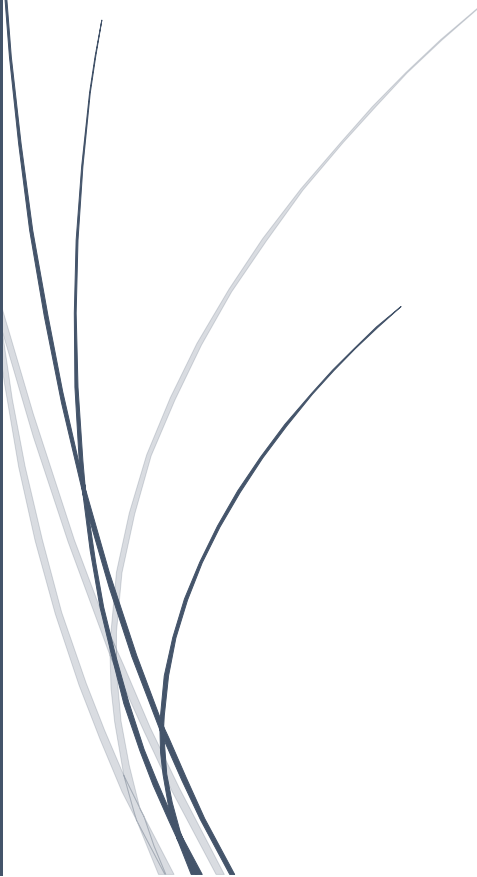


The logo consists of a dark blue vertical bar on the left and a blue arrow pointing right, containing the text "RADemics".

RADemics

Image Processing Techniques for Autonomous Vehicles Including Lane Detection and Obstacle Avoidance

Abstract line art consisting of several thin, curved lines in dark blue and light grey, originating from the bottom left and extending upwards and to the right.

Amit Karbhari Mogal, B. Lokeswara Rao

MVP SAMAJ'S CMCS COLLEGE, HYDERABAD INSTITUTE OF
TECHNOLOGY & MANAGEMENT

Image Processing Techniques for Autonomous Vehicles Including Lane Detection and Obstacle Avoidance

Amit Karbhari Mogal, Assistant Professor, Department of Computer Science and Application, MVP Samaj's CMCS College, Gangapur Road, Nashik, Maharashtra, India, amit.mogal@gmail.com

B. Lokeswara Rao, Professor of ECE & Dean Freshman, Hyderabad Institute of Technology & Management, Hyderabad, dean.freshman@hitam.org

Abstract

This chapter explores the pivotal role of image processing techniques in the development of autonomous vehicles, with a specific focus on lane detection and obstacle avoidance. As the automotive industry increasingly integrates advanced deep learning models, the necessity for efficient data preparation, quality assurance, and real-time implementation becomes paramount. The chapter delves into various deep learning architectures, particularly Convolutional Neural Networks (CNNs) and Residual Networks (ResNets), highlighting their effectiveness in accurately identifying lane markings under diverse driving conditions. Additionally, the integration of edge computing was discussed, emphasizing its advantages in reducing latency and enhancing bandwidth efficiency, critical for real-time decision-making. Furthermore, this chapter addresses the importance of data quality, providing insights into preparation and augmentation techniques essential for training robust models. By examining these key areas, this chapter contributes to the broader understanding of the challenges and opportunities in the application of deep learning for autonomous vehicle technology.

Keywords:

Autonomous Vehicles, Lane Detection, Obstacle Avoidance, Deep Learning, Edge Computing, Data Quality.

Introduction

The advent of autonomous vehicles has heralded a new era in transportation, characterized by increased safety, efficiency, and convenience [1]. Central to the functioning of these vehicles was the effective utilization of image processing techniques, which play a crucial role in enabling the systems to perceive their surroundings accurately [2]. This chapter focuses on two critical aspects of autonomous driving: lane detection and obstacle avoidance [3,4]. These functionalities are paramount for ensuring safe navigation on roadways, as allow vehicles to interpret complex driving environments in real time [5,6]. By employing advanced deep learning algorithms, autonomous vehicles can analyze vast amounts of data from various sensors, leading to informed decision-making that mimics human driving behaviour [7,8].

Lane detection serves as the foundation for autonomous navigation, guiding vehicles along predetermined paths while ensuring adherence to traffic rules [9-13]. Traditional methods of lane detection often struggled with variability in lighting conditions, road surfaces, and lane markings [14]. However, the emergence of deep learning techniques, particularly Convolutional Neural Networks (CNNs), has significantly enhanced the accuracy and reliability of lane detection systems [15]. CNNs excel at feature extraction, allowing them to recognize lane markings with remarkable precision, even in challenging conditions. This capability not only improves the vehicle's ability to maintain its lane but also aids in predicting potential hazards and adjusting driving strategies accordingly [16-18].

In addition to lane detection, the capability to avoid obstacles was critical for the safety of autonomous vehicles [19]. Obstacle avoidance involves the identification and classification of various objects in the vehicle's environment, such as pedestrians, other vehicles, and roadside barriers [20]. Advanced deep learning architectures, including Residual Networks (ResNets), have demonstrated their effectiveness in real-time object detection and classification tasks [21]. By leveraging these sophisticated models, autonomous vehicles can analyze their surroundings and respond proactively to potential threats, thereby enhancing overall safety [22]. The combination of lane detection and obstacle avoidance capabilities empowers vehicles to navigate complex environments with a higher degree of confidence [23].

Data quality was a fundamental aspect that influences the performance of deep learning models in lane detection and obstacle avoidance. High-quality data ensures that models can learn the underlying patterns necessary for accurate predictions. This chapter addresses various data preparation and augmentation techniques essential for training robust deep learning models. Emphasizing the importance of data accuracy, completeness, consistency, and timeliness, it provides insights into how these factors contribute to the overall efficacy of autonomous vehicle systems [24,25]. By establishing a strong foundation of data quality, practitioners can significantly enhance model performance, resulting in safer and more efficient autonomous driving experiences.