Self-driving car to demonstrate real time obstacles & object detection.

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Abstract – *We propose a model for students who are interested in building self-driving cars in future. This model would help students and enthusiasts experiment, build and test software's on toy cars instead of real cars. We have used several machine learning and image processing techniques for achieving same. Also, hardware architecture is described which can be tweaked according to need. This model basically involves 3 tasks – building car hardware, collecting data for processing and building machine learning models on top of data collected for obstacle and object detection.*

Key Words: Object detection, motion detection, Autonomous vehicles, scene analysis, distance measurement

1.INTRODUCTION

A self-driving car is a vehicle that is able of sensing its surrounding and driving without human intervention. Self-driving cars can sense surrounding using many ways like lidar, radar, GPS, camera. Biggest benefit of self-driving cars is reduced number of accidents. If such cars are widely available and engineered properly can also save fuel which will lead to lesser pollution. In recent period there has been tremendous amount of development in self-driving vehicle space which is attracting wide range of consumers mostly due to the benefits it provides. Google is also testing its vehicle on the streets of US from long time. Companies like Tesla Motors have sprung up to the new era of electric self-driving cars which prove to be faster, efficient and environment friendly than any other car produced yet.

There are many challenges while building such vehicles few of which include obstacle detection, lane detection and localization. Apart from technical challenges customers are also concerned about privacy, attacks by hackers and loss in number of driver jobs. To deal with few issues SAE[1] International, a automotive standardisation body published a classification system based on amount of driver alertness required. Those classifications are listed in the document by SAE[2]

As we move towards driverless future we want to provide college student a affordable model on which they can test and build their own implementations of self-driving car algorithms. For simplicity and testing we are using a toy car as a prototype. It works on Raspberry Pi, Arduino, Camera and Ultrasonic sensor.

2. LITERATURE SURVEY

2.1 HISTORY

Since 1920s researchers were involved in solving a challenge to build autonomous cars.

In 1925, first autonomous car was demonstrated. It was radio -controlled driverless by name "Linrrican Wonder" It travelled on New York City streets, from Broadway down to Fifth Avenue. In 1926 Lihrrican Wonder used Radio antennas for sending radio impulses, those radio impulses were caught by the antennae. The antennae introduced the signals to circuit-breakers which operated small electric motors that direct every movement of the car..

In 1953 RCA LABS in USA build first device to control the cars on highways. But first actual self-sufficient and truly autonomous cars were developed in the 1980s with the help of Carnegie Mellon University and ALV projects in 1984 and afterwards in 1987 by Budeswer University Munich's EUREKA Prometheus Project and Mercedes-Benz.

2.2 Stanley

The Stanford University create autonomous car for Stanford Racing Team in cooperation with the Volkswagen Electronics Research Laboratory(ERL). The DARPA Grand Challenge is the second driverless car competition was done in near the California/Nevada state line in October 8, 2005. Stanford Racing Team is the winner of this challenge and won the 2 million dollar prize.

The Stanford Racing Team is led by Professor Sebastian Thrun and Stanford Artificial Intelligence Lab is the director of it. It is purposely developed for 2004 DARPA Grand Challenge .Stanley is one of the standard European diesel model Volkswagen Touareg provided by Volkswagen's ERL for the competition. Stanley used six low power 1.6 GHz Intel Pentium M based computers in trunk. On that they processed sensor data and execute decisions and computers running different Linux versions operating system. They developed 100000 lines of software to run interpret sensor data and execute navigation decisions. And Stanley also utilizes low level modules fed raw data from LIDAR,the camera, GPS sets and inertial sensor into software programs to control the vehicle's speed, direction and decision making.

