International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 08 | August -2020 ISSN: 2582-3930

Autonomous Car

Mukul Sagvekar[1], Manvendrasinh Parmar[2], Abhishek Patil[3]

[1]*Department of Electronics and Telecommunication, MIT College of Engineering, Pune, Maharashtra, India*
[2]*Department of Electronics and Telecommunication, MIT College of Engineering, Pune, Maharashtra, India*
[3]*Department of Electronics and Telecommunication, MIT College of Engineering, Pune, Maharashtra, India*

---***---

Abstract - The field of autonomous automation is of interest to researchers, and much has been accomplished in this area, of which this paper presents a detailed chronology. This paper can help one understand the trends in autonomous vehicle technology for the past, present, and future. We see a drastic change in autonomous vehicle technology since 1920s, when the first radio controlled vehicles were designed. In the subsequent decades, we see fairly autonomous electric cars powered by embedded circuits in the roads. By 1960s, autonomous cars having similar electronic guide systems came into picture. 1980s saw vision guided autonomous vehicles, which was a major milestone in technology and till date we use similar or modified forms of vision and radio guided technologies. Various semi-autonomous features introduced in modern cars such as lane keeping, automatic braking and adaptive cruise control are based on such systems. Extensive network guided systems in conjunction with vision guided features is the future of autonomous vehicles. It is predicted that most companies will launch fully autonomous vehicles by the advent of next decade. The future of autonomous vehicles is an ambitious era of safe and comfortable transportation.

***Key Words*:** autonomous, self-driving car, machine learning, neural network, raspberry pi, journals

1. INTRODUCTION

In the last 20 years the value chain in the car industry has changed drastically. All car producers and suppliers worldwide have worked on improvements in the area of mechanics, the improvement of quality requirements, and improvements in the logistic area. A lot of the potential in these areas is already exploited. A main differentiation factor turns out to be the electronics area, where a change from hardware to software development is carried out. The meaning electronics will have in the next years has been analyzed by a study of Mercer Management Consulting (Mercer, 2004). The study focuses mainly on the question how the cost factors in the development of a car will change until the year 2015 in comparison to the year 2002. In 2015 the costs for the development of electronics will have a value of 35% of the total car production costs. Whereas areas as power train and body have small increases, the costs for the development of electronic systems will be almost tripled. The predicted increases result from a variety of innovations which are being expected in this area.

The majority of innovations are realized with embedded systems and especially with software in the car will be based on electronics and from that 80 percent will be realized by software" (Lederer, 2002). However, today's software development has big challenges to master like shortened development times for the cars in total versus longer development times for the software, high safety requirements and especially the growing complexity because of the rising number of functions and the increasing interaction between the functions.

Autonomous cars (also called driverless cars, self-driving cars, or robotic cars) are a vehicle that is capable of sensing its environment and moving safely with little or no human input. Autonomous cars are no longer confined to the works of science fiction. There are already vehicles on the road today with Advanced Driver Assistance Systems (ADAS) that maintain speed, brake, and maneuver with limited or no driver engagement. Building on these advancements, fully autonomous cars are on the horizon, with development and testing initiatives taking place worldwide.

To be categorized as "fully autonomous," a car must be able to navigate between destinations without any intervention from a human driver. Self-driving cars aim to increase safety by eliminating human errors from driving situations. Fully autonomous cars will be controlled by an onboard computer, using a combination of sensing systems, such as cameras and ultrasonic sensors that perceive the roadways and surrounding environments. Autonomous systems are designed to drive cars safely while eliminating human failings such as cell phone distractions or drowsy inattention.

2. DESIGN OF SYSTEM OF AUTONOMOUS CAR

The working and block diagram of autonomous car is shown in Fig.1.

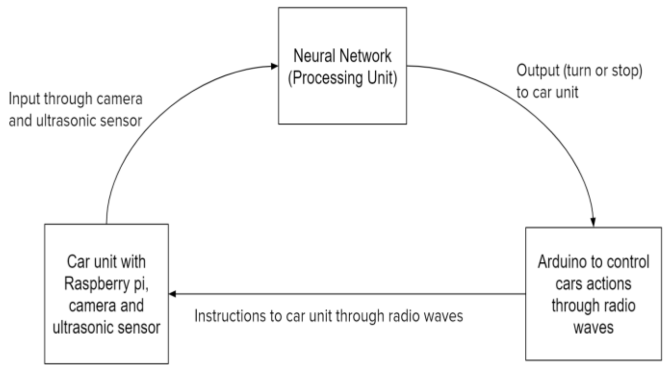


Fig.1 Block Diagram

This consists of three parts – input unit, processing unit, and the car unit (output unit)

1. Input unit

A Raspberry Pi board (model B+), attached with a pi camera module and an HC-SR04 ultrasonic sensor is used 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.

