AUTONOMOUS DRIVING ROBOT USING DEEP LEARNING

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Abstract: Application of Deep Learning is disrupting many industries today with ever increasing data and computing power. One of its new battlegrounds is robotics. Deep Learning is changing the robotics landscape in the areas of perception and control which is the key for the success of autonomous vehicles and its broader deployments. Recent advancements in Deep Learning tools (TensorFlow, Keras, etc.) and accessibility of cheap computing platforms (Raspberry Pi) makes experimentation with robotics and AI much more accessible (and fun!) for people outside academia and big tech companies. This project is really a great example on how Deep Learning can be used to train the car end-to-end to drive itself and solve both perception and control challenges in robotics using AI.

Keywords: Machine Learning, Convolutional Neural Networks, Raspberry Pi, ANN, Computer Vision, Autonomous Driving, Deep Learning

I. INTRODUCTION

Autonomous intelligent robotics systems require two essential building blocks: perception and control. The perception pipeline can be viewed as a passive procedure: intelligent agents receive observations from the environment, then infer desired properties or detect target quantities from those sensory inputs. Compared with pure perception, the problem of control for autonomous agents goes one step further, seeking to actively interact with or influence the environment by conducting sequences of actions. [1]

II. LITERATURE SURVEY

Brilian Tafjira Nugraha ,Shun-Feng Su[1] have demonstrated a detail and step-by-step approach for the road lane guidance. The proposed method use pre-trained YOLOv1, road lane detector, and a controller to integrate them into a smart system. Based on the observations, the proposed methods can adjust the road lane, detect the objects (e.g. cars), and provide the steering suggestion to the driver to help the automation of the driving process. This paper is suitable for highway conditions, when it mostly fails to detect the road lane in the urban roads.

Minh-Thien Duong, Truong-Dong Do and My-Ha Le[2] have improved and obtained a persuading outcome. Data are one of the most important matter lead to the accuracy of their model. authors have created a model which predicts the steering wheel angles and speed for a vehicle using a convolutional neural network. In spite of having obtained a satisfactory outcome

The Research team at NVIDIA corporation[3] have empirically demonstrated that CNNs are able to learn the entire task of lane and road following without manual decomposition into road or lane marking detection, semantic abstraction, path planning, and control. A small amount of training data from less than a hundred hours of driving was sufficient to train the car to operate in diverse conditions, on highways, local and residential roads in sunny, cloudy, and rainy conditions. The CNN is able to learn meaningful road features from a very sparse training signal (steering alone). More work is needed to improve the robustness of the network, to find methods to verify the robust-ness, and to improve visualization of the network-internal processing steps.

Truong-Dong Do, Minh-Thien Duong, Quoc-Vu Dang and My-Ha Le[4] In this paper, they presented an autonomous car platform based on state-of-the-art AI technology: End-to-end deep learning based real-time control. This work addresses a novel problem in computer vision, which aims to autonomously drive a car solely from its camera's visual observation. After they ended up with one that is able to power our car to drive itself on both tracks. The encouraging result showed that it is possible to use a deep convolutional neural network to predict steering angles of the vehicle directly from camera input data in real-time. Despite the complexity of the neural network, the embedded computing platforms like Raspberry Pi 3 are powerful enough to support the vision and end-to-end deep learning based real-time control applications. In addition, one of the most important learnings from this project is that data, without all those images and steering angles, along with their potentially infinite augmentations, they would not have been able to build a robust model.

III. DESIGN

A. SYSTEM ARCHITECTURE

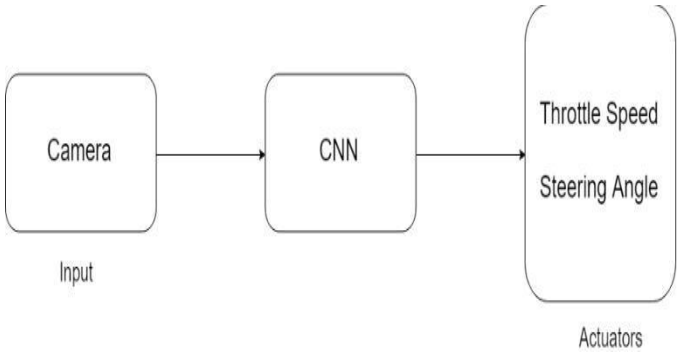

Figure 1: System Architecture

The above figure shows the system architecture, the real-time video input captured from Raspberry pi camera is sent as input to the CNN which predicts the throttle speed and the steering angle for the particular frame and instructs the Raspberry pi to generate PWM signals for steering and throttle actuators.

