AUTONOMOUS CAR USING RASPBERRY PI

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ABSTRACT

Most of the world population uses road as their transport medium. More than 85% of people uses road transportation so the probability of road accidents is been increasing because of negligence done by people. Autonomous cars are a sign of modern and advanced technology implementation for human safety and security. The evolution of the artificial intelligence has served as the catalyst in the field of technology. We can now develop things which were once just an imagination. One such creation is a self-driving car. This paper explains the Road lane detection, Traffic sign and signal detection, Vehicle and Object detection using open cv, python and Raspbian OS.

Keyword: *Lane detection, Object detection, Traffic sign, Signal detection, Autonomous car, AI and ML, Image processing.*

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1. INTRODUCTION

Intelligent Transportation System is today's advanced technology which the whole world is looking forward to. Many of the billion-dollar companies like Google, Uber, Tesla are trying to invent fully autonomous vehicles. Image processing is one of the main drivers of automation, security and safety related application. The data can be collected by using camera and sensors, which is mounted at the front end of the car. Self-driving car (also known as an autonomous car or driverless car) is a robotic vehicle that is designed to travel without human intervention. Autonomous cars must have control systems that are capable of analyzing sensor data to distinguish between different cars on the road. Road Lane detection is the major module in self-driving cars. If video is given as input, then it can be converted to images and processed. Canny edge detection for edge detection and Hough line transform for line detection and some filters to reduce noises occurring in images like Gaussian Filters and Gray Scale imaging are used in this model.

2. PROBLEM DEFINITION

Many accidents occur due to distracted driving and human errors. Partial Autonomous Driver Assistance System (ADAS) can assist the driver to avoid the collision and maintain the control of the vehicle by giving warning signals. To overcome this problem, self-driving car capable of sensing environment and navigating from one location to another without any human interference is designed in this paper.

3. HARDWARE AND SOFTWARE REQUIRED

3.1 HARDWARE REQUIREMENTS

3.1.1 RASPBERRY PI:

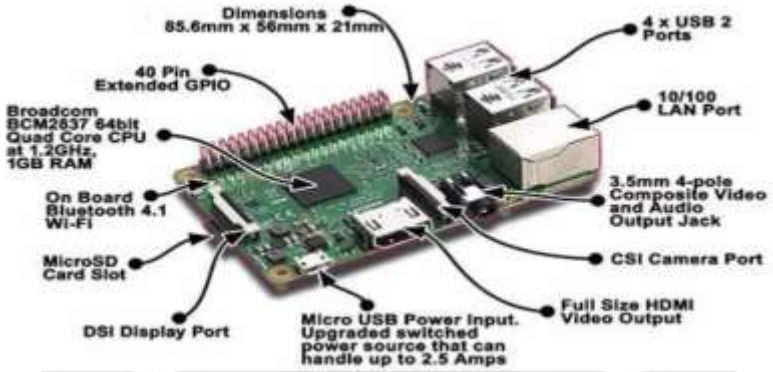

Fig -1: Raspberry pi board

The Raspberry Pi is a small low-cost single board computer having a processor speed ranging from 700 MHz to 1.2 GHz for the Pi 3. The on-board memory ranges from 256 MB to 1 GB RAM. The board supports up to 4 USB ports along with HDMI port. It has number of GPIO pins which support protocols like I²C.Moreover it also supports Wi-Fi and Bluetooth facility which makes device very compatible with other devices. It supports scratch and python programming languages. It supports many operating systems like Ubuntu MATE, Snappy Ubuntu, Pidora, Linutop and many more. The Raspberry Pi is designed to be connected to the Internet. Its ability to communicate on the Internet is one of its key features and opens up all sorts of possible uses, including home automation, web serving, network monitoring, and so on. The connection can be wired through an ethernet cable, or the Pi can use a USB Wi-Fi module to provide a network connection.

