Object Detection System Using Machine Learning Algorithm

Nivetha
Department of Computer Science and Engineering
Velalar College of Engineering and Technology
Thindal, Erode – 638012

Monisadeve S K.
Department of Computer Science and Engineering
Velalar College of Engineering and Technology
Thindal, Erode – 638012

Devadharashini R.
Department of Computer Science and Engineering
Velalar College of Engineering and Technology
Thindal, Erode

Mukesh Kumar T.
Department of Computer Science and Engineering
Velalar College of Engineering and Technology
Thindal, Erode - 638012

Abstract: In recent years, object detection systems have become increasing sophisticated and widely used in a variety of settings, from security and surveillance. One important application of these systems is in traffic monitoring and management, where they can help improve safety and efficiency on the roads. One specific area of focus for traffic-related object detection is the identification of vehicles entering and leaving a lane, which can help authorities enforce traffic rules and prevent accidents caused by reckless driving. Additionally, the ability to detect and read number plates suspects in hit-and-run accidents or other crimes. Another key feature of a comprehensive object detection system for traffic management is the ability to estimate vehicle speed, which can be used to enforce speed system and detect potentially dangerous driving behaviours. Finally, the system may also include the detection of helmets on motorcycle riders, which can help promote safe driving practices and reduce the incidence of head injuries in the event of an accident. An object detection system that incorporates these various features can be a powerful tool for improving traffic safety and efficiency, and has the potential to save countless lives on the roads.

Keywords—YOLO, Conventional neural network, Artificial Neural Network,

I.INTRODUCTION

A computer vision-based project on object detection at traffic management system using YOLO-v7. Object detection finds and identifies things in images, and it's one of the biggest accomplishments of deep learning and image processing. One of the common approaches to creating localizations for objects is with the help of bounding boxes. Object detection is widely used for vehicle detection, pedestrian counting. Object detection and tracking can be used to count objects in a particular scene and determine tracking of the object accurately labeling them. Vehicle detection software uses surveillance cameras to track vehicles in real-time and record the type and number of vehicles passing a certain point at a specific time in the day. Detection of vehicle number uses both object detection and Optical Character Recognition (OCR) technology to recognize the alphanumeric characters on a vehicle. The human detection counts number of persons walking at the pedestrian. The speed detection system suite incorporates traffic surveillance contribute to improving safety and security on roads, thereby saving many of the lives and reduce the accidents occurs on the road.

II. PROPOSED SYSTEM

2.1 YOLO-v7 ALGORITHM

YOLO works to perform object detection in a single stage by first separating the image into N grids. Each of these grids is of equal size SxS. Each of these regions is used to detect and localize any objects they may contain. For each grid, bounding box coordinates, B, for the potential object(s) are predicted with an object label and a probability score for the predicted object's presence. This leads to a significant overlap of predicted objects from the cumulative predictions of the grids. To handle this redundancy and reduce the predicted objects down to those of interest, YOLO uses Non-Maximal Suppression to suppress all the bounding boxes with comparatively lower probability scores.

To achieve this, YOLO first compares the probability scores associated with each decision, and takes the largest score. Following this, it removes the bounding boxes with the largest Intersection over Union with the chosen high probability bounding box. This step is then repeated until only the desired final bounding boxes remain number of new changes was made for YOLO-v7. This section will attempt to breakdown these changes, and show how these improvements lead to the massive boost in performance in YOLO-v7 compared to predecessor models.

