Self Driving Car Using Machine Learning

Tej Kurani[1], Nidhip Kathiriya[2], Uday Mistry[3], Prof. Lukesh Kadu[4], Prof. Harish Motekar[5]

[1,2,3] Student [4,5] Assistant Professor
[1,2,3,4,5] Dept. of Information Technology, Shah and Anchor Kutchhi Engineering College, Mumbai, Maharashtra, India.

---***---

Abstract - *The fundamental idea behind the project is to develop an automated car that can sense its environment and move without human input. This paper proposes Car automation, which is accomplished by recognizing the road, signals, obstacles, stop signs, responding and making decisions, such as changing the course of the vehicle, stopping red signals, stopping signs, and moving on green signals using Neural Network. Self-driving car processes input, tracks a track and sends instructions to the actuators that control acceleration, braking, and steering. The software tracks traffic by means of hard-coded rules, preventive algorithms, predictive modeling, and "smart" discrimination on objects, helping the software to follow rules on transport.*

Key Words: **Self-driving, Neural Network, Actuators, changing course, predictive modeling, preventive algorithms, smart discrimination.**

1. INTRODUCTION

Human-driven Cars use protection systems to Identify Barriers and stop-offs in some high-end cars, but none of them is completely driverless. The automation feature of existing cars is insufficient to allow cars to drive itself. There is a constant need for drivers, without it the car is inaccessible. But with self-driving cars, we can make the presence of cars on the road constantly. The Driver constantly needs to monitor signals, road safety signs, barriers, and lanes for traditional cars and make decisions accordingly. Self- driving is no longer a futuristic dream, but it is becoming a reality. Companies proclaim their dedication to developing and launching autonomous cars and many of them talk about the level of autonomy being developed. Certainly, autonomous driving can be dangerous to some but it also has its advantages. This would result in reduced traffic congestion, reduced emissions, lower travel costs for all, and a reduction in the cost of new roads and services. It would also immensely improve the mobility of people with old and physical disabilities.

(a) (b)

Fig -1: Traditional cars(a) and Autonomous cars(b)

The fields of expertise are self-driving model cars in a model area with few sensors[6] such as Tesla, and such cars use numerous sensors such as lidar and radar. The way we seek to achieve the autonomy of cars is to model it on RC cars on the 1/10 scale. With the aid of the pi camera and the ultrasonic sensor, the car can sense its environment, and data collected from the two are transmitted on the server through the Raspberry Pi, where we are running the neural network, where the images are being processed to detect lane markings. The car automatically drives on its own according to the lane marking, once it is trained. In actual vehicles, the same algorithm and techniques can be used for automation.

2. RELATED WORK

We have studied many papers so far and we have come across the different techniques and technologies which are used to develop the system

In literature[1], an autonomous platform for cars, using the softmax function, is presented which squashes the outputs of each unit between 0 to 1. The softmax function acts as a sigmoid function by ranging output, while that is not done by an actual softmax function. The use of a neural network helps to give output in real-time. Before implementing it, they have tested the model on the MATLAB simulator. The system only uses a single camera for all inputs and drives at approximately 5-6 km /hr, whether the lane markings are present or not.

