Artificial Neural Network based Self-Driving Car

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Abstract – *Autonomous Vehicles are the fast growing technology in the field of Automobiles with advanced features. These vehicles are capable of sensing the environment, navigating and fulfilling the human capabilities without any human interference. The paper touches on building a three wheel vehicular prototype that will detect the obstacles and in turn avoids collision and moves safely towards destination. This paper explains how the Artificial Neural Network aims to control the vehicle without involvement of any human intervention. Various images are captured by the camera module which is the only input to the prototype. The captured images undergo Image processing technique which will calculate the dimensions of the frame or moving objects and detect them.*

***Key Words*: Raspberry Pi, Pi Camera, Motor Driver, Dual Motors, Python, Image Processing, OpenCV, Artificial Neural Network.**

1. INTRODUCTION

Autonomous vehicles are technological development in the field of automobiles. In current days, due to inconvenience of public transportation people are using their private vehicles. Due to increase in vehicles, there is huge occurrence in traffic. To resolve this traffic problem, traffic rules are designed. But the negligence of people towards traffic rules causes accidents. And the reason behind the maximum accidents is due to human error. To reduce these accidents and to improve safety transportation we require Autonomous Vehicle. Driver error is one of the most common cause of traffic accidents. With the number of accidents increasing day by day, it has become important to take over the human errors and help the mankind. All of this could come to an end with self-driving cars which just need to know the destination and avoid the possibility of accidents.

2. HARDWARE DESCRIPTION

2.1 Raspberry Pi

The Raspberry Pi is a small but full-featured computer on a single board. It plugs into a monitor and can be attached to a keyboard, mouse and speakers. It can also connect up

hardware to the Pi's General Purpose Input/output pins and learn to program using electronics components.

Raspberry Pi 3 Model B was released in February 2016 with a 1.2 GHz 64-bit quad core processor, on-board 802.11n Wi-Fi, Bluetooth and USB boot capabilities. The Raspberry Pi 3 Model B builds upon the features of its predecessors with a new faster processor on board to increase its speed. It also features Wi-Fi and Bluetooth Low Energy capabilities to enhance the functionality and the ability to power more powerful devices over the USB ports.

Fig 1: Raspberry Pi

2.2 Pi Camera

Pi Camera is a camera which can be used to take pictures and high definition video. Raspberry Pi Board has CSI (Camera Serial Interface) interface to which Pi Camera module can be attached directly. This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable. The Raspberry Pi camera module was chosen because of its integration with the Raspberry Pi, and also because of its variability in resolution and frames per second.

Fig 2: Pi Camera

2.3 L298N Motor Driver

L298N Motor Driver Module is a high power motor driver module for driving Dual Motors. This module consists of an L298 motor driver IC and a 5V regulator. L298N Module can control up to 4 Dual motors with directional and speed control.
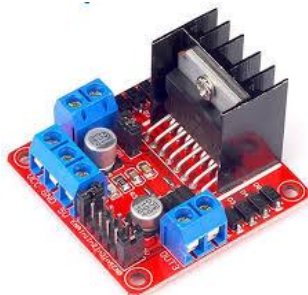

Fig 3: L298N Motor Driver

2.4 Dual Motors

Dual Motors are used to run the vehicle bidirectionally. It is a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The output of the motor driver is connected to dual motor to function it.

Fig 4: Dual Motors

2.5 Hardware Connection

Block Diagram of Hardware Connection

The main component of designed model is Raspberry Pi which acts as a mini computer. It consists of in-built Pi Camera and is the only visual input for the model. The model has two power sources, one for Raspberry Pi and the other for dual motors through motor driver mentioned in 2.3. The chassis consists of two wheels to which dual motors are connected with one supporting wheel. The main aim of motor driver is to rotate the wheels with same speed. As Raspberry Pi supports python programming, the code is written in python.
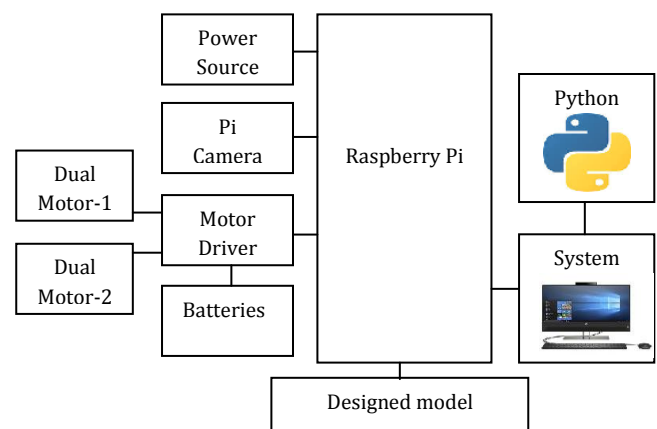

Fig 5: Block Diagram of Hardware Connection

3. SOFTWARE DESCRIPTION

3.1 NOOBS

NOOBS is abbreviated as New Out of Box Software which is an easy operating system installer which contains Raspberry Pi OS.