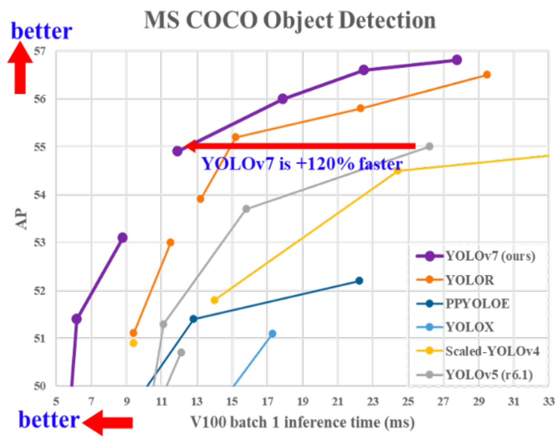

Fig 2. Graph between average precision vs inference time

A. Working

a) **Data Collection:** Collect a large dataset of images or videos that include examples of vehicles entering and leaving a lane, number plates, and helmets. This dataset should be diverse and include different lighting conditions, weather conditions, and vehicle types.

b) **Data Pre-processing:** Pre-process the dataset by resizing, cropping, and augmenting the images to improve the robustness of the model.

c) **Object Detection**: Use an object detection algorithm such as YOLO (You Only Look Once) to detect vehicles, number plates, and helmets in the images. This algorithm will output bounding boxes around the detected objects.

d) **Classification:** Train a classifier to recognize the number plates and helmets within the bounding boxes. For the number plate recognition, you can use optical character recognition (OCR) algorithms. For the helmet detection, you can use deep learning algorithms such as convolutional neural networks (CNNs).

e) **Tracking:** Use a tracking algorithm to track the vehicles as they move across the lanes. This will enable you to determine when a vehicle is entering or leaving a lane.

f) **Speed Estimation:** Use the tracked bounding boxes to estimate the speed of the vehicles.

g) **Integration:** Integrate all the above components into a single system that can take input from a video stream or a set of images and output the results in real-time.

h) **Evaluation:** Evaluate the performance of the system on a test dataset to measure the accuracy, precision, recall, and F1 score. Use these metrics to fine-tune the system and improve its performance.

i) **Deployment:** Once the system is optimized and tested, deploy it in the field to monitor traffic and detect violations. You can also integrate the system with other traffic management systems such as traffic lights and road signs to automate traffic management.

2.2 PROPOSED SYSTEM METHODS

A. LOAD DATASET

Dataset is required for training and testing the machine learning model which plays the vital role in the machine learning. Initially the dataset is uploaded into the model which must belongs to the .csv format for the easy processing. .csv is the simple file format which is used to store data in tabular format.

B. DATA PREPROCESSING

Data Preprocessing is the process of preparing raw data and make it suitable for a machine learning model. The data which are extracted from the various sources make contain
Noises, missing values, duplicate values and in various other forms. Data preprocessing step removes all these types of unnecessary data which lead to increase in the accuracy and efficiency of the machine learning model. The data preprocessing includes the data visualization using the charts, graphs and in various forms

C. OBJECT DETECTION AND TRACKING

An object detection system that includes the detection of vehicles entering and leaving a lane can be used for various purposes, including traffic management, surveillance, and security. The system can detect and track vehicles as they move in and out of a particular lane, providing valuable information about traffic flow, congestion, and violations of traffic rules. In surveillance and security applications, the system can be used to monitor sensitive areas such as border crossings, parking lots, and airports, detecting unauthorized vehicles or suspicious activities. The system can also help prevent accidents caused by reckless driving, such as sudden lane changes or driving against the flow of traffic.

An object detection system that includes the detection of vehicles entering and leaving a lane can contribute to creating a safer and more efficient road network, improving traffic management and enhancing surveillance and security capabilities. The system can also help enforce traffic rules, such as lane-changing and speed limits, by detecting violations and issuing warnings. An object detection model YOLO-v7 is used to classify those moving objects into respective classes. Object detection algorithm in YOLO (You Only Look Once) is improved the accuracy with many tricks and is more capable of detecting objects. It includes feature such as incoming and outgoing vehicle present in a lane.