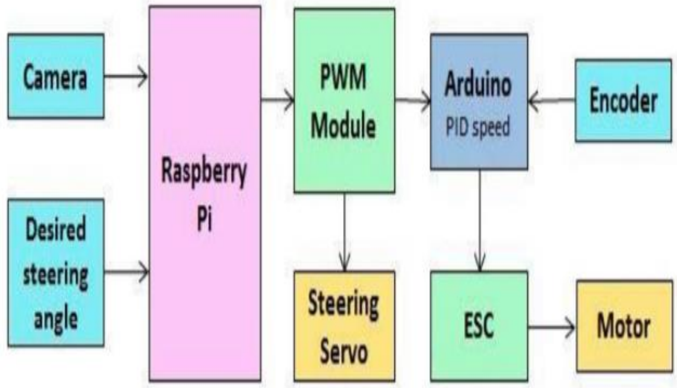


Fig -2: Block diagram of RC self-driving car platform

In literature[2], further research was carried out in real-time order to find the positions on the roadway by Xiaodong Miao, Shunming Li, and Huan Shen. An operation such as canny edge extraction is carried out in order to obtain a map for the matching technique and then to pick possible edge points. In another research[3], an autonomous RC car was built that uses Artificial Neural Network (ANN). It explains the thesis for autonomous vehicles and the neural network. A car is made using L298N IC and motor driver which can be managed by a microcontroller and then sent to the model car in return.CNN detects only grayscale parts and ignores the unnecessary detection data. The use of the system is very limited but accurate. Using an implanted pi camera for input and grayscale images for neural network processing. For each direction, the system detects lane markings and offers no other functions but that.

In literature[4], Abdur R. Fayjie, Sabir Hossain, DoukhiOualid, and Deok-Jin Lee have presented a reinforcement-learning based approach with Deep Q Network implemented in autonomous driving. Using lidar sensors detects objects at a very far distance. The whole system is developed on a simulator depicting actual roads and city streets with traffic. Using a fusion of camera and lidar helps in better knowledge of the surroundings and all kinds of obstacles. They have implemented a model using lidar(laser sensor) which is a very costly sensor and it is applicable for large scale cars.

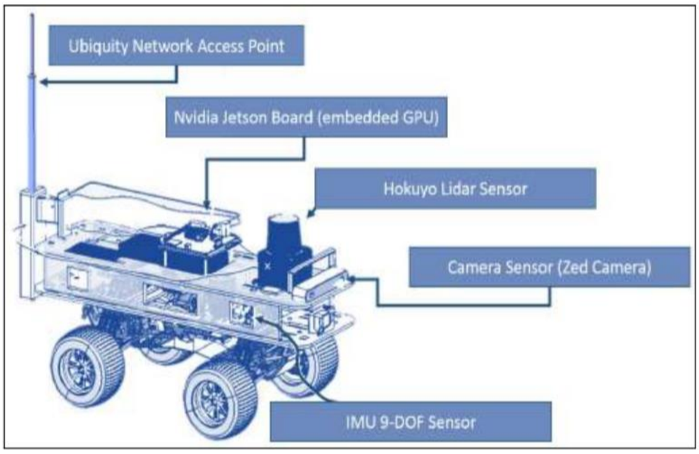


Fig -3: The car prototype for the Real-Time DQN implementation

In another research[5], by Malay Shah, Prof, Rupal Kapdi. The problem discussed in this article is object detection using deep neural network especially convolution neural networks. Object detection was previously done using only a conventional deep convolution neural network whereas using a regional-based convolution network increases the accuracy and also decreases the time required to complete the program. Training a neural network from scratch takes more time and processing power as it is very difficult to find the dataset of sufficient size and ground truth. Using Regional Convolutional Neural Network(RCNN) helps in finding appropriate regions in an image and it enables the system to give real-time outputs. This deep neural network is used for image processing, mainly for medical uses like tumors and such where the data set is too complex to detect regions in comparison to a model road environment.

