ARTIFICIAL INTELLIGENCE BASED TRAFFIC PREDICTION SYSTEM FOR AUTONOMOUS VEHICLES

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DOI: 10.47750/pnr.2022.13.S08.413

Abstract

The self-driving car market will be valued at $2,161.79 billion by 2030 because of the automotive industry's current strong growth. A self-driving automobile, often referred to as a self-driving vehicle, is a ground vehicle with the ability to recognise its surroundings and operate alone. One of the most intelligent features is Lane Departure Warning, but it sometimes doesn't work in practical scenarios. Just above the hood, install the camera to prevent this and the video is next preprocessed in a Python programme to convert it to HSV and HLS frames at a time, leaving behind masked areas of the road that may be utilized with the Hough transform technique to identify vehicles in lanes. The car's steering is directed in the desired direction with the assistance of the Arduino UNO. The majority of accidents can be avoided and people's confidence will rise by using this technology. Both passengers and pedestrians are safeguarded by this. This information shows the car's precise location while it is moving. Based on this insight, the security features using online video downloads is developed.

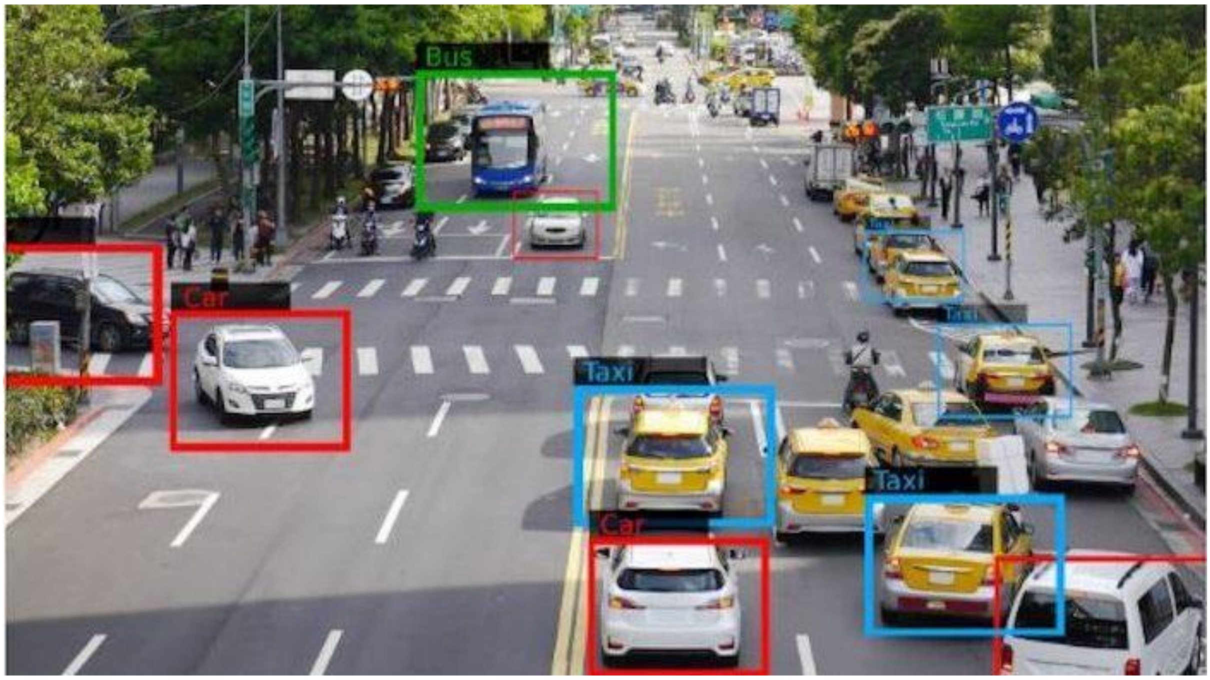
Keywords: Automotive industry, Self driving car, Lane Departure Warning, Arduino UNO.

