Plant Modeling for an Autonomous Vehicle

Nick Nauman, Hannah Grady, Advisor: Dr. Suruz Miah

Department of Electrical and Computer Engineering, Bradley University, Peoria IL

Objective and Contributions

Objective
- Provide accurate plant models of each autonomous vehicle subsystem to be used for designing controllers

Contribution
- Determine if System Identification or Neural Network modeling produces better models
- Non-linearity modeling

Applications
- Use in testing to help develop more accurate vehicle controllers
- Create a guide for modeling future vehicle subsystems

Problem Setup

- Conducted a literature review to look for existing solutions
- System Architecture

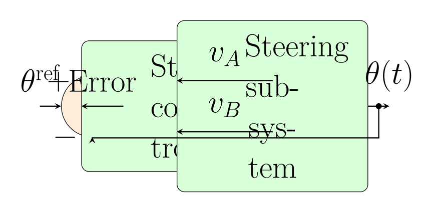

Figure 1:Steering subsystem block diagram.

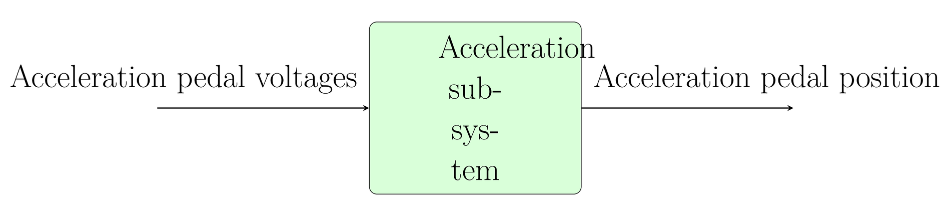

Figure 2:Acceleration subsystem block diagram

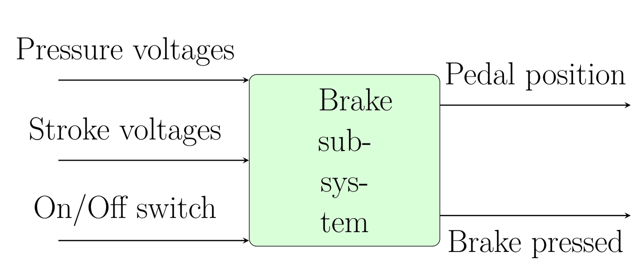

Figure 3:Brake subsystem block diagram

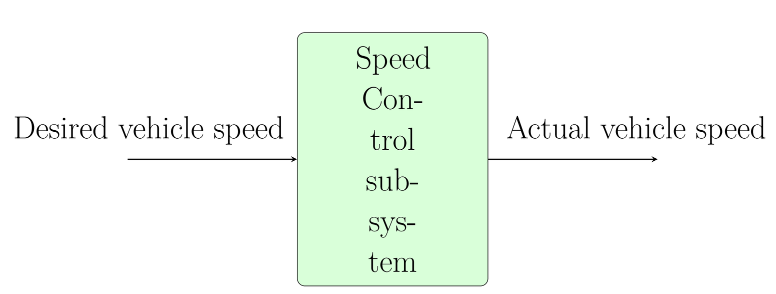

Figure 4:Speed Control subsystem block diagram

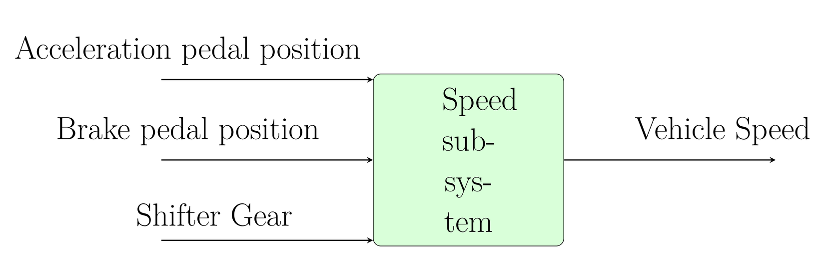

Figure 5:Speed subsystem block diagram

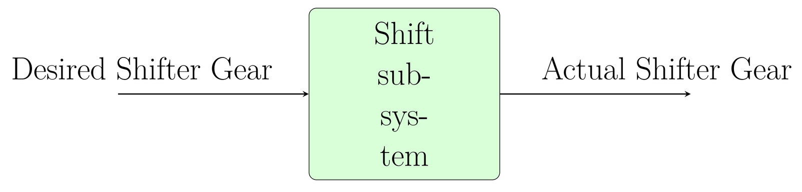

Figure 6:Shift subsystem block diagram

- Data Collection Setup
- Lexus RX450H vehicle platform
- Laptop
- PACMod ECU
- CANCase
- CAN Bus

