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Advances and Future Directions in Road Lane Line Detection Techniques for Autonomous Driving Systems

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Abstract

This paper explores various road lane line detection techniques essential to autonomous driving and driver assistance systems. The methods discussed include edge detection, Hough Transform, and model-based approaches. The advantages, drawbacks, and performance elements – such as accuracy, robustness, and efficiency – of these techniques are examined. The paper also broaches the challenges of road lane line detection in varied driving scenarios, identifying potential avenues for future research in increasing the robustness and reliability of these techniques.

Keywords: Road Lane Line Detection, Autonomous driving systems, Edge detection, Hough transform, Model-Based Methods.

1. Introduction

Road lane line detection plays a critical role in autonomous driving and driver assistance systems. Lane detection is crucial for many applications such as lane departure warning, lane keeping, and lane change assistance, and can enhance the driving experience by reducing accidents and improving traffic flow.

A new method to detect road lanes efficiently and correctly. We started with a real-time video and then turned it into an image. Following the acquisition of the image from the video. The height and weight are detected. We identify some vertices in which the lane should be detected. Using the CVT color approach, turn the previous image into a gray image. Using the canny approach, we can extract some edges from the gray image. A function called the region of interest is created to be defined as a specific point inside a set of vertices on the x and y axes. We utilized the filpoly method to fill an area enclosed by many polygons in the region of interest method. We acquired the polygon from the preceding original image and image. The original image is then used to replace the polygon image. Then we create a function called draw line (the dram line method's purpose is to draw lines or lines). The Hough line transform method is used to detect lanes or lanes from the replacement image in polygon images. The detected line or lanes are then drawn. Finally, when the lines are drawn, we blend the previous image with the replaced image.

2. Literature Review

Saha et al. [2012] discussed an algorithm for detection of marks of road lanes and road boundary by using intelligent vehicles. It converted the RGB road scene image into gray image and employed the flood-fill algorithm to label the connected components of that gray image. After that the largest connected component obtained by the algorithm and which was the road region was extracted. The unwanted region was detected and subtracted like outer-side of the road. The extracted connected component was filtered to detect white marks of road lane and road boundary. The road lane detection algorithm still had some problems such as critical shadow condition of the image and color of road lanes other than white. Tseng et al. [2005] [2] gave a lane marking detection algorithm by using geometry information and modified Hough transform. In that algorithm the captured image was divided into road part and non-road part by using camera geometry information. The color road image was quantized into a binary image. The modified Hough transform with road geometry consideration was used to detect the lane markings. The histogram of intensities was applied to quantize the road image into a binary image. A modified Hough transform method has been developed to detect the lane markings in road image by using the road geometry information. It was time consuming because Hough transform was a full search algorithm in parameter space. It also failed when the lane boundaries intersected in a region which was a non-road part. Shen et al. [2012] [3] discussed a monocular vision system that could 14locate the positions of the road lane in real time. An algorithm proposed for lane detection using single camera. The algorithm worked in five steps. Initially edge detection was done to find all present edges from road image as road line required was included in it. Canny approach has been used to achieve the edge map from road image for its accurate edge detection. Then matching was done to eliminate unwanted figures. A priority and orientation based searching method has been used for enhance and label potential lane segments from edge map, degrading unwanted edge features. Based on results from search, a linking condition was used to assemble matched segment that further strengthen the confidence of the potential lane line. Finally a cluster algorithm was used to localize the road-lane lines. M. Dhana Lakshmi et al. [2012] [4] discussed a novel algorithm to detect white and yellow colored lanes on the road. An automatic lane marking violence detection algorithm was designed and implemented in real time. The lane detection method was robust and effective in finding the exact lanes by using both color and edge orientations. The color segmentation procedure identified the yellow and white colored lanes followed by edge orientation in which the boundaries was eliminated, regions was labeled and finally the lanes was detected. As the height of the camera was relatively constant with respect to the road surface, the road portion of the image can be exclusively cropped by providing the coordinates, so that identifying the lanes became much more efficient Cuong Le et al. [2012] [5] discussed the task of finding the pedestrian lanes that are indicated by painted markers for the vision impaired people. An assistive navigation system has been developed for the blind by employing geometric figures like straight line, parabola, or hyperbola. By combining color and local intensity information, this method detected correctly pedestrian marked lanes in different illumination and weather conditions (sunny, cloudy, strong shadows,times of day). A. Roychowdhury, A. Routray, and D. Patra: Road lane detection and tracking is an important task in computer vision that has many applications, such as autonomous driving, advanced driver assistance systems (ADAS), and traffic monitoring. In this survey, the authors provide a review of road lane detection and tracking algorithms, including both feature- based and model-based approaches. Feature-based methods rely on extracting hand-crafted features from images, while model-based methods use geometric models to detect and track lanes. The authors also discuss the challenges and limitations of these algorithms, such as low-light conditions, occlusions, and complex road layouts. They highlight the need for further research in this area to improve the accuracy and robustness of lane detection and tracking algorithms. The authors first discuss feature-based methods for road lane detection and tracking. These methods rely on extracting features such as edges, lines, or

