Project in Automatic Control FRT090

HT 2014

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Projects in Automatic Control

- Team effort
  - Collaborative problem solving
- Get practical experience
- Apply course knowledge
  - Modeling
  - Identification
  - Control design
  - Implementation

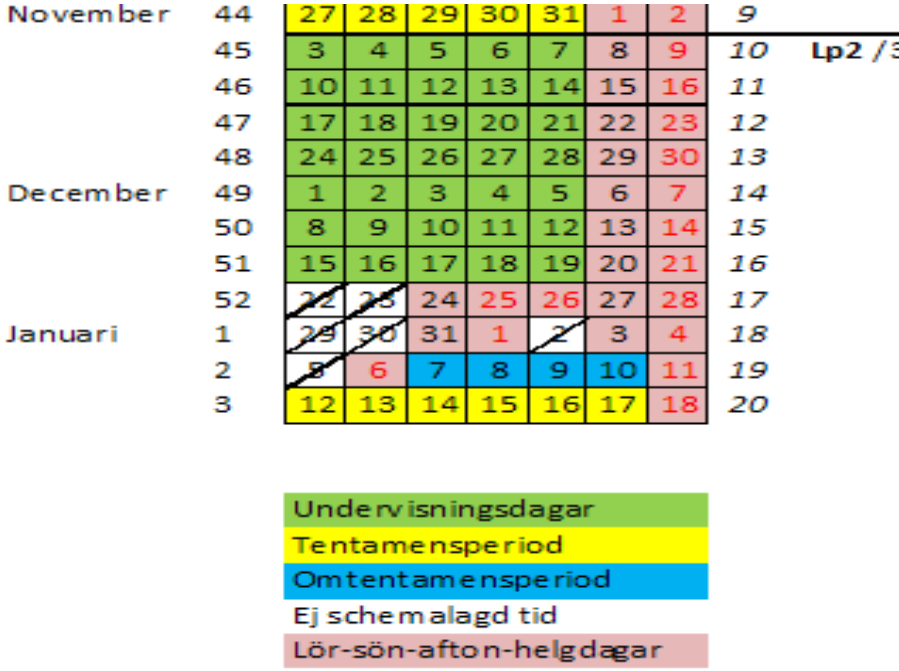
http://www.control.lth.se/Education/EngineeringProgram/FRT090.html

Time line

HT-2014 Study period 2: starts 2014-11-03 (today)

Exam period/ project presentation: 2015-01-12—01-17

(doodle)



Note: Exchange students may present before X-mas (whole project group – contact Anders)

Course plan

w1-w2: Form groups, planning (and quick start!)

- Mo 3/11 Intro-meeting + git tutorial
- Tu 4/11 17.00: mail wish-list with 3 projects in prio order (and possibly list of group members) to anders.robertsson@control.lth.se
- We 5/11: group announcement on webpage
- Thu/Fri/Mo: Meet project supervisor
- Mo 10/11 10.15-12 git-exercise in Lab C
- Tue 11/11: deadline for submitting project plans

w3-w7 Project work include

- Mo Nov 17, 10.15-12 Feedback seminars 1
- Mo Dec 8, 10.15-12 Feedback seminar 2

Project presentations in exam week (January 2015)

» Important to fill in doodle about presentation

Project infrastructure

- Version control system – **Git**
  - Version control
  - Collaborative development
  - Mtrl,
    - see handout on course home page
    - http://en.wikipedia.org/wiki/Git_%28software%29

- **Tutorial (intro today + exercise in lab w2)**

  by Anders Nilsson, Department of Automatic Control

  - **Mo Nov 3**, 11-12, M:21122 (seminar room):
    - Intro to Git
  - **Mo Nov 10,** 10.15-12, Lab C, Dept of Automatic Control (ground floor)
    - Git exercise, hands-on
    - Create and set up project account etc. (gitlab)

Project plan

- An overview of the project.
- Descriptions of the key parts of the project, including materials and methods to be used.
- A decomposition of the project into subtasks and a suggested allocation of the project resources to key tasks.

- A **time plan** (e.g., Gantt diagram)

- New rules for master thesis work, see e.g., http://www.student.lth.se/studieinformation/examensarbete/nyheter-foer-dig-som-ska-goera-examensarbete/

Hints for project planning

- Break project into manageable subtasks
- Establish dependencies between subtasks
- Estimate time required each subtask (person hours/days)
- For each week estimate how many hours every member of the team will work
- Plan deadlines for each subtask using the estimates above
- Put any spare time you might have in the end of the schedule, not the beginning!
- Every week follow up on your progress **compared to your timeplan**, and reschedule if you are falling behind. This is to be discussed with your project supervisor at regular meetings.

