Project in Automatic Control FRT090

HT 2016, Lp 2

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Lund University

LUNDS UNIVERSITET
Lunds Tekniska Högskola

Projects in Automatic Control

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

Course home page:

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

Who are we?

Martin

Martina

Anton

Anders Ro

Mattias

Marcus

Pontus

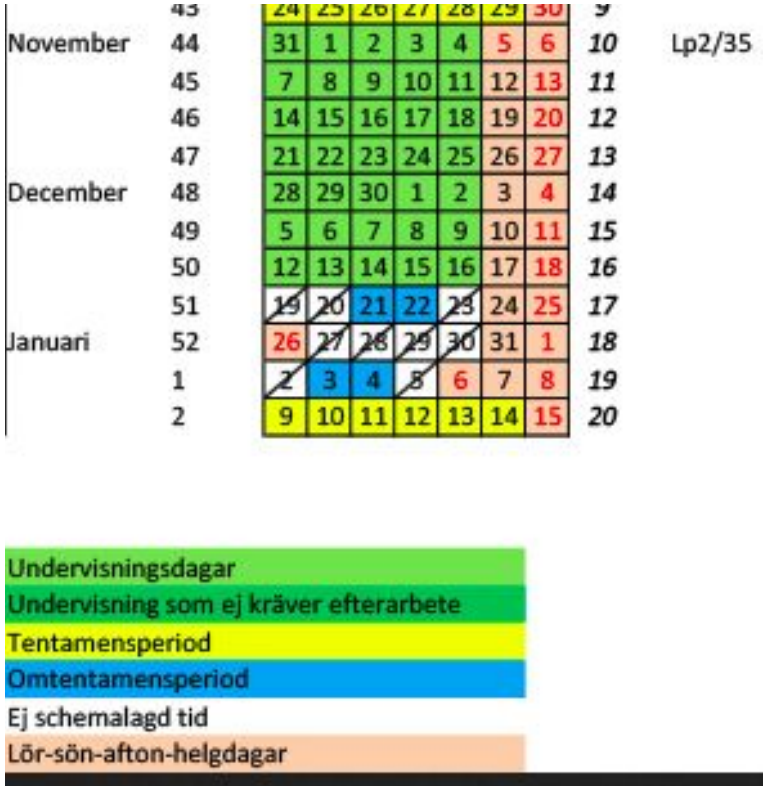
Anders N

Mika

Time line

HT-2016 Study period 2: starts 2016-10-31 (today)

Exam period/ project presentation: 2017-01-09—01-14 (Doodle)



Note: Exchange students may present before X-mas

- whole project group
- specify this when applying for project / contact Anders

Course plan

w1(-w2): Form groups and planning

Mo 31/10 Intro-meeting + git tutorial

Tue 1/11 By 17.00: mail wish-list with 3 projects in prio order (and possibly list of group members) to Anders.Robertsson@control.lth.se

We 2/11: group announcement on webpage

Thu/Fri/Mo: Meet project supervisor

Mo 7/11 git tutorial

Tue 8/11: deadline for submitting project plans

w2-w7 Project work include

- Feedback seminar 1
- Feedback seminar 2
-

Project presentations in exam week (January 2017)

» Important to fill in Doodle about presentation date

Project infrastructure

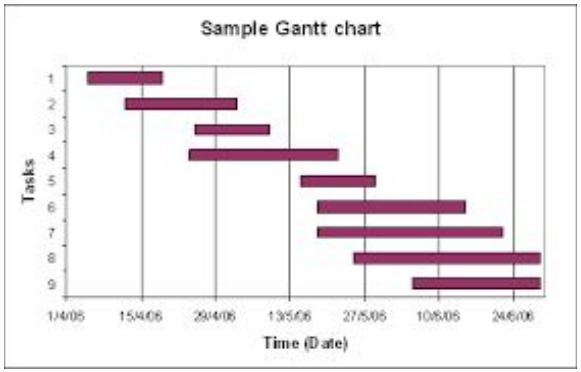
- Version control system – Git
  - Version control
  - Collaborative development

  http://en.wikipedia.org/wiki/Git_%28software%29
- **Tutorial (intro today + exercise in lab week 2)**

  by Anders Nilsson, Department of Automatic Control
  - **Topic: Git**
  - **Material posted on course home page**

