Project work MMD

Anna Nikander: User experience Challenges in Designing Industrial Internet of Things Applications. 2020. B.Sc. Thesis. Aalto

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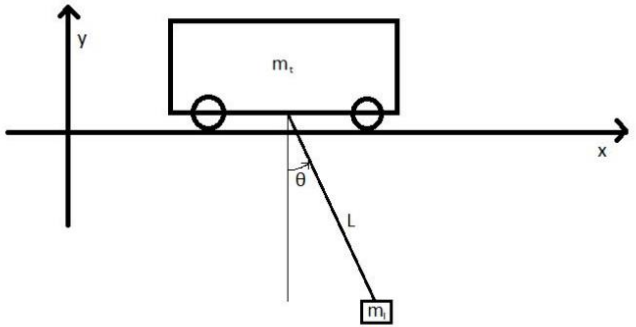
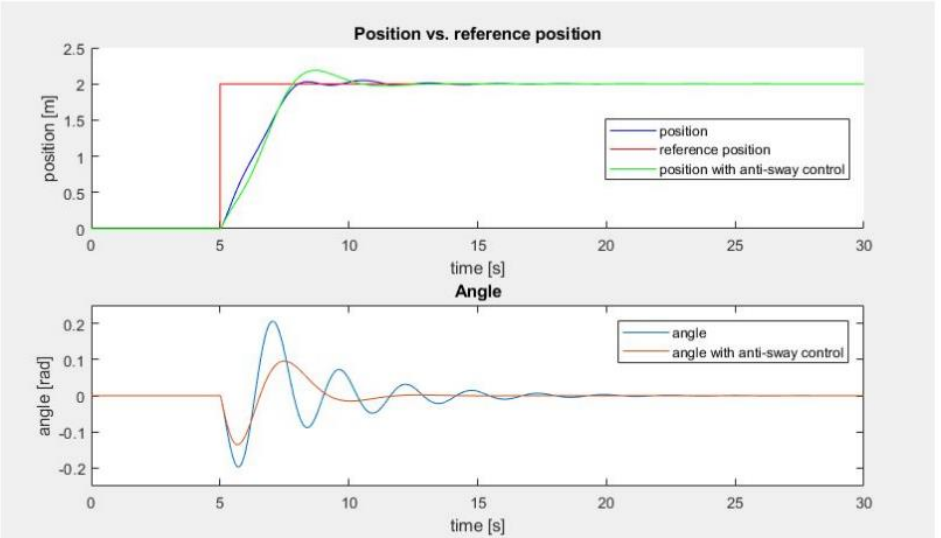
Idea: Build an anti-sway control for an overhead crane

- Derive equations for pendulum
- CAD modelling and component selection
- Build a model using Simulink or Amesim
- Design and implement an antisway control mechanism (for ex, PID, Fuzzy logic, LQR)





Step 1: Background study/startup submission (500p)

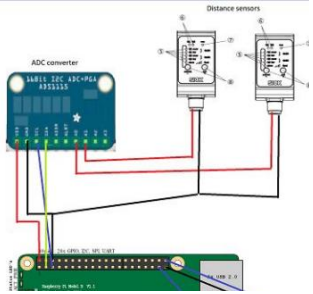
- **Startup submission is intended to get you started and familiarize you with the topic, DL Sun 5th February 11:55 pm. NOTE: couldn’t set the correct DL in A+**
- **Find two academic articles on topic (2p)**
  - Worth to spend time on, you can for example get help for deriving equations for the pendulum
- **Sketch pendulum and consider how the angle is measured (1p)**
- **Describe how you will solve the remaining tasks (2p)**
  - For example, will you use miniature scale, which CAD software you will use
  - 1-2 pages

Step 2: Numeric modelling (400p)

- **a) Make force equations for horizontal and vertical forces in your system according to the Newton's Second law of motion. (100 p)**
- **b) Form the nonlinear equations of motion that are needed for creating the simulation model of the system. (300 p)**
- **This might be a little bit tricky. However, there are a lot of material about (inverted-) pendulum in Internet .**
- **Tip: Lagrangian kinectics and Lagrangian equations. L = T − V, T = kinetic energy, V = potential enegy**

Step 3: Component selection (600p)