Feedback seminars

- Two feedback seminars with different themes
  - Modeling/Design
  - Implementation
- Hand in link to written mini-report on git-repo before seminar
  - To project supervisor+“review group”
- All groups prepare presentations
  - Choices of methods
  - Results
  - Lessons learnt
- 3-4 groups get to present
- Emphasize **feedback between groups** and knowledge transfer

Examination

- Grade: Pass/Fail
- Complete project task
- Active participation in feedback seminars
- Oral project presentation
- Participation in demo session
- Written report

Project allocation

- Course participants submit:
  - Desired projects
    - Rank first, second and third alternative
    - Name + control courses taken/attending
  - Proposals for project groups
  - Nov 4th (Tuesday) before 17:00
  - Send e-mail to anders.robertsson@control.lth.se
- Groups and project announcement
  - Nov 5th (Wednesday)
  - See the course home page

Contact with your project supervisor already this week!

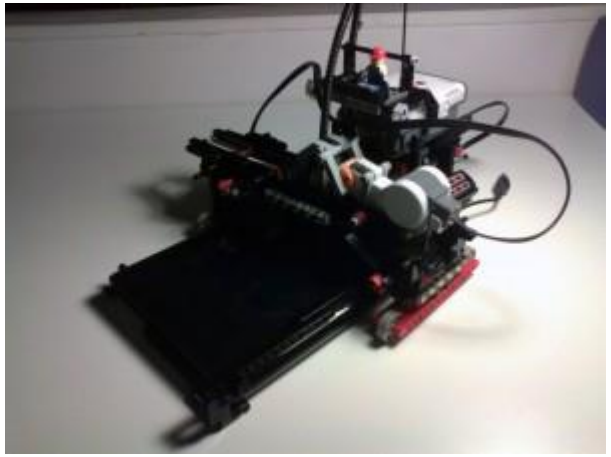
1. Vision-based lego-robot playing ruzzle

Lego-robot moving pen in XY + plus up/down over touch screen

- Lego

  Embedded EV3 (Real-time course)

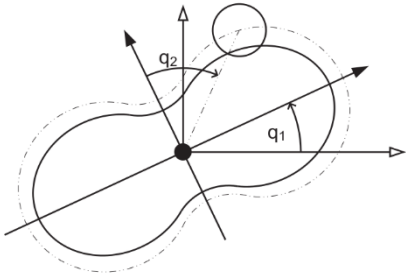
Need to have a feedback solution for robustness



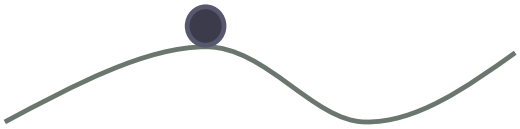
Optimization-based strategy

- ”Which words in what order”

2. Control of a roller-coaster-ball-and-beam-process with industrial robot

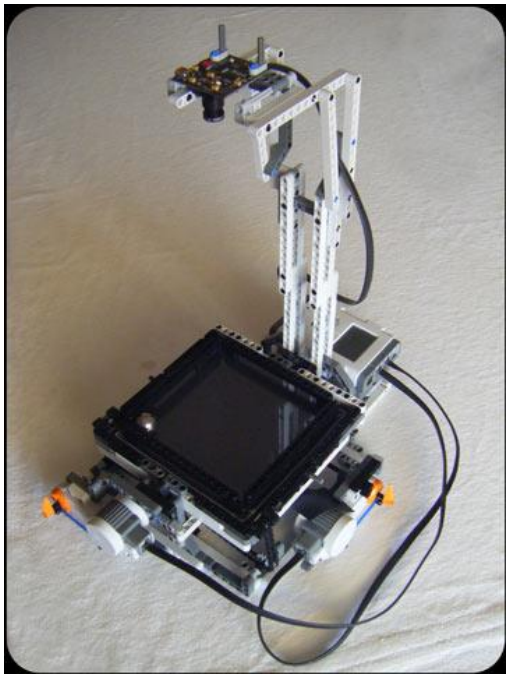


- Ball and Beam Process
- Possibly camera and image processing to measure ball position
- Trajectory generation to switch side
- Model-based state-feedback control design
- Differently shaped beams
- Robot as carrier/actuator



