Self Driving Trolley

Amandeep Singh Arora, Chintamani Satavalekar, Omkar Sawant
Guided by Prof. Jaychand Upadhyay

Abstract— These Navigating and controlling an autonomous vehicle is a major challenge faced today; This paper focuses on tackling the problem in a simplified manner. The approach focuses on minimalistic inputs namely images or video stream and distances from nearest obstacles. The focus is to use input from cameras to focus on a particular object and keep tracking the object in order to decide the navigation for the vehicle. The autonomous vehicle decides the action to be taken based on the stimuli received from the sensors. In a scenario where an obstacle obstructs the way, the vehicle decides on a new course in search of the object to be followed

Index Terms— Self Driving Trolley, Self Driving, Autonomous driving vehicles, Smart Trolley, Object Recognition, Content Based detection of regions, Image Ranging

1 Introduction

Cars have been an economical, efficient and convenient way of transportation for a few decades now. However, with emerging technology all forms of previously known and used technologies are being converted into more convenient and easy to use form, often resulting into the use of autonomous components. Cars can be controlled with use of some actuators who receive input of the environment through some sensors. Decisions for controlling the actions of the car can then be decided based on predefined logic and/or at run time. Although self driving cars are a few years away from being brought on the road, Google, Tesla, etc are working on technologies to realising this dream sooner than anyone can imagine. This paper focuses on combining various technologies, study them in order to create a system that can allow the vehicle to move avoiding collisions autonomously.

According to the government of India ministry of roads, transports and highways the major causes of road accidents in India are due to over speeding, red light jumping, drunken driving, distractions to drivers, and avoiding safety gears [1]. All of these can be summarised into a broader category of human error and negligence. With the introduction of self driving cars, the human operation of the vehicle will be diminished and so will be the causes of road accidents to a certain extent. Some other key factors that encourage the production of self driving cars include decreased Traffic Congestion, lower fuel consumption, increased human productivity, improved mobility for children, elderly and the disabled, [2] etc.

- *Amandeep Singh Arora is currently pursuing Bachelor degree program in Information Technology engineering in Mumbai University, India, PH-9769394754. E-mail: amandeep.arora67@gmail.com*
- *Chintamani Satavalekar is currently pursuing Bachelors degree program in Information Technology engineering in Mumbai University, India, PH- 9869567456. E-mail: maitreyasat@gmail.com*
- *Omkar Sawant is currently pursuing Bachelors degree program in Information Technology engineering in Mumbai University, India, PH- 9987578244. E-mail: sawantomkar96@gmail.com*

2 Sensors required for the Implementation:

Just like a human body has various senses through which we can perceive the environment around us, a self driving car would need some percepts of its own, which include cameras and ultrasonic sensors. Further, we elaborate the use of these two sensors to implement the vehicle.

2.1 Camera

Cameras act as the eyes of the system and help the system detect and recognise objects in order to avoid collisions. In order implement the system using cameras, we need to take into account the object detection and recognition algorithm.

1. Image Acquisition:

This phase is used to capture the image and convert it from an analog form into Digital signals. The next stage id to apply some objective point processing techniques in order to convert the image into a more easily recognisable form.

2. Image Segmentation:

The next phase involves Segmentation of the image which is done using region based segmentation. The image is segmented in order to convert it into various regions and make it easy for processing. The main reason for this phase is to identify objects and detect boundaries.

3. Content based Detection of regions:

Once the image is well segmented, we can apply suitable techniques to filter out similar regions in the image. Point processing techniques to filter the entire image would take longer to process hence, the image is divided into corresponding regions

4. Image ranging:

It rarely occurs that the image captured has the same attributes for colour, illumination, lighting etc. and hence we need to consider the range or threshold of variance that is acceptable.

5. Object Recognition:

After all the above techniques are applied, it can be said that

the object is detected. For further references and ease of access in the same environment, the objects could be classified and clustered into a database which will provide fast and easy retrieval for further processes.

After detection and recognition of objects in path of the vehicle, decisions such as to avoid the object or to stop before the objects have to be made by the vehicle.

2.2 Ultrasonic Sensors

In today's vehicles parking assists have earned a commonplace spot in their features list. This is implemented using upto 4 depth sensors that work on RADAR to estimate the distance from the nearest obstacle. It works by transmitting a sound wave and receiving the same wave back. The time for the wave to complete the two-way journey from the transmitter to the obstacle and back to the receiver again is used to estimate the distance of the object from the vehicle.