3.1.2 ULTRASONIC SENSOR

Fig -2: Ultrasonic sensor

Ultrasonic Distance Sensor provides very short (2cm) to long-range (4m) detection and ranging. It can be easily interfaced to any microcontroller. This ultrasonic sensor module can be used for measuring distance, object sensor, motion sensors etc. High sensitive module can be used with microcontroller to integrate with motion circuits to make robotic projects and other distance, position & motion sensitive products. The module sends eight 40KHz square wave pulses and automatically detects whether it receives the returning signal. If there is a signal returning, a high level pulse is sent on the echo pin. The length of this pulse is the time it took the signal from first triggering to the return echo.

3.1.3 DC MOTOR:

Fig -3: DC Motor

A DC motor is an electric motor that runs on direct current power. In any electric motor, operation is dependent upon simple electromagnetism. A current carrying conductor generates magnetic field. When this is placed in an external magnetic field, it will encounter a force proportional to the current in the conductor and to the strength of the external magnetic field. This device converts electrical energy to mechanical energy. It works on the fact that a current carrying conductor placed in a magnetic field experiences a force which causes it to initiate with respect to its original position.

3.1.4 BATTERY:

Fig -4: Battery

A battery is a device consisting of one or more electro chemical cells with external connections provided to power electrical devices such as flashlights, Smartphone's, and electric cars. When a battery is supplying electric power, its positive terminal is the anode and its negative terminal is the cathode. The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, thin cells used in smartphones, to large lead acid batteries or lithium-ion batteries in vehicles, and at the largest extreme, huge battery banks the size of rooms that provide standby or emergency power for telephone exchanges and computer datacenters.

3.1.5 MOTOR DRIVER:

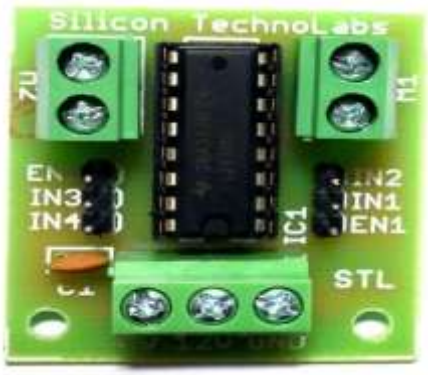

Fig -5: L293D Motor Driver

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

3.1.6 WEB CAM:

Fig -6: Web Cam

A webcam is a digital video device commonly built into a computer. Its main function is to transmit pictures over the Internet. It is popularly used with instant messaging services and for recording images. Webcams can be built-in computer hardware or peripheral devices, and are commonly connected to a device using USB or wireless protocols. They can provide advanced features such as image archiving, motion sensing, custom coding, or even automation. Furthermore, webcams are used for social video recording, video broadcasting, and computer vision and mainly used for security surveillance and in videoconferencing.

3.2 SOFTWARE REQUIREMENTS

3.2.1 RASPBIAN OS:

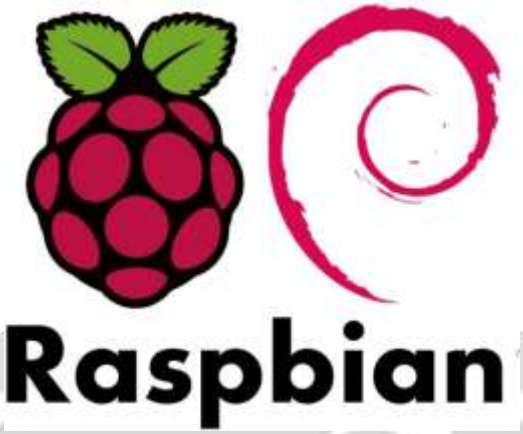

Fig -7: Raspbian OS

Raspberry Pi OS (formerly Raspbian) is a Unix-like operating system based on the Debian Linux distribution for the Raspberry Pi family of compact single-board computers. Raspberry Pi OS is highly optimized for the Raspberry Pi with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE desktop environment with the Open box stacking window manager, along with a unique theme. Raspberry OS has a desktop environment, PIXEL (short for Pi Improved X windows Environment, Lightweight), based on LXDE, which looks similar to many common desktops, such as mac OS and Microsoft Windows. A menu bar is positioned at the top and contains an application menu and shortcuts to a web browser (Chromium), file manager, and terminal. The other end of the menu bar shows a Bluetooth menu, Wi-Fi menu, volume control, and clock. The desktop can also be changed from its default appearance, such as repositioning the menu bar.

