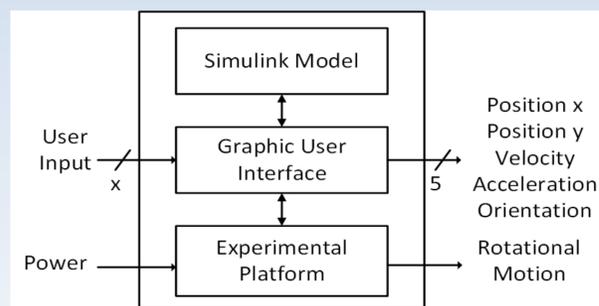


The Design of a Simulink-Based Control Workstation for Mobile Wheeled Vehicles with Variable Velocity Differential Motor Drives

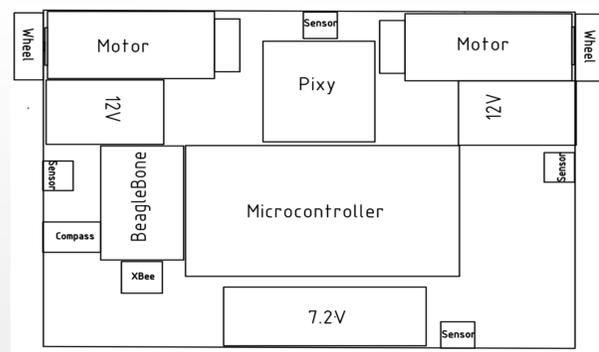
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Introduction

The goal of this project was to design a Simulink-based control workstation. The system consists of 3 subsystems: a Simulink model, an experimental platform, and a graphical user interface.



The user interacts with the workstation through the graphical user interface, which then communicates to either the Simulink model or experimental platform and returns velocity data to the user. The system will simulate a vehicle that will be able to operate at variable velocities using a differential drive consisting of two direct current motors.



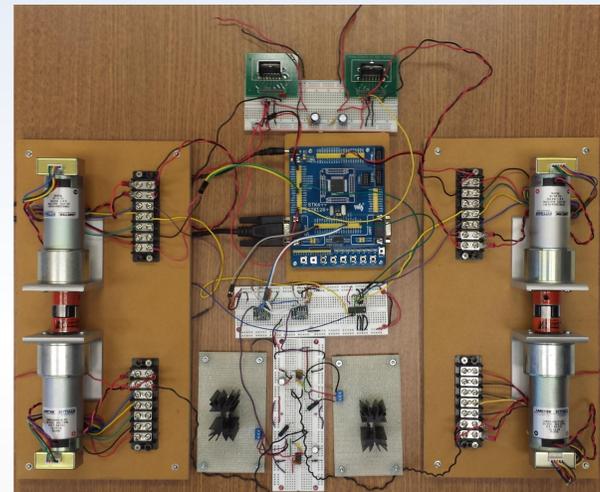
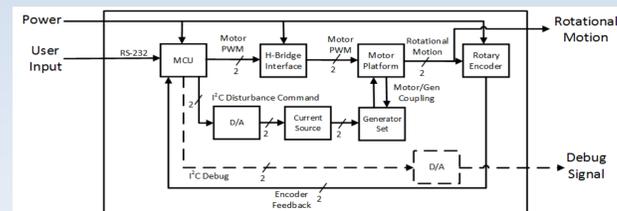
Motivation

Control theory is a pivotal part of the Electrical Engineering curriculum at Bradley University. The control workstation provides the faculty with an educational aid, as well as a platform on which to perform various types of control algorithm research.



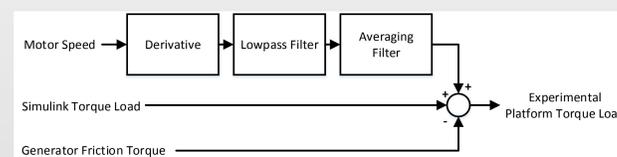
Experimental Platform

The experimental platform is composed of two motor-generator sets, a pair of digital to analog converters, two H-Bridges, a dual current source, and a microcontroller.