3.2 VNC Viewer

Virtual Network Computing is a graphical desktop-sharing system that uses the Remote Frame Buffer protocol to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical-screen updates back in the other direction, over a network. It also interprets commands coming from the *viewer* and carries them out on the remote computer. *VNC* is platform independent and is compatible with any operating system.
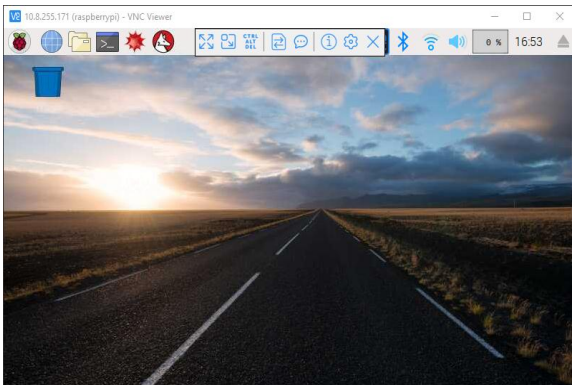
Fig 6: VNC Viewer for Raspberry Pi

3.3 Python

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991. Python is a widely-used programming language with an easy, beginner-friendly syntax. Hence, it is used for the Raspberry Pi, starting off as a scripting language to a full-fledged programming language option for software configurations.

3.4 RPi.GPIO Python Library

The RPi.GPIO Python library allows you to easily configure and read-write the input/output pins on the Pi's GPIO header within a Python script.

3.5 Image Processing
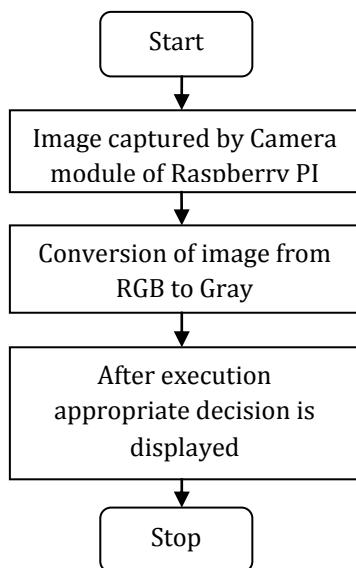
The flowchart for Image Processing is as shown below

Fig 7: Flowchart for Image Processing

3.6 OpenCV

Open Source Computer Vision is a library of programming functions mainly aimed at real-time computer vision. It has Computer Vision, which can be used for image processing, detection and face recognition, object identification, classification actions, traces, and other functions. This library allows these features be implemented on computers with relative ease, provide a simple computer vision infrastructure to prototype quickly sophisticated applications. It is based on python programming language which is used to detect the objects and guide the vehicle on roads.

3.7 TensorFlow

Tensorflow is Google's Open Source Machine Learning Framework for dataflow programming across a range of tasks. Nodes in the graph represent mathematical operations, while the graph edges represent the multi-dimensional data arrays (tensors) communicated between them. Tensors are just multidimensional arrays, an extension of 2-dimensional tables to data with a higher dimension.

3.8 Artificial Neural Network

Artificial Neural Network (ANN) is an efficient computing system whose central theme is borrowed from the analogy of biological neural networks. ANN is one of the main tools used in machine learning. As the term "neural" suggests, they are brain-inspired systems which are intended to replicate the way that we humans learn. Neural networks consist of input and output layers, as well as a hidden layer consisting of units that transform the input into something that the output layer can use. ANN acquires a large collection of units that are interconnected in some pattern to allow communication between the units. These units, also referred to as nodes or neurons, are simple processors which operate in parallel.
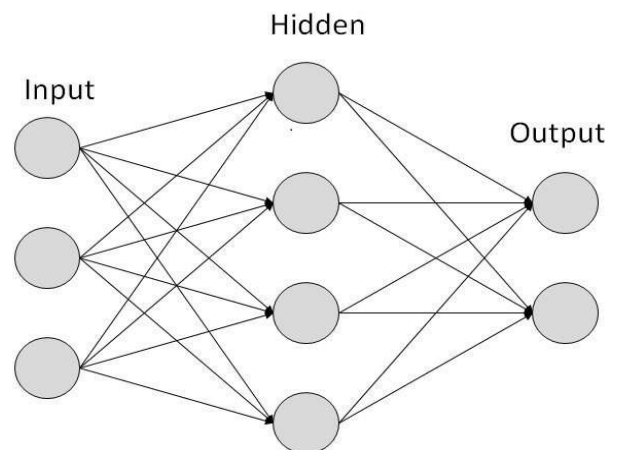

Fig 8: ANN layers

Basically Artificial Neural Network is generalized term for Neural Network which consists of many algorithms and one among them is Convolutional Neural Network which is used in this paper.