3.2.2 IMAGE PROCESSING USING OPEN CV IN PYTHON:

Image processing is the process of manipulating pixel data in order to make it suitable for computer vision applications or to make it suitable to present it to humans. For example, changing brightness or contrast is an image processing task which make the image visually pleasing for humans or suitable for further processing for a certain computer vision application. Python, is an object-oriented programming language. The processing happens during the runtime, and this is performed by the interpreter. Python's simple to learn and easy to use feature is an advantage and that makes it developer friendly. It is easier to read and understand as the syntax is conventional. The code can be executed line by line using the interpreter.Python can support multiple platforms like Linux, UNIX, windows, Macintosh, and so on. The paradigms of Object-oriented programming are supported by python. The functions such as polymorphism, operator overloading and multiple inheritance is supported by python.

4. SYSTEM DESIGN

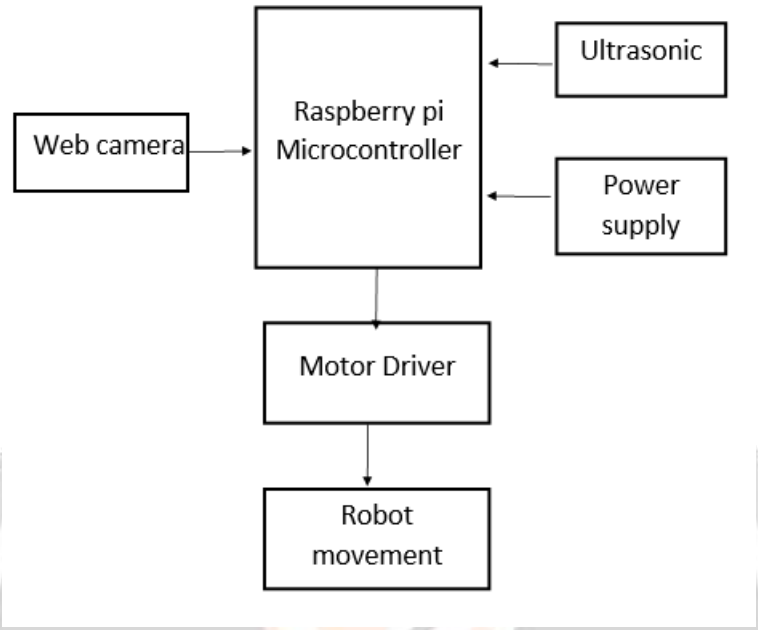

Fig -8: Block diagram of self-driving car

This model aims at designing an autonomous car prototype using Raspberry Pi as a processing chip. An HD camera along with an ultrasonic sensor is used to provide necessary data from the real world to the car. The car is capable of moving on its own thus avoiding the risk of human errors. Many existing algorithms like lane detection, obstacle detection are given to provide the necessary control to the car. The proposed model uses a web camera to capture a picture. Web camera is connected to raspberry pi and captured images will be sent to the Convolutional Neural Network as the input image. Signals are created in the python coding, which come from the execution of the kit and are sent to the car/robot. The robot car effectively detects objects. Before moving the picture to the Neural Network, it is gray scaled. The model predicts one of four possible outcomes: left, right, forward, or stop. When a predicted outcome is obtained, the corresponding signal is triggered, which in turn causes the corresponding signal to be triggered with the assistance of its controller, and assists the car in moving in a specific direction.