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.lth.se/english/education/master/information-for-current-students/degree-project-guidelines/guidelines-degreeproject-master-eng/

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 and to “review group”
- All groups prepare presentations
  - Choices of methods
  - Results
  - Lessons learnt
- Split of groups for presentations in parallel rooms
  - (everyone prepared to present)
- Emphasize **feedback between groups** and knowledge transfer

Examination

- Complete project task
- Active participation in feedback seminars
- Oral project presentation
- Participation in demo session
- Written report

- Uploaded and documented code on git repo
- All equipment and tools returned

Project allocation

- Course participants submit:
  - Desired projects
    - Rank first, second and third
  - Proposals for project groups
  - **Nov 1st (Tuesday) before 17:00**
  - Send e-mail to anders.robertsson@control.lth.se
    - Also submit a list of control courses and for the project other relevant courses you have taken
- Groups and project announcement
  - **Nov 2th (Wednesday)**
  - See the course home page

Contact with your project supervisor already this week!

Student representatives

Student feedback

- Ongoing during course
- Reporting (batch)
  - CEQs from previous years available at **http://www.ceq.lth.se/**

see e.g.,

http://www.ceq.lth.se/rapporter/2015_HT/LP2/FRT090_2015_HT_LP2_slutrapport_en.html

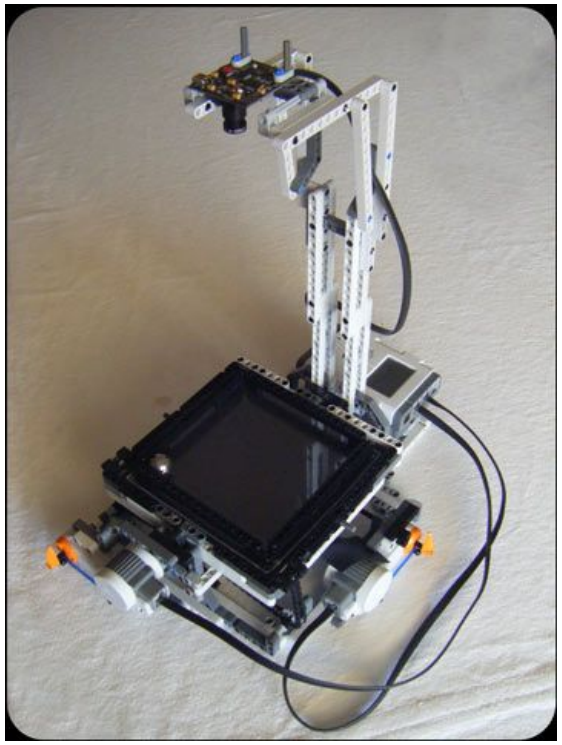
Choose 2 student representatives from the course

Please, help us to close the loop for better performance.

Vision-based control of ball and plate process / maze-game

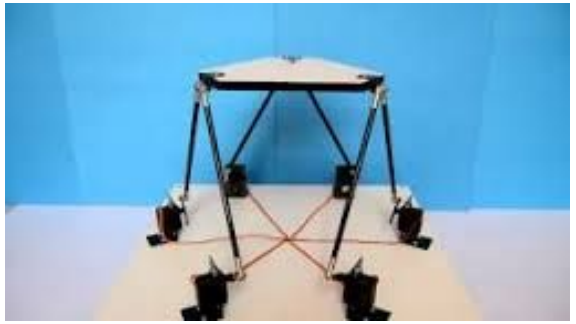
- Ball and Plate Process
  - e.g., Stewart platform
- Camera to measure ball position
- Lego NXT / Arduino

(or something else)