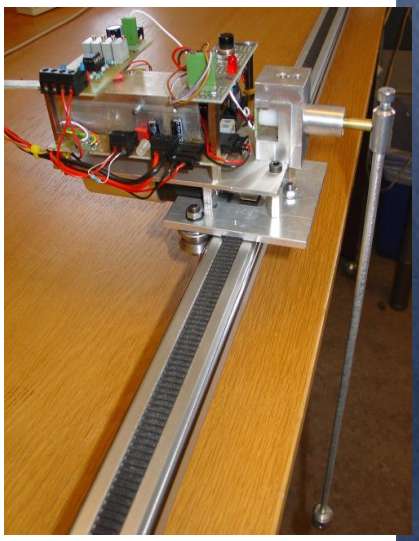
3. Vision-based control a ball and plate process / maze-game

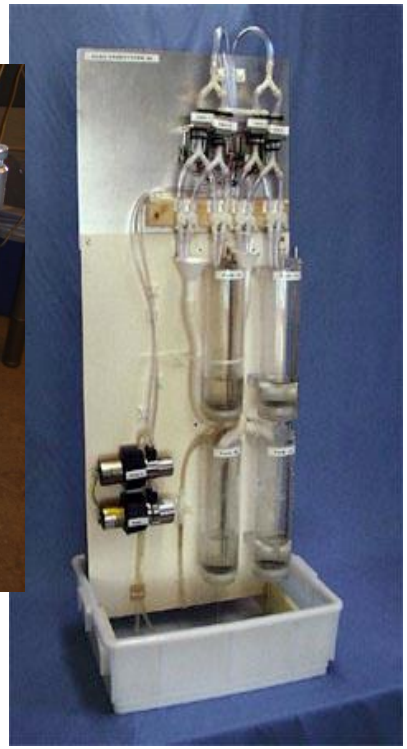
- Ball and Plate Process
- Camera to measure ball position
- Lego NXT / Arduino
- (or something else)
- Maze with obstacles/holes



4. Python + Control theory

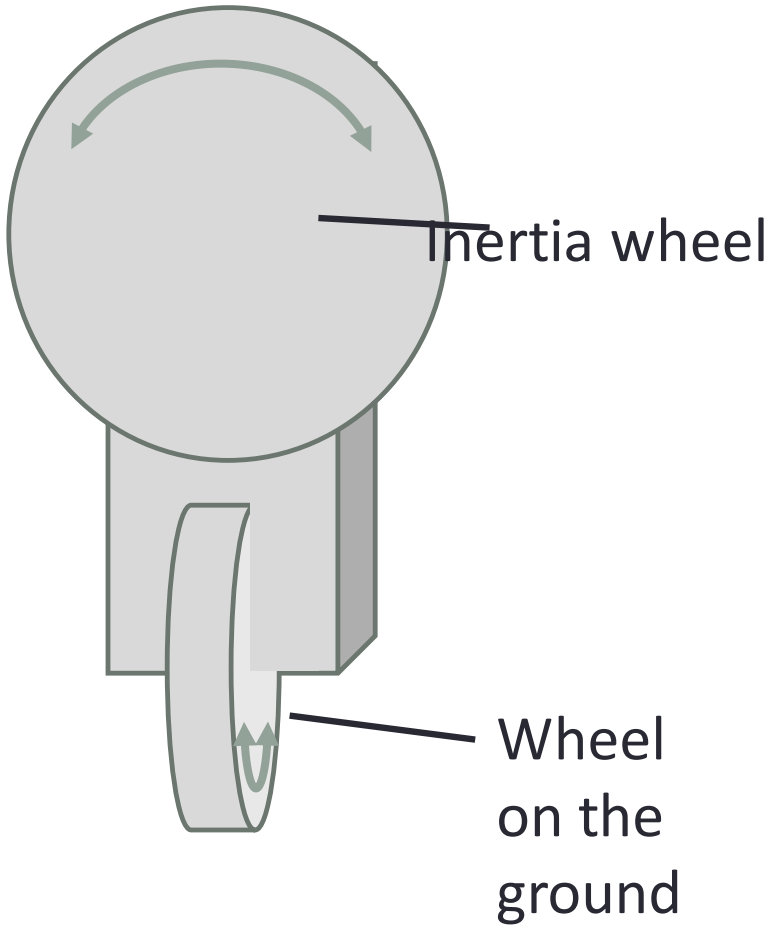
- Controlling a labprocess using python
  - (Inverted Pendulum, Quadtank etc)
- Relatively new area
- Examples
  - Using cvxgen for optimal control
  - Particle filtering with new Python toolbox for sensor fusion
  - MPC (model predictive control)





