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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)

Vol. 03, Issue 04, April 2023, pp : 510-514

e-ISSN : 2583-1062

Impact Factor : 5.725

ROAD LANE LINE DETECTION

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ABSTRACT

Autonomous Driving Car is one of the most disruptive innovations in AI. Fueled by Deep Learning algorithms, they are continuously driving our society forward and creating new opportunities in the mobility sector. An autonomous car can go anywhere like a traditional car can go and does everything that an experienced human driver does. But it's very essential to train it properly. One of the many steps involved during the training of an autonomous driving car is lane detection. In this project, a computer vision model is built to detect the lanes for self-driving cars in real time by using the concepts of computer vision using OpenCV library. The OpenCV tools like color selection, the region of interest selection, grey scaling, Gaussian smoothing, Canny Edge Detection, and Hough Transform line detection are being employed. The main goal is to determine the route for the self-driving automobiles in order to reduce the chance of entering another lane.

Keywords: Machine Learning; Support Vector machine, Computer Vision (OpenCV), Region of Interest, Canny-Edge Detection, Noise Reduction, Hough Transform.

1. INTRODUCTION

The traffic safety becomes more complete necessary with the increasing urban traffic. The majority of accidents on the avenues are caused by drivers leaving the lane without following the correct procedures. The majority of these are the result of the driver's distracted and sluggish behavior. Maintaining traffic lanes is essential for both motorists and pedestrians' safety. The system's goal is to locate the lane markings. Its goal is to create a secure environment and enhance the traffic environment. The suggested system's capabilities can range from showing the position of the road lines to the driver on any outside display to more complex applications like anticipating lane changes to prevent highway concussions. A crucial problem with lane recognition and departure warning systems is the accurate detection of lane roads. Vehicles equipped with predicting lane boundaries systems instruct the vehicles to avoid crashes and produce an alarming condition if an automobile crosses a lane confinement. It is not always required for lane borders to be readily visible for these types of intelligent systems to provide safe travel, as bad road conditions and insufficient paint application for lane boundary markings make it difficult for systems to accurately detect lanes and other reasons can include Invariant lighting circumstances generate environmental effects like fog, shadows cast by objects like trees or other cars, streetlights, day and nighttime situations, etc. These elements make it difficult for a person to recognize a road lane in the background of a picture that was recorded. In intelligent transportation systems with improved technologies, the vehicles are made more sophisticated with better infrastructure. But the way to move on the roads by means of lane detection aspect is neglected by many automobile companies and the ways to improve these aspects does not change from many years. Lane detection plays vital role for accidents. For human vision and human intelligence, the task of lane detection changes due to variations in the road conditions. Sometimes it is very easy to detect with the human eyes but in some conditions due to externals effects the human intelligent have detection problems that appears for the lane detection which may lead for the accidents. In this Project, we are going to detect the lane lines on the road for a self-driving car. This is done using the techniques like Edge Detection, Region of Interest and Hough Transformation present in OpenCV library of Computer Vision. The detection is achieved by capturing the video of the road with the camera fitted on the car. So, with this detection, a lot of human driving errors can be removed, and pattern of deaths can be reduced.

2. RELATED WORK

1. Edge detection information using image intensity: Rong, Weibin, et al. introduced the concept of image gradient with gravitational field intensity and obtained the gravitational field intensity operator. Two approaches for choosing an adaptive threshold based on the average of the images gradient magnitude and standard deviation were put forward for two kinds of typical images (one has less edge information, and the other has rich edge information) respectively [1].

2.Analysis of Scale Multiplication in Canny Edge Detection: Bao, Paul analyzed in the context of Canny edge detection, the scale multiplication technique was examined. The sum of the detection filter's responses at two scales is known as a scale multiplication function. When the results of scale multiplication are threshold, edge maps are created as the local maxima. The scale multiplication detection and localization criteria are derived. Scale multiplication can

significantly increase the localization criterion at a slight cost in the detection criterion. The performance of edge detection is improved since the product of the two scale multiplication criteria is bigger than the product for a single scale. [3].

3. Estimating of Object boundaries in image using Edge Detector: In this work, Ding, Lijun, and Ardeshir Goshtasby. proposed in computer vision, the canny edge detector is frequently used to find sharp intensity changes and object boundaries in an image. If a pixel's gradient magnitude is greater than that of pixels on both of its sides in the direction of highest intensity change, the Canny edge detector labels the pixel as an edge [2].

