VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY, NAMBUR, AP, INDIA
(An Autonomous Institution permanently affiliated to JNTUK - Approved by AICTE New Delhi - Accredited by NBA - NAAC with 'A' Grade - All eligible branches are Accredited by NBA - ISO9001:2015 Certified)
Department of Computer Science & Engineering
Proceedings of International Conference on Advanced Computing Technologies (ICACT-2025), 3rd April 2025 & 4th April 2025, ISBN: 978-81-977391-1-8

Autonomous Traffic Management System

Jeevan Babu Maddala[1], P. Raghavendra[2], N. Teja Vishnuvardhan Reddy[3], P. Satya Sai Sree Rama Koushik[4], Sk. Basha[5]
[1]Assistant Professor, Department of Computer Science and Engineering, Vasireddy Venkatadri Institute of Technology, (Autonomous), Guntur, Andhra Pradesh, India, [1]jeevan.projects@gmail.com
[2,3,4,5] Students, Department of Computer Science and Engineering, Vasireddy Venkatadri Institute of Technology, (Autonomous), Guntur, Andhra Pradesh, India,
raghavendramadhu0@gmail.com, tejavishnuvardhan.nagireddy@gmail.com, koushikpenumarti2004@gmail.com, sb2508886@gmail.com

Abstract- Traffic management is a growing problem in many cities leading to accidents, high delays, and increasing air pollution. Generally, traffic is managed manually by traffic policemen or with fixed traffic light times. This research will provide an autonomous method by selecting the efficient method among RCNN, YOLO V7 & YOLO V8. The detection speed by using the mentioned methods is 20 FPS, 40 FPS & 45 FPS respectively. Based on the detection speeds, YOLO V8 is the most efficient method among them. The ambulance custom dataset is used to train YOLO V8 for ambulance detection. The trained model attained an average precision of 99.1% and an accuracy of 97.7%. Overall, the research will manage the traffic based on the vehicle count of each lane. It will also prioritize the lane for ambulances.

Keywords: YOLO, Ambulance detection, Smart traffic management system, Vehicle count detection, COCO dataset.

I. INTRODUCTION

The traditional traffic management systems are manually controlled by traffic policemen and by fixed traffic light cycles. Both of them have several limitations. Fixed signal timings will not work out for real-time traffic flow, it may cause unnecessary delays and an increase in accident count. On the other hand, manual traffic control will require a lot of manpower. To overcome these drawbacks this research will provide a way to manage traffic autonomously by utilizing the efficient method.

With the help of several deep learning methods like Region-Based Convolutional Neural Networks (RCNN), You Only Look Once (YOLO) V7, and YOLO V8 vehicle detection will be achieved. This deep-learning vehicle detection will detect the vehicles with different class labels and draw the vehicle count. The main advantage of this approach is to improve traffic management in real time and reduce accidents.

This research will demonstrate the efficient model among RCNN, YOLO V7 & YOLO V8 for vehicle detection. Our study evaluates these models based on the detection speed which is an important aspect of traffic management. The detection speed for the RCNN model is 20 FPS, the YOLO V7 model is 40 FPS and the YOLO V8 model is 45 FPS. Based on this output, YOLO V8 is the efficient model for vehicle detection.

Additionally, this research implemented ambulance detection by further training the YOLO V8 model with a custom ambulance dataset. The performance metrics of ambulance detection are 99.1% average precision and 97.7% accuracy. This detection will help to prioritize the ambulance-detected lane.

The proposed system will allow the green time based on the vehicle count. If an ambulance is detected in any lane, then the signals will pause and prioritize the ambulance lane after 30 seconds the regular signal will resume. By integrating this autonomous traffic management system, we can ensure the safety and minimize the delays.

II. RELATED WORKS

In the past years, researchers have researched several ways to overcome the drawbacks of the 2 traditional ways. For example, few researchers utilized YOLO V3, V2, and V7 for autonomous traffic management. These methods have illustrated the improvement over traditional ways. In a few cases, it has some limitations.

