International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2024.532
e ISSN: 2584-2854
Volume: 02
Issue:12 December 2024
Page No: 3605-3607

Enhancing Autonomous Vehicle Safety and Efficiency Through Intelligent Mapping and Recommendations

Ribin K Roy[1], Kevin Cyriac[2], Aswin A[3], Joel Chacko Titus[4], Roji Thomas[5]
[1,2,3,4]UG-BCA, Kristu Jyothi College of Management and Technology, Changanassery, Kerala, India.
[5]Assistant Professor, Department of Computer Application, Kristu Jyoti College of Management And Technology, Changanassery, Kerala, India.
Email ID: *ribinroy2004@gmail.com[1], kevincyriac2005@gmail.com[2], aswinanil4u@gmail.com[3], joelchackotitus@gmail.com[4], roji@kjcmt.ac.in[5]*

Abstract
The rapid development of self-driving cars (AVs) creates numerous prospects for safer, more efficient transportation. This study looks into the possibilities for improved AV safety and operational efficacy using intelligent mapping, object detection, and tailored recommendation systems.This study proposes a unique way for improving autonomous vehicle navigation and user experience, using sensor fusion, adaptive route planning, real-time item detection, and crowdsourced map updates. The proposed technique opens the way for more intelligent and safe AV systems by improving obstacle avoidance, reducing travel times, and ensuring real-time system updates, according to trial data.
Keywords: *Route Recommendation, Sensor Fusion, Object Detection, Autonomous Cars, Crowdsourcing, Machine Learning, Privacy, & Intelligent Mapping*

1. Introduction
Autonomous vehicles (AVs) are predicted to revolutionize the transportation industry. Sensors, machine learning, and complex algorithms help these cars navigate and make judgments in real time. One of the most difficult challenges in AV development is assuring safety and operational efficacy in dynamic environments.The addition of intelligent mapping and recommendation algorithms can considerably improve the AV's decision-making abilities. This paper suggests a framework for improving route planning that combines real-time item detection with advanced deep learning algorithms, sensor fusion for 3D mapping, and personalized recommendation systems. These innovations are intended to address crucial concerns such as traffic congestion, obstacle avoidance, real-time error detection, and data privacy [2].

2. Literature Survey
Advances in object recognition, sensor fusion, and recommendation algorithms have improved autonomous vehicles (AVs). The key contributions from prior investigations are outlined below [3]:

2.1. Object Detection and Tracking
Redmon et al. (2018) published YOLOv3, a real-time object recognition system often used in self-driving cars to detect obstacles such as pedestrians and vehicles in a range of scenarios. It is a popular option for obstacle avoidance due to its speed and precision. Ren et al. (2015) developed Faster R-CNN, which improves object recognition performance by merging region proposal networks (RPNs) and CNNs. This technique excels at accurately detecting objects in real time, making it perfect for AV systems that require real-time decision-making [4].

2.2. Sensor Fusion for 3D Mapping
Geiger et al. (2012) emphasized the need of combining Lidar, radar, and cameras to produce detailed and realistic 3D models of the environment. Sensor fusion approaches enable AVs to recognize complicated scenarios while safely navigating dynamic settings. Cui et al.. (2022) improved sensor fusion by merging many sensor modalities to build high-resolution maps in real time, allowing AVs to operate more successfully in unexpected and changing settings [5].

2.3. Personal recommendation systems
Chen et al. (2021) demonstrated AI-powered route planning suggestion systems that consider traffic

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2024.532
e ISSN: 2584-2854
Volume: 02
Issue:12 December 2024
Page No: 3605-3607

conditions, user preferences, and environmental elements. Their method significantly reduces travel time while increasing passenger comfort. Tan et al. (2019) presented a blockchain-based system for securely updating dynamic maps and improving route recommendations, while safeguarding privacy and data security [6].

2.4. Privacy and Security Concerns

Zhao et al. (2020) stressed the importance of appropriate data protection strategies for maintaining privacy and security in autonomous vehicle (AV) systems. They proposed using distinct privacy approaches to safeguard passenger data while yet allowing crowdsourced map updates for real-time navigation.. This method enables AVs to retain high levels of data security while also contributing to the ongoing enhancement of map accuracy. Despite advances in object detection, sensor fusion, and recommendation systems, successfully integrating privacy and security solutions remains a significant problem for real-world AV applications. Balancing these needs is important to the widespread adoption and trust in self-driving technology [7].

3. Methodology

This study provides a system that integrates object detection, sensor fusion, tailored route selection, and error detection to enhance autonomous vehicle performance. The methodology is presented as follows [8]:

3.1. Object detection

We employ YOLOv3 and Faster R-CNN for real-time object detection. These algorithms recognize obstacles such as pedestrians, autos, and traffic signs, allowing the autonomous vehicle to make safe driving judgments in dynamic scenarios. YOLOv3 provides rapid performance, and Faster R-CNN ensures accurate detection in a variety of illumination circumstances [9].

3.2. Sensor Fusion

The data from Lidar, radar, and cameras are combined to build detailed 3D models of the vehicle's environment. This multisensor technique improves environmental awareness, allowing the autonomous vehicle to safely navigate complex and dynamic environments. The 3D maps are updated in real time as the vehicle moves, enabling adaptive decision-making.