Introduction

Self-driving vehicles, also known as autonomous vehicles, can drive themselves using artificial intelligence, radar, sensors, cameras, and other tools. Autonomous driving may be accomplished in five steps. For this car to be driven at these speeds, ADAS are crucial. In the event that the lane cannot be detected, lane departure warning is available. It chose to mount a camera on the car's hood as a workaround for this. In the following step, the camera extracts and records the video. After that, use image processing to prepare the video. The process of enhancing image quality and offering helpful information is called image processing. It involves importing a picture using the OpenCV module, editing the image, then producing the output image as the updated image. These adjustments are made in order to run a Hough transform algorithm, which determines the size of the road and modifies the steering accordingly. Through the use of the Hough transform, it will determine the traffic in this project and locate the track. The first step is to download a video from the Internet. To use image processing, the video is then converted frame by frame. After image processing, it can use several techniques to identify vanishing points using

Hough transform space, locate the region of interest, and detect edges using detection techniques. intelligent edge detection, followed by road detection during pathfinding in the image obtained by the vehicle.

Figure 1: Traffic recognition system



In addition, the Arduino board is used to control the servo motor to follow the rails. The reference for the car's steering system in this case is the servo motor. It appears to be a video, which will be used in real time, so a video from the hood camera is posted to the internet. In order to gather the essential images for identification, it will also pre-process the video using the OpenCV module. After pre-processing, the Canny edge detection technique and the Hough transform algorithm establish the size, location, and lane-direction of the road. A green zone is then displayed on the road, marking a zone where moving cars are safe. Self-driving cars include a variety of features, including lane-keep assist. Although it's one of the most intelligent features, it frequently fails in practice when it's raining or going uphill. With this project, the bug has been fixed. A camera mounted on a moving vehicle may or may not catch a picture of a road that is absolutely flat, has clearly defined boundaries, or has some other type of irregularity. In the presence of a recognised pattern, single image road recognition can be used to locate roads in photos, so it may be included into an automated driving system for a car to steer it onto the proper road.

Related Work

The world is changing as a result of automation. Several technologies are currently being used by self-driving cars. In this reviewed studies that were conducted using the available techniques and then presented our findings. In a research paper on autonomous driving and advanced driver assistance systems (ADAS), Lentin Joseph and Amit Kumar Mondal test, develop based on test results, and work on sensor placement, sensor fusion, cameras, etc. They also described the verification of alignment, algorithmic performance, and composition as well as computer vision. [1]-[4]. Here, it mostly talks about contemporary systems that are useless in the presence of weather conditions like rain, like lane departure warning systems. Implement traffic detection and lane detection in place of lane departure warning to address the current issue.

The Driver Aid Systems Handbook, written by Herman Winner, Stephan Hakuli, Felix Lotz, and Christina Singer and released in 2015, describes safety features, equipment operations, and driver assistance systems. Our viewers have been kept up to date and have a better understanding of the fundamental ideas underlying these systems because they have provided in-depth information on the most recent technologies. assemble the necessary ADAS system. The most significant factor is this. gives information about image processing to help readers better grasp the safety features of self-driving cars[5].

John Ball and Bo Tang write in their 2019 paper, "Machine Learning and Embedded Computing in Advanced Driver Assistance Systems," that these two technologies are crucial to the development of self-driving automobiles.Modern machine learning techniques and embedded computing enable ADAS to recognise objects, pedestrians, other cars, and more. Although it has numerous functions, one of its main flaws is that it lacks edge detection, which makes it impossible to have parking assistance systems, which are crucial for self-driving cars[6]-[7].

