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Self-Driving Car Using Artificial Intelligence

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Abstract

Self-driving cars have the prospective to transform urban mobility by providing safe, convenient and congestion free transportability. This autonomous vehicle as an application of Artificial Intelligence (AI) have several difficulties like traffic light detection, lane end detection, pedestrian, signs etc. This problem can be overcome by using technologies such as Machine Learning (ML), Deep Learning (DL) and Image Processing. In this paper, author's propose deep neural network for lane and traffic light detection. The model is trained and assessed using the dataset, which contains the front view image frames and the steering angle data captured when driving on the road. Keeping cars inside the lane is a very important feature of self-driving cars. It learns how to keep the vehicle in lane from human driving data. The paper presents Artificial Intelligence based autonomous navigation and obstacle avoidance of self-driving cars, applied with Deep Learning to a simulated cars in an urban environment.

Keywords—Self-Driving car, Autonomous driving, Object Detection, Lane End Detection, Deep Learning, Traffic light Detection.

I. INTRODUCTION

An autonomous car (sometimes referred as a self-driving car or a driverless car) are a autonomous vehicle which is a amalgamation of many hardware's and software's which include camera, sensors, processor in hardware part while the Artificial should be able to navigate without human help to a given destination over roads. The United States government invested in three projects for autonomous car which were displayed by US Army (Demo-I, Demo-III) and DARPA (Demo-II) in the end of 20th century. From 2004 to 2007, DARPA has organized 3 car autonomy challenges which grasped attention all over the world at that time. Companies developing and/or testing autonomous cars which included Audi, BMW, Ford, Google, General Motors, Tesla, Volkswagen and Volvo. Google's test involved a fleet of self-driving cars - including Toyota Prii and an Audi TT - navigating over 140,000 miles over the California streets and highways.

One of the most difficult and important tasks for a self-driving car is to find the proper vehicle control input to maintain it in the lane. The lane markings are mainly detected by image processing techniques such as color enhancement, Hough transform, Edge Detection, Canny edge detection etc. Its performance highly depends on the feature extraction and interpretation of the captured image data.

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The combination of traffic signals and road signs indicate a visual language that forms a set of rules whose interpretation aids for disciplined driving. The vision system helps to analyse current traffic situation on the road, danger and difficulties near the vehicle, warn and help the vehicle for safe and convenient navigation by providing the useful input. The vision-based object detection and recognition in traffic scenes is still a major issue to be successfully overcome by the autonomous driving industry. Deep learning integrating Computer Vision has the potential to engender reasonably affordable, robust solutions for autonomous driving industry. So, for Lane Detection and Traffic Light detection problem in the self-driving cars, authors have presented a deep learning-based solution that reliably detects the lane and traffic signs which performs image processing methods.

II. RELATED WORK

A. DARPA Grand Challenge

The DARPA Grand Challenge is a prize competition for American autonomous vehicles, sponsored by the Defense Advanced Research Projects Agency, the most known research organization of the US Department of Defense. Congress has authorized DARPA to award cash prizes to further DARPA's mission to sponsor revolutionary, high-payoff research that fills the gap between fundamental discoveries and military use. The initial DARPA Grand Challenge was created to urge the event of technologies needed to form the first fully autonomous ground vehicles which is capable of completing a substantial off-road course within a given limited time. The third event which was the DARPA Urban Challenge extended the initial Challenge to the autonomous operation during a mock urban environment. The most recent Challenge is the 2012 DARPA Robotics Challenge which is focused on autonomous emergency-maintenance robots. The first competition of the DARPA Grand Challenge was conducted on March 13, 2004 within the Mojave region of the US, along a 150-mile (240 km) route which follows along the trail of Interstate 15 from just before Barstow, California to only past the California–Nevada border in Primm. None of the participated robot vehicles finished the route. Carnegie Mellon University's Red Team and car Sandstorm (a converted Humvee) covered the farthest distance, completing 11.78 km (7.32 mi) of the course before getting hung on a hard rock after making a switchback turn. No official winner was declared, and therefore the cash prize wasn't given. Therefore, a second DARPA Grand Challenge event was scheduled for 2005.[2]

B. Google Waymo

In 2015, Google provided "the world's first fully driverless ride on public roads" to a legally blind friend of principal engineer named Nathaniel Fairfield. The ride was taken by Steve Mahan, former CEO of the Santa Clara Valley Blind Centre, in Austin, Texas. It was the first primary driverless ride that was on a public road and wasn't amid a driver or police escort. The car had no steering or floor pedals. In December 2016, the following unit was renamed Waymo, and made into its own separate division in Alphabet. The name Waymo indicate us about its mission, "a new way forward in mobility". Later on Waymo moved to further test its cars on public roads after becoming its own subsidiary.[5]

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III. METHODOLOGY

Image Recognition Methodology

The execution of the proposed system is mainly distributed into following manner: collecting images of Indian traffic lights, pre-processing images to generate the dataset, training the R-CNN for detection and recognition of Indian traffic lights, signs and finally conformation of model through experimental results.