One of the main drawbacks of the previous studies is the lower detection speed of the models. Models like YOLO V2, V3, and V7 have slower detection speeds. This delay in detection may reduce the efficiency of adjusting traffic signals dynamically. When the real-time detection is not fast enough then vehicles are not counted accurately and cause accidents.

Another issue with the previous research is the lack of ambulance detection and prioritization. Many studies have focused on traffic management by detecting and counting vehicles. There is no previous study about the emergency response mechanism in their systems. This means during emergencies previous systems are unable to prioritize the lane with the ambulance arrival. In the absence of this feature

VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY, NAMBUR, AP, INDIA
(An Autonomous Institution permanently affiliated to JNTUK - Approved by AICTE New Delhi - Accredited by NBA - NAAC with 'A' Grade - All eligible branches are Accredited by NBA - ISO9001:2015 Certified)
Department of Computer Science & Engineering
Proceedings of International Conference on Advanced Computing Technologies (ICACT-2025), 3rd April 2025 & 4th April 2025, ISBN: 978-81-977391-1-8

traffic management systems are not efficient in emergencies. Additionally, there is no system that combines both traffic management and emergency vehicle prioritization into a single system. Existing research works have either traffic management or ambulance prioritization. In real-time emergencies are very important so that traffic management will be effective.

By solving these limitations, this research develops an autonomous traffic management system using YOLO V8. This model has a 45 FPS detection speed and also detects ambulances and prioritizes the lane. This system will set the signal timers dynamically.

III. METHODOLOGY

This research about autonomous traffic management system is designed to manage traffic dynamically in real-time and prioritize emergency vehicles, particularly ambulances. The methodology consists of mainly five phases: Data Collection, Model Selection for Vehicle Detection and Training for Ambulance Detection, Traffic Signal Management, Emergency Vehicle Prioritization, and Real-time Traffic Detection.

A. Data Collection

Traffic management mainly depends on vehicle detection. This research uses the COCO dataset (Common Objects in Context) for general vehicle detection. The COCO dataset is generally used for object detection. This dataset contains around 45k vehicle images of different vehicle types. One major drawback that this dataset has is that it does not contain a category for ambulances.

Several ambulance images were collected from multiple sources. These images are carefully annotated with drawing boxes and labelled ambulance with the help of the Roboflow platform. By collecting and annotating the custom ambulance dataset, the research ensures efficient detection.

B. Model Selection for Vehicle Detection and Training for Ambulance Detection

Initially, RCNN, YOLO V7, YOLO V8, and YOLO V9 are the proposed models. These models were selected based on their best performance in object detection. However, the YOLO V9 model has not yet been officially released this research will proceed with the other three models. This research evaluated the RCNN, YOLO V7, and YOLO V8 models for vehicle detection.

The primary objective of this evaluation is to select an efficient model that has a high detection speed for real-time vehicle detection. To compare these models the performance metric is the detection speed which is calculated in Frames Per Second (FPS). The evaluation results are as follows: RCNN- 20 FPS, YOLO V7- 40 FPS, YOLO V8- 45 FPS

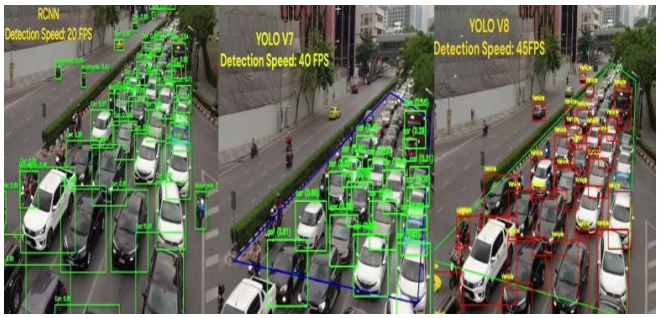

Figure 1. Detection Speed Comparison

From these results, YOLO V8 is the efficient model for vehicle detection and it is the selected model for this research. By using this model, the autonomous traffic management system can achieve faster and more accurate vehicle detection.

The YOLO V8 model is further trained with the custom ambulance dataset and attained an average precision of 99.1% for ambulance detection. This ambulance detection system will detect the ambulance and prioritize the lane to ensure the passage of an ambulance in emergencies.

