Name(s)
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Project Number
S1518

Project Title
Analyzing 2D-Convolutional Neural Network's Ability to Learn Obstacle Avoidance in Self-Driving Applications

Abstract

Objectives/Goals
Analyze the ability of a 2D Convolutional Neural Network to learn random 3D objects as obstacles by training it with fixed set of 3D objects of varying color and orientation placed randomly on the track.

Methods/Materials
Added a Hall Effect sensor and related code changes to the "Donkey" open source based self-driving car project which lacked consistent speed control and precise maneuverability so that it could be used with my project. After mastering repeatable autonomous driving around a test track loop, several iterations of training placing a pre-selected list of various 3D objects and avoiding them was carried out. Training included systematically varying the independent variables such as color of the given object, its orientation and its position on the track. After training, a random set of new 3D objects where used to evaluate the learning achieved in general and to see how each independent variable impacted the effectiveness of learning in a quantitative manner. Experiments were carried out in controlled environment (light condition, speed, track etc.) to ensure the results observed could be repeated.

Results
When 3D objects used during training and random new 3D objects not seen before by the car were randomly placed at different orientations and at random places on the track during testing, the car avoided them as obstacles in most conditions, failed to maneuver effectively or failed to detect the object as obstacles in others.

Conclusions/Discussion
The experiment clearly demonstrated that 2D CNN with a single camera input could be used to achieve obstacle avoidance. However, the effectiveness of the results depended upon specific aspects of the independent variables. For example, darker objects were avoided much predictably than lighter colored ones. Obstacles were avoided consistently on straight sections than on curves. Both quality and quantity of training had a great impact on the observed behavior of a run.

Summary Statement
The obstacle avoidance behavior observed during testing with random new 3D objects which differed significantly from the training objects clearly demonstrated 2D CNN's ability to learn obstacle avoidance.

Help Received
I built the car per Donkey project and added Hall Sensor. Discussed new concepts with father. My mentor helped point to useful research. Parents helped placing objects on track as I trained.