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Development of Driverless RC Car

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ABSTRACT

One of the most challenging parts of developing an autonomous car is to achieve low cost and low power consumptions in addition to the various features. The objective of this paper is to explain how we developed a scaled down model of an autonomous vehicle using an RC car to implement an advanced driverless system using Neural Networks and Computer Vision. The proposed approach is focused on application of autonomous car, in which the car will detect the lanes, obstacles, traffic signals and stop signs while driving itself on a predefined track and monitoring the environment with the help of a pi-camera and an ultrasonic sensor. These sensors are used to provide necessary data from real world. Raspberry Pi collects and processes this data and sends data to a computer wirelessly. The computer processes input images and sensor data for object detection (stop sign and traffic light) and collision avoidance respectively. A neural network model runs on a computer and makes predictions for acceleration and direction control based on input images in real time. Predictions are then sent to the Arduino to control the movement of the car via remote control. All the computations are done on the computer, including recognition of environment and decision-making.

KEYWORDS— Autonomous Car, Neural Networks, Computer Vision, Lane and Obstacle Detection, Raspberry Pi, Object Detection, Environment recognition and Decision Making.

1. INTRODUCTION

The Indian government has released the official statistics for road accidents, injuries and fatalities for the year 2017, and the news continues to be bad. As per the latest data, in 2017, a total of 4,64,910 road accidents were reported in the country, claiming 1,47,913 lives and causing injuries to 4,70,975 persons, which translates into 405 deaths and 1,290 injuries each day from 1,274 accidents. This also means that 16 people are killed and another 53 are injured every hour on Indian roads. [1]

Areas like avoiding the tens of thousands of fatalities every year are priceless, but here we will try to quantify the problems driverless cars solve. These markets total $1.3 trillion dollars. Since self-driving cars could, in theory, significantly reduce or eliminate many of these line items, I estimate that self-driving cars could save more than $1trillion in these costs one in a single year. The costs of operating driverless cars in the U.S. will be significantly less than $1 trillion. And then there are problems solved that we had more difficulty quantifying or finding the necessary information.

1. Lives saved from car crashes and road rage.
2. Fewer greenhouse gas emissions.
3. Less government overhead for detecting and enforcing driving violations.
4. Higher financial viability of on-demand products and services.
5. Fewer car thieves processed and jailed.

There’s an argument that could be made that these areas add another trillion dollars, if not much more. Also, the priceless benefits of being able to enjoy. We think driverless cars will be great thing and that they could ultimately help us reduce the $20 trillion national debt. [2]

2. PROPOSED SOLUTION

Autonomous cars are better adapted to situations where it is impossible for a person to prevent car accidents than conventional ones. It involves huge cost, time investment and space to work with full sized vehicles. A scaled down model of autonomous cars can be used in any situation where researchers want to test a

RC cars often come with their individual remote control which restricts modification and improvement in car control. So, the controller is reconstructed and organized to meet requirements of self-driving RC car. It can be designed in the many ways assure likes this including many features rather than just controlling the RC car

Camera is an important part of this project. It is used to detect the line of the track. One of the options is to use night vision camera which can work in the dark, but it is too expensive. So, it does not meet the low-cost objective.

3. METHODOLOGY

3.1 System Design

The system design is divided into 3 units:

3.1.1 Data Collection

Pi camera module and an HC-SR04 ultrasonic sensor to collect input data. Two client programs run on Raspberry Pi for streaming color video and ultrasonic sensor data to the computer via local Wi-Fi connection. In order to achieve low latency video streaming, video is scaled down to QVGA (320×240) resolution.

3.1.2 Processing Unit

The processing unit (computer) handles multiple tasks: receiving data from Raspberry Pi, training the neural network and prediction (controlling the motion), along with other tasks such as object detection (stop sign and traffic light), distance measurement (monocular vision), and sending instructions to Arduino through USB connection.

3.1.3 RC Car control unit

Usually the car is controlled by a remote control which sends signals to steer the wheels depending on which buttons the user presses. In our case, we want to control the car purely with a computer program. In order to do that, we will need to buy several extra parts, rewire it and connect it to the onboard computer. We will also need a camera to collect images and a motor controller.

The RC car used in this project has an on/off switch type controller. When a button is pressed, the resistance between the relevant chip pin and ground is zero. Thus, an Arduino boar disused to simulate button-press actions. Four Arduino pins are chosen to connect four chip pins on the controller, corresponding to forward, reverse, left and right actions respectively. Arduino pins sending LOW signal indicates grounding the chip pins of the controller; while sending HIGH signal indicates the resistance between chip pins and ground remain unchanged. The Arduino is connected to the computer via USB. The computer outputs commands to Arduino using serial interface, and then the Arduino reads the commands and writes out LOW or HIGH signals, simulating button-press actions to drive the RC car. The picture below shows the training data collection process. First each frame is cropped and converted into a NumPy array. Then the train image is paired with train label (human input). Finally, all paired image data and labels are saved into a .npz file. The neural network is trained using back propagation method. Once training is done, weights are saved into a xml file. To generate predictions, the same neural network is constructed and loaded with the trained xml file.