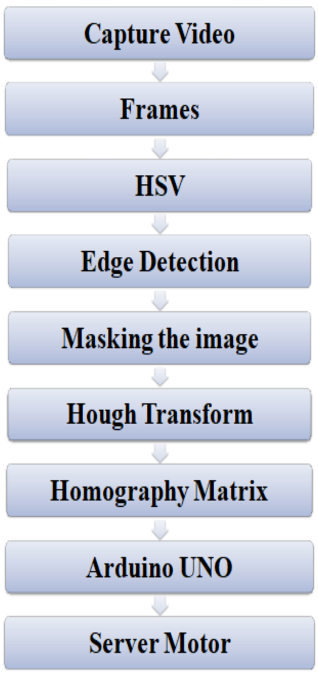
A study on the "Effect of Lane Departure Warning Camera Misalignment on Driver Behavior" and a piece by Richard Romano and David Maggie both claim that the error range for lane departure warning is between -0.66 and 0.66 meters. He used two paths to arrive at this assessment. Along with the steering wheel being frequently inverted, the car's camera alignment had numerous issues. Because of this, it was challenging for the driver to maintain control of the vehicle. In this study, the accuracy, driving experience, and outcomes of the lane departure warning system, as well as the misalignment of the sensor and camera, were examined[9]-[11].

The camera is positioned using our method slightly over the car's bonnet. To allow for image processing, the video is then changed frame by frame. In order to detect lanes and traffic signs after image processing, a Hough transform technique is used[12]-[15]. Due to this, it can endure the failures mentioned above and is unaffected by adverse weather.

Proposed Methodology

In this proposal (Figure. 2), video is recorded from an automobile using a camera. Following preprocessing the video, the road dimensions are additionally estimated using Canny's recognition and the lines are identified using the Hough transform. In order to perform these operations, a Python compiler is used. Herein lies the value of Thonny, a very approachable Python compiler. It also connects a Raspberry Pi to a servo motor, and uploads the servo motor control code to the Raspberry Pi using the Arduino IDE. A stepper motor serves as the CPU and steering wheel, respectively, to process the code.

Figure 2 : AI-based traffic recognition system for autonomous vehicles

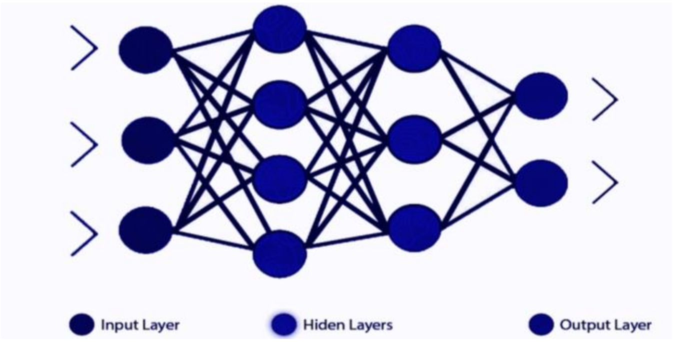


Video is first captured by a camera mounted in the hood's center. The audio will be taken out before the video is converted frame by frame. It then converts the frames to HSV format. Edge detection is then used to determine the lane threshold for car entry. After that, the altered image is covered up. The slope direction of the lane is ascertained using the Hough transform. The steering lane slope is then calculated using the homograph matrix. The servo motors are controlled by the servo controller Arduino UNO.

Make a lane-finding and identification model for modeling. Even in brand-new self-driving cars, accuracy can be achieved by training the model on thousands of images. Moving objects' lane position and direction can be ascertained. The Arduino UNO is programmed with code, and it steers the vehicle. Create safe corners for self-driving cars. Sample videos will be acquired from the internet after all necessary libraries have been imported. By declaring the root in the compiler, it is also eliminated from the system (Thonny). The steps to be followed in AI based traffic recognition system for autonomous vehicle are,