Convolutional Neural Network Algorithm

Convolutional Neural Networks have a different architecture than regular Neural Networks. Regular Neural Networks transform an input by putting it through a series of hidden layers. Every layer is made up of a set of neurons, where each layer is fully connected to all neurons in the layer before. Finally, there is a last fully-connected layer, the output layer that represents the predictions.

Convolutional Neural Networks are a bit different. First of all, the layers are organized in 3 dimensions: width, height and depth. Further, the neurons in one layer do not connect to all the neurons in the next layer but only to a small region of it. Lastly, the final output will be reduced to a single vector of probability scores, organized along the depth dimension.

The main approach of this paper is to use Convolutional Neural Network (CNN) to implement an autonomous vehicle by mapping pixels from the camera input. The network automatically learns the maximum variable features from the camera input, hence requires minimal human intervention.

4. METHODOLOGY

The three main objectives of Artificial Neural Network based Self-Driving Car are mentioned below,

1. Object detection
2. Collision avoidance
3. Self-track

For detecting the objects appearing in front of the car the images of objects are captured using the camera module of Raspberry Pi. As, storage capacity being the advantage in Raspberry Pi, huge number of images can be stored and video streaming can also be done. The captured images are being processed with image processing technique. And then the feature extraction is done for processed image.

For getting the video stream OpenCV(Open Source Computer Vision) library is used, which can be done by installing the library i.e., "sudo pip3 install opencv-python".

TensorFlow Object Detection enables to easily create or use an object detection model by making use of trained models. The models are trained using Convolutional Neural Network (CNN) Algorithm which is coded in form of python programming language.

Finally, when the detected object is sensed by the model, the signals are sent to CNN Algorithm. CNN Algorithm acts as

brain of the model which in turn avoids the collision and controls the motor by sending the stop signal. Thus, collision of vehicle is avoided. In case if there is no object being detected then the vehicle moves forward by self driving.
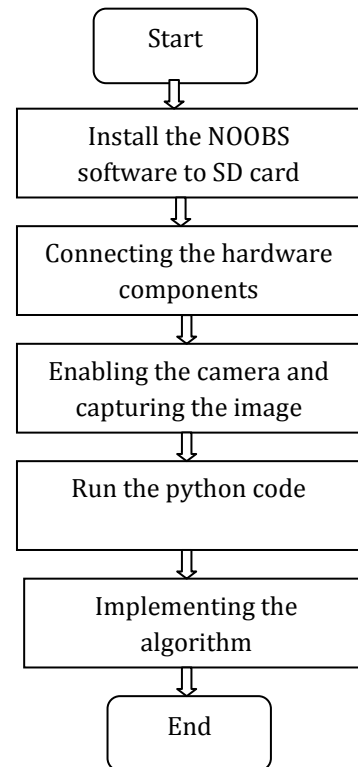
The proposed method implementation is as shown below

Fig 9: Flowchart for proposed methodology

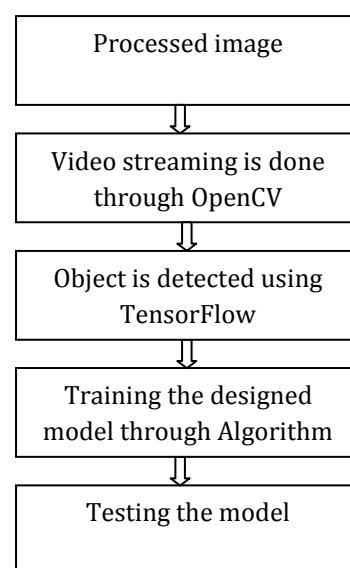The implementation of CNN Algorithm is as shown below