4. PROGRAM EXECUTION

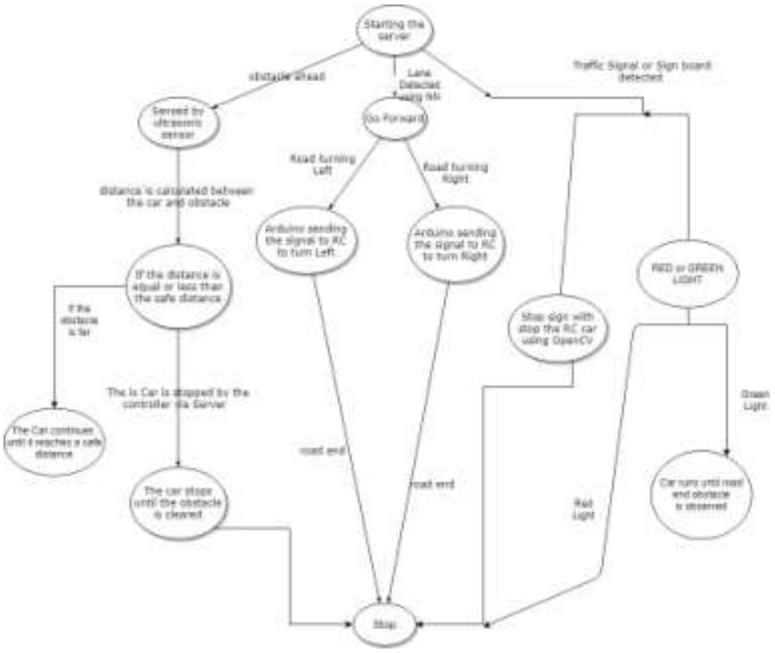

Fig 4: - Program Execution Flowchart

4.1 Object Detection

This project adapted the shape-based approach and used Haar feature-based cascade classifiers for object detection. Since each object requires its own classifier and follows the same process in training and detection, this project only focused on stop sign and traffic light detection.

Open CV provides a trainer as well as detector. Positive samples (contain target object) were acquired using a cell phone, and were cropped that only desired object is visible. Negative samples (without target object), on the other hand, were collected randomly. In particular, traffic light positive samples contain equal number of red traffic lights and green traffic light. The same negative sample dataset was used for both stop sign and traffic light training. Pictures below show some positive and negative samples used in this project.

Fig 4.1: - Positive and negative samples. [3]

4.2 Distance Measurement

Raspberry Pi can only support one pi camera module. Using two USB web cameras will bring extra weight to the RC car and also seems unpractical. Therefore, monocular vision method is chosen.

OpenCV provides functions for camera calibration. Camera matrix for the 5MP pi camera is returned after calibration. Ideally, a_x and a_y has the same value. Variance of these two values will result in non-square pixels in the image. The matrix below indicates that the fixed focal length lens on pi camera provides a reasonably good result in handling distortion aspect.

5. PROS AND CONS

5.1 Pros

1. Safety**:** A major advantage of self-driving cars is to avoid accidents. Every year, over a lakh people die in road accidents in India alone and the proportion of those who get injured is nearly three to four times higher. Driverless cars avoid the risks arising due to over speeding, drunk driving, distractions like cell phones, music, etc.
2. Increasing roadway capacity**:** Self driving cars can travel in convoy, inches apart thus reducing the distances between the cars without any problem.
3. Parking**:** People are free to do other tasks and let the car park for itself. Its location can later be determined using GPS.
4. Cost**:** Buying, insuring and maintaining a car is expensive. Self- driving cars save the expenses due to accidents and crashes or dents as it is safe.

5.2 Cons

1. Knowledge**:** While the computer takes over once the vehicle is operational, the driver would still be required to maintain some knowledge about how to operate it safely.
2. Security**:** The very security behind self-driving cars would be a major obstacle, especially because the technology would be of very high interest to hackers.
3. Human Traffic Signals**:** If other technology fails, such as traffic signals that the cars rely on, there's no accounting for human traffic signals. In the event of an accident, for example, where a police officer is directing traffic, the cars cannot interpret human signals.
4. Loss of job**s:** Replacing human controlled driving will see people who drive taxis or trucks for transporting goods as their livelihood in need of new employment.

6. CONCLUSION

This paper introduces the development of a driverless RC car. The different hardware components and their assembly are clearly described. It also explains the process of machine learning using neural network and a novel method of lane detection is also explained in details relying upon Open CV. Obstacle detection is carried out using ultrasonic sensors.

7. REFERENCES

[1] Road accidents in India claim more than 1.4 lakh livesin 2017 17th Oct 2018 7:00 am https://www.autocarindia.com/industry/road-accidents-in- india-claim-more-than-1.4-lakh-lives-in-2017-410111
[2] The Problems Driverless Cars solve https://www.creightontaylor.com/future/driverless-cars/the-problems-driverless-cars-solve/
[3] https://zhengludwig.wordpress.com/projects/self-driving-rc-car/
[4] https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/
[5] Socket Programming in Python https://www.geeksforgeeks.org/socket-programming-python/]
[6] Elmenreich, W. (2002). *Sensor Fusion in Time-Triggered Systems, PhD Thesis* (PDF). Vienna, Austria: Vienna University of Technology. p.173.
[7] Haghighat, Mohammad Bagher Akbari; Aghagolzadeh, Ali; Seyedarabi, Hadi (2011). "Multi-focus image fusion for visual sensor networks in DCT domain". *Computers &Electrical Engineering*. **37**(5): 789–797. doi:10.1016/j.compeleceng.2011.04.016.
[8] https://www.modmypi.com/blog/hc-sr04-ultrasonic-range-sensor-on-the-raspberry-pi