Autonomous Vehicle Navigation and Obstacle Avoidance Using Yolo

[1] Dr P S Naveen Kumar, [2] CHEBROLU SAILAJA, [3] GANJI VENKATA SRIDEVI, [4] KARRI LOKESH SATYANARAYANA

[1]Associate professor, Dept CSE-AI&ML, St.Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist, Andhra Pradesh – 523187, India

[2,3,4]U. G Student, Dept CSE-AI&ML, St.Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist, Andhra Pradesh – 523187, India

ABSTRACT

Autonomous vehicle navigation requires accurate perception of the surrounding environment to ensure safe and efficient movement. This project presents an obstacle detection and avoidance system using the YOLO (You Only Look Once) deep learning algorithm. YOLO enables real-time object detection by identifying obstacles such as vehicles, pedestrians, traffic signs, and road barriers from live video streams. The detected objects are analyzed to estimate distance and position relative to the vehicle. Based on this information, navigation decisions are generated to avoid collisions. The proposed system enhances driving safety by reducing human intervention. Experimental results demonstrate improved detection speed and accuracy in real-time scenarios.

INTRODUCTION

Autonomous vehicles are transforming modern transportation by reducing accidents and improving traffic efficiency. One of the key challenges in autonomous driving is real-time obstacle detection and navigation control. Traditional sensor-based systems alone are insufficient in complex traffic environments. Computer vision combined with deep learning provides an effective solution for environment perception. YOLO is a fast and accurate object detection algorithm suitable for real-time applications. This project integrates YOLO with navigation logic to detect obstacles and perform avoidance actions. The system aims to achieve safe autonomous movement in dynamic road conditions.

LITERATURE SURVEY

Several studies have explored obstacle detection using sensors such as LiDAR, radar, and ultrasonic modules. Vision-based methods using CNNs have gained popularity due to their flexibility and accuracy. Earlier models like R-CNN and

Fast R-CNN provided good accuracy but suffered from slow processing speed. SSD improved speed but still struggled with small object detection. YOLO introduced a single-stage detection approach, significantly improving real-time performance. Recent versions of YOLO achieve high precision and low latency. These studies motivate the use of YOLO for autonomous navigation systems.

RELATED WORK

Several research works have explored obstacle detection and navigation for autonomous vehicles using deep learning techniques. Early approaches relied on sensor-based systems such as LiDAR and radar, which provided accuracy but increased system cost. Vision-based methods using convolutional neural networks improved environmental perception significantly. Models like R-CNN and SSD were used for object detection but suffered from higher latency. YOLO-based approaches gained popularity due to their real-time detection capability and multi-object handling. Recent studies demonstrate that YOLO achieves better speed–accuracy balance for autonomous navigation systems.

EXISTING SYSTEM

Existing autonomous navigation systems mainly rely on sensor fusion techniques using LiDAR and radar. While these systems are effective, they are expensive and computationally heavy. Traditional computer vision methods use edge detection and thresholding, which perform poorly in real-world environments. Many systems detect obstacles but lack intelligent avoidance strategies. Real-time performance is often limited due to complex processing pipelines. Existing solutions also struggle with multiple object detection. These limitations reduce system reliability and scalability.

PROPOSED SYSTEM

The proposed system uses YOLO for real-time obstacle detection through a camera-based vision system. YOLO detects multiple objects simultaneously with high accuracy and speed. Detected obstacles are analyzed to estimate distance and direction. A navigation algorithm determines safe paths by avoiding detected objects. The system continuously updates vehicle movement based on live video input. This approach reduces hardware cost and improves real-time performance.
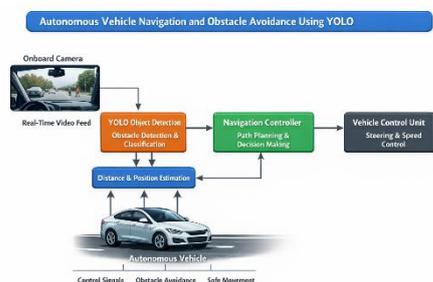
SYSTEM ARCHITECTURE

