Problem Statement and Goals
Pole Balancing

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January 2023

Table 1: Revision History

Date	Developer(s)	Change
20 Jan. 2023	Mina Mahdipour	First version of document
25 Jan. 2023	Mina Mahdipour	Changes in problem and input-output sections

1 Problem Statement

An inverted pendulum is a pendulum upside down with it pivot point under its center of mass. it is unstable and without additional help and by any small disturbances will fall over. To stay upright, it needs a controller to keep its center of mass above its pivot point even when disturbances occur. The objective of the control system is to balance the inverted pendulum by applying a force to the place that the pendulum is attached to.

Inverted Pendulums are Everywhere, from the human posture systems, Segway, to the launching of a rocket.

1.1 Problem

Stabilizing One unstable pole mounted on a cart that can move horizontally is the main problem. There are two degrees of freedom. The horizontally movement of cart and the pendulum angle with vertical axis. Hence there are two equations of motion, one for each. Solving these equations describe the motion needed on the cart to keep the whole system at the equilibrium point.

1.2 Inputs and Outputs

The inputs of the control system will be the external force to the cart which moves it, and the outputs are the angular position of the pendulum, and the

horizontal position of the cart. Although there are lots of parameters such as mass of the card, mass of the pendulum, pendulum length and so on which we consider as constant values.

1.3 Stakeholders

As the inverted pendulum is widely used as a benchmark for testing control strategies and algorithms, and it can be used in different applications, so the potential stakeholders could be all the related industries. On the other hand, it is a classic problem in dynamics and control theory, so the final system can be used in high school as an educational material.

1.4 Environment

There is no limitation and the final software will be compatible with Windows, MacOS and Linux operating systems.

2 Goals

1. Designing a software system that can control and stabilize the pendulum.
2. Verifying that the controller can handle disturbances.
3. Measuring the effect of the different parameters.

3 Stretch Goals

1. Visualizing the problem with an interactive graphic design.
2. Making a real model includes a rod with a weight on the bottom and the controller.
3. Simulating double inverted pendulum problem.