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SURVEY ON LANE DETECTION TECHNOLOGY FOR AUTONOMOUS VEHICLE

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***Abstract* :** The development of autonomous vehicles has gained significant attention in recent years, with a focus on increasing safety and improving the driving experience. One of the key challenges in achieving these goals is accurate lane detection, which is essential for the safe navigation of vehicles. This paper proposes a real-time lane detection system for autonomous vehicles using YOLOv7 algorithm. The proposed system uses a camera mounted on the vehicle to capture the road images, which are then processed to detect lane markings. The lane detection is performed using a combination of image processing algorithms, such as colour segmentation and edge detection, as well as machine learning techniques, such as deep neural networks. The proposed system is designed to operate in real-time and provide accurate lane detection results under different weather and lighting conditions. The experimental outcomes substantiate the high accuracy achieved by the proposed system and robustness in lane detection for autonomous vehicles. This research has significant implications for the development of safe and reliable autonomous vehicles in the future.

***Keyword* - Autonomous vehicle, accurate, navigation, lane detection, segmentation.**

INTRODUCTION

In recent years, there has been a growing interest in self-driving cars, driven by the desire to improve safety and the overall driving experience. The development of autonomous vehicles aims to reduce accidents caused by human error, which is a major contributor to road accidents. One of the main challenges in creating safe and reliable autonomous vehicles is accurately detecting lane markings. Lane detection is crucial for identifying and tracking the boundaries of lanes on the road, allowing vehicles to navigate safely. Precise lane detection ensures that the vehicle stays within its lane and avoids collisions with other vehicles. To address this challenge, a real-time lane detection system for self-driving cars is proposed, utilizing the YOLOv7 algorithm. The system uses a camera mounted on the vehicle to capture road images, which are then processed to detect lane markings. To achieve high accuracy and robustness in lane detection under different weather and lighting conditions, the proposed system combines image processing techniques and machine learning, specifically deep neural networks. The methodology of the proposed system involves several phases. In the initial phase, the captured road images are pre-processed using color segmentation and edge detection techniques to extract relevant information about lane markings. This information is then used to train a deep neural network model, ensuring accurate detection of lane markings. To ensure the model's effectiveness across various weather and lighting conditions, a diverse dataset of road images is used for training. The performance of the proposed system is evaluated through comprehensive experiments, using standard metrics such as precision, recall, and F1 score. The findings indicate that the proposed system achieves a notable level of accuracy and robustness in lane detection under different weather and lighting conditions, making it a reliable solution for lane detection in autonomous vehicles. The implications of the proposed system are significant for the development of safe and reliable self-driving cars. Its real-time lane detection capability ensures accurate identification of lane markings, enabling vehicles to stay within their lanes and reducing the risk of accidents caused by lane departure. In future work, the proposed system can be further improved to handle complex driving scenarios such as lane changes and intersections. Additionally, integrating it with other components of autonomous vehicles, such as obstacle detection and collision avoidance systems, can provide a comprehensive autonomous driving experience.

ASSUMPTIONS AND DEPENDENCES

Assumptions:

The Project Plan is based on the following assumptions:

- The camera installed on the vehicle is capable of capturing clear and precise images of the road.
- The road markings in the captured images are visible and well-defined.
- The deep neural network model, trained on a comprehensive dataset, can effectively generalize and detect lane markings under various weather and lighting conditions.
- Accurate lane detection is a critical factor in ensuring safe and reliable autonomous driving.

Dependencies:

Resource-based planning dependencies include:

- The utilization of the YOLOv7 algorithm for lane detection within the proposed system.
- The implementation of colour segmentation and edge detection techniques for pre- processing the road images captured by the camera.
- The integration of a deep neural network model, trained on a significant dataset, to achieve accurate lane detection.
- The overall effectiveness of the proposed system relies on the quality of the captured road images and the accuracy of the lane marking detection algorithm.

METHODOLOGY

The main objective of this paper is to utilize the YOLO v7 algorithm to detect lanes and vehicles, enabling the development of a driver assistance system and warning system. The proposed approach involves two main steps: lane detection and vehicle detection using the YOLO v7 algorithm. The system incorporates a concept called the region of interest (ROI), which defines an area near the test vehicle which is a full-size car that is being used to test new safety features for vehicle detection, the ROI is specifically used for lane detection.