3 Components required for Implementation [4][6]

Now that the working of the sensors is defined, we move to the implementation of the approach for the vehicle. The autonomous vehicle will have a single camera facing the forward direction and three ultrasonic sensors facing forward and to the sides. The camera will capture a continuous feed at a predefined resolution and frame rate which will be processed for the computation.

1. Raspberry Pi 3 Model B:

Raspberry Pi is a Single Board Computer. Raspberry Pi is an economical mini computer with a quad core 1.2 GHz processor and 1GB of RAM. The mini computer comes equipped with 4 usb ports, 1 ethernet port, 1 HDMI port, and a special port for connecting a specially customised camera to the system itself.

2. Motor driver:

The raspberry Pi works on a +5V or +3.3V operating voltages which is insufficient to power the motors of the vehicle, and hence a separate motor driver that works on a power source of 12V is required to operate the motors. The motor drives can control 2 dc motors or 1 servo motor at a time. We use a single motor driver to power 2 dc motors to control the vehicle.

3. Motor and Tyres:

The motor driver controlled motor are used to navigate the vehicle. Two dc motors working at +5V are used to control the navigation of the vehicle.

4. Chassis:

In order to provide structural support to the vehicle we require a chassis that can hold all the specified components including the Raspberry Pi, Motor driver, motors, Pi camera, breadboard and the ultrasonic sensors.

4 Implementation

The working of the system begins with connecting the sensors to the Raspberry Pi and providing the required power voltages to the same. The Pi camera is attached directly to the CSI camera port whereas the ultrasonic sensors are attached to the GPIO pins on the Pi. The ultrasonic sensors also require some resistance in order to adapt to the voltages from the Pi which must be considered. The motor driver is also connected to the Pi via GPIO ports and requires an external power source for operation. The connections of the ultrasonic sensors, Pi camera and the motor driver bridge can be viewed from the following schematic diagram.

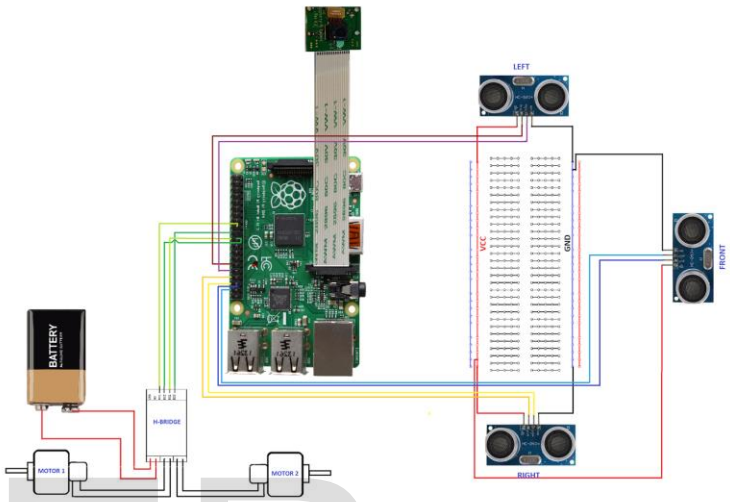

Fig. 1. Block diagram for connections of sensors. [3]

Now that the components are all connected, it is time to move forward with the implementation. We use Raspberry Pi's GPIO ports to access the ultrasonic sensors in order to fetch the distance measures from the environment. This input is a secondary decision factor for the movement of the vehicle, while the Pi camera input is the primary decision factor. The assembled vehicle looks as given below:

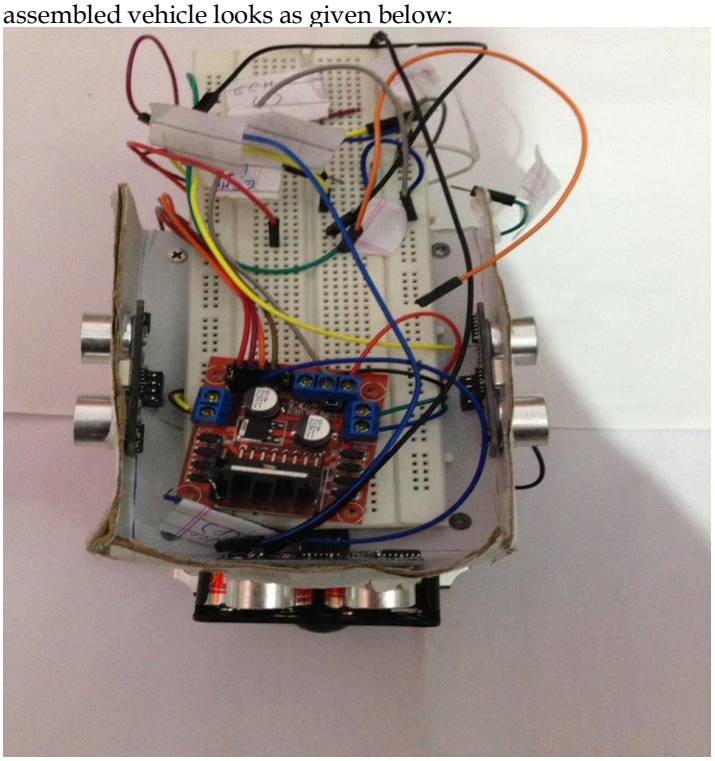

Fig. 2. Top View of the bot.

