Inverted Pendulum Position Controller

Team B:

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Overview

Proportional-Integral-Derivative (PID) control is the most common control algorithm used in industry and has been universally accepted in industrial control. The popularity of PID controllers can be attributed partly to their robust performance in a wide range of operating conditions and partly to their functional simplicity, which allows engineers to operate them in a simple, straight forward manner.

As the name suggests, PID algorithm consists of three basic coefficients; proportional, integral and derivative which are varied to get optimal response. The task is to implement a PID controller for an inverted pendulum system using Scilab.

Task 1.1

Installing required software (day 1)

On day 1 the team members are supposed to install the necessary software and libraries required for completing the task.

1. Scilab & Xcos and control packages.
2. Arduino IDE

Also the team members are advised to stage up their GitHub account before the commencement of the tasks.

Learn Control system basics (day 2 & 3)

Learn about Control System, transfer function, poles and zeros, stability etc. Derive a transfer function for an Inverted Pendulum System without control input. Plot the impulse response and poles and zero plot of the system. Find the stability criterion and comment on the same.

Test cases.

1. $(s - 1)(s - 2j)$
2. $4s - 56j$
3. $1/(s^3 + 1)$

Mathematical modeling of the system (day 4)

Design the system equation for the inverted pendulum and configure it in Scilab - Xcos using appropriate packages.

Analyze the response of the system (day 5)

Study the response in Scilab using the following plots.

1. Impulse response
2. Pole and zero plot

Find the stability criterion and comment on the same.

(*note submission document must include the screenshots of the plots)

Task 1.2

Implement the PD controller (day 6 and 7)

Implement PD Controller for Inverted Pendulum System with control input as torque at the pivot and stabilize it at vertically upright position (0 degree).

Implement the PID controller (day 8)

Implement PID Control for Inverted Pendulum System with control input as torque at the pivot and stabilize it at vertically upright position (0 degree). Show the transfer function, Plot the step response and impulse response, show the poles of the controlled system on the s-plane, and explain stability criterion.

Compare the result (day 9)

Compare the output of the PD Controller and PID controller. Also compare the output of the system using different gains including the optimal one.

Note: The plots and graphs which you observe should be stored for further use during documentation.

Task 1.3

<table>
<tr><th>Day</th><th>Arduino programming</th><th>Hardware build up</th></tr>
<tr><td>10</td><td colspan="2">Decide the architecture of hardware and programming like pin configurations, sensor types and calibrations etc.</td></tr>
<tr><td>11 & 12</td><td>Build basic program for PD controller</td><td>Build whole Model of system and verify it</td></tr>
<tr><td>13</td><td colspan="2">Check the PD controller Program and tune the system.</td></tr>
<tr><td>14 & 15</td><td colspan="2">Modify the Program with PID controller and tune the system accordingly.</td></tr>
<tr><td>16 & 17</td><td colspan="2">Documentation</td></tr>
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