4.1 CIRCUIT CONNECTION

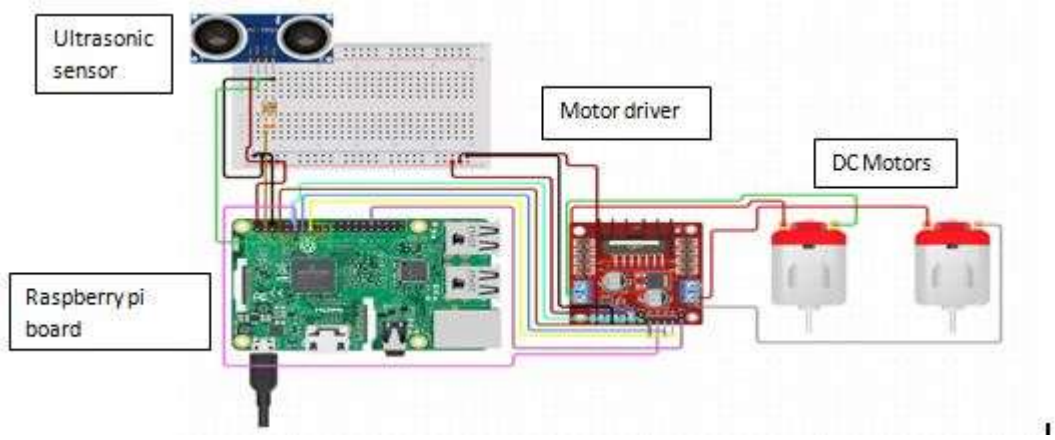

Fig -9: Circuit Diagram

- 2 DC Motors are used which are connected to the DC Motor Driver.

- One of the DC Motor is connected to pin numbers 23 and 24 of Raspberry pi board.
- The other DC Motor is connected to pin numbers 22 and 27 of Raspberry pi board.
- The rest of the pins of DC Motor driver is given to +12v, +7.5v and to the ground.
- The ultrasonic sensor's trigger pin is connected to pin 5 of Raspberry pi board and echo pin is connected to pin 6 of Raspberry pi board. VCC pin is connected to +5v and GND pin is connected to ground of power supply.
- The Raspberry pi is powered using Power bank.
- The Motor Driver is powered using 12v lead acid battery.

4.2 AUTONOMOUS CAR MODEL USING RASPBERRY PI

The self driving car model consist of raspberry pi board, power supply ,motor driver, DC motors and ultrasonic sensor. The power bank is used to give power to raspberry pi. 12v battery is used to drive the motors.It detects the lane and obstacle. The model in the figure shows object detected .