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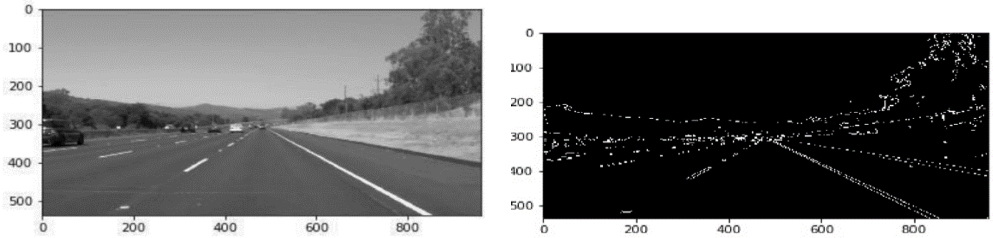
curves from images and using these features to detect and track lanes. They discuss several popular feature-based methods, such as Hough transform, Canny edge detection, and Sobel edge detection. They also discuss the limitations of these methods, such as sensitivity to noise and difficulty in handling curved lanes. Next, the authors discuss model-based methods for road lane detection and tracking. These methods use geometric models to represent the road and lane markings and detect and track lanes based on these models. They discuss several popular model-based methods, such as the polynomial model, the Fourier transform model, and the Kalman filter-based model. They also discuss the limitations of these methods, such as difficulty in handling occlusions and complex road layouts. Finally, the authors discuss the challenges and limitations of road lane detection 16 and tracking algorithms. They highlight the need for robust and accurate algorithms that can handle various lighting conditions, weather conditions, and road layouts. They also discuss the importance of real-time performance in ADAS and autonomous driving applications and the need for efficient and scalable algorithms. The authors conclude by calling for further research in this area to improve the accuracy and robustness of road lane detection and tracking algorithms

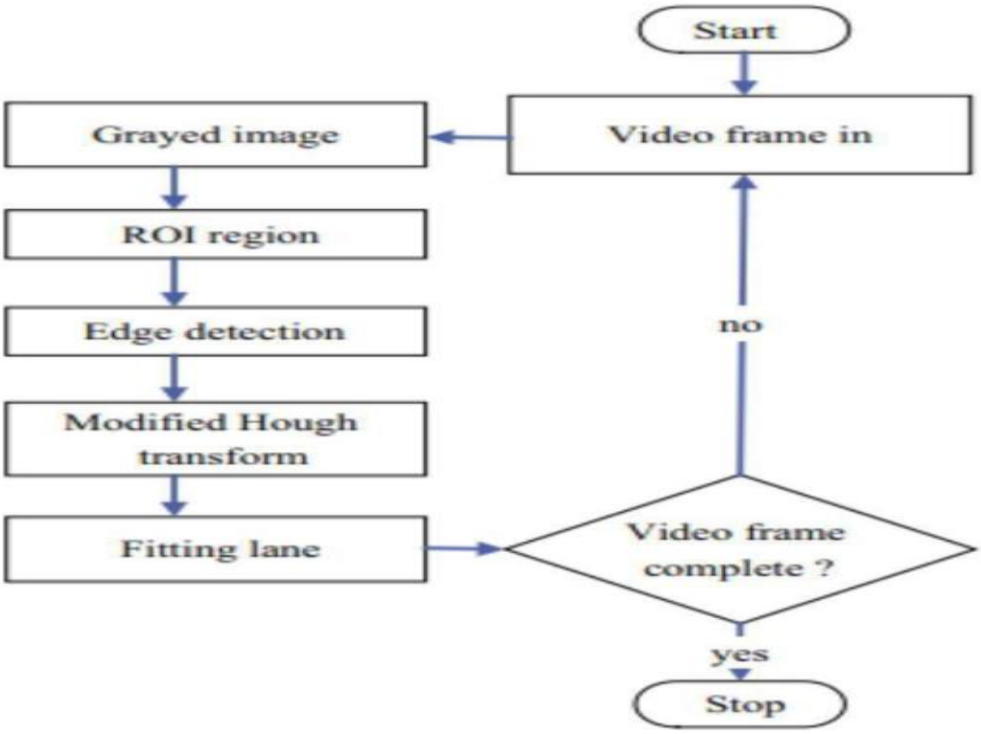
3. METHODS

Grayscale is an image format that represents each pixel's brightness value in shades of gray, ranging from black (minimum brightness value) to white (maximum brightness value). In a grayscale image, there is only one color channel, representing the brightness or intensity of each pixel, instead of the typical three-color channels (red, green, and blue) found in a color image. Fig 1. Gaussian blur is a widely used image processing technique in computer vision that smooths out an image by reducing high-frequency noise and removing sharp edges or details. It works by convolving the image with a Gaussian filter kernel, which is amatrix of values derived from the Gaussian function.



Canny edge detection is widely used in computer vision applications such as object detection, image segmentation, and feature extraction. It can be implemented using various programming languages and libraries, such as Python with OpenCV, MATLAB, or C++. The Canny edge detection function is often included in these libraries as a standard image processing function and can be called with a few lines of code to apply the edge detection effect to an image. The Hough transform works by transforming an image into a parameter space where the geometric shape of interest is represented as a single point. For example, aline in an image is represented by a single point in Hough space, where the point represents the line's parameters (slope and intercept). Each point in Hough space corresponds to a possible line in the image, and the accumulation of points can be used to identify the most likely lines in the image.

4. System Architecture Diagram:



5. RESULT

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