C. Traffic Signal Management

Initially, all lanes will have a red signal. The YOLO V8 model will detect and count the number of vehicles in each lane with high accuracy. This research uses an algorithm that allows a green signal based on the vehicle count. The lane with the most vehicles gets the first green signal. This approach will improve the traffic flow and reduce delays.

The signal timing is dynamically adjusted based on vehicle count. Each vehicle is allotted 2 seconds to pass through the intersection. The minimum green signal that the system allows is 10 seconds and the maximum is 60 seconds for a lane. If no vehicles are detected in the lane during an active green signal, then the system automatically switches the signal to yellow before turning back to red.

Additionally, this approach is particularly important during off-peak hours, when few lanes may have little to no traffic. Instead of following a fixed cycle, this system skips empty lanes and reduces unnecessary delays for vehicles in other lanes.

D. Emergency Vehicle Prioritization

The model continuously scans for ambulances within the traffic lanes. Whenever it detects an ambulance, the system overrides the standard signals to prioritize the ambulance. The lane with the ambulance detected gets the green signal and all other lanes get red to ensure the passage of the ambulance.

To prevent unnecessary traffic delays the ambulance lane is allotted a green signal duration of 30 seconds. During this duration, the ambulance will pass the intersection. Once this 30-second duration completes then the standard traffic

signals resume from where it paused, dynamically adjusting the green signal based on the vehicle count. This emergency vehicle prioritization in this system will provide a smooth flow for the ambulance in emergencies.

E. Real-time Traffic Detection

The real-time traffic detection is the main phase of this research. The YOLO V8 continuously monitors the feed from CCTV cameras at the intersections. This model has high detection speed and accuracy in detecting and counting the vehicles. By implementing this in real-time the drawbacks of traditional methods can be solved by reducing delays and dynamically adjusting the signal times.

By implementing this system, the drawbacks of traditional traffic management methods such as manual control and pre-set signal durations can be overcome. The system ensures that lanes with higher vehicle counts receive longer green signals reducing delays. Additionally, if a lane has no detected vehicles, the system automatically transitions the signal from green to yellow and then red.

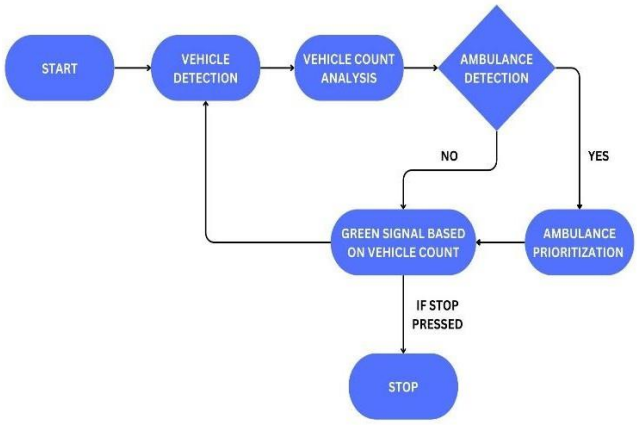

Figure 2. Autonomous Traffic Management System flowchart

The fig. 2. is the flowchart of this research. The YOLO V8 model is used for Vehicle detection and counting. It has also been trained with a custom ambulance dataset. So, that it can undergo ambulance detection. If no ambulance is detected then the general algorithm will be considered.

IV. RESULTS AND DISCUSSIONS

The COCO dataset is used to find the efficient model among the RCNN, YOLO V7 & YOLO V8. The efficiency of the models is calculated in detection speed in terms of Frames Per Second (FPS). The output of the models is mentioned in table 1.

MODEL	DETECTION SPEED (In FPS)
RCNN	20 FPS
YOLO V7	40 FPS
YOLO V8	45 FPS

Table 1. Comparison between models

This research utilizes YOLO V8 because of its high detection speed. The COCO dataset doesn't contain the ambulance category. So, a custom ambulance dataset is been created and used to train the model to detect the ambulances in the lanes. The training results are shown in fig. 3.