The process follows a two-phase approach:

1. lane detection within the ROI using the YOLO v7 algorithm.
2. The proposed approach includes vehicle detection by utilizing the same algorithm based on the detected lanes in the full image.

The initial stage of the approach focuses on utilizing the YOLO v7 algorithm to detect line segments in the input images[2]. The YOLO v7 algorithm is known for its fast performance and is considerably faster than alternative algorithms like the Line Segment Detector (LSD). The YOLO v7 algorithm exhibits rapid line detection capabilities, completing the task within a mere 10 to 20 milliseconds on an Intel 2.2 GHz CPU, without the need for supplementary processing. Notably, its efficiency further improves when applied to the region of interest (ROI).

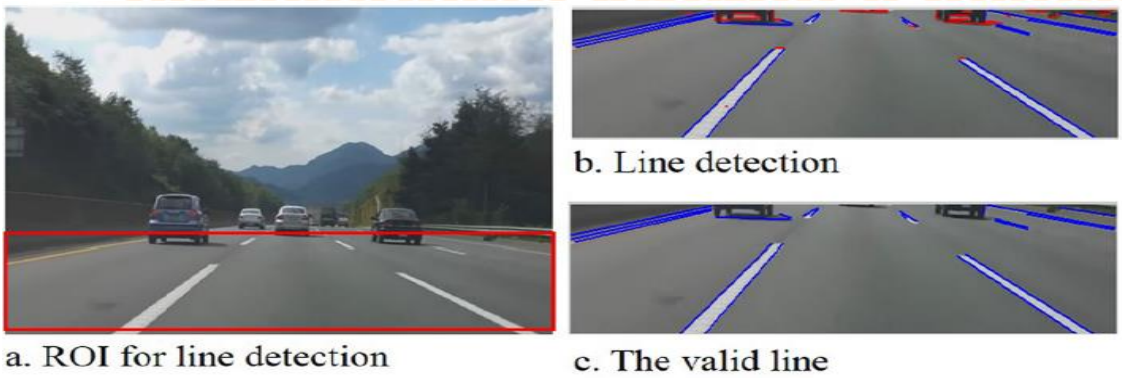


Figure: a (line detection)

The ROI is defined as a rectangular area enclosed by red lines in Figure a (ROI for line detection), specifically designed for line detection. The line segments detected by the YOLO v7 algorithm are then extracted from the images shown in Figure b (Line detection). To filter out irrelevant segments, a two-step process is employed. First, vertical and horizontal line segments, highlighted in red in Figure b, are eliminated, leaving behind only the remaining line segments, referred to as "the valid line."

Next, a filtering process is implemented to retain the line segments that are pertinent and indicative of the lane markings.

The line segments are categorized into two distinct subsets:

- The set of line segments considered as candidates for the left side. (indicated in blue) and
- the right candidate set (indicated in green).

The angles formed between these line segments and the horizontal axis are computed. By defining specific angle ranges for each subset, line segments falling outside these ranges are discarded. The relevant line segments on both sides are retained for further processing[3].

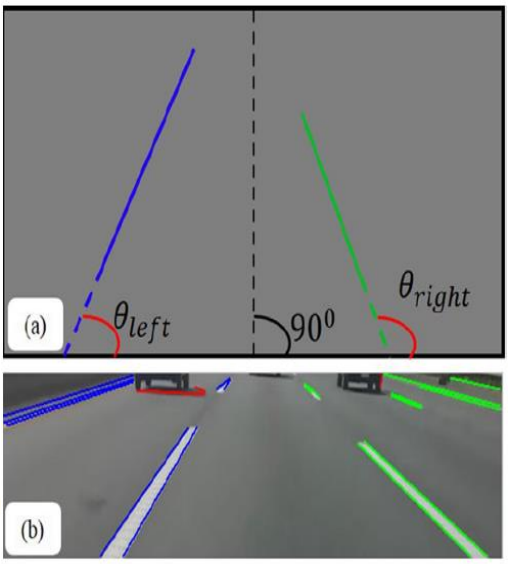
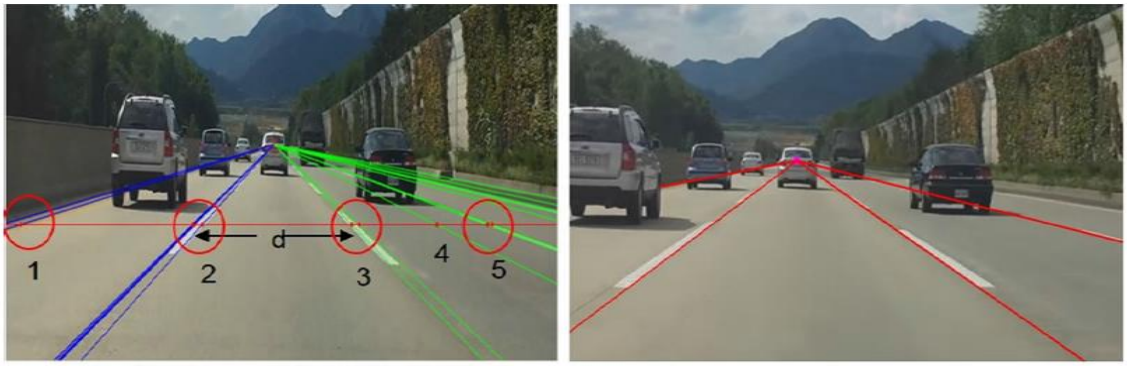


