Overview

Since our initial proposal, our project plans have changed. We had planned to work on a proactive approach to gear shifting but after further consideration and research we have decided to change our project. This decision was due to both data acquisition and verification problems involved with the initial project along with our interest in tackling a problem with a larger scope and applicability.

For our new project we will build a vehicle that can autonomously follow single track trails. This project will have two main components, hardware and software. We will build a rover that can handle the difficult terrain of single track trails. It will then navigate a front facing camera and a machine learning model that we will train by gathering data by remotely controlling the vehicle and correlating front facing images with steering direction (AI Camera).

Use Cases

An autonomous vehicle that can navigate rough single track trails has many potential use cases. The self driving vehicle problem is a major challenge for engineers and computer scientists, however most self driving vehicle research is centered around self driving on roadways. Our project will focus on off road applications and as a result will have a different applicability. An autonomous rover could be used for search and rescue, assess trail conditions, and assist with wildfire management (Self-Driving) (Off Road Autonomy).

Hardware

Our first big challenge will be creating the vehicle. We plan to build this vehicle from scratch instead of modifying a prefabricated remote control car or using a kit. There are many resources online that we can reference for this project and we believe that it is a more pragmatic approach because we will be able to use components that are more suited to handle the difficult terrain. Modifications such as a larger wheel base, better suspension system, low gear ratio, and larger radius tires should make the rover more capable over rougher terrain. When building our vehicle we will build in remote control capabilities. This will be necessary in order to gather data for training our self driving model. The rover’s micro controller will likely be an arduino R3. An onboard raspberry pi should have enough power to handle the necessary image recognition software for our self driving model.

Software

Traditional computer algorithms work by modeling the real world processes that influence solutions. Given a desired set of input variables and output variables, traditional models apply a set of functions—determined by the programmer—to determine the intended output. Machine learning algorithms, in contrast, provide a framework for learning these real world processes from existing data. By providing a dataset of input variables and resultant output variables, the model learns to determine outputs for unseen inputs (MIT Sloan).

The computational model which directs the autonomous vehicle will be the latter type of algorithm. By providing a training dataset of camera views and steering angle, the model will be able to determine steering angles for new camera inputs. Applied to the vehicle, this will result in autonomous steering. The python library SciKit-Learn will likely be used for implementation (SciKit-Learn).

Training

A training dataset correlating camera view and steering angle is required. In order to capture this training dataset, the vehicle will be driven using a remote control (non-autonomously) with intermittent captures of camera data and steering direction. This dataset can then be used to train the model, maintaining an 80/20 split of training and verification data. Verification can also occur through testing of the hardware.

Progress

To this date, we have conducted research on machine learning to adequately understand the best way to construct the vehicle. We have determined to use a rotational front wheel steering mechanism as opposed to a difference in rotation on either side in order to have correlation between steering and image for training. We have additionally designed the vehicle to use commercially available parts, and are currently speaking with contacts to look into borrowing hardware before ordering.

https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained
https://scikit-learn.org/stable/
https://www.ucs.org/resources/self-driving-cars-101
https://www.appliedintuition.com/blog/drivers-seat-of-off-road-autonomy
https://www.raspberrypi.com/documentation/accessories/ai-camera.html