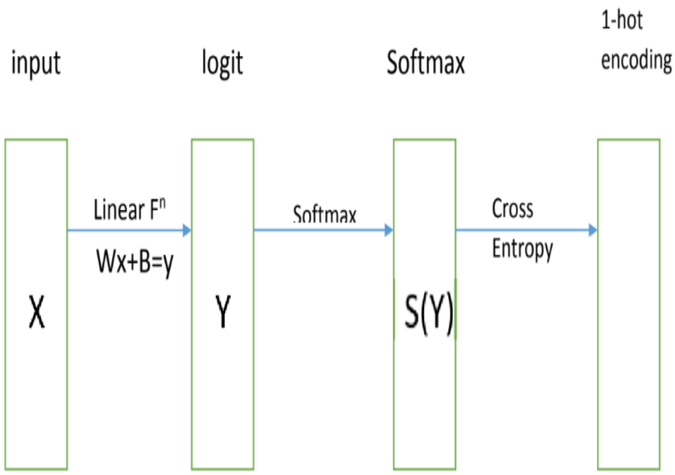


Fig -4: Multinomial logistic classification

In Literature[6], by Aditya Kumar Jain. His proposed model takes an image with the help of Pi cam attached with Raspberry Pi in the car. The Raspberry-Pi and the laptop are connected to the same network, the Raspberry Pi sends the image captured which serves as the input image to the Convolutional Neural Network. The image is gray-scaled before passing it to the Neural Network. Upon prediction the model gives one of the four output i.e. left, right, forward, or stop. When the result is predicted corresponding Arduino signal is triggered which in turn helps the car to move in a particular direction with the help of its controller. Their car was trained under different combinations of the track i.e. straight, curved, a combination of straight and curved and etc. A total of 24 videos were recorded out of which images were extracted.10868 images were extracted and were categorically placed in different folders like left, right, straight, and stop. In this paper, a method to make a model of a self-driving car is presented. The different hardware components along with software and neural network configuration are clearly described. With the help of Image Processing and Machine Learning, a successful model was developed that worked as per expectation. Thus the model was successfully designed, implemented, and tested. The car slightly moves out of the track which can be a serious issue if it hits nearby objects if we consider a real car.

3. PROPOSED MODEL

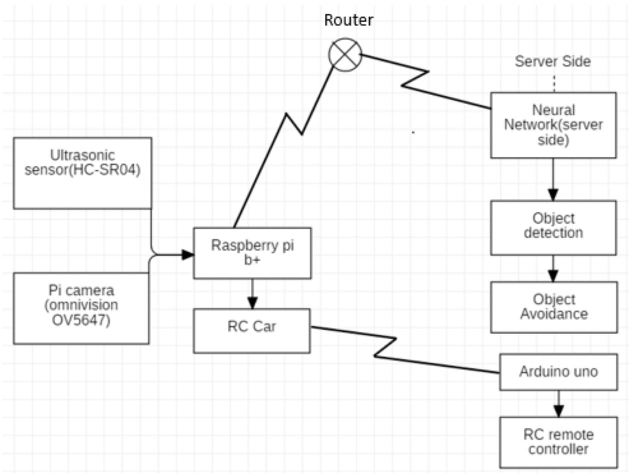


Fig -5: Block diagram of the proposed system

The model prototype which is developed aims to implement automation by handling tasks such as self-driving through lane line detection, stop sign and traffic signal detection, and fore collision avoidance. The system design for implementing the same will consist of three units first is an input unit containing a pi camera and ultrasonic sensor, the second is the processing unit which is our laptop that will act as a server, the neural network will be running over here and third, is the RC control unit which is Arduino. Firstly, in the input unit, the raspberry pi board of the B+ model will be connected with the pi camera and an ultrasonic sensor to stream input data[8]. Two client programs will be running on raspberry pi one to stream images collected by the pi camera and another to send sensor data through a local wi-fi connection.

Then the processing handles more than one task such as collecting data from raspberry pi, neural network training and steering prediction, stop sign and signal detection, distance measurement using monocular vision, and sending commands to Arduino through a USB connection. A multithreaded TCP server program will execute on the raspberry pi to receive image frames and sensor data. The image frames will be converted to grayscale and decoded into NumPy arrays.