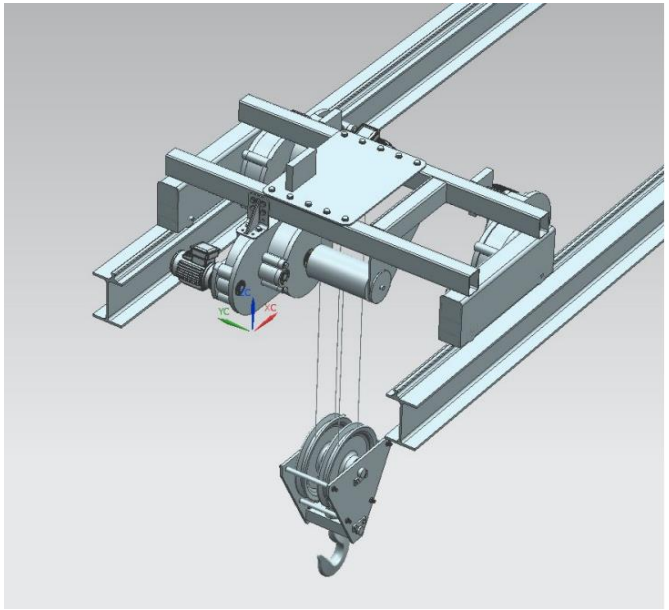
- **For component selection you need to decide the size of the crane**
- **Ilmatar specification can be found from (connect to Aalto VPN to get access) https://doi.org/10.1109/WF-IoT.2018.8355217 or project work document**
- **You need to select:**
  - Actuator moving the trolley (150p)
  - Sensor measuring the rope angle (150p)
  - Electric components: controller and power supply (200p)
- **Draw a sketch of electric circuit (100p)**



Rope length	L	0.5-3.0 m
Trolley max speed	v	20 m/min
Trolley movement range	L_2	9 m
Trolley weight	m_1	250 kg
Trolley motor power	P	1.5 KW
Hoist (vertical) max speed	v_2	8 m/min
Hook weight	m_2	5 kg
Lifting capacity	m_{max}	3200 kg

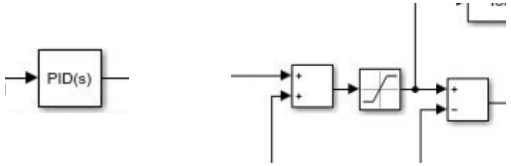
Step 4: CAD modelling (500p)

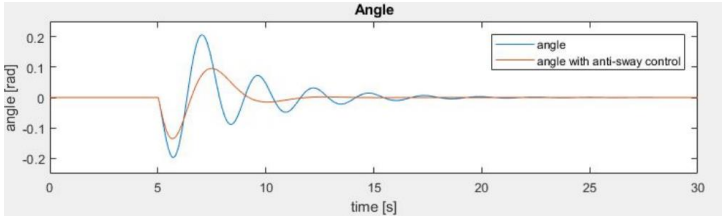
- You can use any CAD software
- Please, include a few photos, so that it is clear and easy to see if the component is modelled or not.
- 50 points modelled, 100 point modelled in detail
- 1. Hook, trolley and rail frame modelled (100p)
- 2. Actuator and sensor modelled (100p)
- 3. Bearings and couplings/gears/belts modelled (100p)
- 4. Electronics modelled (e.g. controller and power supply, wires NOT needed) (100p)
- Max 500p so you get 100p for doing this task

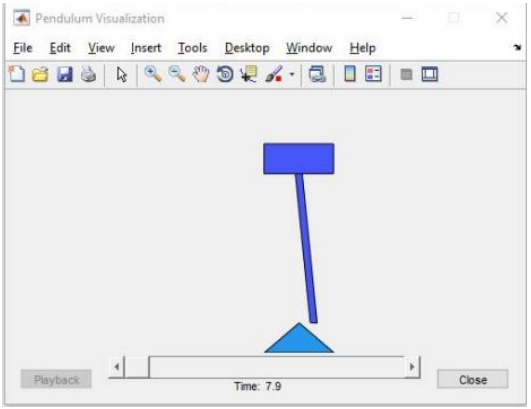


Step 5: Simulation and control (9p)

- **Make a Simulink model based on equations (300p)**
- **Make visualization, does not have to be fancy (example video with penddemo) (200p)**
- **Introduce sway control (400p)**
  - Control performance (200p)
  - Control method (200p)
    - PID with manual tuning 50p, PID with more advanced tuning 100p
    - Fuzzy logic, at least 100p
    - LQR 200p







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Step 6: Feedback (100p)

- **Did everyone participate to the project equally?**
- **How many hours in total did you spend (per person) for the project?**
- **How difficult was the project?**
- **Do you think that the topic of the project was interesting and useful?**
- **Answer on A+ feedback form**
- **Everyone submits alone**

Presentation Tue 14th February 9-12

- **Each group gives max 5 minutes, can be less, you can aim to 3 minute-presentation**
- **Only few slides (3-5)**
- **Concentrate on one aspect you found interesting. For example: deriving equations, CAD modelling, building simulation model, control algorithm…**
- **If you can’t make it, please come to talk with me or prof. Tammi. Please, before the presentations.**

Some practicalities

- **DL Sun 26th February, note: presentation already 14th.**
- **If questions, ask in Teams using Project Work channel**
- **The project work is laborious, so, please, reserve enough time. Starting at the final week is not possible**
- **We strongly recommend 3 persons per group to share workload**
- **Workload approx. 20-40 hours per person**
- **riku.ala-laurinaho@aalto.fi**