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Model Demonstrating the Working Principle of Autonomous Vehicle

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ABSTRACT: Rapidly increasing number of vehicles on road has led to problems such as increasing the number of road accidents, traffic system failures, increased pollution and many more. Automation in vehicles may be the solution to those problems. Automation in vehicles has many advantages that can change the whole idea of driving such as decreased chances of accidents, fewer traffic jams, reduced emissions, efficient parking, independency of differently able people & children on others etc. The main aim of automation in vehicles is to reduce human efforts and human errors. SAE International has standardized six levels of automation and the current scenario is that there is level 3 autonomous vehicle present on road. It is not wrong to say that autonomous vehicles are the future of transportation. Therefore, it is necessary to understand the basic working of an autonomous vehicle. The whole purpose of this paper is to demonstrate the working principle of an autonomous vehicle through a scaled model. In addition, we will look forward to the role of different hardware components & programmable software in our scaled model. Various challenges faced by autonomous vehicles are also taken into consideration.

KEYWORDS: Autonomous, Microcontroller, Assistant Microcontroller, Image Processing, Machine learning.

I. INTRODUCTION

The increasing traffic density on the roads of India has led to the rise in road accidents by 0.5% for 2017(4,64,910) to 2018(4,67,044). 1214 road crashes occur every day in India, out of which 377 people loose lives, equivalent to a jumbo jet crashing every day. As per 2018 International Bank for Reconstruction and Development Report, over a period of 24 years from 2014 to 2038, if India could reduce its

death and injuries rate due to road traffic to halve, its GDP could increase by 7%.

The rapid growth of technology and innovations had made the human to work faster and more efficient. Development of science and technology to Artificial Intelligence is proven an excellent milestone in the history of the human race. Turning the vehicles intelligent could help human to save many lives from road accidents. Vehicles with

a higher level of Intelligence can help in reducing road congestions. An initial level of an intelligent vehicle will assist the human for better handling, will alert the driver and would be helpful to avoid the accidents. But switching to a completely autonomous vehicle, we might be able to eliminate every possibility of an accident. Moreover, it will be advantageous to all the human being (e.g. children, differently able people, people who can't drive, etc) who are hooked on someone else for mobilisation (e.g. taxi, passenger bus, metro, etc).

The ability of faster and better decision making of autonomous cars will increase the mobility rate of the population which will directly increase the productivity of the country. Hence, the autonomous vehicles will help in reducing traffic

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along with other advantages and bring a huge change in improving the lifestyle of a commoner.

II. REQUIREMENTS

I. Hardware

i. Chassis
It is the frame of the vehicle on which all the components are mounted.

ii. Camera
The use of the camera in this system is to observe the environment and provide real-time information to the system in the form of images. It is also used for creating a database of Deep Learning.
For this purpose, we used a 'Raspberry Pi Camera V2.1'.

iii. Distance Measuring Sensor
It is the device used for sensing the distance from the object.
For this purpose, we used an 'HC-SR04 Sensor'.

iv. Microcontroller
A device which provides the output in desirable format by processing the input data. It is a less sophisticated PC which is integrated on a single circuit board.
For this purpose, we used a 'Raspberry pi Model 4'.

v. Assistant Microcontroller
A device which is used to assist Microcontroller for reducing the load on Microcontroller.
For this purpose, we used an 'Arduino Uno'.

vi. Power Split Device
It is a device used for providing different speed to different motor.
For this purpose, we used an 'L298 motor driver'.

vii. Motor
It is a device used for providing rotation to wheels.

II. Software

i. Library for Computer Visualization
It enables the microcontroller to understand the input of camera and distance measuring sensor. It also empowers the camera for lane and object detection.
For this purpose, we used the 'Open CV'.

ii. The operating system of MicroController
It is a low-level software used for supporting the basic function of a microcontroller.
For this purpose, we used the 'Raspberry Pi OS (Raspbian)'.

iii. Setup of Assistant Micro Controller
It is the platform to write the programs in Arduino board. This function causing the physical movement of the model.
For this purpose, we used the 'Arduino IDE'

III. CONSTRUCTION

The camera is mounted on top of the vehicle body at a position from which it can view the maximum area of the road ahead. The camera takes the real-time images of the surrounding and feeds it to the microcontroller, in this model Raspberry Pi. It is connected to Raspberry Pi using the flex cable. Now, software programming inside the Raspberry Pi processes these images to understand the situation of the road and make a decision of how the vehicle is going to respond under those circumstances. The number of responses based on the circumstances are Forward, Left, Right, Backward and Stop. The Raspberry Pi makes the decision and send it to the assistant microcontroller, in this model Arduino Uno. Raspberry Pi and Arduino Uno are connected with each other by jumper wires. In return, Arduino controls the motor system accordingly with the help of a motor driver. Ultrasonic Sensors are also mounted at both sides and rear of the vehicle body to detect objects on sides and rear of the vehicle. Appropriate pins are used to connect the ultrasonic sensors with Raspberry Pi. Ultrasonic sensors detect the distance of any objects to help Raspberry Pi in making the decision whether it is safe for the vehicle to turn right or left or to move back.

