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Autonomous Vehicle Using Machine Learning and Computer Vision.

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Abstract - *In this proposed work, a prototype of autonomous vehicle is designed and developed which uses raspberry pi as the core functioning and uses OpenCV and machine learning technology. The vehicle uses the core processing unit as Raspberry pi, which is interfaced with the Pi camera module, which feeds the captured images to the raspberry pi for image processing. Based on which detection like road lanes, traffic signals, obstacles are done and commands are sent to arduino to operate the car.*

***Key Words*: OpenCV, Pi camera, Raspberry Pi, Arduino, Machine Learning**

1. INTRODUCTION

Road Safety is one of the major issues faced globally. Every year roughly 5 million people meet with road accidents and around 1.3 million lose their lives worldwide. These deaths are majorly caused by human negligence and human error. The most common reasons for road accidents are over speeding, drink & driving, distractions to driver, red light jumping, lane changing and avoiding safety gears like seat belts. Traditional and manual cars require complete human control and attention over them while travelling, where most of the people make mistakes which eventually results into road accidents. To overcome this issue Autonomous vehicles technology come into picture. Autonomous vehicles are those vehicles which are capable of sensing its environment and move safely with no human input. Various high-end sensors are situated in different parts of the car which detects its surrounding and sends the data to the High-performance computing devices which then instructs the vehicle to follow a particular path and take decisions. Majorly with the help of video cameras, vehicle detects the traffic lights, road signs, pedestrians and other cars on the road and sends those real time images to the processor. Machine learning is mostly used for perception and decision-making in real-time. The algorithms need to make the decisions within a fraction of a second for applying a break or to make a turn right or left. The main goals of project is to a design and develop a low-cost prototype of autonomous vehicle which uses raspberry pi as the core functioning unit and uses OpenCV and machine learning technology. The vehicle uses the core processing unit as Raspberry pi, which is interfaced with the 8MP Pi camera module, which feeds the captured images to the raspberry pi for image processing .Based on which detection like road lanes, traffic signals, obstacles are done and commands are send to arduino to operate the car and follow designed path on our self-made track, which helps car to travel to specified place cautiously and timely.

2. LITERTURE SURVEY

1. Truong-Dong Do, Minh-Thien Duong [1] proposed a monocular vision based in this paper, a monocular vision-based autonomous car prototype using Deep learning on Raspberry Pi. Convolutional Neural Networks (CNNs) have shown great results in this domain. The main reason behind these great results is their ability to learn millions of parameters using a large data. In this work, authors have focused on finding a model which directly maps raw input images to a predict steering angle as output using a neural network. The CNN model parameters were trained by using data collected from vehicle platform built with RC car, Raspberry Pi 3 Model B computer and front facing camera.
2. "Convolutional Neural Network based Working Model of Self Driving Car - A Study" [2] authors of this paper proposed that to achieve good results then technologies like Deep learning techniques namely Convolution Neural Networks, YOLO algorithm, Hough Transform Algorithms, Canny Edge Detection algorithm. Software components such as Arduino IDE, Raspberry Pi Cam Interface, Open CV and hardware components such as Raspberry Pi 3, Arduino UNO, Pi Camera, sensors should be used.
3. "Traffic Light Detection and Recognition for Self-Driving Cars using Deep Learning" [3] authors of this paper proposed deep learning-based model for detection and recognition of traffic lights using transfer learning. The method uses faster region based convolutional network (R-CNN) Inception V2 model in TensorFlow for transfer learning. The model was trained on dataset containing different images of traffic signals in according to the Indian Traffic Signals which are distinguished in five types of classes. The model was able to detect traffic light with correct type.
4. "A Lane Detection Approach for Driver Assistance" [4] authors of this paper proposed a general technique for lane detection that combines filters developed by Freeman and Adelson with Canny edge detection algorithm. The steerable filters used in this paper are based on second derivatives of two-

dimensional Gaussians. These filters are helpful in many early vision and image processing tasks. The filter results are then processed to remove noise based on the road. There algorithm is able to provide accurate extraction of lane edge markings under different light and road situations.

5. "A Vision-based Method for Improving the Safety of Self-driving" [5] in these authors have used computer vision and deep learning to train existing data sets. They have used efficient convolution neural networks trained the data in Traffic Sign Recognition Benchmark and KITTI respectively to realize classification of traffic signs and detection of vehicles, and functions of OpenCV are used to identify and locate traffic identification lines. To plan and make decisions on the driving path for the car.