5. Design and control of a Lego Segway

Build a self-balancing robot with Lego Mindstorms + some kind of remote control (android etc)



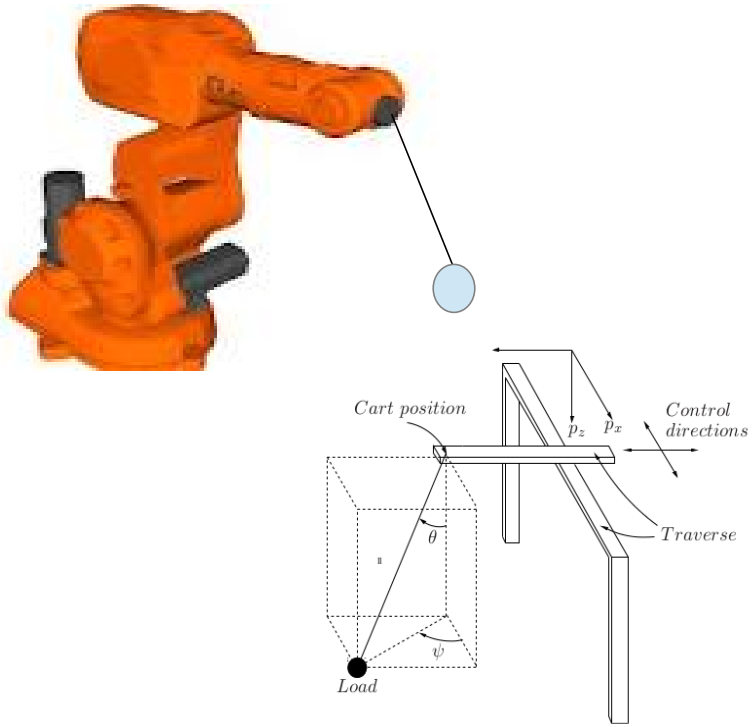
- Balance in the forward direction with a wheel on the ground
- Lateral balance with an inertia wheel
- State estimation with gyros and accelerometers
- Programming on Lego NXT
  - several language options
  - NQC/NXC, Java
- Can it be done?

- http://www.youtube.com/watch?v=OnRV-ggJmQ4

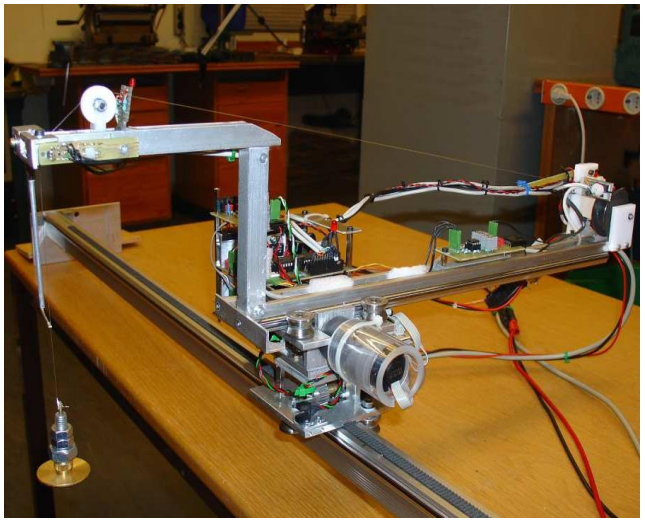
- http://www.youtube.com/watch?v=mJJeb3cvwjY&feature=related

