Balancing of the inverted pendulum

Semester project: Control and Simulation of Automation Systems.

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Introduction

The theme of this semester project is control and simulation of automation systems. The aim of the project is to familiarize yourself with the equipment and methods that are often used in automation. Specifically, simulation and control of a system consisting of servo motors, drives/control units for servo motors, drive mechanics and PLCs.

The gained professional competences in the project are:

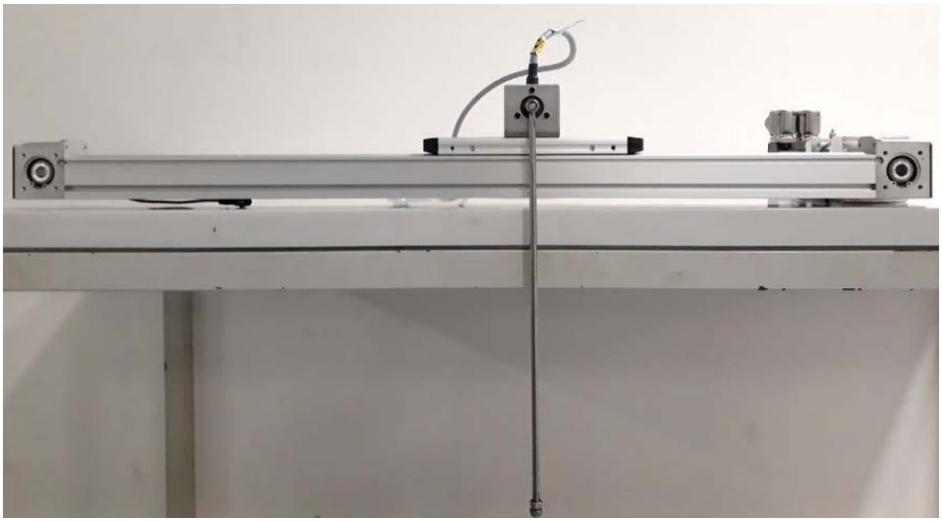
- Applied automation: design control software according to the IEC61131-3 standard for a platform controlled with a PLC.
- Simulation: perform dynamic simulation of automation systems.
- Control technique: control design for dynamic systems to achieve desired behavior using classical and modern control methods.

All the above skills must be included in the project, which has a scope of 10 ECTS. The project concludes with an oral examination, which is based on a submitted project report. The report must document and disseminate the project results and supporting theory in a structured, understandable and reproducible form.

Project description

The problem aimed to be solved in the project is the classical control problem of stabilizing an inverted pendulum. The system used in the project is shown in the figure below and consists of a pendulum mounted on a carriage controlled by a servo motor. The requirement is to control the movement of the carriage so that the pendulum remains in its upright position.

Due to the current circumstances, the project cannot be carried out as originally planned. This semester you will not be able to access the hardware in the labs, therefore all activities related to the semester project will be more of a theoretical nature.



Project requirements:

- Give a description of the proposed physical system. Describe the functionality of the components and the control procedures that can be implemented.
- Analyze the presented problem, prepare a problem formulation and set the project goals. In addition, present some related real-world applications and describe how this control problem is implemented.
- Model the system, use the classical modeling approach and the block modeling procedure with SimMechanics in Matlab/Simulink.
  - Compare the results, back them up with a written description.
- Implement the following control strategies:
  - Classical control: PID control, Parallel PID control, Cascade PID control (define the PID parameters, with root locus and auto tuning in Simulink. Implement anti wind up).
  - Modern control (pole placement method).
  - Add noise to the feedback loops (use the random noise generator).
- Validate and compare the responses of the controlled strategies (settling time and step response).
- "Make a visualization of the system, for easier inspection" – optional.
- Define the difference equations from differential equations sot that they can be implemented on a real system (S transform).
- Give a description and a preliminary PLC implementation of the control program derived from the model.

As mentioned, the project will be handled on a more theoretical level, the gathered data and tests that were already conducted on the real system before the lockdown should also be presented in the final report. The report deadline is the 29th of May 2020 at 12.00.

All other information, regarding the oral exam will be provided.