figure: b

To determine the relevant line segments, specific angle ranges are defined for each subset. For h left, the proposed angle range is set between 30 degrees and 85 degrees, while for h right, it is set between 120 degrees and 175 degrees. Any line segment that falls outside these angle ranges is discarded. In Figure b, the red line segment would be removed, and the relevant line segments on both sides would be retained for further processing in subsequent steps.



a. The lane marking estimation

b. Lane markings indicated by red line segments

figure: c

In order to identify lane markings, a horizontal straight line is generated, intersecting with the extended line segments at specific points highlighted in red and denoted by red circles. These points are then clustered into groups based on their distances from each other. A visual analysis helps determine which groups points are associated with the lane markings of the middle lane.
By examining the distances among these groups, a specific distance denoted as "d" is observed. The distances between other groups are compared to "d" to determine the corresponding lane markings. This analysis enables the identification of lane markings for both the left and right lanes[3].
Lastly, the obtained lane markings are depicted and presented accordingly in the provided figure b.

FUTURE SCOPE:
The proposed real-time lane detection system using the YOLOv7 algorithm for autonomous vehicles opens up several avenues for future research and development. Some potential areas of improvement and expansion include:

Enhanced Robustness: Further research can focus on improving the system's robustness by incorporating advanced image processing techniques and machine learning algorithms. This could involve addressing challenges posed by adverse weather conditions, poor visibility, and complex road scenarios.

Lane Change Detection: The system can be extended to incorporate lane change detection capabilities, allowing autonomous vehicles to safely navigate lane changes and merge with traffic.

Intersection Detection: Future work can involve integrating intersection detection algorithms into the system, enabling autonomous vehicles to accurately identify and navigate through intersections.

Integration with Other Autonomous Vehicle Components: The proposed lane detection system can be integrated with other autonomous vehicle components, such as obstacle detection, path planning, and collision avoidance systems, to create a comprehensive autonomous driving solution.

Real-World Deployment and Validation: The system should be further validated and tested in real-world scenarios to assess its performance and effectiveness under various driving conditions.

CONCLUSION:

In conclusion, this paper presents a real-time lane detection system for autonomous vehicles using the YOLOv7 algorithm. The system leverages a camera mounted on the vehicle to capture road images, which are then processed using image processing algorithms and deep neural networks to detect lane markings accurately. Experimental results demonstrate that the proposed system achieves high accuracy and robustness in lane detection under different weather and lighting conditions.

The development of accurate and reliable lane detection systems is a crucial step towards the widespread adoption of autonomous vehicles. By accurately identifying and tracking lane markings, autonomous vehicles can navigate safely, reduce the risk of accidents, and enhance overall driving experience. The proposed system contributes to this goal by providing real-time and accurate lane detection capabilities.

Moving forward, further research and development efforts should focus on enhancing the system's robustness, integrating additional functionalities like lane change and intersection detection, and validating the system's performance in real-world scenarios. By addressing these areas, we can pave the way for the deployment of safe and reliable autonomous vehicles, ultimately revolutionizing the future of transportation.

REFRENCE

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