D. DETECTION OF NUMBER PLATE

Recognizing a Car License Plate is a very important task for a camera surveillance-based security system. We can extract the license plate from an image using some computer vision techniques and then we can use Optical Character Recognition to recognize the license number. The automatic license plate recognition system consists of digital image capture units (like high-speed cameras with IR filters), application software (like video analytics software), processors capable of performing various object and character recognition, different algorithms to capture information from fast-moving vehicles, and an alert capability to notify operators.

a) **Moving vehicle number plate identification** – It first detects the vehicles and then captures, normalizes, and enhances the image of vehicle number plates using a series of image manipulation techniques.

b) **Number plate character identification** – Then OCR extracts accurate information such as the alpha numeric of the number plates.

c) **Number plate character translation into encoded content** – At last, the software verifies the sequence of those alphanumeric characters, converts them into text format, and stores the database.

Fig 1. Process of extraction from a number plate

E. NUMBER OF PERSON WALKING

An object detection system that includes the detection of the number of people in a particular area can be used for various purposes, including crowd management, surveillance, and security. The system can detect and track people as they move in and out of a particular area, providing valuable information about crowd size, density, and movements.

In crowd management, the system can help manage and control crowds in public spaces, such as stadiums, concerts, and festivals. The system can detect overcrowding and alert authorities to take appropriate actions to alleviate the situation and ensure public safety.

In surveillance and security applications, the system can be used to monitor sensitive areas such as airports, train stations, and government buildings, detecting unauthorized individuals or suspicious activities. The system can also be used to monitor the movements of people in and out of a building or facility, ensuring that only authorized individuals have access. An object detection system that includes the detection of the number of people in a particular area can contribute to improving crowd management, enhancing surveillance and security capabilities, and ensuring public safety.

F. SPEED DETECTION

An object detection system that includes the detection of vehicle speed can be a valuable tool for traffic management and safety monitoring. The system can estimate the speed of passing vehicles and provide information to traffic authorities, enabling them to enforce speed limits, detect reckless driving behaviors, and reduce the incidence of accidents caused by speeding.

In traffic management, the system can help improve traffic flow and reduce congestion by providing real-time information about traffic speed, allowing authorities to adjust traffic signals and optimize traffic flow. The system can also be used to monitor the speed of commercial vehicles and prevent them from exceeding speed limits, reducing the risk of accidents and improving safety on the roads.

In safety monitoring, the system can be used to detect vehicles traveling at excessive speeds in hazardous areas, such as school zones or construction sites, enabling authorities to issue warnings or fines and prevent accidents.

An object detection system that includes the detection of vehicle speed can contribute to improving traffic safety and efficiency, reducing accidents caused by speeding, and promoting compliance with traffic regulations. The tracked bounding boxes to estimate the speed of the vehicles.

The two class namely

1. Euclideandisttracker
2. Speed estimator.

The Euclideanandistracker in functionlibrary.py takes the input from Euclidean disttracker in main.py. The Euclidean andistracker in main.py has the video capture when the video is true then it reads the captured image and do the necessary function that need to display the desired output. The speed estimator does some functions like speed estimation, which is done by bounding boxes. The bounding boxes are formed by pixel image surrounded by the space which will be helpful in detecting the speed of vehicle more accurately.

G. HELMET DETECTION

An object detection system that includes the detection of helmets can be a valuable tool for promoting road safety and reducing the incidence of head injuries in the event of an accident involving motorcycle riders. In road safety applications, the system can detect whether a motorcycle rider is wearing a helmet, allowing authorities to enforce helmet laws and promote safe driving practices. The system can also detect whether a passenger on a motorcycle is wearing a helmet, providing additional safety benefits.

Non-Helmet Rider detection system is built which attempts to satisfy the automation of detecting the traffic violation of not wearing helmet and extracting the vehicles' license plate number. The basic idea behind this is whether travelers is wearing helmet or not which is detected by using the data available with us. We a build a model using YOLO-v7 approach which will detect the object based on bounding boxes. We collect data from the CCTV camera available in the specific area. Here the data set we have is coco dataset. The dataset involves

1. Helmet
2. Person

We draw a bounding box around a area on road to detect whether the rider is wearing helmet or not. We give the video file as .mp4 format to training model. The training model has different functions like helmet detection function. Here mapping also done to detect we use xml file to convert the file into YOLO format.

