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Autonomous Car using Lane Detection

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Abstract
Everyone in the world is extremely concerned about safety. Thus, to increase safety by a considerable reduction in road accidents is a major factor being looked upon globally with today's advanced technological development. As a result, interest in Autonomous Cars has been significantly increased in recent years, as most of the human driving errors can be minimized with its application. This paper aims at an Autonomous mini-car prototype using Raspberry Pi as a central processing chip. It will be having the feature to automatically detect the curves in its path using Image Processing done through processes such as Thresholding, Warping, Pixel summation, etc. We have implemented and tested this technique using our prototype and it has correctly detected the lane by itself.

Keywords: *Autonomous Car, Raspberry Pi, Thresholding, Warping, Pixel Summation, Image Processing*

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I. INTRODUCTION

In recent years, global traffic has shown significant growth due to improved transportation facilities. This has ultimately made vehicle accidents, the top most reason for accidental deaths and injuries in many dense-populated countries which highly demands the need for safe driving and reduced road accidents. The human ability of driving has certain limitations based on the driver's fitness condition. A driver might be exhausted, drunk or might have certain health issues. This endangers the lives of not only passengers in that vehicle but also people and vehicles in the nearby surrounding area. An Autonomous Vehicle Technology is the concept being researched widely to solve major driving-related issues. The operation of such vehicle is controlled with the aid of recent advancement in the technology that includes Computer Vision, Artificial Intelligence, Machine Learning, Data Science which accurately processed the data collected via sensors and move the vehicle accordingly. In our prototype, we have implemented a simple Image Processing Technique using python and OpenCV to developed automatic lane detection capability for the mini-car prototype.

II. LITERATURE SURVEY

1. Lane detection using a fast-vanishing point estimation algorithm based on captured video was proposed by Benligiray, Topal, and Akinlar. The algorithm was based on extracting and validating line segments from images and angle-based elimination of line segments. [3]
2. Taylor et al lane extraction system is a parameter-based model for the appearance of the lanes in the images. This model captures the position, orientation, and width of the lane along with the height and inclination of the stereo rig as far as roads are concerned. They have used stereo vision, while in our model we are dealing with video captured from one camera only. [4]
3. Schneiderman and Nashman have developed a visual processing algorithm for autonomous road following. It includes edge extraction, matching extracted edge points with a geometric model of the road, and updating the geometric road model. The major requirement of the algorithm is clear lane markings. [1]

4. TFALDA is a lane detection algorithm projected by yam et al which is known as 3 Feature-based Automatic Lane Detection Algorithm. It was appropriate for rapid automated detection of lane boundaries in environments without any prior information or approach on the way. [2]

III. PROPOSED SYSTEM

Our proposed model is based on Raspberry Pi as a central chip. We have created a testing path using white A4-sized papers. Raspberry Pi Cam is installed on the front side of the mini-car prototype which continuously captures video of the foreground path. This captured video is then converted into several frames. Each frame is analyzed using various processes namely Image Thresholding, Warping, Pixel Summation, Averaging, and finally, the correct lane detected is displayed on a remote display. Using the value of curve angle obtained, the Raspberry Pi sends controlling commands to the motor driver and all the 4 DC motors connected to the driver moves accordingly.

IV. BLOCK DIAGRAM

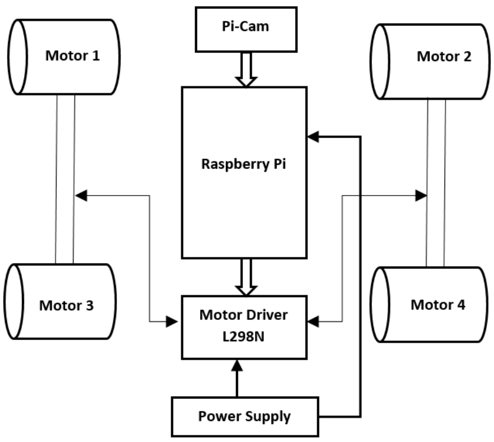

Fig.1: Block diagram of the proposed system

Description:

Fig.2: Raspberry Pi

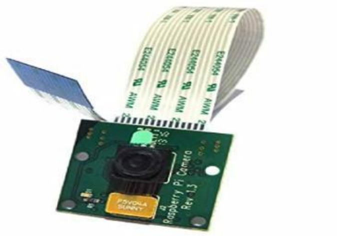

Fig.3: Raspberry PI 5MP Camera Board Module

1. **Raspberry Pi:** We are using Raspberry Pi as a microcontroller for our design as it is low cost, single-board, a small-sized computer that supports an embedded operating system such as Raspbian. It provides excellent peripheral connectivity for USB, Ethernet, digital video, camera board, sensor board add-ons, etc

2. **Raspberry Pi Cam:** We are using a Raspberry Pi 5MP Camera module board for lane or path detection. This camera has 5-megapixel native resolution sensor-capable of 2592 x 1944-pixel static images. This camera supports latest Raspbian software and raspberry pi module too, and have small strips for connection.

3. **Motor Driver L298N:** L298N motor driver is used to drive a dc motor that rotates the wheels of the prototype car model. This module includes a 78M05 5V regulator along with driver IC and can drive up to 4 motors.

4. **DC Motor:** It is a plastic-based dual shaft geared motor with a shaft on both sides. For the efficient result, it is usually operated for a voltage range of 5V-12V.

5. **Power Supply:** This implementation requires a power supply of 12V DC and 5V DC.

