

Undergraduate Research Project Proposal

Control Strategies for Stabilizing an Inverted Pendulum on a Cart: A Comprehensive Investigation through Simulations and Experimental Analysis

The stabilization of an inverted pendulum on a cart is a seminal challenge in control systems. This project will explore various strategies to stabilize an inverted pendulum on a cart using tools like Arduino, Simulink, and MATLAB. Emphasis will be on the analysis of different variations and limitations in the control signal input, exploring how these factors impact stabilization. Both simulation and experimental testing on a laboratory prototype will be conducted. The research will begin with a mathematical analysis of the pendulum's dynamics, followed by simulations to test different control strategies, such as PID,

LQR, and nonlinear controls. These simulated findings will be validated experimentally, with an emphasis on adaptive control and the robustness of various controllers. Sensors interfaced with Arduino will be used to measure the pendulum's position and angle, linking theoretical predictions with real-world data. In summary, this project adopts a multidimensional approach to the problem of stabilizing an inverted pendulum on a moving vehicle, with a focus on understanding the impact of input variations, potentially contributing significantly to academia and industry.

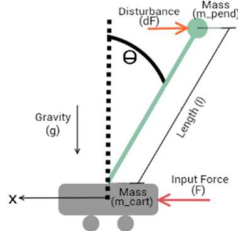


Figure 1. Inverted pendulum system.

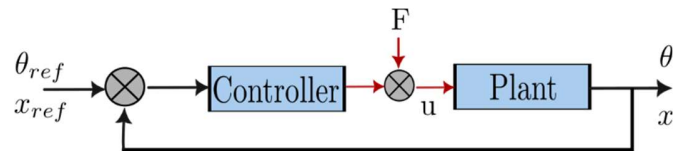


Figure 2. Closed-Loop Block Diagram for Pendulum Control.

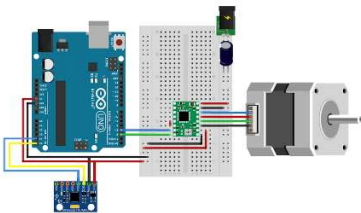


Figure 3. Schematic diagram of the electronic devices and wiring for pendulum movement.

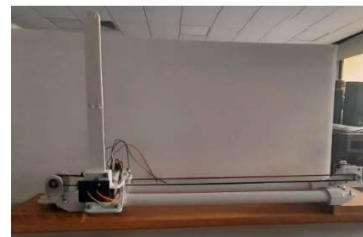


Figure 4. Physical prototype of the inverted pendulum that the student will have access to in the electronic engineering department.

Special requirements: Matlab and Arduino. No ethical approval is required.

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