California State University, Chico

College of Engineering, Computer Science, and Construction Management

MECA 482 –Control System Design

Control System Design of Furuta Pendulum

The description of the project:

"Furuta Pendulum – or rotational inverted pendulum- consists of a driven arm which rotates in the horizontal plane and a pendulum attached to that arm which is free to rotate in the vertical plane. It was invented in 1992 at Tokyo Institute of Technology by Katsuhisa Furuta and his colleagues." [1] The problem that the team investigates with this project is creating a test platform for control system algorithms -in a low-cost and streamlined fashion. In that regard, the project team is expected to create a mathematical model of the system with a designed control system. The deliverables are listed in later section.

Sample High-Level Architecture:
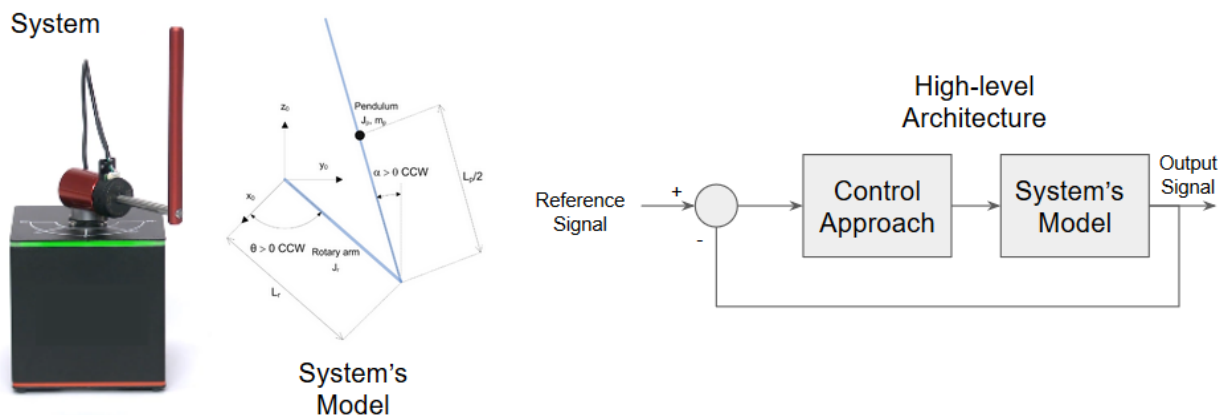
Sample Furuta System from Quanser [2]

Deliverables:

- The team is expected to present their project (~ 5mins) and build a web page which contains all deliverables in GitHub.
- The mathematical model of the system must be delivered -preferably in Python or MATLAB.
- The control system should be provided preferable in Simulink, State-flow, or with a high-level programming language (e.g., C, C++, or Python). However, the team must show that the control algorithm will give the design requirements for the target system. In other words, one cannot build the system solely hands-on approach similar to the videos below:
    o Pan and Tilt Mechanism
- The system will have a simulation with the control system and mathematical model by connecting Coppelia Sim to MATLAB, Simulink, or whatever the programming landscape is used.
- If the system contains hardware, the design of hardware should consist the necessary architectural explanations such as hardware and software relationships.

Team and Plan:

- The team can use their cap-stone projects for MECA 482 – Control System Design class.

The team will consist minimum 3 students and maximum 5 students.

Notes:

1- Sample project delivery template
2- Sample Simulink code of Furuta Pendulum [2]
3- Sample Control System Design Tutorials from University of Michigan, Ann Arbor [3]
4- Sample projects to interface Python and VREP [4] and sample video to interface MATLAB and VREP [5]

References:

[1] Wikipedia, Furuta Pendulum, Retrieved by Jan., 27, 2020 from
https://en.wikipedia.org/wiki/Furuta_pendulum

[2] Quanser, Rotary Inverted Pendulum, Retrieved by Jan, 27, 2020 from
https://www.quanser.com/products/rotary-inverted-pendulum/

[3] Control System Tutorials for MATLAB and Simulink, Retrieved by Jan, 27, 2020 from
http://ctms.engin.umich.edu/CTMS/index.php?example=InvertedPendulum&section=SystemModeling

[4] Kildare, R., Hansen E., Leon, E., PID Control of Furuta Pendulum, Control System Design Project Fall 2019

[5] Pick and place application with Kuka KR16 Robot Using V-Rep, Retrieved from Internet, Jan 28, 2020
https://www.youtube.com/watch?v=CVoV08T0Aqo