- Extensions

Maze with obstacles/holes



Quadcopter

Quadcopter and ROS (Robot operating system)

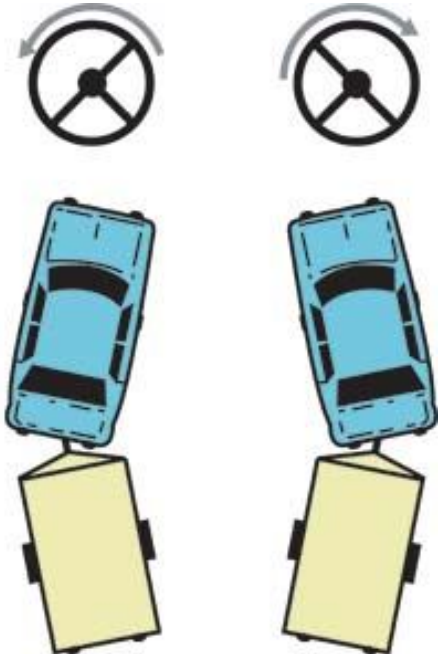
Collaboration of multiple semi-autonomous vehicles

http://global.parrot.com/au/products/bebop-drone/

http://www.ros.com/

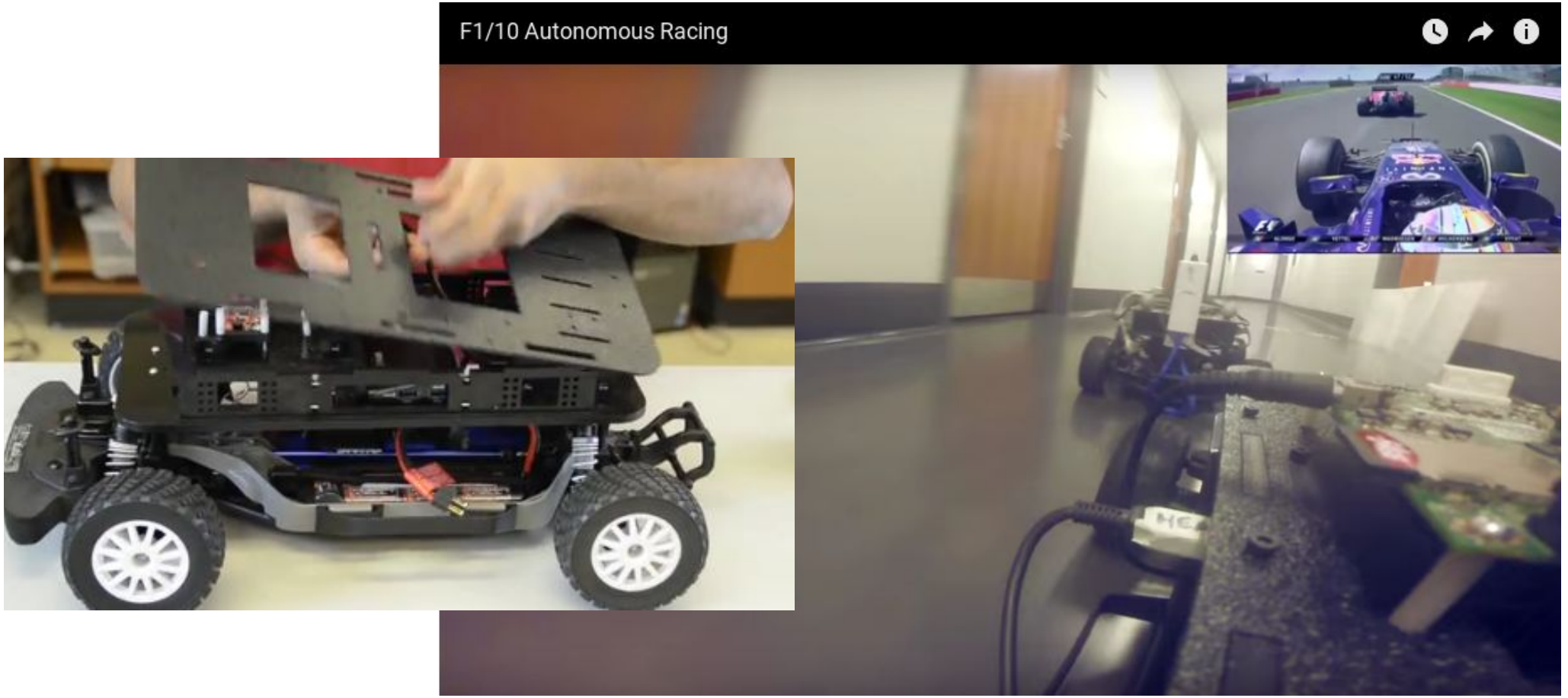
(Lego) Trailer system

Design and implement (multi-) trailer system with support for autonomous parallel parking and/or backing



F1/10

A ‘crash’/’absolutely no-crash’ course in design and implementation of autonomous driving with F1/10-cars