2. Processing Unit

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

3. Car Unit

The 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 board is used 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; on the other hand 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 car.

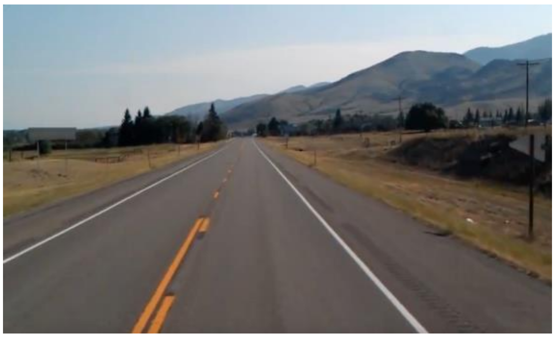
3. SUB-SYSTEMS OF AUTONOMOUS CAR

A. TCP Server

A multithread TCP server program runs on the computer to receive streamed image frames and ultrasonic data from the Raspberry Pi. Image frames are converted to gray scale and are decoded into numpy arrays.

B. Lane Detection

The input frames captured form Pi camera are transmitted to processing unit (pc or laptop) through the raspberry pi attached on the car unit. These frames are converted into gray scale and cropped in half vertically. The lower cropped images is used for further processing as whole images also consists of the scenery and for lane detection only lower part of the image is required which also reduces processing time.



a. Input from pi camera

b. Converted to gray scale

c. Cropped image

```
[[-0.09443539 -0.09443531  0.29860729 -0.09761513 -0.09440866]
 [-0.09443526 -0.09443531  0.25596021 -0.10824217 -0.094422  ]
 [-0.09443524 -0.09443531  0.37198598 -0.12371693 -0.09442577]
 [-0.09443568 -0.09443531  0.30667577 -0.10257815 -0.09441752]
 [-0.09443562 -0.09443531  0.41545527 -0.06368836 -0.09441873]
 [-0.09443647 -0.09443531  0.34410876  0.00738793 -0.09440932]
 [-0.0944355  -0.09443531  0.33180906 -0.12472302 -0.09442687]
 [-0.09443587 -0.09443531  0.3643611  -0.16894118 -0.09443041]
 [-0.09443721 -0.09443531  0.43028699  0.0095     -0.09441093]
 [-0.09443846 -0.09443531  0.34737789 -0.07818481 -0.09439922]
```

d. Converted to numpy array

Fig. 2 Lane Detection

Then the lower half of the image is converted into numpy array. This array is paired with the input from user while training the model. The lanes are in while color and the road are in dark color, so their difference in code is large.

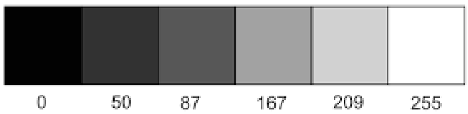


Fig.3 Color code

These sudden changes in code are used to detect lanes. So the training data consists of input image from car unit i.e. pi camera converted to array and the user input. The model uses this data for prediction.

C. Neural Network

One advantage of using neural network is that once the network is trained, it only needs to load trained parameters afterwards, thus prediction can be very fast. Only lower half of the input image is used for training and prediction purposes. There are 38,400 (320×120) nodes in the input layer and 32 nodes in the hidden layer. The number of nodes in the hidden layer is chosen fairly arbitrary. There are four nodes in the output layer where each node corresponds to the steering control instructions: left, right, forward and reverse respectively shown in Fig.2 (though reverse is not used anywhere in this project, it's still included in the output layer).

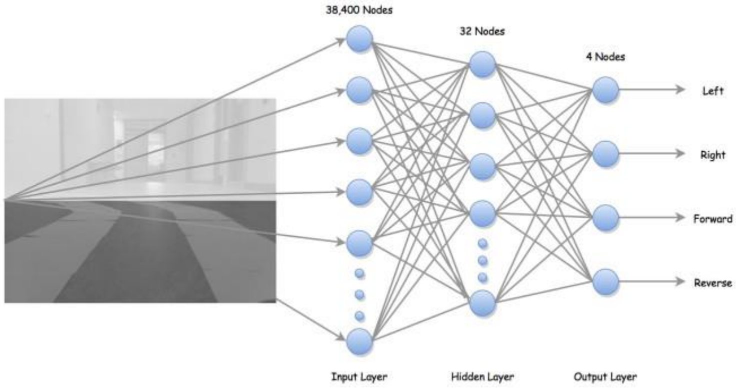


Fig.2 Neural Network

Below shown in Fig.4 the training data collection process. First each frame is cropped and converted to 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 in OpenCV 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.