IV. WORKING

When microcontroller gets the real-time images from the camera, software program inside the microcontroller starts digital image processing with the functions of 'Open CV' library. It converts the image colour scale from RGB to Grey. Then, these Greyscale images are merged with canny edge images to find the lane in which a vehicle has to move forward and backwards. For steering the vehicle, image centre is overlapped with lane centre and when lane centre changes (means there is a turn), Raspberry Pi directs the Arduino to stay in the lane centre.

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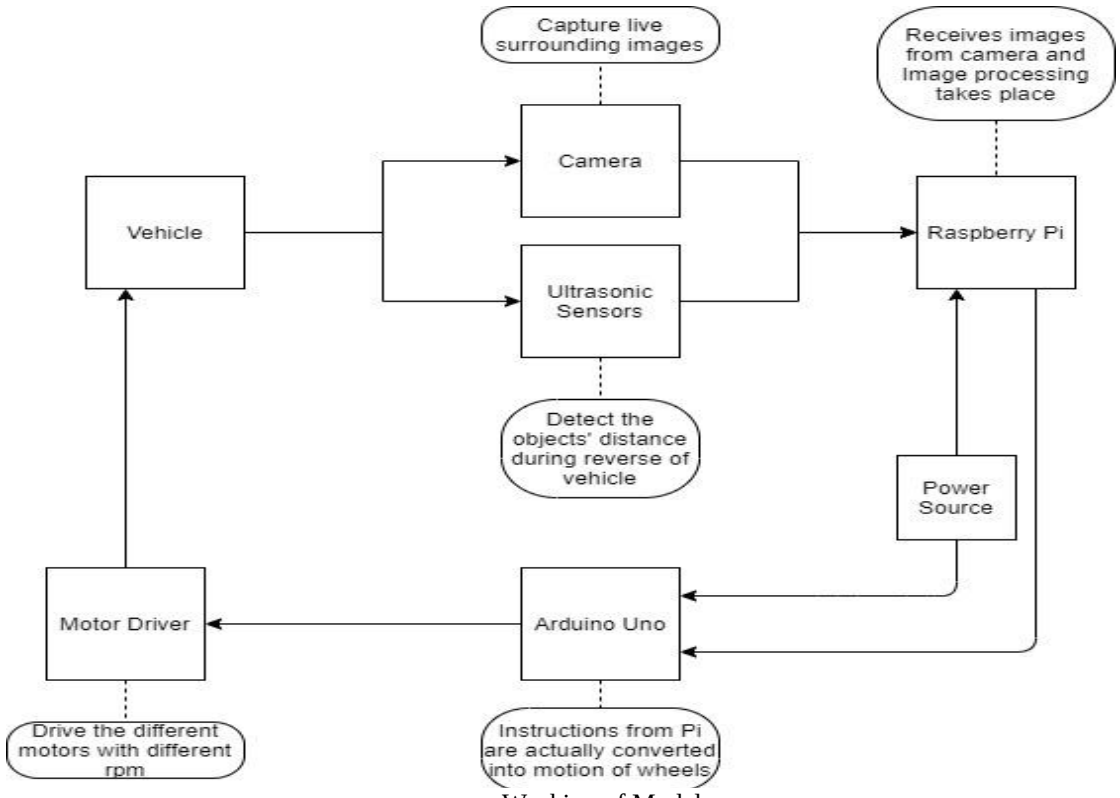

Working of Model

The images from the camera are also used for the machine learning algorithm. A number of positive and negative samples are taken to create a cascade file with the help of a GUI software. Positive samples are the images of objects which we want to detect and negative samples are the images which do not contain any useful information. Now, the cascade file is loaded into the software programming of microcontroller. Machine learning algorithm enables the microcontroller for object detection, signs detection and traffic signal detection over the road and responds as per learning.

Ultrasonic sensors which are placed at both sides and rear of the vehicle continuously detect the distance of objects around the vehicle. If any object comes within a specified distance around the vehicle during a turn or during backward movement of the vehicle, it will send a signal to the microcontroller to act accordingly.

V. CONCLUSION

The main purpose of this paper is to demonstrate the working principle of an autonomous vehicle with the help of a scaled model. This model gives us an idea of how an actual autonomous vehicle might work. Now, the hardware in an autonomous vehicle can be different from what we have used in this model. For example, for sensing the environment, an actual autonomous vehicle uses a combination of sensors such as LIDAR, RADAR, IR Sensors and Camera instead of camera & ultrasonic sensor which is used in this model. Also, an actual autonomous vehicle uses much more complex software architecture.

Autonomous vehicles are the solution to problems such as road accidents, traffic system failures, increased pollution and many more. But there are challenges it has to face and overcome yet.

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