H. TRAFFIC RULE VIOLATION MESSAGE

Once you have chosen a messaging platform, you need to integrate its APIs into your object detection system. This will allow your system to send messages automatically when certain conditions are met, such as when a vehicle is detected without a helmet or when a speeding violation is detected.

a) **Define the traffic violations:** Define the traffic violations that your system will detect and issue fines for, such as speeding, not wearing a helmet.

b) **Determine the fine amount:** Determine the amount of the fine for each violation. This may be based on local laws and regulations, or may be set by your organization.

c) **Integrate messaging platform APIs**: Integrate the APIs of a messaging platform that supports sending fine messages, such as SMS or email.

d) **Set up violation triggers:** Set up triggers in your object detection system that will detect when a vehicle commits a violation and send a fine message to the vehicle owner or driver. For example, when a vehicle is detected speeding or not wearing a helmet, the sending of a fine message to the registered owner of the vehicle.

e) **Send the fine message:** Use the messaging platform APIs to send the fine message to the registered owner of the vehicle.

III. RESULT

Model for building the object detection system using machine learning algorithm prediction using the machine learning gives the accurate result. To make sure the model is accurate and dependable for analysis method has average precision, number of parameter and inference time. Its performance on test data once the model has been trained. The effectiveness of the model may be assessed using metrics such as mean average precision (mAP), Intersection over Union (IOU). The performance and accuracy of the model. This model improves the efficiency in comparison with YOLOV4, YOLOV7 reduces the number of parameters by 75%, requires 36% less computation, and achieves 1.5% higher AP (average precision) for prediction in traffic system.

TABLE I. COMPARTSON OF VARIOUS ALGORITHMS

Model	#Param.	FLOPs	Size	AP^{val}
YOLOv4 [3]	64.4M	142.8G	640	49.7%
YOLOR-u5 (r6.1) [81]	46.5M	109.1G	640	50.2%
YOLOv4-CSP [79]	52.9M	120.4G	640	50.3%
YOLOR-CSP [81]	52.9M	120.4G	640	50.8%
YOLOv7	36.9M	104.7G	640	**51.2%**
improvement	-43%	-15%	-	+0.4

IV CONCLUSION

In conclusion, developing a machine learning-based an object detection system that includes the detection of vehicles entering and leaving a lane, number plates, speed, and helmets can be a valuable tool for traffic management and safety. This system can be developed using a variety of techniques, including both machine learning and conventional neural networks. Machine learning techniques such as deep learning can be particularly effective for object detection, allowing for the identification of complex patterns and features within images and videos. However, these approaches require large amounts of labelled data and computational resources, and may be more challenging to implement and interpret compared to conventional neural networks.

Conventional neural networks can also be used for object detection, and may be simpler to implement and require less data to train. However, these networks may not be as effective in handling complex or dynamic scenes, and may require more manual tuning and optimization.

The choice of approach for developing an object detection system for traffic management and safety will depend on factors such as the available data, computational resources, and specific application requirements. With careful consideration and planning, however, an object detection system can be a powerful tool for improving traffic safety and efficiency, and has the potential to save countless lives on the roads.

ACKNOWLEDGMENT

We would acknowledge our guide for development of the Object Dectection System Using Machine Learning Algorithm prediction model with full support and guidance. We would like thank the traffic system who contribute their data to study.