The experimental platform torque loads delivered to the motors by the generators are designed to mimic acceleration and external disturbances of the Simulink vehicle model. This process must match the net torque to inertia ratio in both systems shown with the following equation:

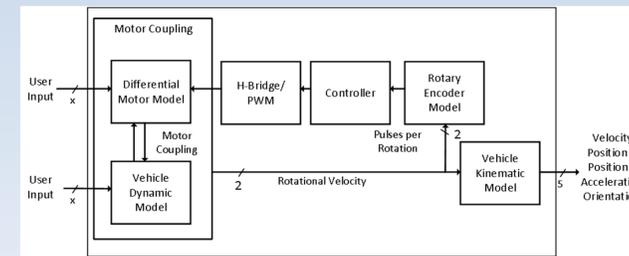
$$\frac{T_{SIM}}{J_{SIM}} = \frac{T_{EXP}}{J_{EXP}} = a$$



Simulink System

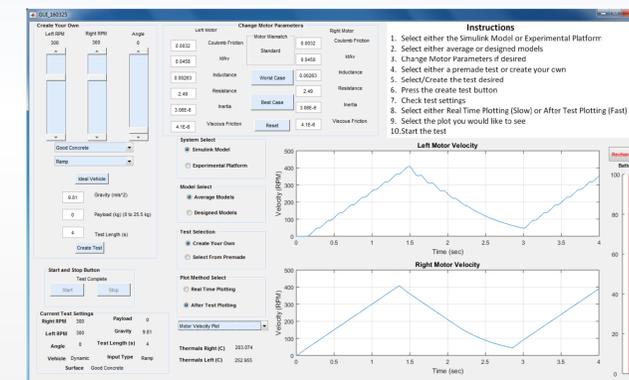
The Simulink model represents the experimental platform and contains the kinematic and dynamic vehicle models.

The model was used to develop the various controllers that were used in both the Simulink system and the experimental platform.



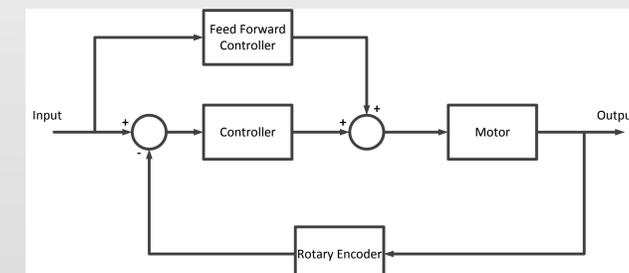
Graphical User Interface

The graphical user interface is the only subsystem of the workstation that the user will interact with directly. It communicates with both the Simulink system directly through MATLAB and with the Experimental Platform via RS-232 serial communication.



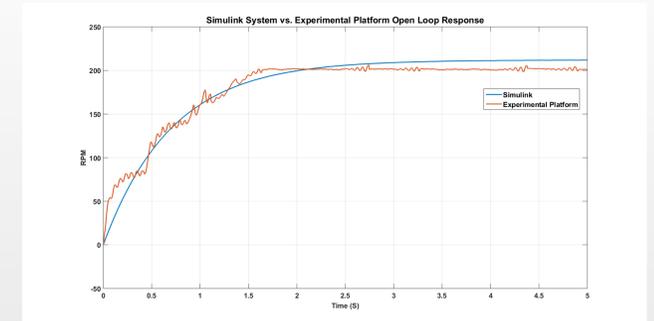
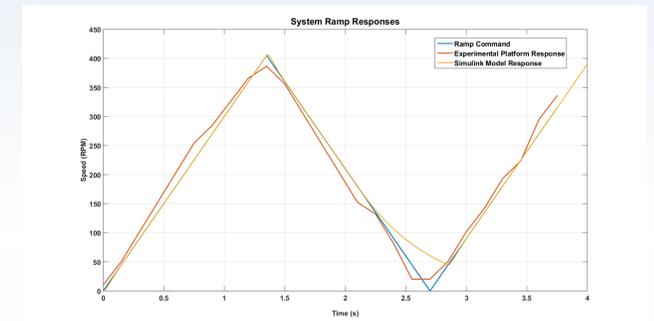
Controller

The velocity controller ensures the system follows the velocity command input. It includes a model-based feedforward controller and proportional-integral feedback controller. It also includes a rate limiting and anti-windup system.



System Testing

The systems were tested using step, ramp, and parabolic inputs. The output of each of the systems was compared against the command input which allowed the percent error to be determined. Both the experimental platform and the Simulink system have the ability to follow a velocity input with a small percent error. The Simulink motor models were designed to mimic the experimental platform motors. The difference between the two systems was tested and measured to describe the accuracy between the two systems. Keeping the systems similar and accurate was a main specification for the testing plan.



Conclusion

The output of both the Simulink system and the experimental platform follow a velocity command input. The dual current source paired with the generators successfully mimics the dynamic vehicle model. The graphical user interface allows the user to manipulate either system with ease.