The neural network which is the convolutional neural network will be trained to make steering predictions based on detected lane markings. The lower half from the input image will be used for training and prediction purposes. There will be input, hidden and output layers, there will be four nodes in the output layer each corresponding to steering control instructions that are left, right, forward, and reverse. The training data can be collected or the datasets already available can be used. For training, each frame will be cropped and transformed into a NumPy array. Then the train image will be paired with the train label. Then all the paired image data and labels will be stored in the npz file. OpenCV will be used to train the neural network. After training the weights will be stored in an XML file and for generating predictions the same neural network will be created and loaded with the trained XML file. For signal and stop sign detection that is part of object detection will be done using a shape-based approach; Haar feature-based cascade classifier will be used for object detection. Since each object requires its classifier Haar cascade is used.

The Arduino board will be used to imitate button press actions. Four Arduino pins will be used to connect four chip pins on the RC remote controller, corresponding to forward, reverse, left, and right actions respectively. The Arduino will be connected to the computer through USB and the computer will send the output commands and write out low or high signals, simulating button press actions to drive the car autonomously.

4. FLOW CHART

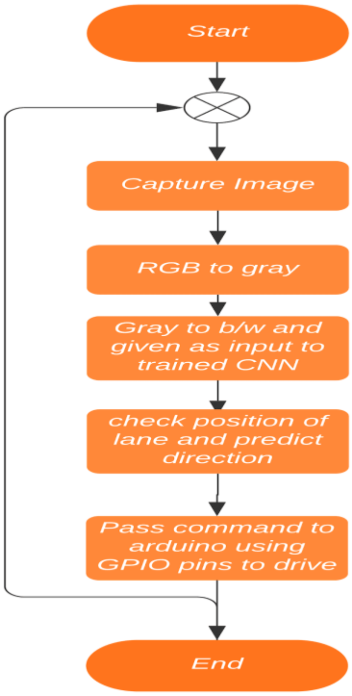


Fig -6: Flowchart for Lane detection

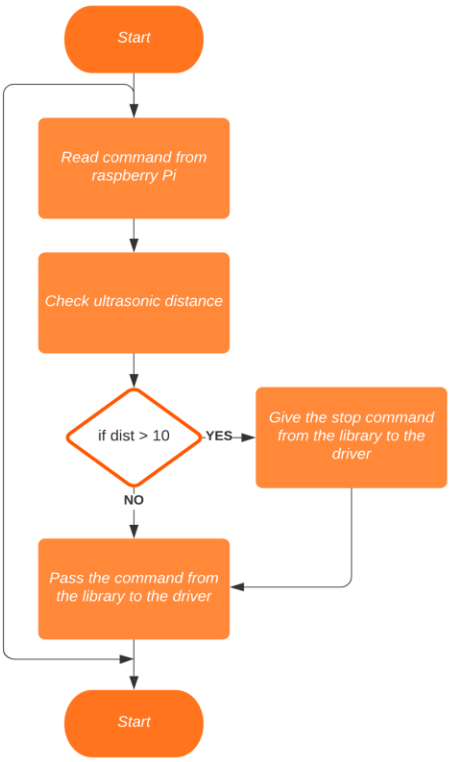


Fig -7: Flowchart for Object detection

5. RESULTS/ANALYSIS

The car was trained in various track combinations. That is a straight, curved, straight and curved combination, etc. They captured a total of 14 videos from which images were extracted. Approximately 647 images were extracted and classified into various folders such as the left, right, right, and stop. Below is the sample image in its grayscaled version from each of the scenarios.