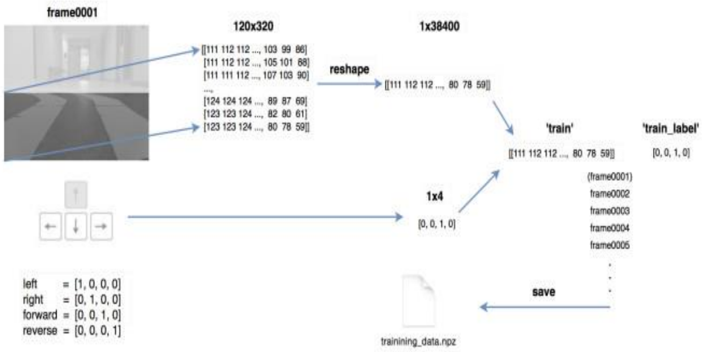


Fig.4 Collection of Training Data

D. 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.

OpenCV 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, a traffic light positive sample contains 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.

Fig.5 Samples of Traffic light and Stop sign

To recognize different states of the traffic light (red, green), some image processing is needed beyond detection. Flowchart below summarizes the traffic light recognition process.

Fig.6. Flowchart of traffic light recognition process

Firstly, trained cascade classifier is used to detect traffic light. The bounding box is considered as a region of interest (ROI). Secondly, Gaussian blur is applied inside the ROI to reduce noises. Thirdly, find the brightest point in the ROI. Finally, red or green states are determined simply based on the position of the brightest spot in the ROI.

3. CONCLUSIONS

At present, the image of autonomous driving is formed by the big automobile manufacturers. The general public considers autonomous cars to be rather unimportant in the context of public transport. However, it is important to put autonomous vehicles into the context of public transport because they offer some opportunities to public transport if they are integrated meaningfully. It is important that transport companies and associations as well as districts, cities and municipalities, which are the competent authorities and owners of the transport companies or traffic planners, deal with the impacts that autonomous vehicles – in the form of fully automated transport systems, the services of which can be fetched by the users – might have on public transport. The development towards autonomous driving will automatically increase the attractiveness of private cars and is therefore at first counterproductive to public transport.

However, fully autonomous driving also opens up new opportunities all of a sudden as fully autonomous vehicles can also be operated as part of a public fleet (robot taxis, car sharing etc.) or as part of public transport. Consequently, fully autonomous fleets could strengthen public transport, on the one hand, and be an alternative to owning a private car, on the other hand.

Thus, it will be possible to develop sustainable transport concepts, which realize extensive mobility with far fewer cars (used more efficiently), less automobile traffic and more public transport.

ACKNOWLEDGEMENT

It is our immense pleasure to express our sincere gratitude and thanks to all our teachers for their help and encouragement.

We would like to express our sincere gratitude towards our Head of Department, Prof. Dr. S. B. Somani, and our project coordinator, Prof. R. D. Komati for their encouragement and mentorship in carrying out this project.

We are very thankful to our project guide, Prof. S. R. Kinge for his valuable guidance and unflinching help during the project work.

We wish to extend our sincere thanks to the various laboratory assistants; teachers and all our committee members for their contribution towards making this project a success.

REFERENCES

1. A Review and Analysis of Literature on Autonomous Driving. Article | Oct 9, 2015 | by joint - authorship
2. Self-driving car From Wikipedia
3. Autonomous Car: Past, Present and Future A Review of the Developments in the Last Century, the Present Scenario and the Expected Future of Autonomous Vehicle Technology Keshav Bimbraw Mechanical Department, Thapar University, P.O. Box 32, Patiala Punjab, India
4. Scenarios for Autonomous Vehicles – Opportunities and Risks for Transport Companies – Position Paper / November 2015, Verband Deutscher Verkehrsunternehmen e. V. (VDV) Kamekestr.
5. Real Engineering – The Challenge of Building a Self-Driving Car - https://www.youtube.com/watch?v=P8aTDusU7dw
6. Zheng Wang – Self-Driving RC Car