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Stabilizing the dual inverted pendulum.

By:

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INTRODUCTION:

A system that is inherently unstable is particularly interesting as it won't function without feedback. The dual inverted pendulum is one such system. The system plant consists of 2 independent pendulums constrained to fall in one plane and controlled by the movement of a single cart. The goal is to keep both the pendulums simultaneously upright. This system is an extension of the the single inverted pendulum. A video on the working of this pendulum has been attached below->

https://www.youtube.com/watch?v=B6vr1x6KDaY

BASIC ALGORITHM:

Single Pendulum Control:

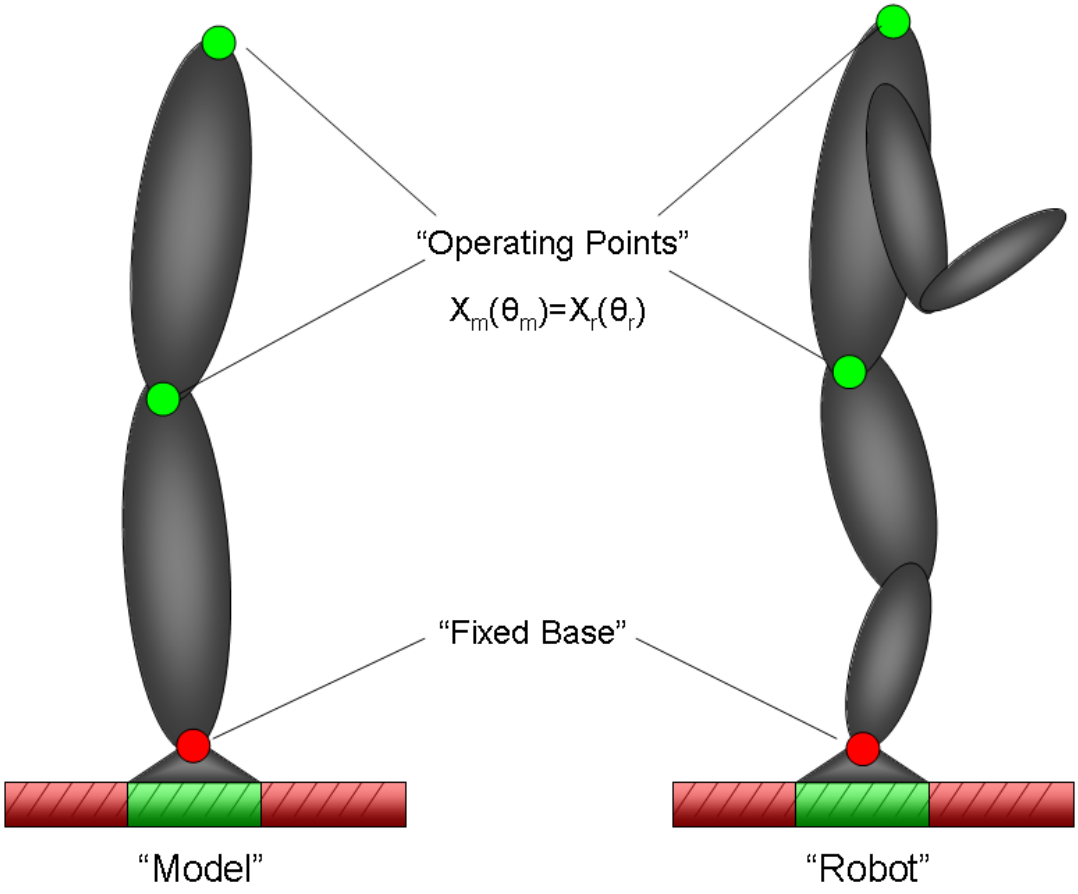
The single pendulum control is intuitive to anyone who has attempted to balance a yardstick in one hand. An angle from vertical results in a force on the pendulum, which must be corrected by an acceleration by the hand in the direction the yardstick is falling. If the pendulum base is accelerated at e.g. twice the rate of fall of the top of the pendulum, the pendulum will move towards vertical. The mechanical system takes this approach, accelerating the cart at some multiple of the pendulum angle.

Double Pendulum Control:

It is evident that the two pendulums controlled must have different effective lengths. If they are the same length, then any acceleration of the cart would affect their angles equally so the difference between their angles would be constant. The intuitive way to stabilize two pendulums of different lengths, then, is to “catch” the shorter one first, since it falls more quickly, and to try to do so in a way that brings the taller one closer to vertical. The strategy is to drive the cart such that the short pendulum’s angle is always, say, twice that of the slow pendulum, so that the next cart move will bring both of them to upright.

Applications:

This project, after some modification, can be used in the field of Humanoid Robot Balancing, which is a challenging domain of research these days. Our project is a simplified version of of tackling this problem.



DEMONSTRATION:

Demonstration will include a bot with motion allowed only in 1 axis with 2 pendulum rods constrained to rotate along the plane passing through axis of motion and line of gravity. The bot will move such that the dual pendulum apparatus always remains balanced while being inverted and resists minor disturbances.

TIMELINE:

Week -2 & -1:-

-Learning adequate Systems and Control theory.
-Learning Microcontroller programming and gaining knowledge of basic circuitry and electronic components along with learning Simulink.

Week 1:-

-Buying all the components

Week 2:-

-Making of bot.

Week 3:-

-Start coding.

Week 4:-

-Prototype testing.

Week 5:-

-Troubleshooting of the project.
-Testing accuracy of the system
-Adding aesthetics to the final product.

COMPONENTS REQUIRED:

PC preferably running Windows 8 with Matlab and Simulink.
Arduino Uno or compatible(1) + power source.
300 rpm motors(2)
Chassis and wheels(4)
Pendulum Rods(2)
Webcam w/ UBS interface.
Accelerometer(1)
Gyroscope(1)
Lead Acid Battery (12V)
Breadboard and PCB
Jumper wires.

ESTIMATED COST:

Rs. 7,000/-

References:

http://dspace.mit.edu/bitstream/handle/1721.1/45611/319175708.pdf
http://www3.math.tu-berlin.de/Vorlesungen/SS12/Kontrolltheorie/matlab/inverted_pendulum.pdf

Team:

Our team consists of four UG Aerospace Engineering freshman, who share a common interest of creating machines. Machines that can think, machines that can balance, machines that do stuff better than humans. The preceding project is a brainchild which has been conceptualized owing to this fascination and love towards the same.