REFERENCES

[1] Cheng-jian lin, Jyun-yu Jhang, Intelligent Traffic-Monitoring System Based on YOLO and Convolutional Fuzzy Neural Networks, Feb2022 IEEE ACCESS

[2] Durriya Bandukwala1, Muskan Momin3, Akmal Khan2, Aasim Khan5, Dr Lutful Islam, Object Detection using YOLO, May 2022 IEEE ACCESS

[3] Emin Guney Cuneyt Bayilmis, and Batuhan cakan, Implementation of real time traffic signs and road object detection based on mobile GPU platform, Aug 2022 IEEE ACCESS

[4] Fahmida Sultana Mim, S.M. Naimur Rahman Sayam, Md. Tanvir Amin,Traffic participants detectionand classification using yolo neural network,June 2022 Research gate

[5] Geethapriya.S, N. Duraimurugan, S.P. Chokkalingam, Real- time object detection using YOLO, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-3S, February 2019.

[6] Guofa Li, Zefeng Ji, Xingda Qu, Rui Zhou, and Dongpu Cao, cross domain for automation for automation driving a stepwise domain adaptive yolo approach, ieee transactions on intelligent vehicles, VOL. 7, NO. 3, September 2022

[7] R. Shree Charran and Rahul Kumar Dubey, Two-Wheeler Vehicle Traffic Violations Detection and Automated Ticketing for Indian Road Scenario, NOV 2022 IEEE
[8] C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of ELECTRICAL ENGINEERING, Vol.63 (6), pp.365-372,Dec.2012.
[9] C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011.
[10] C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor & Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011.
[11] Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- Iranian Journal of Electrical & Electronic Engineering, Vol.8 (3), pp.259-267, September 2012.
[12] G.Neelakrishnan, S.N.Pruthika, P.T.Shalini, S.Soniya, "Perfromance Investigation of T-Source Inverter fed with Solar Cell" Suraj Punj Journal for Multidisciplinary Research, 2021, Volume 11, Issue 4, pp:744-749
[13] 5. G.Neelakrishnan, P.Iraianbu, T.Abishek, G.Rajesh, S.Vignesh, "IOT Based Monitoring in Agricultural" International Journal of Innovative Research in Science, Engineering and Technology, March 2020, Volume 9, Issue 3, pp:814-819
[14] R. M. Singh, S. Kumari and D. K. Gupta, "A novel methodology for vehicle number plate recognition using artificial neural network," in *Proc. 3rd Int. Symp. Comput. Vis. Internet*, Sep. 2016, pp. 110–114.
[15] Ruoming Pang, Quoc V. Le, Mingxing Tan, Ruoming Pang, EfficientDet: Scalable and Efficient Object Detection,Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Year of Publication: 2020
[16] S. Kumari, D. K. Gupta, and R. M. Singh, "A novel methodology for vehicle number plate recognition using artificial neural network," in *Proc. 3rd Int. Symp. Comput. Vis. Internet*, Sep. 2016, pp. 110–114.
[17] V. Mandal and Y. Adu-Gyamfi, "Object detection and tracking algo- rithms for vehicle counting: A comparative analysis," *J. Big Data Anal. Transp.*, vol. 2, pp. 251–261, Nov. 2020.
[18] Wei Li, Liqian Ma, Qiang Wang, Jianmin Li, Wei Li, and Luc Van Gool,RepPoints V2: Verification Meets Regression for Object Detection ,Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Year of Publication: 2021
[19] X. Wang, L.-M. Meng, B. Zhang, J. Lu, and K.-L. Du, "A video-based traffic violation detection system," in *Proc. Int. Conf. Mech. Sci., Electr.Eng. Comput. (MEC)*, Dec. 2013, pp. 1191–1194
[20] Xinpeng Liu, Lei Cui, Jiarui Xu, and Feiyue Huang,Densely Connected Search Space for More Flexible Neural Architecture Search,Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Year of Publication: 2021
[21] Yuqing Zhu, Hanxiao Liu, Bing Zeng, and Jing Qin, Class Balanced Loss Based on Effective Number of Samples, Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Year of Publication: 2019