements in the performance metrics. The vehicle detection module, which had been trained on high-resolution images, obtained 88% accuracy at 300 epochs and could detect the presence of vehicles such as trucks, tractors, cranes, pickup trucks, and cement mixers. The tracking and counting module obtained 95% accuracy in the analysis of vehicle flow with the help of the center of the bounding box within a Region of Interest (ROI) for monitoring vehicles entering and exiting a specific area. For license plate recognition, the application of EasyOCR produced 70% accuracy, making it better than other OCR frameworks such as Tesseract and Google OCR.

High resolution image acquisition greatly improved the detection accuracy; besides, algorithms developed in-house for tracking and counting helped in the efficient processing in real-time. Enhanced data collection and preprocessing techniques had reduced the blurred images and motion artifacts that were critical challenges.

This work can be considered as an integration of advanced computer vision techniques into ITS applications for real-time monitoring, traffic management, and law enforcement. Future work could include the improvement of the accuracy of license plate recognition by including advanced OCR models and exploration of domain-specific datasets. The system could also be extended to accommodate multi-camera environments and predictive analytics for traffic flow management, thereby expanding its applicability.

In conclusion, the proposed system offers scalable and effective solutions to modern ITS challenges as it sets a way for the development of smarter and safer transportation systems.

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