3. METHODOLOGY

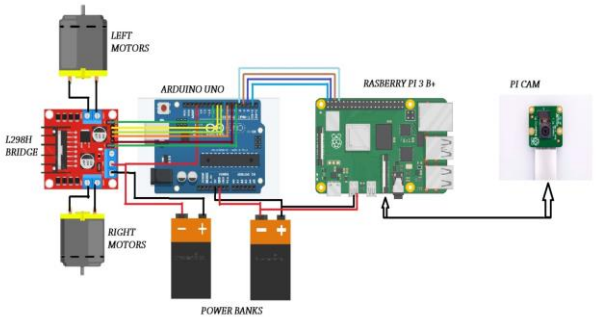

Figure 1: Circuit Diagram

The raspberry-pi is the main core controller which will be attached on the vehicle. The module of pi-camera will be attached on the top of the prototype. The ln298 IC is used for the movement of the prototype. Computer vision is utilized to find object in front of the prototype and take necessary movements. When there is any object in front of the prototype and is in a measurable distance from the prototype. The raspberry-pi gives instructions to the arduino uno and it gives orders to the l298n integrated circuits to stop giving power to the tires and therefor halts the movement of the prototype contingent on the nearness of the object. The displacement calculated is also showed on the output window of the program. The following process is finding of lanes and road traffic signs.

3.1 Hardware Used

3.1.1 Raspberry Pi

Raspberry Pi 3 B+ is the main processing unit of this project and is mounted on the top of the car. Using raspberry pi 3 B+ version for image processing with the help of OpenCV software. Pi camera is interfaced to the Raspberry Pi. A machine learning algorithm is implemented and the images are trained using neural network technology. All the function like traffic sign detection and obstacle detection is performed Raspberry Pi using machine learning.

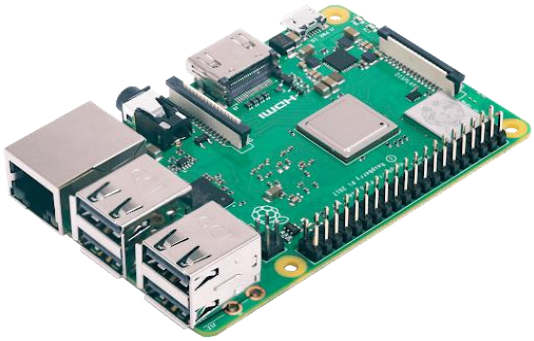

Figure 2: Raspberry Pi 3 B+

3.1.2 Raspberry Pi Camera

The Pi-camera used is V2 version which is having specifications of 8 mega pixels and supports 1080p 30 fps resolutions along with Sony IMX219 sensor with F2.9 aperture. This Pi camera captures the images and sends it to the raspberry pi for image processing and machine learning.

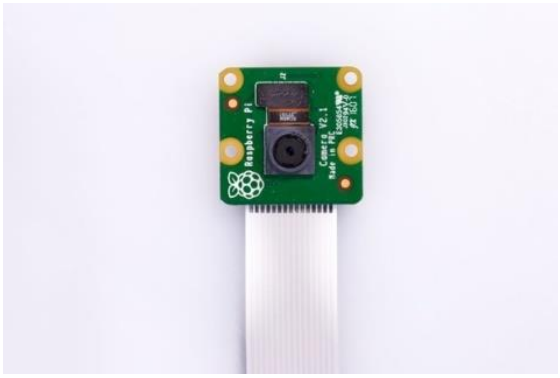

Figure 3: Raspberry Pi Camera V2 8 MP

3.1.3 Arduino Uno

Arduino Uno is ATmega329P based microcontroller board. In our project Arduino is used to control forward, backward, stop, left and right movement of vehicle. All the functions are programmed in Arduino using Arduino IDE.

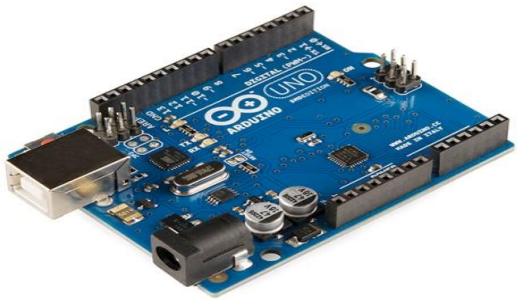

Figure 4: Arduino Uno

3.1.4 Motor Driving Circuit L298N

It is a basic motor driver module used to drive dc motors as well as stepper motors. H Bridge is used along with L298N IC to drive motors