The vehicle is designed in order to follow a predefined object, which acts as the reference for the path to be followed by the vehicle. We scan the environment in order to find the desired object to follow. The orientation of the object is considered in order to decide upon the movement of the vehicle, i.e. whether to take a right or left turn or to move forward.

5 Algorithm

Step 1: Initialize all the required parameters like the ultrasonic sensors distance parameters and the camera's frame rate and resolution. Also define the movement sequences to go forward, backward, left and right turns and to stop.

Step 2: For a continuous capture of frames do steps 2 through 7. Capture the distances of nearest obstacles in the direction of all three sensors.

Step 3: Search the captured frame for the object to be followed. If the size of the object is significant to be recognised, draw a frame around the object and compute the center of the frame.

Step 4: If no object is found in step 3, search the environment by moving in the last known direction of the object.

Step 5: When the object is found, check the distance measurement of the forward facing ultrasonic sensor.
If the distance is less than 10 cm do:
If the distance measure of the right ultrasonic sensor is greater than 8cm, do:
Take a right turn, move forward 8cm, take a left turn and Stop.
Else if the distance measure of the left ultrasonic sensor is greater than 8cm, do:
Take a left turn, move forward 8cm, take a right turn and Stop.
Else,
Do nothing and stop.
Else, move in the forward direction till capture of a new frame.

Step 6: Set up the last known location of the object. If the frame created around the object is to the left of the center, the last location of the object is to the left, else it is to the right.

Step 7: Create room for the new frame to be captured and move back to step 2.

The above algorithm sets up an indefinite loop of actions over the RAspberry Pi, and in order to stop the loop an external breakpoint is required.

6 Observations and Result:

The vehicle is capable of navigating on its own. The implementation of object following and collision avoidance has been implemented successfully. The vehicle is tested in a closed environment with zero obstacles and also in presence of multiple obstacles. The vehicle handles its navigation is both the environments satisfactorily. However, when using a neural network, the performance of the vehicle drops as it generates the camera outputs at around 1 frame per second. This causes the vehicle to not take necessary actions in some cases. On the other hand, when using the above proposed system, the vehicle works well.

7 Conclusion

In this paper, we proposed a study of an autonomous self driving agent learning to drive in a simplified environment consisting of an object to be followed, and in presence of zero or more obstacles. We used a Raspberry Pi driven model to capture the environment with a camera and process the data with the help of basic image processing and extraction techniques, and thus making decisions for navigation. Future prospects of our study include making use of a server processing that will help use neural networks in order to make decisions for the route to be followed by the vehicle.

References

[1] http://jhtransport.gov.in/causes-of-road-accidents.html
[2] https://www.autobytel.com/car-ownership/advice/10-benefits-of-self-driving-cars-121032/
[3] https://www.hackster.io/junejarohan/ball-tracking-robot-7a9865
[4] Qudsia Memon, Muzamil Ahmed, Shahzeb Ali, Azam Rafique Memon and Wajiha Shah "Self-Driving and Driver Relaxing Vehicle" in 978-1-5090-4059-9/16 ©2016 IEEE available at https://mafiadoc.com/self-driving-and-driver-relaxing-vehicle-pdf-download-available_598ed9ad1723ddcb690d9108.html
[5] Geetinder Kaur, Sourabh Joshi, Jaspreet Kaur and Samreet Kaur "GOING DRIVERLESS WITH SENSORS" in ISSN: 2348-4098 VOLUME 2, ISSUE 5 JUNE 2014 available at http://ijset.in/wp-content/uploads/2014/06/ijset.0620140074.1011.1806_Geet_298-305.pdf
[6] Gurjashan Singh Pannu, Mohammad Dawud Ansar and Pritha Gupta "Design and Implementation of Autonomous Car using Raspberry Pi" in International Journal of Computer Applications (0975 – 8887) Volume 113 – No. 9, March 2015 available at http://research.ijcaonline.org/volume113/number9/pxc3901789.pdf