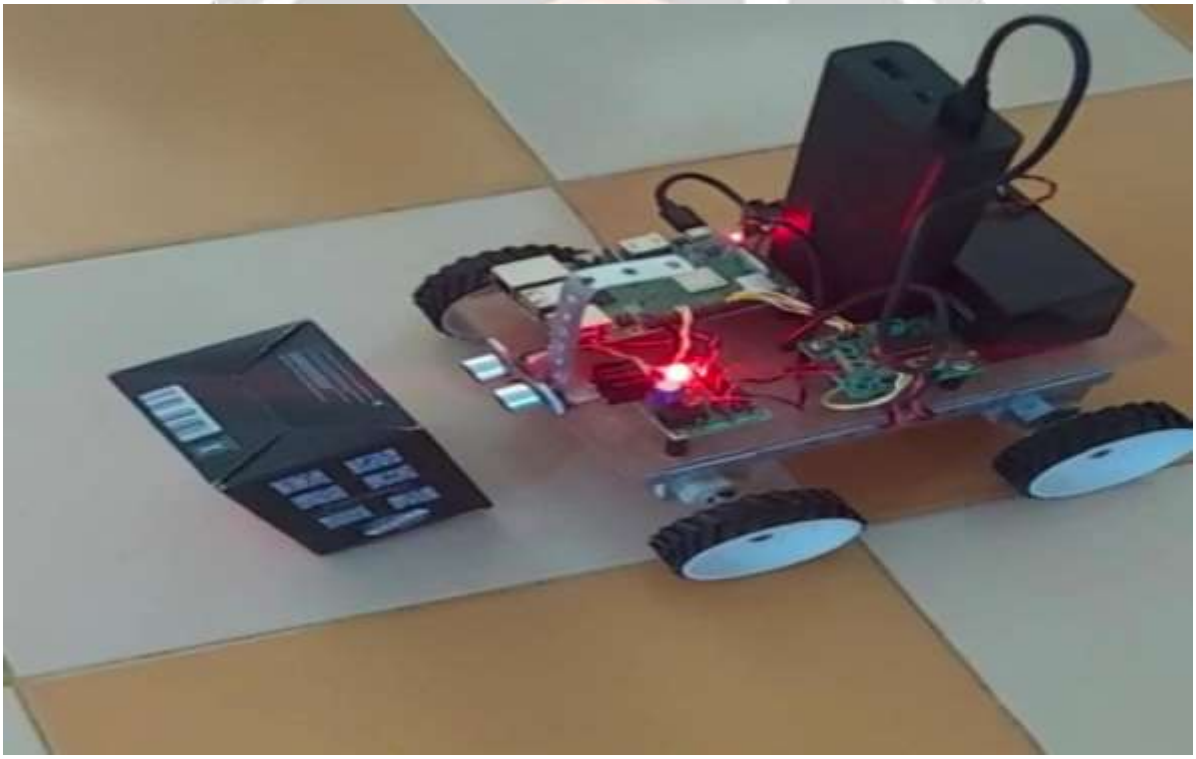

Fig -10: Autonomous car model

5. RESULTS

The following images in figure 11, 12 and 13 shows lane detection. The values between lesser than -50 and greater than 60 indicates straight path. Values lesser than -50 indicates left lane.Values greater than 60 indicates right lane.

Fig -11: Value between <-50 and >60 indicates a straight path

Fig -12: Value <-50 indicates left lane

Fig -13: Value >60 indicates right lane

The image below shows obstacle detection.

Fig -14: Object detected as a person and bicycle in video path

The figure 15 shows lane detection in live video,where it shows -9 as straight indicating that the model is moving in between the lane as it it between -50 and 60