V. WORKING

The main purpose is to find the path using color detection and then getting the curve using Pixel Summation in the y-direction. Whole image processing is performed in 5 different steps and an individual module is created for every step. Separate python files are created each of which is assigned these 5 tasks separately. Also, separate modules for operating a Pi-Cam and Motor Driver are created. The main script is created which links all the separate modules together which is required to perform automatic lane detection.

When the power supply is connected, the Pi Cam starts capturing the video of the path. This video is passed on to Raspberry Pi for Processing. After performing all the necessary steps for image processing, the curve value is computed. Based on this curve value, Raspberry Pi sends controlling commands to the motor driver. All the 4 dc motors connected to the driver get the signal from it and they start moving accordingly. This process keeps on going continuously and cars keep moving with the proper lane detection. There are various steps involved in process of detecting lane curve value which is as follows:

1. Thresholding:

In Thresholding, a currently captured image is converted from color into a binary image, i.e., one which is simply black and white. If the pixel or component value is greater than a threshold value, it is denoted one value which is white, else it is assigned another value which is black. It is done to select areas of interest of an image while ignoring the rest of the part. In this project, A4-size White paper is used as a path, therefore simply color detection is used to find the path.

2. Warping:

Warping is performed on all the binary images to get the Bird's Eye View i.e. top view of the image. The Bird's Eye View of the image is considered ideal for Image Processing Applications. It is easy to obtain the direction and value of the curve using the Top View of the image than the image taken from a random angle.

3. Histogram:

Histogram of Pixel intensity values is to be plotted using the values calculated through Pixel Summation. It is a graph showing the number of pixels in an image at different intensity values found in that warped image. The converted image is scanned in a single pass and a running count of the number of pixels found at each intensity value which is kept stored. This is often then want to construct a suitable histogram.

4. Averaging:

The Averaging algorithm operates by computing and arithmetic mean of the intensity values for each pixel position in a set of captured images from the same scene. Each corrupted image has 2 components i.e. a stable signal part and a random noise part. In the averaging process, the signal component of the image remains the same, but the noise component differs from one image frame to another image frame. When the averaged image is computed, the result is an enhanced signal component.

5. Displaying:

When the final image with the required lane area is obtained, it can be displayed either by placing a mini screen over the model or using ThingsBoard open source IoT cloud we can display it on any remote device. In our Project, we have published and displayed the live streaming values of the detected path on the Remote PC using the ThingsBoard IoT platform.

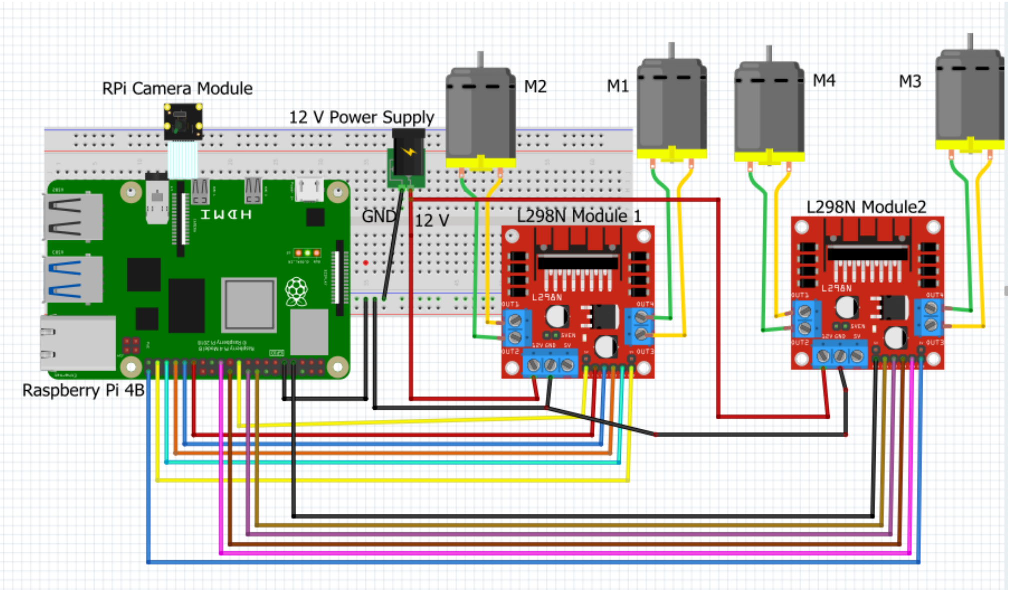

Fig4: Circuit diagram

VI. CONCLUSION

In this paper, we have presented the implementation of an important feature of Autonomous Car Technology which is Lane Detection using Image Processing Technique on a miniature Autonomous Car prototype. Color-based detection is used to obtain the region of interest from the path. Using Pixel summation, the curve value is computed. Raspberry Pi has processed data and controlled the car's movement effectively while testing the model over the white-colored path. The prototype has accurately taken the turns while encountering the Lanes on the path and it reached the destination successfully. Along with this, we have used IoT technology in this project to display live images and lane values on the ThingsBoard IoT platform to monitor lane and vehicle position on the lane from anywhere.

So due to greater autonomous nature and efficiency, the autonomous vehicle of this nature can be practical and is highly beneficial for better regulation in the goods and people mover's section. In the car's performance, we have found that the detection algorithm is good enough, but results could be improved by using more advanced tracking methodologies. As future work, we are planning to add object detection features into the model using Machine Learning concepts.

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