3. ARCHITECTURE

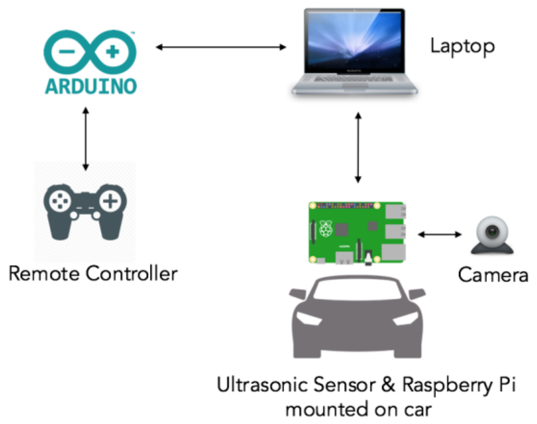


Fig-1: Architecture

Fig-1 shows the architecture for our self-driving car model. We are using raspberry pi as our primary processor. Since we are using toy car, it needs to be controlled via remote controller, which is connected to arduino. For obstacle detection, we are using camera and ultrasonic sensor HC-SR04 which is connected to raspberry pi. Entire system is in sync with on a WiFi network. Below is the detailed description of components:

3.1 Raspberry Pi

Raspberry pi acts as the primary processor for this car. It is responsible for obstacle and object detection as well as its separation. Raspberry Pi is also doing other things like maintaining car on a stable WiFi network via static IP. Also, other components like camera and ultrasonic sensor is interfaced with it. For WiFi we are using separate adapter connected via USB. Main task for Raspberry Pi is to send driving signal information to laptop which will further show it on a dashboard and in turn to arduino.

3.2 Laptop

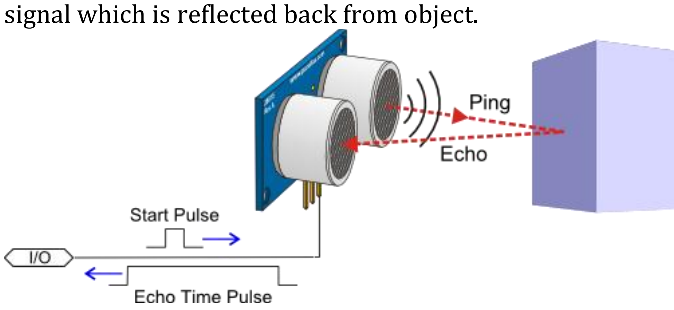
Laptop acts as dashboard for car. It will help in showing algorithm performance in real time. In situations when objects are missed to get detected, laptop screen becomes handy to diagnose.

3.3 Arduino

To send driving signals from RC to Raspberry Pi we have interfaced arduino with laptop and RC. It gets driving signals from laptop and sends it to arduino.

3.4 Ultrasonic HC-SR04 Sensor

Obstacles in front of car can be detected with the help of ultrasonic sensor. It calculates distance from car to immediate object and passes it to raspberry pi. This sensor has four ports: echo, trigger, Vcc, ground. Trigger sends signal from sensor to environment and echo receives the signal which is reflected back from object.



3.5 Camera

Raspberry Pi camera is used to detect objects and classify them based on properties. Like start/stop signals and actual obstacles.

3.6 Car

We are using a RC toy car for demonstration purpose.

4. NETWORKING

To maintain entire system on a network we are using WiFi, where all components are communicating with each other. We are using socket programming for this purpose, sockets are combination of IP address and Port number. A server can *bind* itself to Internet Protocol address and other clients and *connect* to it. To achieve the same, we have used Python.

5. MEASURING DISTANCE FROM OBSTACLES

Ultrasonic Sensor converts ultrasound waves to electrical signals or vice versa. Ultrasonic distance sensor determines the distance to an object by measuring the time taken by the sound to reflect back from that object. One part of sensor produces sound, another catches reflected echo. So the echo signal reflects basically the time during which the sound reaches to the object and comes back from the object. By measuring this time and multiplying it by the speed of sound and then divide it by two we get the distance to the object.

6. OBJECT DETECTION USING CAMERA

To detect objects using camera we have made a object detection module using Python OpenCV. This module works in steps described below:

1. Grab a video feed.
2. Convert video feed to image frames.
3. Convert image frames to grayscale.
4. Gaussian blur them.
5. Save initial frame.
6. Compare every successive frame with initial frame.
7. Dilate threshold image to fill in holes, then find contours on thresholded image.
8. If there is a change in frames, compare frame pixels to that of initial frame and detect it as object.

4. CONCLUSIONS

In this paper, we have proposed the model which would be helpful for students and hobbyists for experimenting on self-driving car algorithms. It would be useful in prototyping and rapid testing in limited environments as in toy car.

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