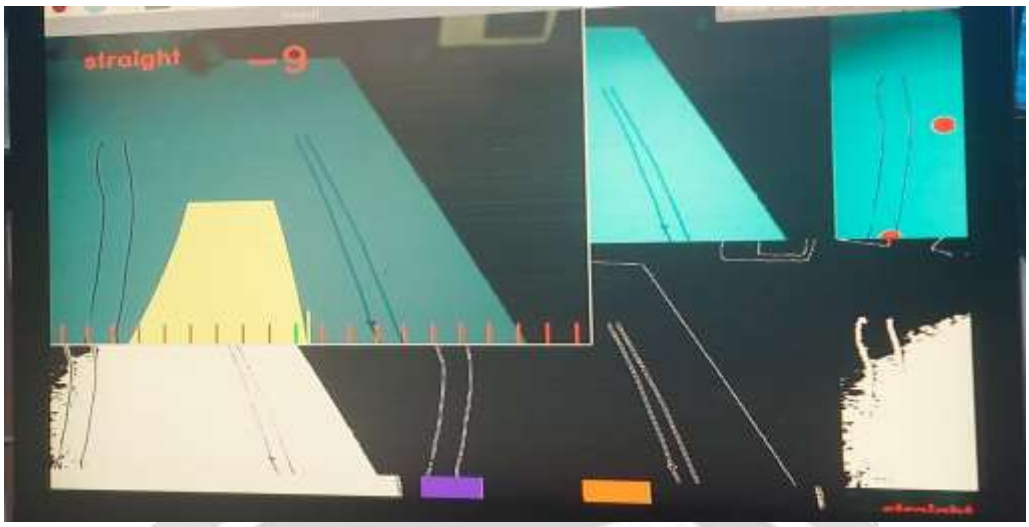

Fig -15:The output of live video is shown

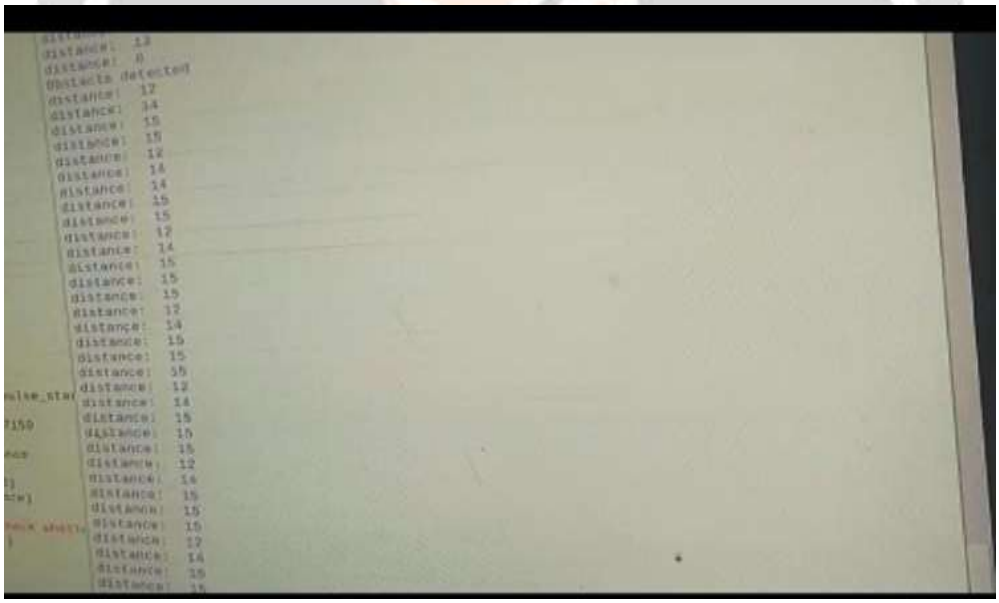

Fig -16: Distance of obstacle detected by ultrasonic sensor

The image below shows model detecting the yellow lane.

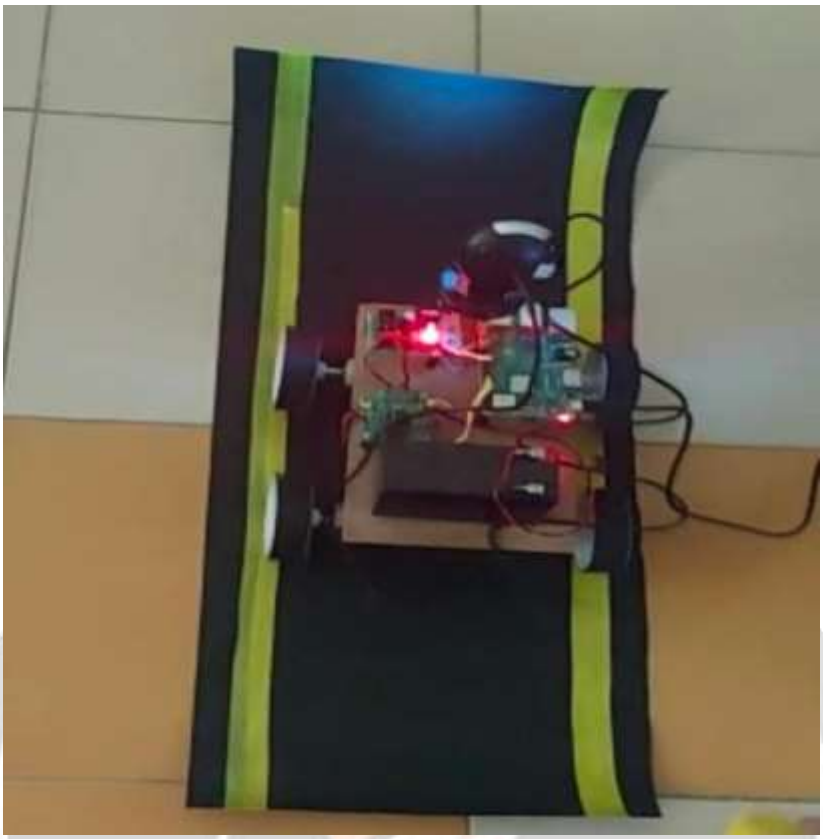

Fig -17: Car moving forward by detecting the lane

6. CONCLUSION

Self driving car (Robot car) is a robotic vehicle that is designed to travel between destinations without human intervention. It is capable of sensing environment and navigate without human input. The potential benefits of autonomous cars include reduced mobility and infrastructure costs, increased safety, increased mobility, increased customer satisfaction and reduced crime.

7. FUTURE ENHANCEMENTS

In future this model can be enhanced as follows:

- The model can be made to run within the lane whenever it is moving away from the lane
- In addition to stopping after detecting the obstacle the model can be made to navigate away from the obstacle.
- The model can also be programmed to move from one location to another using cloud platform.

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