6. Robot crane

Path planning and control along trajectory



Compare lab 3 in Multivariable control



6 Crane / Robot cont'd

Prerequisite: Multivariable control

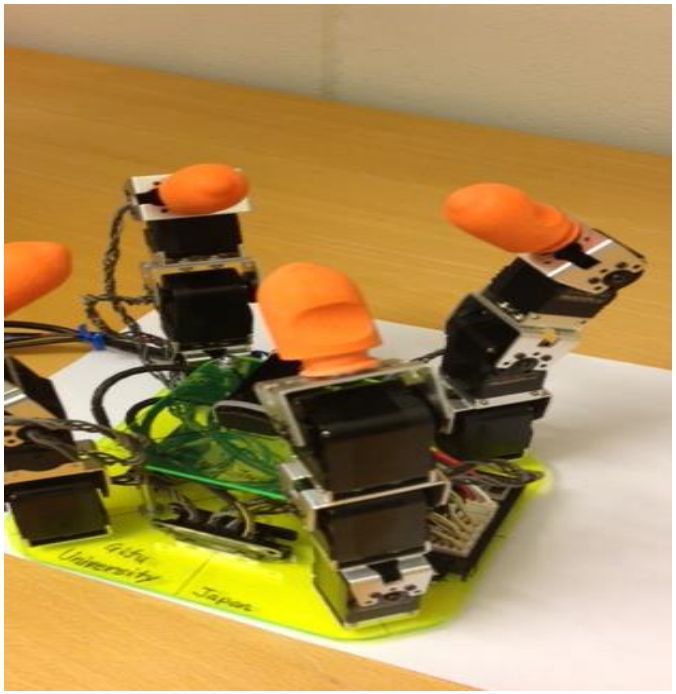
http://www.youtube.com/watch?v=08K_aEajzNA

7. Robot gripper interface

Model and control interaction of forces for each finger for stable gripping

Located on moving platform

Each finger has three links/servos



Demo - Gripper by Prof T. Yamada, Gifu

8(A). Mobile robot and sensor fusion

Control of mobile robot with omniwheels

Positioning of moving platform with sensor fusion from multiple "flow sensors"

Extension to XY-platform for inverted pendulum control

8. Optimization and Software Interfacing for Mobile Robots

Based on a mobile robot with omnidirectional wheels (successor of Care-O-bot 3)

Alt. 8B Visual based docking (research project ENGROSS)

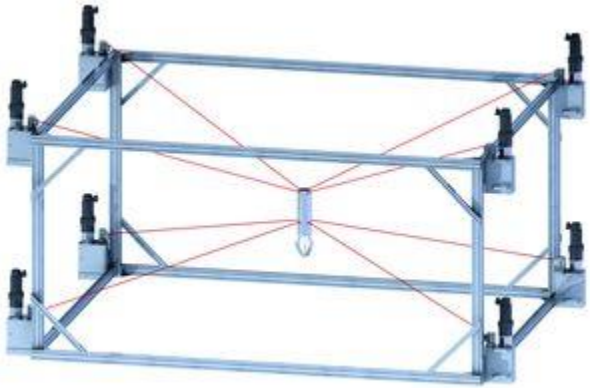
Alt. 8C Study navigation (SLAM)

- Interface to ROS via rospy
  - http://www.ros.org/wiki/
  - http://www.ros.org/wiki/rospy

9. Cable robotics

Building and controlling a cable robot

Step 1: Lab setup with two antagonistic motors working along one cable



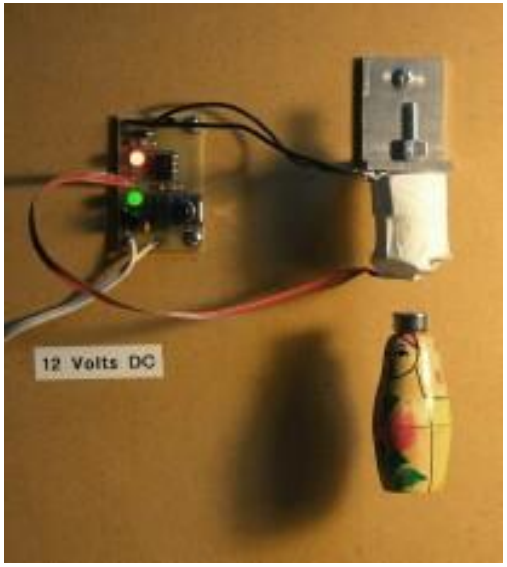
Step 2: Planar “lecturing robot” (4 wires), drawing on white board

Comprises: embedded control, kinematics, motor drives, some mechanical construction

10. Electronics

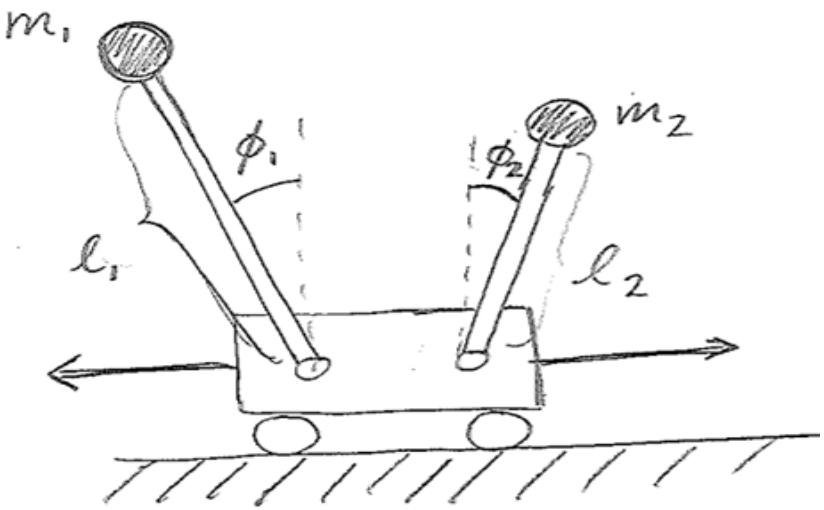
Mixing analog and digital controller for lab development at EIT and Department of Automatic Control

