AUTONOMOUS CAR DEMONSTRATING LANE ASSIST AND TRACKING TECHNOLOGY

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Keywords

Raspberry Pi, Polycarbonate Chassis, NCS - Neural Compute Stick, Warping, thresholding, Pixel Summation, Exponential Smoothing, Image Stack, ALEXNet Architecture, Deep neural network, Autonomous driving, SAE standards, Ultrasonic sensors, Collision avoidance system.

Introduction

A road accident is the worst incident that could ever happen while driving and the majority of them are caused by human error. Automation can help reduce the number of crashes on our roads. An autonomous car is a vehicle capable of sensing its environment and operating without human involvement. A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all. Self-driving cars are projected to lower traffic deaths by 90 percent, saving 30,000 lives per year[1]. Mis happenings including impaired driving, drugged driving, unbelted vehicle occupants, speeding and distraction.

Driving automation is one of the methods, which can reduce and eliminate human input errors. Autonomous drive technology is one of the most important innovations in the automotive industry. It provides faster travel and lesser commuting time, general convenience, and a way to reduce the stress and fatigue of driving. Implementing this technology and having total control over it, then can result in large benefits for both individuals & society.

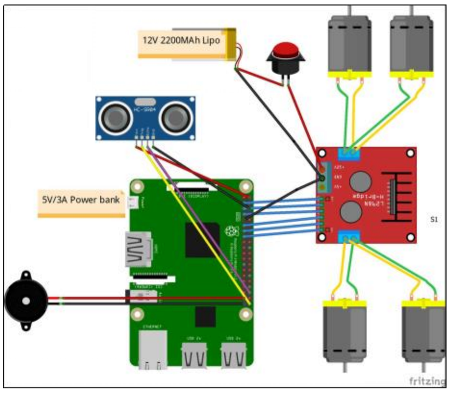
Objective

The scope of our project is to build a self-driving car with lane detection using Raspberry pi mini computer. It is based on lane detection which includes the localization of the road, the determination of the relative position between vehicle and road, and the analysis of the vehicle's heading direction.

The task is the vehicle's dynamic controller according to its position, speed and direction.The system acquires the front view using a camera mounted on the vehicle then applying a few processes in order to detect the lanes . The proposed lane detection system can be applied on both painted and unpainted roads as well as curved and straight roads in different weather conditions. As well as perform obstacle avoidance based on relative position of object from the vehicle.

Methodology

This project mainly consists of two major elements for its operation namely Hardware and Software aspect. Only with the integration of both requirements in sync we are able to achieve the autonomous feature to deliver effective results.
We have designed and built a four wheel drive (4WD) chassis which is used as a base to mount on which following hardware components are fit. The chassis is made up of laser cut polycarbonate sheet to ensure durability and structural integrity. Upon this, all functional hardware modules are placed with precision mounts.
We are using Raspberry Pi 4 as our local processing unit of the autonomous car prototype. Since, it doesn't have a powerful GPU to run deep learning algorithms. We are making use of Intel Neural Compute Stick - NCS 2 is a small, fanless neural network training and deployment device that can be used for AI programming at the edge. We are applying Image processing techniques on the real time feed obtained from USB webcam.
Furthermore, lanes are simulated using A4 size paper tracks. By using the concept of Pixel summation, we are calculating the turning angle and the corresponding radius. Track images and corresponding turning radius is saved in a CSV file. This is fed into a deep learning model to achieve autonomicity in the car prototype.
This Deep Learning model was created and trained by feeding in 3000 images of the leane and the steering data generated by manually controlling the prototype car using ps4 controller and this model also follows the same principle architecture as the AlexNet but has been fine tuned and changed to generate a regression output that is the steering values which are been sent to the motor driver for the steering.
Based on the feed captured by the camera is processed to generate the steering values from the deep learning model this is then used for the autonomous steering of the car to follow the lane that is the A4 sheet setted up as track.
Additionally, we have added a Collision avoidance warning system, implemented using Ultrasonic sensors. Thereby, Detecting Pedestrians and incoming traffic



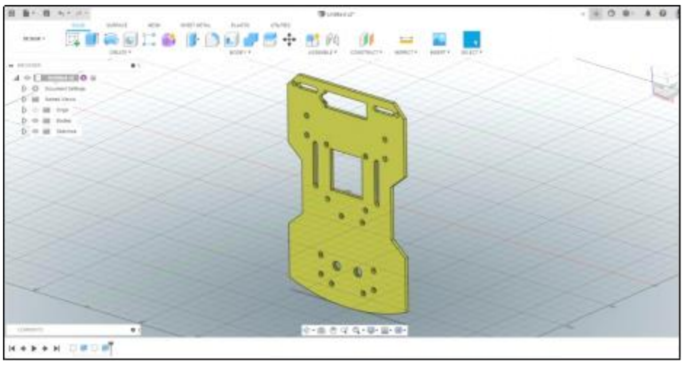


Fig 1 &2 : Hardware Connection made on Fritzing software & Design simulation on Fusion 360