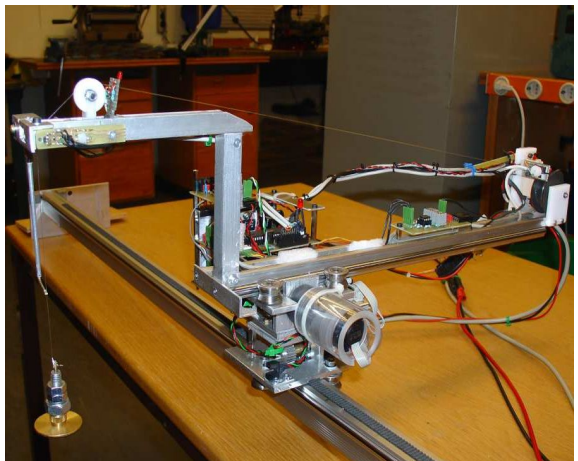


http://f1tenth.org/

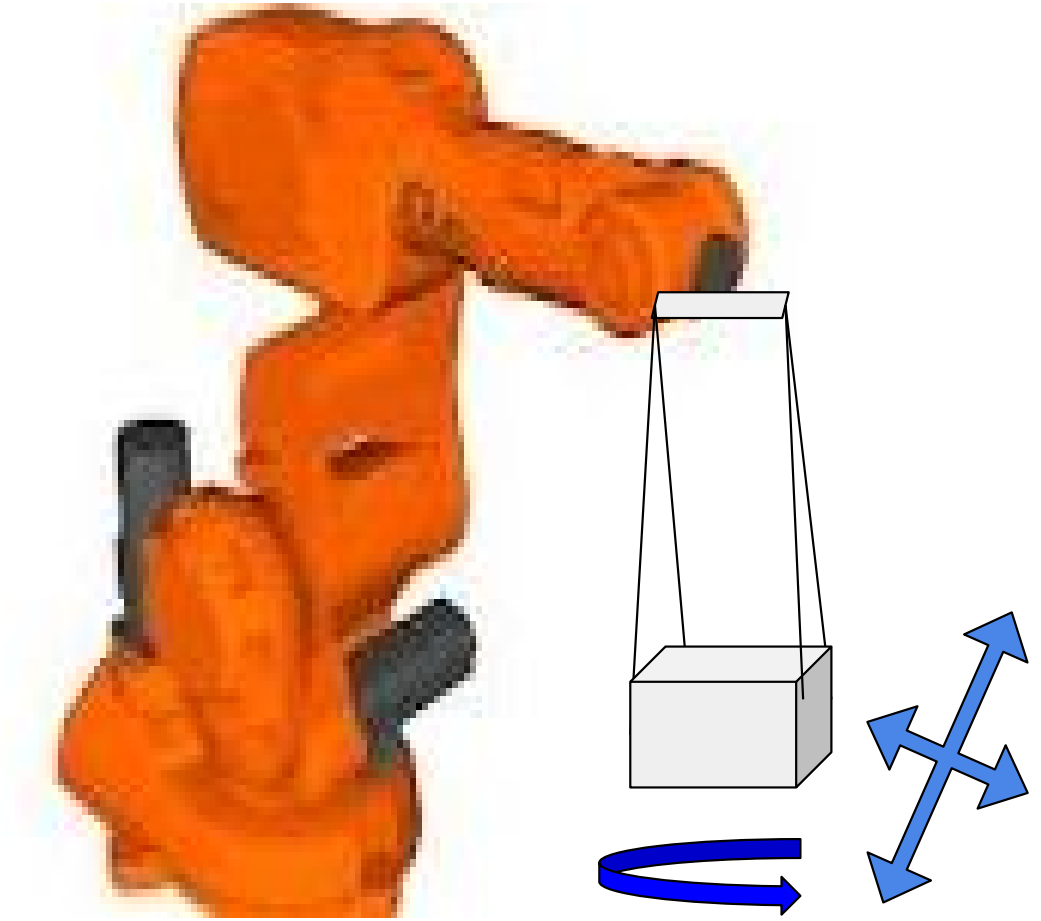
http://www.ros.com/

Modeling and control of container crane system

Compare lab 3 in Multivariable control



Path planning and control along trajectory
(e.g., MPC)



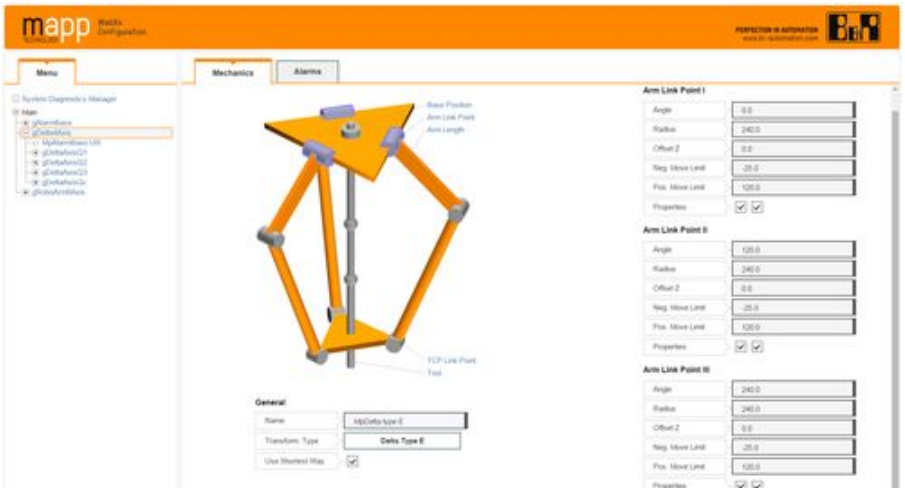