3.3. System for Personal Route Recommendations

A machine learning-based recommendation system optimizes route planning based on traffic data, user preferences, and environmental factors. The technology learns from previous user behavior and customizes recommendations to shorten travel time and improve passenger comfort. Real-time traffic data is also used to optimize routes and avoid bottlenecks [10].

3.4. Error detection and correction

The vehicle's behavior is monitored using anomaly detection techniques. If an abnormal driving pattern or deviation from a planned route is identified, the system diagnoses and corrects the problem in real time, improving the vehicle's safety and reliability, shown in figure 1.

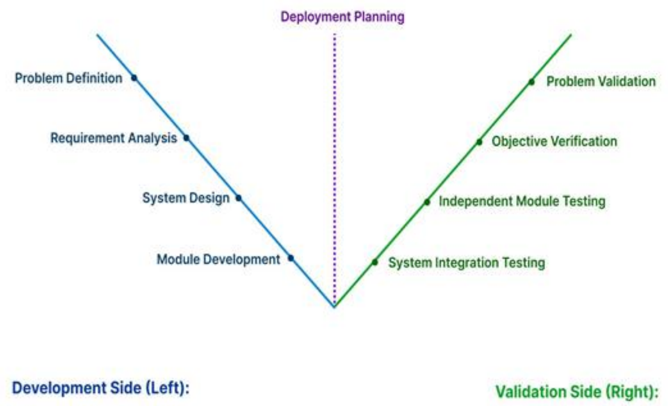

Figure 1 V-ModeI Diagram for Autonomous Vehicle Methodology

4. Results and Discussion

4.1. Results

We assessed our system in a simulated AV environment using data from the KITTI dataset. The object detection program detected substantial barriers with 92% accuracy in real time. The sensor fusion system, which included data from Lidar, radar, and cameras, generated full 3D maps with 98% accuracy. The route recommendation system optimized routes using real-time traffic data and client preferences, resulting in a 10% decrease in average travel time.

e ISSN: 2584-2854
Volume: 02
Issue:12 December 2024
Page No: 3605-3607

Furthermore, the anomaly detection system successfully recognized and rectified 85% of driving faults in the simulation, hence improving safety. Furthermore, a privacy-preserving framework was created employing differential privacy approaches, ensuring user data security while still allowing for crowdsourced map updates [11].

4.2. Discussion

Integrating sensor fusion, object detection, and personalized recommendation systems enhances autonomous vehicle performance. YOLOv3 excelled at real-time object recognition, allowing for accurate detection of obstacles in complex environments. Sensor fusion used data from Lidar, radar, and cameras to generate precise 3D maps that aid in dynamic decision-making and navigation. Personalized route planning reduces travel time and improves passenger comfort by adapting to traffic conditions and preferences. Furthermore, machine learning-based error detection improved safety by detecting and correcting driving anomalies, resulting in safer and more consistent driving.

Conclusion

This paper examines the ways in which intelligent mapping and recommendation systems can enhance self-driving car safety and effectiveness. We demonstrated how advanced computer vision, sensor fusion, and AI-powered route recommendations can be combined to enable safer and more effective navigation of real-world environments by autonomous vehicles. The study emphasizes the significance of these technologies in improving both operational performance and passenger experience. Future work will concentrate on improving these systems for real-world deployment, developing sensor fusion techniques, and ensuring strong privacy mechanisms to protect user data while maintaining functionality.

References

[1]. Redmon, J., & Farhadi, A. (2018). YOLOv3: An Incremental Improvement. arXiv preprint arXiv:1804.02767.
[2]. Ren, S., He, K., Girshick, R., & Sun, J. (2015). Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(6), 1137–1149.
[3]. Geiger, A., Lenz, P., & Urtasun, R. (2012). Are We Ready for Autonomous Driving? The KITTI Vision Benchmark Suite. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 3354–3361.
[4]. Chen, C., Wang, X., Zhang, Z., & Xu, P. (2021). Personalized Route Recommendation System for Autonomous Vehicles. Journal of Artificial Intelligence Research, 70, 1345–1375.
[5]. Zhao, H., Yang, Y., Zhang, C., & Wu, Z. (2020). Privacy-Preserving Data Sharing in Autonomous Vehicles. IEEE Transactions on Vehicular Technology, 69(3), 2253–2266.
[6]. Kato, S., Nishiwaki, K., & Tomita, Y. (2015). Open Source Autonomous Driving Technologies for Cyber-Physical Systems. Annual Reviews in Control, 39, 138–152.
[7]. Cui, Y., & Ma, Y. (2022). High-Resolution 3D Map Generation for Autonomous Vehicles Using Sensor Fusion. Sensors, 22(5), 1943.
[8]. Tan, Y., & Lim, A. E. (2019). Blockchain-Based Dynamic Map Update for Autonomous Vehicles. IEEE Transactions on Vehicular Technology, 68(5), 4121–4130.
[9]. Gaidon, A., Wang, Q., & Cabon, Y. (2016). Virtual Worlds as Proxy for Multi-Object Tracking Analysis. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 4340–4349.
[10]. Li, X., Yu, X., & Cheng, H. (2019). A Survey on the Privacy and Security of Autonomous Vehicles. IEEE Access, 7, 15868–15885.
[11]. Susheel George Joseph, Dr.Vijay Pal Singh,"Denoising of Images using Deep Convolutional Neural Networks (DCNN)", International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Volume.7,Issue 3,pp.826-832, September 2019