Fig 1:Autonomous vehicle navigation system

METHODOLOGY DESCRIPTION

First, real-time video frames are captured using a front-mounted camera. These frames are preprocessed and fed into the YOLO model. YOLO detects objects and outputs bounding boxes with class labels and confidence scores. Distance estimation is performed using object size and position. The navigation logic determines safe movement directions. Commands are generated for steering and speed control. The process repeats continuously for real-time navigation.
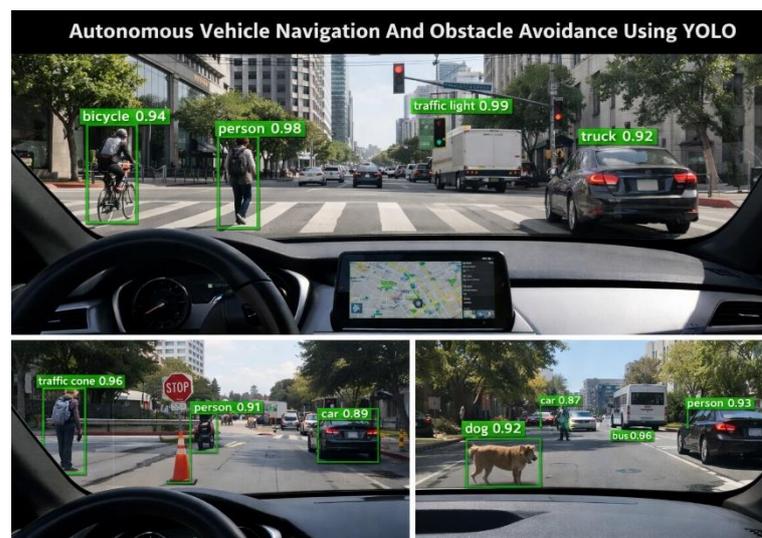
RESULTS AND DISCUSSION

Fig 2:Result of autonomous vehicle navigation and obstacle

This image shows a real-time autonomous vehicle navigation system using the YOLO object detection algorithm to identify road obstacles. The system accurately detects and labels objects such as pedestrians, bicycles, cars, buses, trucks, animals, and traffic signals with high confidence scores. Bounding boxes around each object enable the vehicle to understand its surroundings instantly. Based on these detections, the vehicle can make safe navigation decisions like slowing down, stopping, or changing direction. The image demonstrates effective obstacle avoidance in urban traffic scenarios. Overall, it highlights how YOLO supports fast, reliable perception for autonomous driving systems.

CONCLUSION

This project demonstrates an efficient autonomous navigation and obstacle avoidance system using YOLO. The system achieves real-time object detection with high accuracy and speed. Integration of detection and navigation logic enables safe vehicle movement. The approach reduces dependency on expensive sensors. Experimental results confirm improved performance over existing systems. The proposed solution is suitable for real-world autonomous driving applications. Overall, YOLO proves to be a powerful tool for intelligent vehicle navigation.

FUTURE SCO0PE

Future enhancements can include sensor fusion with LiDAR and GPS for improved accuracy. Advanced distance estimation techniques can be implemented. Integration with traffic signal recognition can improve decision-making. Reinforcement learning can be used for adaptive navigation strategies. Performance optimization for edge devices can be explored. Deployment in fully autonomous vehicles can be tested. The system can be extended for smart city transportation solutions.

REFERENCE

[1]. Mukiri, D. R. R., Grandhi, D. P., & Chapala, D. H. K. (2023). New Security Models in Cloud Iot System Using Hash Machine Learning. Industrial Engineering Journal ISSN, 0970-2555.

[2]. Naveen Kumar Polisetty, S., Sivaprakasam, T., & Sreeram, I. (2023). An efficient deep learning framework for occlusion face prediction system. Knowledge and Information Systems, 65(11), 5043-5063.

[3] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR)*, Las Vegas, NV, USA, pp. 779–788, 2016.

[4] J. Redmon and A. Farhadi, "YOLOv3: An Incremental Improvement," arXiv:1804.02767, 2018.

[5] A. Geiger, P. Lenz, C. Stiller, and R. Urtasun, "Vision Meets Robotics: The KITTI Dataset," *Int. J. Robot. Res.*, vol. 32, no. 11, pp. 1231–1237, 2013.

[6] M. Bojarski et al., "End to End Learning for Self-Driving Cars," NVIDIA Corp., arXiv:1604.07316, 2016.

[7] K. Simonyan and A. Zisserman, "Very Deep Convolutional Networks for Large-Scale Image Recognition," *Int. Conf. Learn. Represent. (ICLR)*, 2015.

[8] W. Liu et al., "SSD: Single Shot MultiBox Detector," *Proc. Eur. Conf. Comput. Vis. (ECCV)*, pp. 21–37, 2016.

[9] S. Ren, K. He, R. Girshick, and J. Sun, "Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 39, no. 6, pp. 1137–1149, 2017.

[10] P. Dollar, C. Wojek, B. Schiele, and P. Perona, "Pedestrian Detection: An Evaluation of the State of the Art," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 34, no. 4, pp. 743–761, 2012.

[11] S. Thrun et al., "Stanley: The Robot That Won the DARPA Grand Challenge," *J. Field Robot.*, vol. 23, no. 9, pp. 661–692, 2006.

[12] Y. LeCun, Y. Bengio, and G. Hinton, "Deep Learning," *Nature*, vol. 521, no. 7553, pp. 436–444, 2015