- The hood's center is equipped with a camera that captures video.
- The video is then divided into frames, which it can then process for images. So that the distortion matrix can be found, the frames are then undistributed.
- Color conversion comes next in the process. In order to gain a little more precision, BGR is converted to HSV and HLS in this instance.
- With the use of img_thr_hls_l and img_thr_hls_b variables, it can point out the lane line using the color code, and it can be predicted using a hough transform algorithm. It then moves up to two points on each lane for observation.
- In order to indicate the direction of the lane lines, it will use the histogram polyfit function. Following that, the Canny's edge is detected, and the lane line's angle and direction are predicted. Here, it will calculate the separation between two lane lines and wrap the area through which the car will travel.
- Displaying the angle and the output is done here.Then, using a serial cable and after the code has been processed on the PC, it is sent via USART communication to the Arduino board.
- Embedded C is then used in the Arduino IDE to turn the servo motor, which is turned in accordance with the angles that the Python software
- ***Video Capture:*** A standard webcam put on the test car was used to build up a permanent system. A video feed is accepted by a webcam for processing. The initial step is to analyze the camera's captured images.
- ***Segmentation of images:*** A webcam is used in this video feed acquisition system to segment images. In order to make ANN (Artificial Neural Network) analysis easier, it is used to split or separate a video signal into images or frames. The image is divided into many groups of pixels known as superpixels once the video is divided into frames. The different characteristics that each pixel possesses help us recognise images.

Figure 3 : ANN



● ***Analysis and detection engine :*** For visual image processing, CNNs (Convolutional Neural Networks) or ANNs (Artificial Neural Networks) are utilized as shown in figure 3. This self-learning network analyses pixel data using deep learning methods. No additional programming is needed because it automatically detects the image setup from the previous example based on the provided data. Recognized photos are examined for additional analysis using library functions that have already been saved.

● ***An interpreted traffic sign:*** Based on the output, the test car is guided. Based on the outcomes, the test car chooses the course on its own.

Hough Transform

The Hough Transform technique, which is crucial for lane identification, is used in this proposal. Hough transform algorithms are used in computer vision, image processing, and digital image processing to extract features from images. Tracing lines is a traditional Hough transform technique for identifying lines in an image. This concept was developed in 1972 by Peter Hart and Richard Duda. Automated digital image surveillance has difficulty identifying shapes in images. Edge detection can be used to obtain image pixels of image points. Due to missing points from the image's curvature and deviation, this has errors. By grouping the edge points, the Hough transform can, however, address this issue. To achieve the highest accuracy, create the model in conjunction with the edge detector.

Result and Discussion

In performance analysis, confusion matrices are employed as shown in Figure 4. Truepositives (TP), which refers to the percentage of positive tests that are indeed true positives, are highlighted. False positive rate (FP), false negative rate (FN), and true negative rate (TN) show the positive class that tested positive, negative class that tested negative, and respective false positive and false negative rates. Performance of proposed deep learning models is assessed based on accuracy, recall, precision, and F1 score.

Figure 4 : Confusion Matrix

	Predicted 0	Predicted 1
Actual 0	TN	FP
Actual 1	FN	TP

The model's learning performance is also seen through the learning curve. For algorithms that learn gradually from a training dataset, a learning curve is a typical diagnostic approach used in machine learning. After each update during training, a model can be tested against the training and holdout validation datasets, and graphs of the tested performance can be created. According to the traffic recognition system condition,

a. Green represents areas that are detected and in which the vehicle can move.

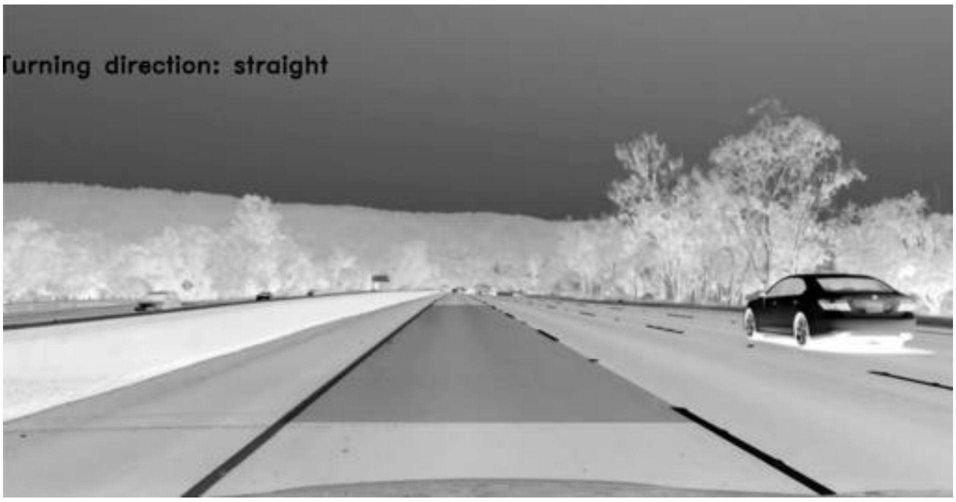
b. In the event of lane departure, the vehicle is steered accordingly.

c. Orientation is indicated in the upper left corner of the video.