4. Edge Detection with the Threshold values using OpenCV: Xu, Zhao, Xu Baojie, and Wu Guoxin proposed that Canny operator is used and improved across widely. Hysteresis threshold is used by Canny, and while differing threshold values have a significant impact on the detection outcome, the number itself cannot adequately convey the outcome of the detection. Through the use of Open CV programming, four algorithms are introduced. This programming can visibly display the detection results under various thresholds, which is useful for picture edge detection.

5.Improvised Lane detection through ROI Selection: Hu, Jianjun, et al focused-on accuracy of lane detection, a unique method is proposed in this research that is based on the dynamic region of interest (DROI) selection in the horizontal and vertical safety vision. To precisely choose the DROI at this precise instant, the lane line equation and eight vehicle speed data from the previous frame are utilized to solve the curvature of each location on the edge of the road and the maximum safe distance. The next step is to apply the DROI's global search to find the lane line feature points. Interpolation is then used to process the discontinuous points. The lane line is fitted in the polar coordinate equation to complete quick and precise matching of lane feature points and mathematical calculations. [4].

6. Enhancing the methods of detection through ROI and CNN Algorithms: Hoang and Kang Ryoung Park. aimed at improving the efficiency of arrow and bike marker recognition and categorization using an adaptive region of interest (ROI) and deep convolutional neural network (CNN). To construct the ROI image, a vanishing point is found in the first stage. In the second stage, the CNN-based detector and classifier are trained using the ROI image that primarily covers the road region. On a desktop computer and NVIDIA Jetson TX2 embedded system, the suggested method is tested on three open datasets: the Malaga urban dataset, the Daimler dataset, and the Cambridge dataset.

3. METHODOLOGY USED

The proposed system tries to implement the sequence of operations to get the required result. It involves Capturing the video in the camera and decoding the video file and send it to the system and it has been initialized every frame to be decoded. Then Grayscale Conversion for converting the frames from RGB format to grayscale to reduce the process time also includes noise reduction for detecting false edges so that they can be smoothened. In addition to this, Gaussian filter is used to perform the process. After that, essential step comes into play which is Canny-Edge detection for detecting edges of the blurred and also traces the images with large intensity. The processed image/frame is passed through ROI which mask the unwanted region and only focuses on the road direction. The mask frame from ROI is finally passed through Hough Transformation for detecting lines and circles to give the plain lane as the final output in the system.

Advantages: Accuracy: Accuracy is the main criteria for system design since the goal of intelligent transportation system development is to lower the rate of urban traffic accidents. The vehicle may go in the wrong direction, which is detrimental to its own driving safety and increases the danger to road safety, if there is an error or deviation in the detection of the lane line.

High Efficiency: The car must be able to maintain a specific speed when travelling on the road in addition to being able to follow the lane line precisely. This calls for efficient and real-time lane line identification processes that can accurately and quickly detect objects.

Memory: In the intelligent public transport system, in addition to the vehicle's ability to detect the image of the lane line in real time, it also has a good memory function, which can efficiently store and manage the recorded data information and facilitate investigation and evidence gathering after a traffic accident.

Avoidance of Complex design Structure: Since automobiles are where the system design is most frequently used, the occupied space should be as little as possible. Without interfering with other aspects of the vehicle's operation, you can fully utilize 5G communication real-time connectivity.

4. OBJECTIVES OF THE PROJECT

- We will build a computer vision project to detect lane lines in real-time.
- This will be a critical part of autonomous cars, as the self-driving cars should not cross its lane and should not go in opposite lane to avoid accidents.

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- To stop accidents caused by careless driving on the roads, this technology can be placed in automobiles and taxis.