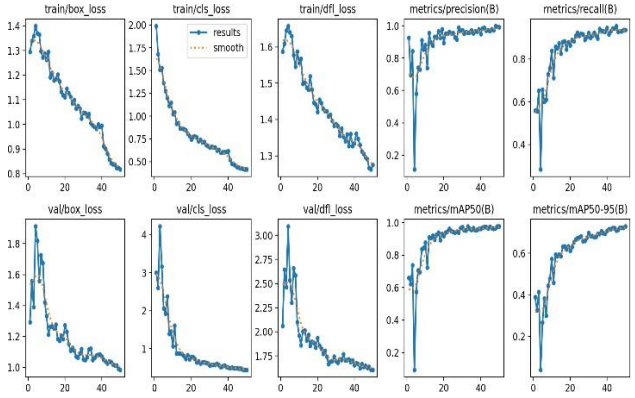

Figure 3. Training results of ambulance detection

All the CCTV feeds will undergo the YOLO V8 model which will draw the boxes and label all the vehicles including ambulances. The output of this system is as follows

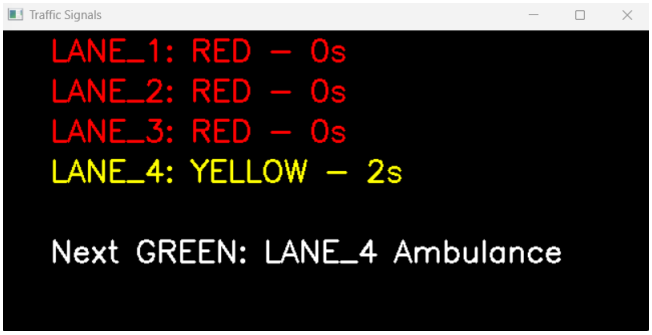

Figure 4. Traffic Signals with ambulance detected

Figure 5. Ambulance detection in lane 4 from CCTV feeds

V. CONCLUSION AND FUTURE WORK

This research presents an autonomous traffic management system utilizing deep learning-based object detection models to manage traffic flow and prioritize emergency vehicles. This study compared RCNN, YOLO V7, and YOLO V8 in terms of detection speed and accuracy. It determined that YOLO V8 is the most efficient model by achieving 45 FPS with high detection speed.

A custom dataset for ambulance detection was created and trained using YOLO V8 achieving an average precision of 99.1% and an accuracy of 97.7%. The system successfully detected ambulances in real-time and dynamically adjusted traffic signals to ensure uninterrupted movement for emergency vehicles.

In the future, a custom time should be calculated and allotted for each type of vehicle to cross the intersection based on the distance from the signal to cross. Another feature is to train the model with other emergency vehicles like fire engines, police cars, etc.

VI. REFERENCES

[1] Mamoona Humayun, Maram Fahhad Almufareh and Noor Zaman Jhanjhi, "Autonomous Traffic System for Emergency Vehicles," Electronics, vol. 11, pp. 510-528, February 2022.

[2] Pankaj Kunekar, Yogita Narule, Richa Mahajan, Shantanu Mandlapure, Eshan Mehendale, and Yashashri Meshram, "Traffic Management System Using YOLO Algorithm," in Proceedings of Engineering, Dubai, United Arab Emirates, 2024.

[3] Dr. Sreelatha R, Mahalakshmi B S, Riya Yadav, Shreyam Pandey, and Vandit Agarwal, "Artificial Intelligence Based Autonomous Traffic Regulator," in Proceedings of CEUR Workshop, New Delhi, India, 2023.

[4] Nitin Sakhare, Mrunal Hedau, Gokul B., Omkar Malpure, Trupti Shah, and Anup Ingle, "Smart Traffic: Integrating Machine Learning, and YOLO for Adaptive Traffic Management System," International Journal of INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING, vol. 12, no. 12, pp. 347-355, January2024.

[5] Izhak Rubin, Andrea Baiocchi, Yulia Sunyoto, and Ion Turcanu, "Traffic management and networking for autonomous vehicular highway systems," Ad Hoc Networks, vol. 83, pp. 125-148, February 2019.

[6] Christofel Rio Goenawan, "ASTM: Autonomous Smart Traffic Management System Using Artificial Intelligence CNN and LSTM," arXiv preprint arXiv:2410.10929, October 2024.