Fig 10: Flowchart for implementing Algorithm

5. RESULTS AND DISCUSSION

In this Autonomous Vehicle prototype, the first focus is on the task of detecting the objects, so that the collision can be avoided which would be helpful in real world for preventing accidents. In this paper, to achieve the result few things are to be considered with various conditions and appropriate decisions should be taken by the trained model at the same time. So the camera module is used to capture image and based on that image, the trained model will take decisions automatically.
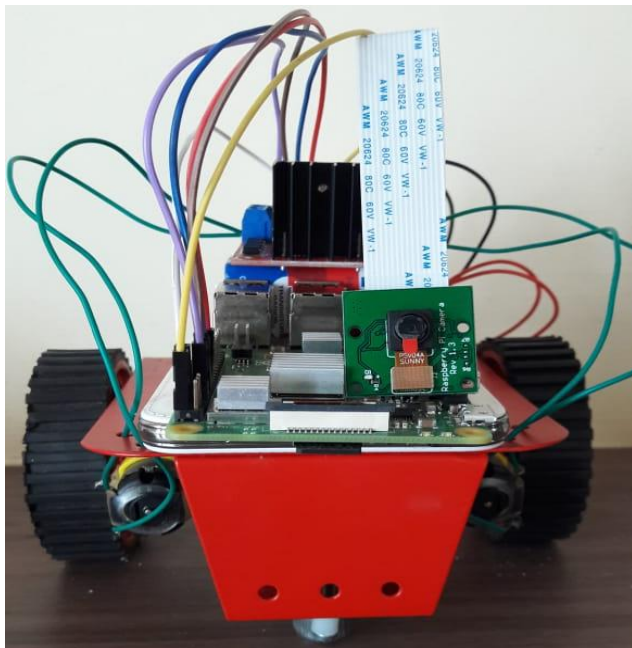

Fig 11: Front view of Prototype of Self-Driving car

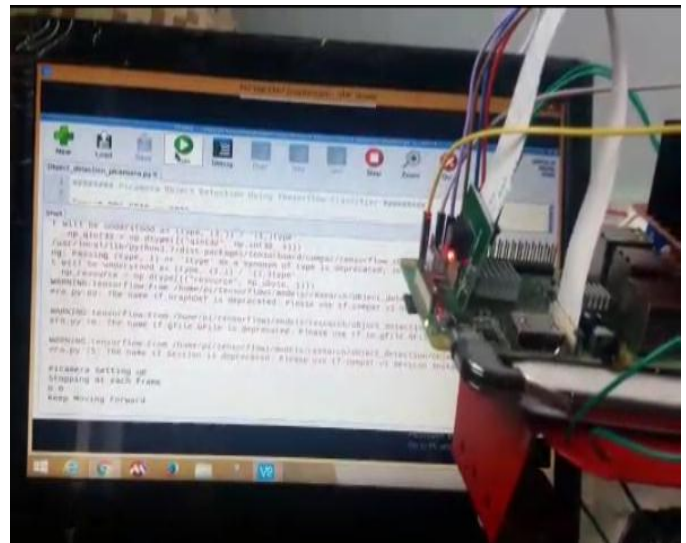Fig 12: Top view of Prototype of Self-Driving car
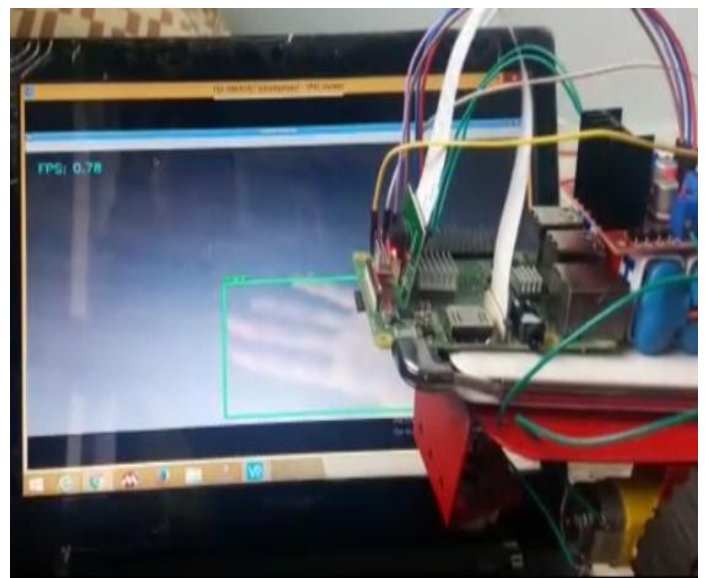

Fig 13: Result shown in command window

Fig 14: Object detection using Computer Vision

6. CONCLUSION

Autonomous Vehicle appears to be an important next step in transportation technology. Autonomous Vehicle stands to solve all sorts of problems, like traffic delays and traffic collisions caused by driver error. In this paper, an autonomous robot is designed and trained with the help of artificial neural network. It is observed that, once trained, robot worked autonomously without any intervention of human being.

7. FUTURE SCOPE

An ANN is complex, just as the human brain, and even though the concept is easy to grasp there are a few notations that are of interest. Development in autonomous vehicles is

continuing and the software in the car is continuing to be updated. Though it all started from a driverless thought to radio frequency, cameras, sensors, more semi-autonomous features will come up, thus reducing congestion, increasing the safety with faster reactions and fewer error. This paper aims at navigating the vehicle without human intervention, moving forward by itself and stopping the vehicle as soon as it detects the object to avoid collision. But, it can be improvised in later period by taking accurate turns.

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