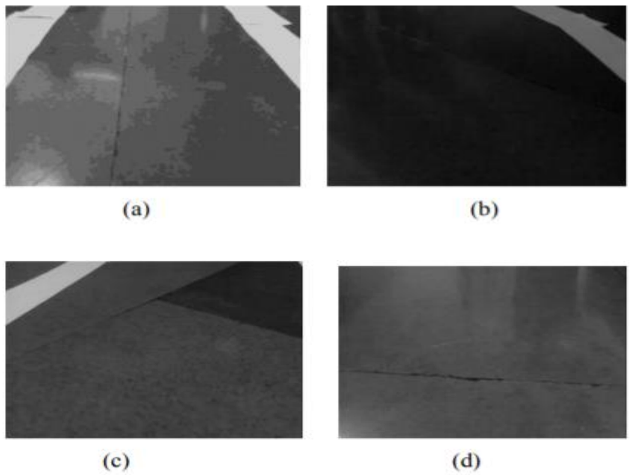
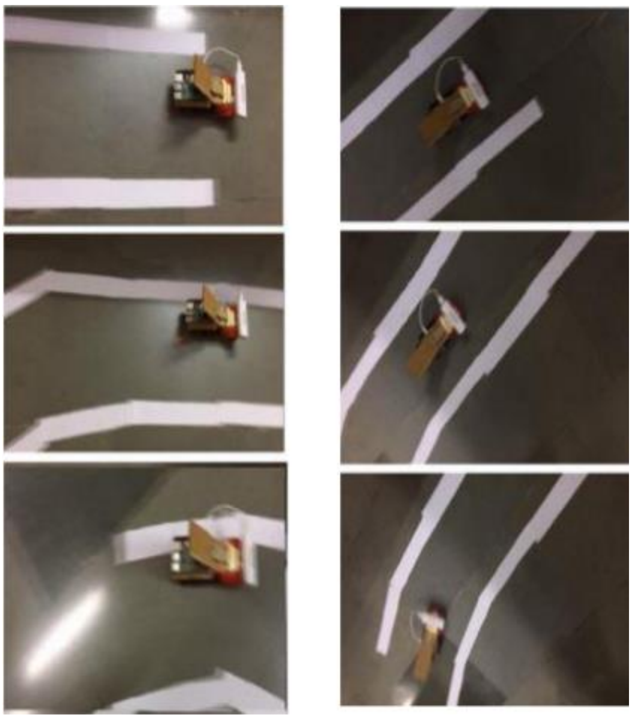


Fig -8: Sample images of the track on which the car is trained. (a) shows straight track, (b) shows left turn, (c) shows the right turn and (d) shows when to stop



(a) (b)

Fig -9: Car moving on straight followed by curved track (a) and (b) (top to bottom sequence)

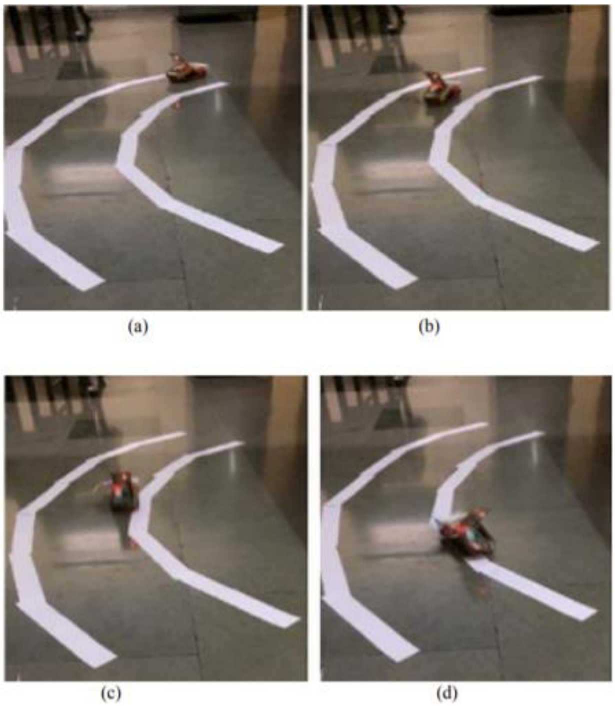


Fig -10: Car moving on curved track (Alphabetical sequence)