Transfer Function Modeling

- MATLAB's System Identification Toolbox used to create models
- Models needed to meet best fit and error requirements

Neural Network Modeling

- Used MATLAB's Neural Network Time Series App
- Generated models using the Bayesian Regularization Algorithm
- Models trained using collected log data

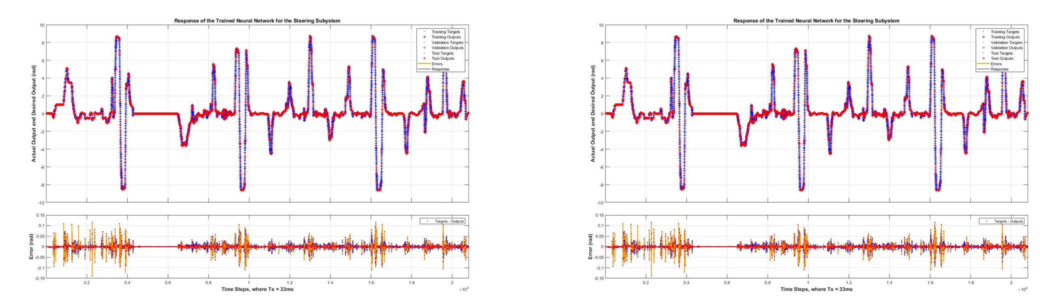

Figure 7:Steering System Training Plots

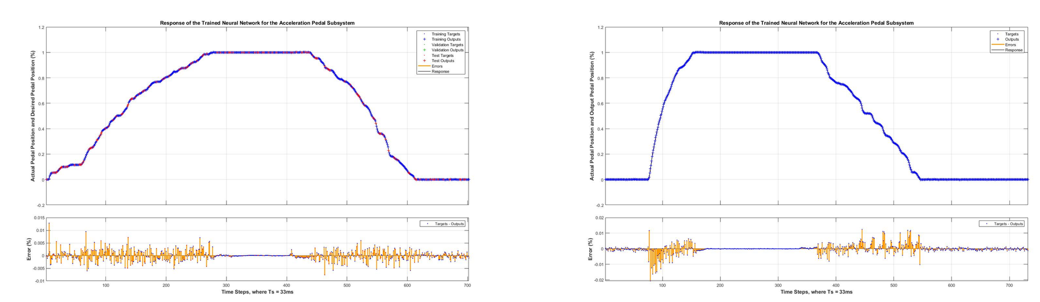

Figure 8:Acceleration System Training Plots

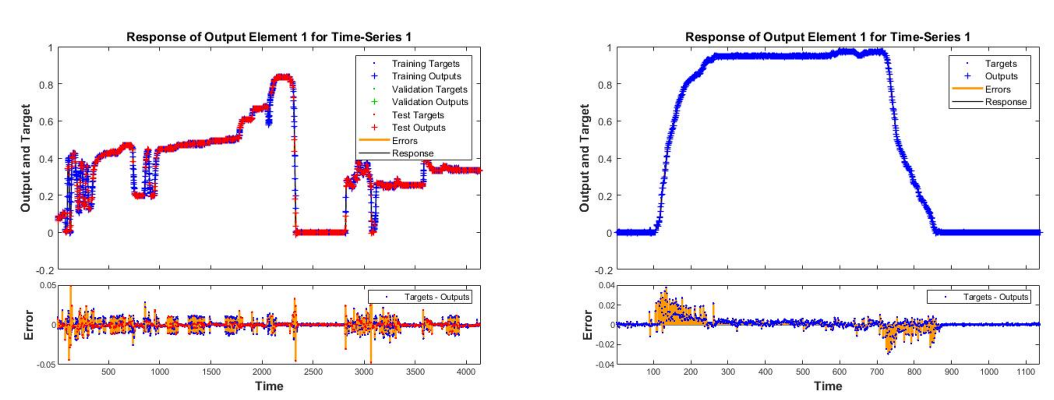

Figure 9:Brake System Training Plots

Neural Network Algorithm

- Uses neural network based on difference between desired and actual orientation to determine optimal gain

Figure 10:ADP Neural Network

Experimental Results

Figure 11:Experimental Setup

(a)(b)

Figure 12:ADP experimental results for (a) the main rotor and (b) the tail rotor given a step input

(a)(b)

Figure 13:Comparison between P and PI control for a step input is shown for (a) the main rotor and (b) the tail rotor

(a)(b)

Figure 14:(a) Time = 0 and (b) Time = 10

Conclusion and Future Work

- Using Neural Networks produced more accurate models than System Identification
- Test models using Hardware-in-the-Loop
- Create new vehicle controllers