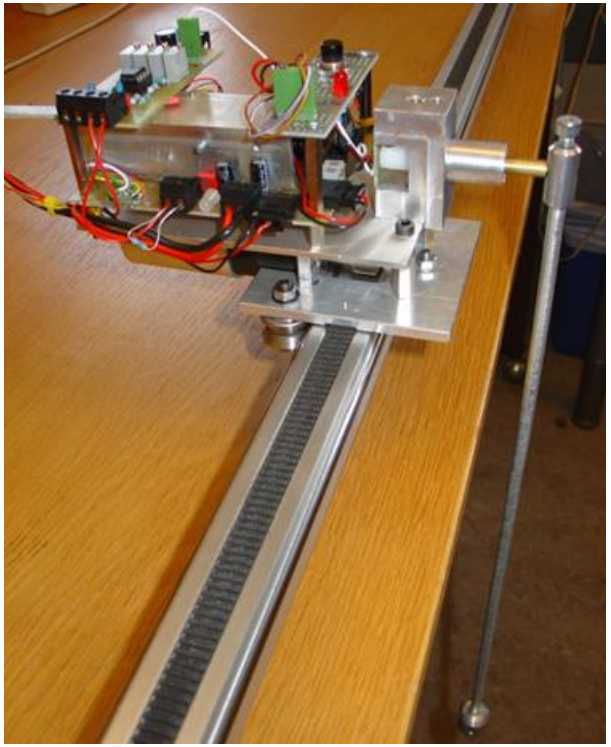
Example: High-performance levitating magnet system (control current for electro-magnet to get object with magnet to levitate at desired height.)



Prerequisite: At least one project participant well experienced with electronics design.

11.Multiple Inverted Pendulums





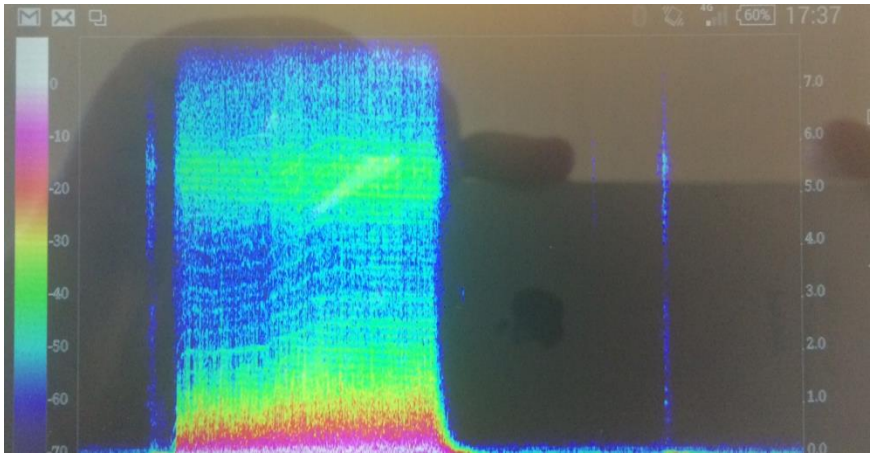
Different time-constants for the different pendulums makes it (theoretically) possible to stabilize several pendulums in their upright positions.

Is it possible in practice?

https://www.youtube.com/watch?v=iKvGr9IfVyE

12. Active noise cancellation

The main objective is to investigate the disturbing "mosquito sound" from a small quadcopter and model and if possible implement an "stealth mode" by "onboard" active noise cancellation for a crazyflie.



Note: The initial implementation will be done on separate cortex processer where the crazyflie will be used as noise source.

Prerequisite: embedded control/real-time systems

http://www.bitcraze.se/crazyflie/

13. Project idea of your own

You are very welcome to suggest your own ideas for projects.