A. Dataset

A collective set of required images according to Indian streets has not been yet published in standard format for evaluation of the model. Hence, the collection of images and video sequences is done by using a 5 Megapixel camera which supports the image resolution of 2592 × 1944 pixels and video recording resolution of 640 × 480 pixels at a frame rate of 30 fps. The pre-processing of these selective frames is done by resizing them to the size of 240 × 400 pixels resolution which are then used for labelling the lane and traffic signs. There are six classes namely red, yellow, green, straight, left, right which are used for classification of Traffic Light Signals. Each frame is labelled manually on the basis of class it contains.

B. Traffic Light Detection Model

The system is dependent on transfer learning based pre-trained method wherein Faster R-CNN-Inception-V2 model is used. Transfer learning is basically a machine learning technique in which there is enhancement in learning of a new task by channeling the knowledge through a related task that has formerly been learned. It is a method in deep learning that allows to eliminate the complicated extensive computational and time resources that are essential to develop neural network models by using pre-trained models in the system. For the Traffic Light detection considering the application requirement and available computational resources, Faster R-CNN Inception-V2 model is used which provides the accuracy and speed trade-off. The model is continuously trained on dataset at each step of training. The model is trained on the Raspberry pi 3 B+ processor using C++.[4]

C. Lane Detection Methodology

The basic method of lane detection is to first take a picture of road with the help of a camera fixed within the vehicle. Then the following image is converted to a Grayscale image in order to minimize the processing time. Secondly, as the presence of noise is within the image which will hinder the right Canny edge detection. Therefore, filters must be applied to remove noises such as Bilateral filter, Gabor filter, Trilateral filter after that the Edge Detector is used to produce an edge image by using Canny filter with automatic thresholding to obtain the edges. Thereafter, edged image is sent to the line detector after detecting the edges which will produces a right and left lane boundary segment. The lane boundary scan uses the understanding of the edge image detected by the Hough Transform to perform the scan. The scan in return gives a series of points on the proper right and left side. Finally, a pair of white line is fitted to those data points to represent the lane boundaries. For visualization purposes the white line is displayed on the first colour image.[1]

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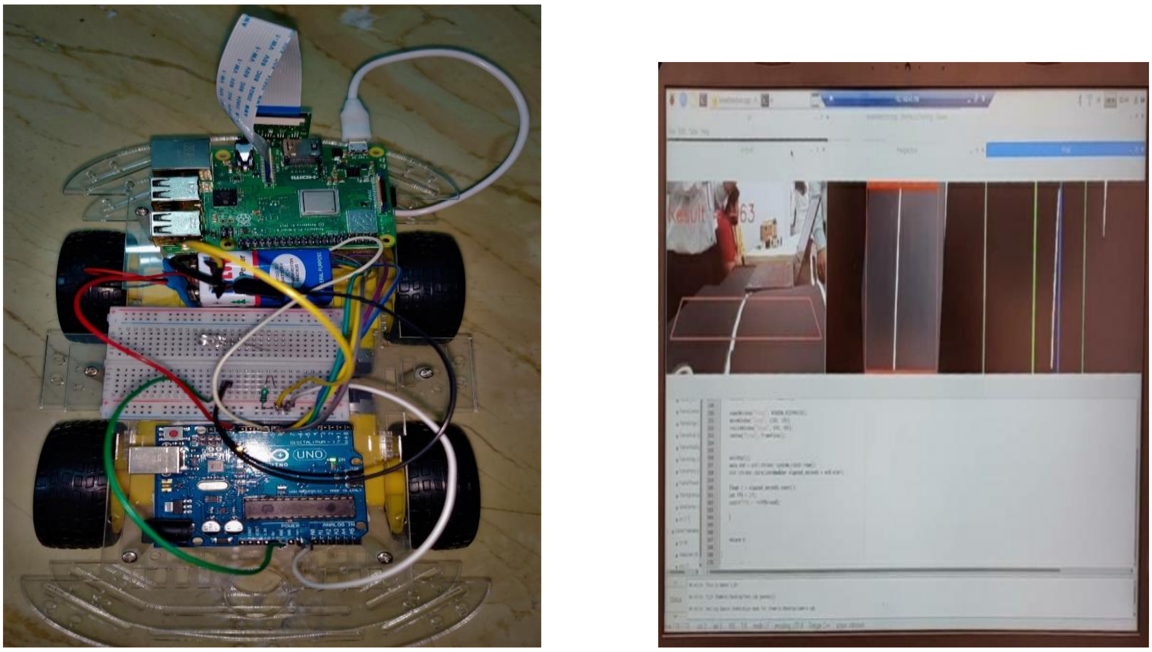

Fig. 1. Model of the Self Driving Car and Lane Detection

IV. CONCLUSIONS

In the field of self-driving cars or autonomous driving, the proposed work vastly serves as a module for navigation system on the road detecting the edge. The use of Faster R-CNN Inception-V2 model via transfer learning improves the accuracy of lanes and signs which makes the system reliable for real time application. The outcomes with bounding boxes provide guidelines for real time control actions of the autonomous vehicle. The trained dataset created for the system covers various use-cases according to the Indian Signal System and signs. So, the work done in this paper cover the way for realization of self- driving cars on Indian streets and as well as advancement to this, the system can also be optimized for safe driving despite unclear lane markings on roads.

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