Figure 5: Left Turn

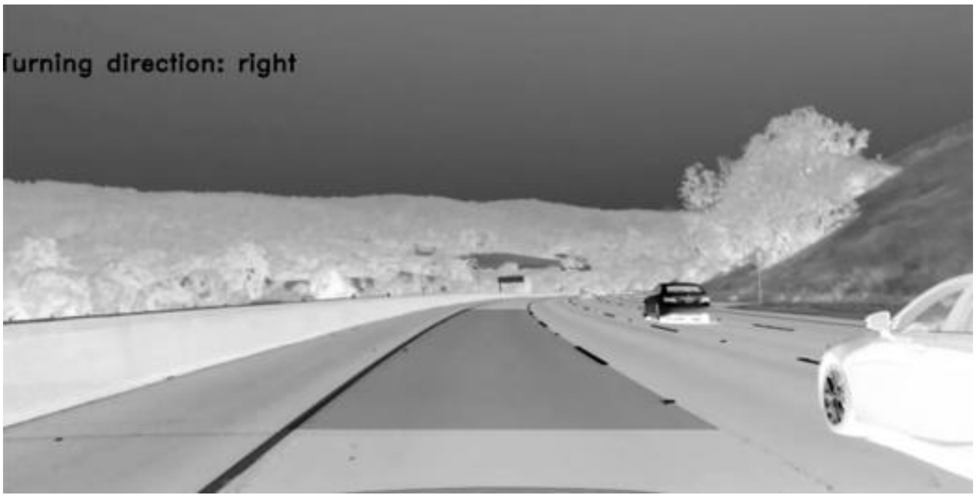
The Arduino UNO microcontroller, which will be controlling the servo motor in this case, receives the value that is below 90 because the lane is turning to the left as shown in Figure 5. As a result, the servo motor will tilt the steering to the left until the lane is directed to the left.

Figure 6: Go Straight



The microcontroller, an Arduino UNO, receives the value 90 because the lane is moving in a straight line with no deviations in this instance. Since the value is 90, the Arduino will cause the servo motor to tilt the steering toward the center until the lane is directed in a straight direction as shown in Figure 6.

Figure 7: Right Turn



The value is supplied to the Arduino UNO microcontroller since the lane is turning to the right and is therefore greater than 90. Since the Arduino UNO will be driving the servo motor, if the value is above 90, the servo motor will tilt the steering to the right until the lane is directed to the right as shown in Figure 7.

Conclusion

When people are driving, the decisions are dependent on the vision. Driving a car relies heavily on the lane markings on the highway. Naturally, one of the first objectives to accomplish while developing self-driving cars is automatically detecting lane lines using algorithms. Flexible region-of-interest (ROI) detection is needed for roads. When traveling up and down steep slopes, the horizon transforms and loses its dependence on the frame's proportions. Additionally, keep this in mind when driving around tight curves and crowded spaces. This ground-breaking concept is mostly based on image processing and road identification used in self-driving cars. A particular method was used throughout the implementation to specifically identify the root. The safety of self-driving cars is already high and will continue to rise if public attitudes of them do not alter. They will appreciate the luxury of driving with computer control if they have faith in it and give it a try. Self-driving vehicles appear to be a big advancement in transportation technology. They are brand-new multimedia pods that can send an unlimited number of encrypted SMS. Both the creation of self-driving cars and software upgrades for already-existing vehicles are in progress. The concept of self-driving cars was a beginning, but soon other semi-automated components would appear, such as radio frequencies, cameras, and sensors, making traffic faster and less error-prone, thereby reducing traffic congestion and improving safety.

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