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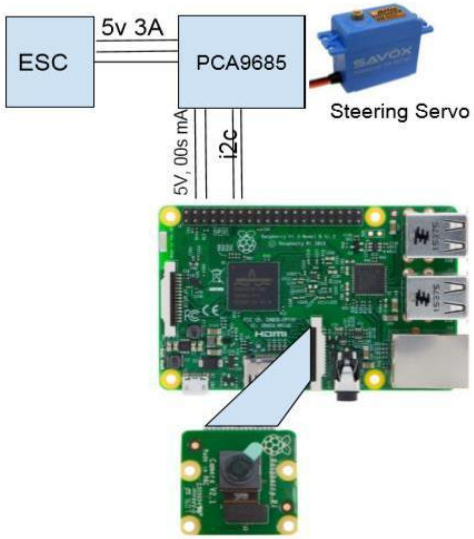
B. HARDWARE ARCHITECTURE



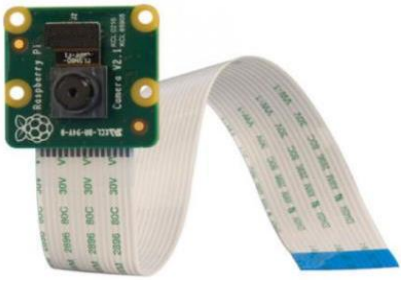
The above figure shows the hardware architecture, Raspberry pi is used as the main controller. In the training mode, it acts as the receiver. The user manually controls the car web interface. In the autopilot mode, the CNN deployed on Raspberry pi predicts the control signals of the car.
PCA9685 servo shield is used to control the throttle and the steering of the car.

C. COMPONENTS

1. Raspberry Pi

The Raspberry Pi is a series of credit card-sized single-board computer. All models feature a Broadcom System on a Chip (SoC), which includes an ARM compatible central processing unit (CPU) and an on chip Graphics Processing Unit (GPU, a Video Core IV). CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 and on-board memory range from 256 MB to RAM. Secure Digital (SD) cards are used to store the operating system.

2. The Raspberry Pi Camera V2



The Raspberry Pi Camera Board v2 is a high quality 8-megapixel Sony IMX219 image sensor custom designed add-on board for Raspberry Pi, featuring a fixed focus lens. It's capable of 3280 x 2464 pixel static images, and also supports 1080p30, 720p60, and 640x480p90 video

3. PCA-9685 Servo Driver

The PCA9685 is a 16-channel I2C-bus controlled Servo controller. Each output has individual 12-bit resolution (4096 steps) PWM controller with a fixed frequency. The controller operates at a programmable frequency from a typical 24 Hz to 1526 Hz with a duty cycle that is adjustable from 0% to 100%. All outputs are set to the same PWM frequency.

With the PCA9685 as the master chip, the 16-channel 12-bit PWM Servo Driver only needs 2 pins to control 16 servos, thus greatly reducing the occupant I/Os. Moreover, it can be connected to 62 driver boards at most in a cascade way, which means it will be able to control 992 servos in total.

4. Servo Motor (SG90)

It is a Digital Servo Motor which receives and processes PWM signal faster and better. Servo motor here is used for controlling steering speed.

5. Brushless DC Motor (BLDC)

A brushless DC motor (BLDC) is a permanent magnet synchronous electric motor which is driven by direct current

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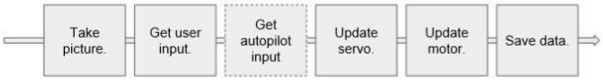
electricity. BLDC motors are also called as trapezoidal permanent magnet motors. BLDC motors here are used to control the throttle speed.

IV. IMPLEMENTATION AND SNAPSHOTS

The system is implemented as follows:
Step 1: Input is taken from the pi camera.
Step 2: User input is taken during the training of the model.
Step 3: The Input values for auto pilot mode is transferred from the CNN (trained model) instead of manual inputs from the user.
Step 4: The changes in the values of PWM signals with respect to the servo (steering) and BLDC (throttle) get updated.
Step 5: The image frame and corresponding steering and throttle values are stored.
The above five steps are repeated for each frame of the input video.



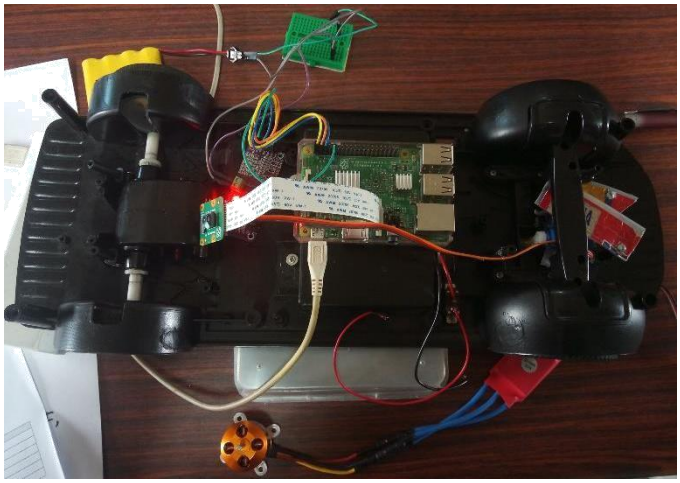


Figure 2: Snapshot of the Project.

V. CONCLUSION

There are many projects related to self-driving car, in our case we have created a customized car and environment from scratch which helped in understanding all the back-fall one can face. We also found that there cannot be a single technique to solve the whole problem. For our project, we used supervised learning to train the convolutional neural network. In addition to this, we trained our model for detecting the sign board such as stop sign.

Furthermore, future extensions of this project includes a variety of applications. such as,

- Last-mile delivery robots
- Trash cleaner robots

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