



Major Task: Furuta Pendulum

Description:

You are required to make a **Furuta Pendulum (Rotary Pendulum)** as shown below in Figure 1.

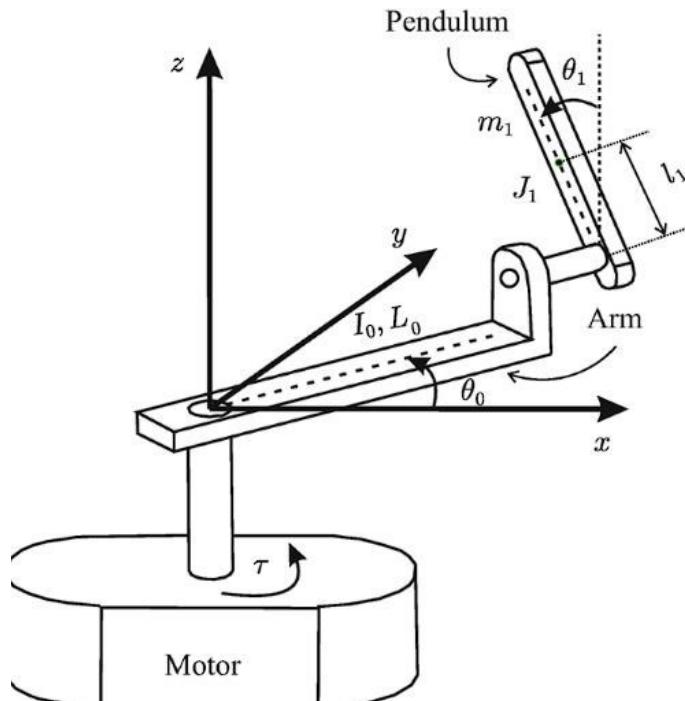
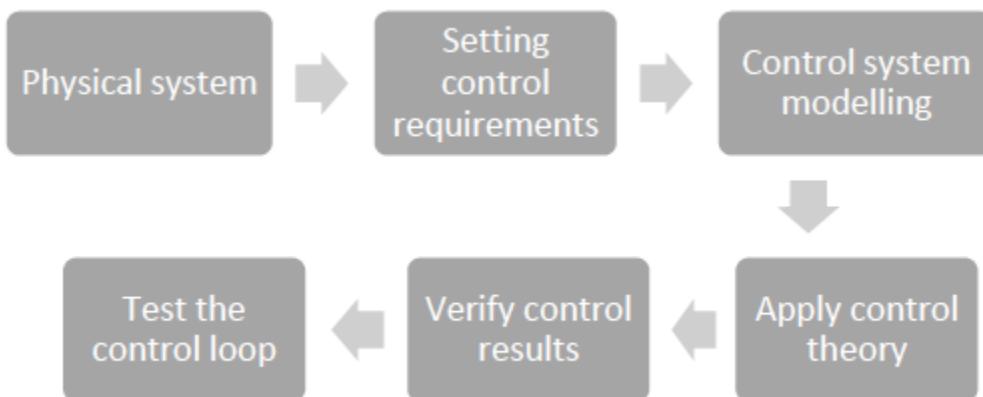


Figure 1-Furuta Pendulum

Requirements

- 1- Use pole placement / LQR techniques to control the pendulum. (using PID will result in deducted points)
- 2- Control the angle θ_1 to be zero. So, the pendulum stands in the upright position.
- 3- Overcome any disturbances that may affect the pendulum. So, the pendulum should maintain its upright position and don't fall.
- 4- Follow the standard procedure for performing a control task to design a controller to regulate the system's output according to the set control requirements.





Quick bullets you need to care for:

- You need one motor equipped with an encoder to control *theta0* and one encoder (at least 360 pulses/revolution) for *theta1*.
- Wires should be **hidden as much as you can**, and All components must be fixed well.
- You can choose any platform that can be connected to the MATLAB from the below list in **Figure 2**.
- You **must** build and control your model on **MATLAB/SIMULINK**.
- You must implement HIL (Hardware in the loop) using **SIMULINK**

Configuration Parameters: untitled/Configuration (Active)

Search

Solver
Data Import/Export
Math and Data Types
▶ Diagnostics
Hardware Implementation
Model Referencing
Simulation Target
▶ Code Generation
Coverage
▶ HDL Code Generation

Hardware board: Determine by Code Generation system target file
Determine by Code Generation system target file
Altera Arria 10 SoC development kit
Altera Cyclone V SoC development kit
Arduino Due
Arduino Leonardo
Arduino MKR WiFi 1010
Arduino MKR1000
Arduino MKRZero
Arduino Mega 2560
Arduino Mega ADK
Arduino Micro
Arduino Nano 3.0
Arduino Nano 33 BLE Sense
Arduino Nano 33 IoT
Arduino Robot Control Board
Arduino Robot Motor Board
Arduino Uno
Artix-7 35T Arty FPGA evaluation kit
Custom Hardware Board
ESP32-WROOM(Arduino Compatible)
NXP FRDM-KL25Z
Robot Operating System (ROS)
Robot Operating System 2 (ROS 2)
TI Delfino F28379D LaunchPad
TI Delfino F2837xD
TI F2838xD (SoC)
Xilinx Kintex-7 KC705 development board
Xilinx Zynq UltraScale+ MPSoC ZCU102 Evaluation Kit
Xilinx Zynq UltraScale+ RFSoC ZCU111 Evaluation Kit
Xilinx Zynq UltraScale+ RFSoC ZCU208 Evaluation Kit
Xilinx Zynq UltraScale+ RFSoC ZCU216 Evaluation Kit
Xilinx Zynq ZC706 evaluation kit
ZedBoard
Get Hardware Support Packages...

Figure 2 - Example of supported platforms



Project Submission

- Working in the project should be in groups of 4 - 5 students.
- The project submission has 2 phases:
 - Phase #1: SimMechanics Model (Week 7)
Deliver a MATLAB model of the pendulum system (preferably using SimMechanics) of your design of furuta pendulum + controller in simulation. (10%)
 - Phase #2: Final Submission (Week 13)
Full project delivery according to the following table.
- Final Submission Form & Grading Scheme

#	Deliverable	Weight
1	<p>Working prototype with a GUI to display pendulum angle (θ) and actuator signal (u)</p> <p>The prototype shall demonstrate robustness against disturbances</p> <p>Note: Bonus points are awarded for swing up controller design (10%)</p>	20%
2	<p>Technical Report including the following:</p> <ol style="list-style-type: none"> 1- Contribution of each member of the group 2- Detailed discussion of the following <ul style="list-style-type: none"> - Modelling of the pendulum system - Method of controller design - Controller requirements - Implementation details - Simulation results - Detailed analysis of simulation vs actual results 	20%
3	Oral discussion	20%
4	Simulation results and Controller implementation (Simulink model)	15%
5	<p>Demo video (5 min's max) that contains</p> <ol style="list-style-type: none"> A) Demonstration of a working prototype B) Brief discussion of controller design and simulation 	15%