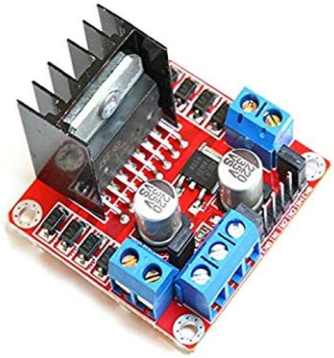

Figure 5: L298N

3.2 Software Used

3.2.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software application (for Windows, macOS, Linux). The Arduino IDE has the languages C and C++ using rules of code structuring. The main code, created on the IDE platform will generate a Hex File which is then uploaded in the controller on the board. The IDE environment mainly contains two major parts: Editor and Compiler where editor is used for writing the required code and compiler is used for compiling and uploading the code into the Arduino Module.

3.2.2 OpenCV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library developed by Intel. OpenCV is used to provide a common architecture for computer vision applications and to accelerate the use of machine learning in the commercial products. The library has more than 2500 algorithms, which includes a set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms are used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects. Computer Vision tasks performed in this project are:

- Region of Interest
- Perspective Transformation (Bird Eye View)
- Grayscale Conversion and Thresholding
- Canny Edge Detection
- Gaussian Blurring

3.3.3 Haar Cascade

Haar cascade classifier is a machine learning object detection software that identifies objects in an image and video. The algorithm can be state in four phases: 1. Calculation of Haar Features, 2. Creating Integral Images using Adaboost, 3. Implementing Cascading Classifiers. This algorithm requires a lot of positive images samples and negative images samples of its surroundings to train the machine learning model.

4. TEST RESULTS

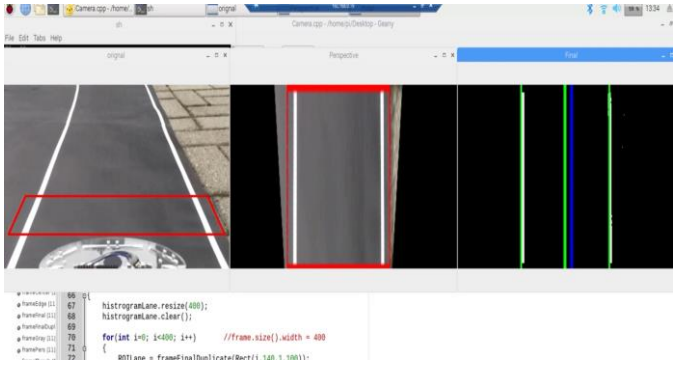

Figure 6: Lane detection

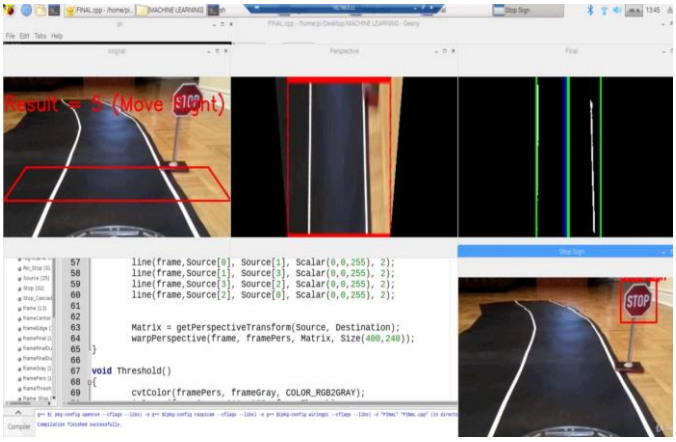

Figure 7: Stop Sign Detection

5. CONCLUSION

A prototype of an autonomous vehicle model is designed and developed. With the help of Image Processing and Machine Learning techniques a successful model is developed which worked as per our expectation. Image processing techniques like calculating region of interest (ROI), conversion of images from RGB into gray scale, applying Gaussian filter for removing noise, canny edge detection for extracting lane edges are successfully performed for detection of lanes as well as machine learning model is successfully trained in HAAR cascade software by using positive and negative samples of Stop Sign, Red Light, Green light and Obstacles for traffic sign detection. At last, the car is able to follow lane efficiently and the traffic signs are detected properly as well as followed and decisions are made accurately.

6. FUTURE SCOPE

Further improvements can be made in this project by using GPU based high speed processing system and a high definition camera. In addition, computer vision techniques such as camera calibration, structure from motion, etc. can have very profound impact on the accuracy of navigation.

7. AKNOWLEDGEMENT

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