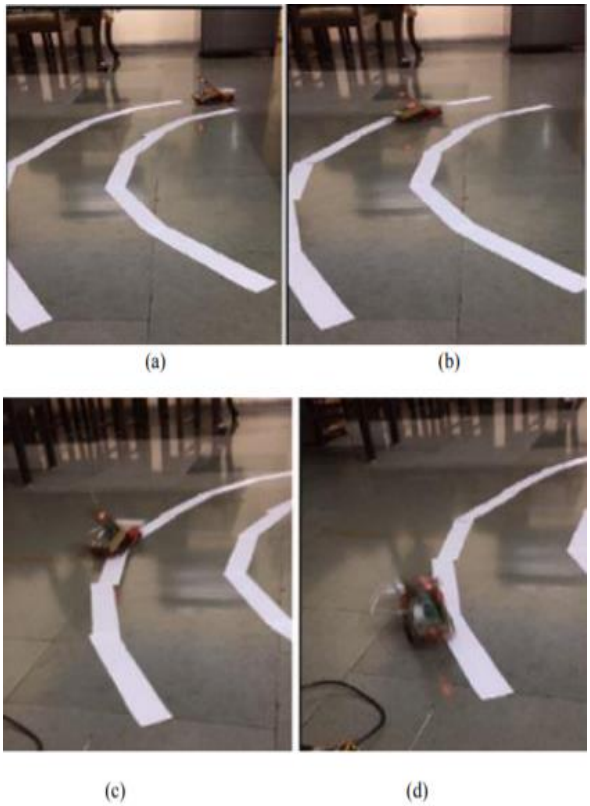


Fig -11: Car moving on curved track (Alphabetical sequence)

6. CONCLUSION

Developments in autonomous cars are continuing and the software in the car is continuing to be updated. Though it all started from a driverless thought to radiofrequency, cameras, sensors, more semi-autonomous features will come up, thus reducing the congestion, increasing safety with faster reactions, and fewer errors. Despite the inherent benefits, autonomous vehicle technology must overcome many social barriers.

REFERENCES

[1] Truong-Dong Do, Minh-Thien Duong, Quoc-Vu Dang, and My-Ha Le, “Real-Time Self-Driving Car Navigation Using Deep Neural Network” in International Conference on Green Technology and Sustainable Development (GTSD), 2018.

[2] Miao, Xiaodong, Shunming Li, and Huan Shen. "ON-BOARD LANE DETECTION SYSTEM FOR INTELLIGENT VEHICLE BASED ON MONOCULAR VISION." International Journal on Smart Sensing & Intelligent Systems 5.4 (2012).

[3] Hajer Omrane, Mohamed Slim Masmoudi, and Mohamed Masmoudi, “Neural controller of an autonomous driving mobile robot by an embedded camera” in International Conference on Advanced Technologies For Signal and Image Processing - ATSIP, 2018.

[4] Abdur R. Fayjie, Sabir Hossain, Doukhi Oualid, and Deok-Jin Lee, “Driverless Car: Autonomous Driving Using Deep Reinforcement Learning. In Urban Environment” in 15th International Conference on Ubiquitous Robots (UR) Hawaii Convention Center, Hawai'i, USA, June 27-30, 2018

[5] Malay Shah, Prof, Rupal Kapdi, “Object Detection Using Deep Neural Networks”, in International Conference on Intelligent Computing and Control Systems ICICCS 2017.

[6] Aditya Kumar Jain, “Working model of Self-driving car using Convolutional Neural Network, Raspberry Pi and Arduino”, in Proceedings of the 2nd International Conference on Electronics, Communication and Aerospace Technology ICECA 2018.

[7] Syed Owais Ali Chishti, Sana Riaz, Muhammad Bilal Zaib, Mohammad Nauman, “Self-driving Cars Using

CNN and Q-learning", in 2018 IEEE 21st International Multi-Topic Conference (INMIC)

[8] U. Karni, S. S. Ramachandran, K. Sivaraman, and A. K. Veeraraghavan, "Development Of Autonomous Downscaled Model Car Using Neural Networks And Machine Learning," 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2019, pp. 1089-1094.