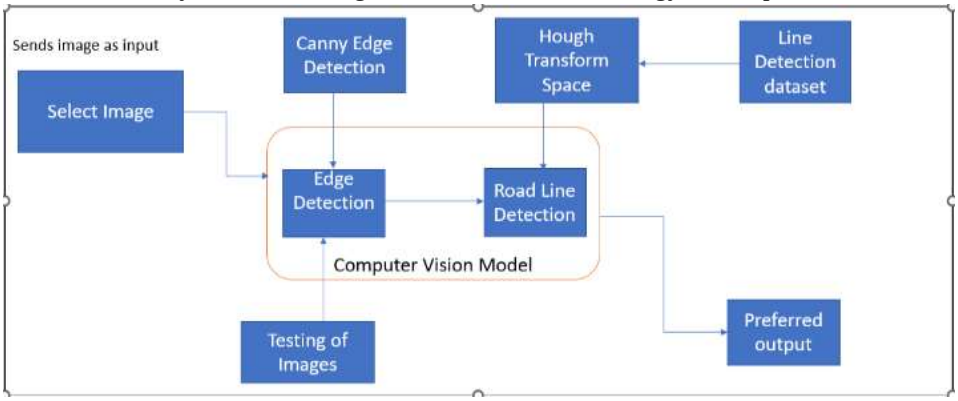

Fig. 1. Project flow diagram

Steps involved in the Process flow:

- Take Video as Input
- Convert into frames or images
- Selects an image as input
- Images are converted into grey color by using Grey- Scaling.
- Noise is reduced by using Gaussian Blurring
- Edges are detected using Canny-Edge Detection
- Unwanted area/region is being masked by Region of Interest (ROI) selection.
- Finally, shapes or circles are ignored by Hough Transformation.

The detection of lanes is mainly based on the road accidents which are happening frequently and to provide simple lanes for all the cars for a safe ride and the vision model is a good prototype which includes algorithms gives accurate and efficient results.

5. TOOLS AND TECHNOLOGIES

Python: History was about to be written in the late 1980s. At that time, Python development got underway. Following that, Guido Van Rossum started working on application-based projects in December 1989 at the Netherlands-based Centrum Wiskunde & Informatica (CWI). He initially started it as a side project since he was seeking for something entertaining to do to pass the time during the holidays. He also made a good programming language that fixed all the bugs. A number of fundamental exception handling and routines. 3.10.4 is the most recent stable version of Python. It was used to express the concepts as compared to C, C++, Java. It gives user a facility of code readability and capability to provide core data type concepts as inheritance and other tools.

NumPy: NumPy is a python library which is used for computing numerical values. Which provides the powerful tools for arrays and matrices. It provides a number of functions for performing the mathematical operations on arrays and for random number generation. A general-purpose package for handling arrays is called NumPy. It offers a multidimensional array object with outstanding speed as well as capabilities for interacting with these arrays. It is the cornerstone Python module for scientific computing. The program is an open-source for all the interfaces.

OpenCV: A free and open-source software library for computer vision and machine learning is called OpenCV. To offer a standard framework for computer vision applications, OpenCV was created. More than 2500 optimized algorithms are available in the collection, including a wide range of both traditional and cutting-edge computer vision and machine learning techniques. These algorithms may be used to recognize faces, identify objects, categorize human behaviors in films, follow camera movements, follow moving objects, extract 3D models of objects, create 3D point clouds from stereo cameras, and patch together images to produce a high resolution image of an entire scene, detect related pictures in an image database, fix red eyes in flash photos, track eye movements, identify scenery and create markers for augmented reality overlays, etc. More than 47 thousand people use OpenCV, and it has been downloaded more than 18 million times, according to estimates. The library is heavily utilized by businesses, research teams, and governmental organizations.

Matplotlib (version 3.1.2): For Python and its numerical extension NumPy, Matplotlib is a cross-platform data visualization and graphical plotting package. As a result, it presents a strong open-source substitute for MATLAB. The APIs (Application Programming Interfaces) for matplotlib allow programmers to incorporate graphs into GUI applications. A useful stateful interface in the MATLAB paradigm is available in the pyplot API. In actuality,

matplotlib was created as an open-source replacement for MATLAB. Although regarded more challenging to use than pyplot, the OO API and its UI are more powerful and adaptable.

Pre-Processing:

Preprocessing, which would be regarded as the first step in Canny's process, primarily involves the grey scale conversion and smoothening techniques. The selected image is converted into grey scale using an open-source computer vision package, and smoothening is then applied by implementing the Gaussian Blur algorithm on the selected grey scale image. Thus, preprocessing is applied to the chosen image. The processing time for the subsequent major procedures can be sped up by converting the grayscale image to black and white and minimizing the image noise. In general, a data pretreatment or cleaning step is involved in machine learning initiatives. Before you create your learning model, you will need to invest a significant amount of effort cleaning and preparing the data.