Crane / Robot cont'd

Prerequisite: Multivariable control

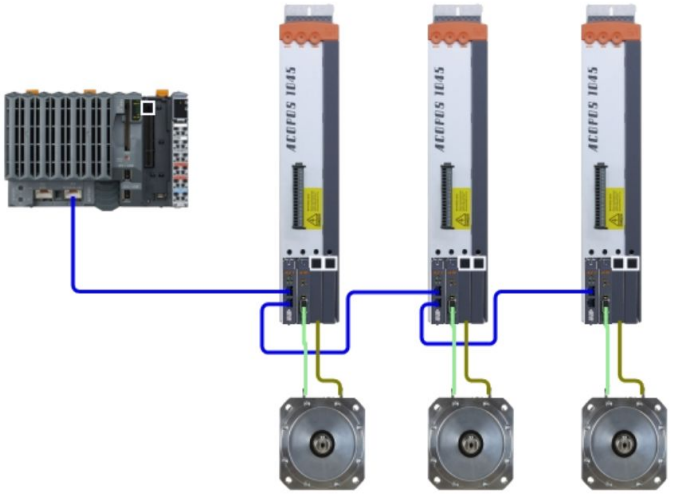
http://www.youtube.com/watch?v=08K_aEajzNA

Industrial robot control system

Modelling, implementation and tuning of a parallel kinematic robot (ABB's Flexpicker) in B&R's industrial control system for a 3D-printing application.