Fig 3: Pixel summation

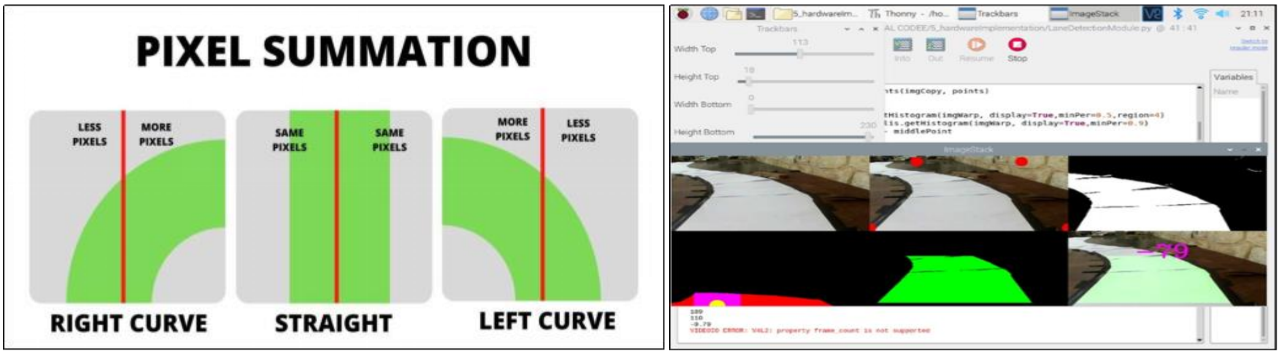


Fig 4- and 5-Pixel summation in right curve, straight, left curve and Exponential curve smoothing and Image Stack

Results:

Currently we are able to achieve the autonomous driving of the vehicle by deploying an autonomous steering model in combination with lane detection through thresholding and also an addition of an obstacle avoidance system using ultrasonic sensors**.**

Fig 6 and 7: Collision avoidance system using ultrasonic sensor Car prototype demonstrating lane assist technology

The Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). We have achieved Level 2 (Partial Driving Automation) as per SAE standards[2]. This means advanced driver assistance systems or ADAS. The vehicle can control both steering and accelerating/decelerating. Here the automation falls short of self-driving because a human has to be in the driver's seat to take precautionary measures. Features like colloidal avoidance systems also add into this category.

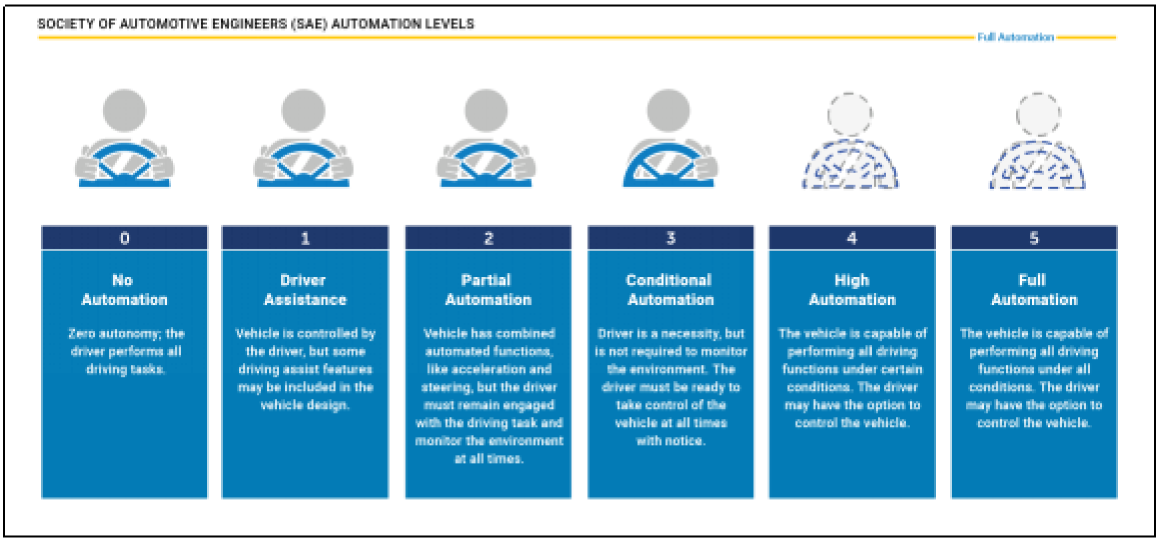


Fig 8: Automation levels according to SAE standards.

Scope for future work

Self-driving cars are poised to revolutionize the transportation industry. Autonomous vehicles will not completely replace human drivers in the foreseeable future. However, they are likely to have a large impact in specific areas, such as urban ridesharing.

The challenge is implementing uniform guidelines across geographic boundaries. Public officials should address questions such as who will regulate autonomous vehicle technology and how it will be regulated and issues like legal liability, privacy, and data collection.

The national governments around the world insistthat fully autonomous vehicles retain a steering wheel and brakes, and that there be a licensed driver in the car. Light detection and ranging systems - LiDARs and artificial intelligence are key to improved navigation and collision avoidance.In the long run, driverless cars will help us reduce accidents, save time spent on commuting, and make more people mobile. The onboard technology is developing rapidly, but we're entering a transition stage in which we need to think carefully about how it will interact with human drivers and the wider driving environment.

During this period, the key question we should be asking is not when will self-driving cars be ready for the roads, but rather which roads will be ready for self-driving cars.