Algorithm:

Algorithm implementation on frames from the video refers to the process of using a machine learning algorithm to build a vision model related to the other implementation of the algorithms. This involves feeding the algorithm with the training data to learn the underlying patterns and relationships between the input variables and the target variable. The proposed system uses machine learning algorithms Canny Edge Detection, Hough Transform Selection, ROI and Gaussian blurring. The suggested system yields effective outcomes. Algorithms for machine learning are processes that are written in code and applied to data. The quality and size of the training dataset, the algorithm's complexity, and the data analyst or data scientist's level of experience all affect how well an algorithm performs when applied to a training dataset. To guarantee that the model is reliable and successful in giving the accurate product or outcome, it is crucial to properly choose and preprocess the data as well as an appropriate algorithm.

Table 1: Various Previous Techniques used for the Lane Detection.

S.No.	Reference Paper Title	Purpose	Drawbacks
1.	Enhanced Detection and Recognition of Road Markings Based on Adaptive Region of Interest and Deep Learning	Detection of lanes by enhancing the approach based on ROI and CNN algorithms.	Does not work for multiple datasets as the cost is expensive due to processes involved.
2.	Canny Edge Detection Enhancement by Scale Multiplication	In the Canny Edge Detection, Technique of Scale multiplication is analysed for detecting local area and constructing edge maps.	Bulk and time taken process due to more computations in scale multiplication.
3.	Canny edge detection based on Open CV	A traditional algorithm used for edge detection by taking threshold values of image intensities.	It does not provide any basement for 3D object views and only canny function used for interpretations.
4.	Research on Lane Detection and Tracking Algorithm Based on Improved Hough Transform	The purpose is about the use of improved Hough transform to achieve straight-track detection of lane detection	The algorithm designed cannot completely avoid the interference of other lines in the identification due to lack of ROI.
5.	Lane Detection Based on Improved Feature Map and Efficient Region of Interest Extraction	A conventional approach to estimate the lateral offset of the lanes from the IPM image is by adding feature points column by column.	Set up cost is very high because ROI is considered both sides of right and left shifts of roads.

Performance evaluation:

Algorithms are evaluated based upon their performance and their accuracy.

6. RESULTS AND DISCUSSIONS

We have taken the sample videos as test cases and they gave the accurate result which matches the desired output. They are shown in tabular form:

Table 2: List of Observations for Results.

Test Case ID	Test Case Name	Expected Output	Actual Output	Status
1.	First road video given as input	Detect the lane lines by displaying the coloured lines on the road	Detect the lane lines by displaying the coloured lines on the road	PASS
2.	Second Video of a road given as input	Detect the lane lines by displaying the coloured lines on the road	Detect the lane lines by displaying the coloured lines on the road	PASS

7. CONCLUSION

Robust lane detection is an important application of Intelligent Transport System. To avoid victims and number of accidents in heavy traffic countries like USA, China, Malaysia, UK, where it becomes difficult for the driver to exact location and detection of line and cars especially during cloudy environment that it is important to make Intelligent Transport System more robust and as well in other way lane detection is one of important future application of auto drive vehicle. In this project, we have successfully detected the lane lines on the road for the self-driving cars using the advanced lane detection techniques like Canny edge detection, Region of Interest (ROI) Generation and Hough Transformation. The development of autonomous vehicles seems to be a critical next step in transportation technology. The software in autonomous vehicles is always being upgraded, and development in this area is ongoing. Even if the idea of driverless cars was the beginning, more semi-autonomous features—such as cameras, sensors, and radio frequency—will emerge. This will ease traffic and improve safety by allowing for quicker reflexes and fewer mistakes.Future ScopeSince we implement our models in modules, it is simple to update the algorithms, and work on changing the implementation of the model may continue in the future. We insert the pickle file of the model in the necessary places so that it may be quickly copied onto goods. Therefore, this may easily avoid compiling the big code in its entirety each time. By offering a new future in which the road can be seen in the dark, or at night, we may also enhance the project. The ability to identify and choose colors when driving at night is quite effective in daylight. While adding shadows will make some noise, it won't be as demanding of a test as driving at night or with poor visibility. Therefore, this research can be enhanced further to identify the roads with loamy soil that are present in the communities and stop accidents. As we did with Python, we can also use the forthcoming, simple, and understandable programming language Julia to implement our project. The most anticipated project, self-driving cars, depend heavily on this road detection system.

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