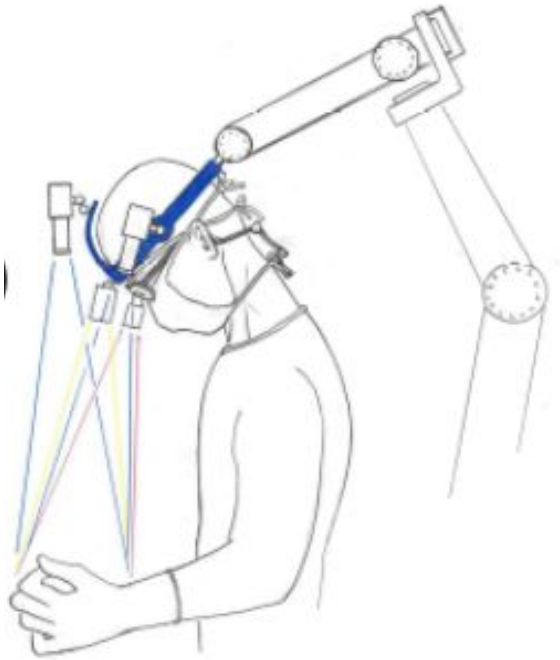
https://www.youtube.com/watch?v=ggFdvUlp8YU



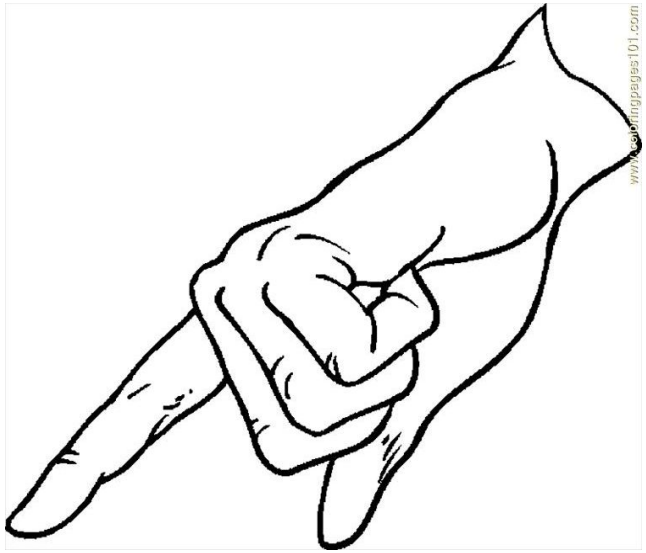
Assisting arm for camera in surgery

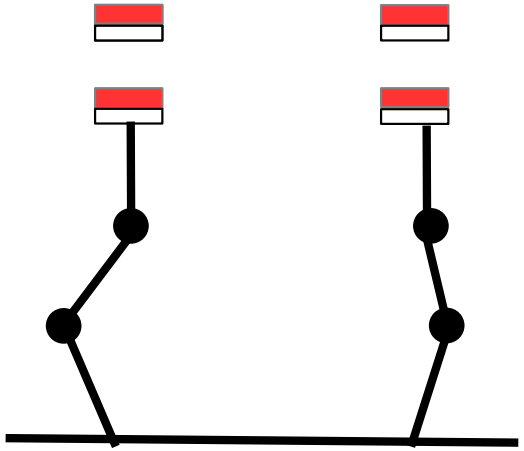
Setup
Surgeon with laser pointer attached to glasses (or any other device to see where he/she has the center of attention).
The laser pointer points towards an object/location.
A camera is mounted on a robot arm.

Problem formulation: The camera should follow the object marked by the laser beam, but should suppress fast motions and trembles (like a steady cam).
If the surgeon turns too much and moves the laser away from a certain pre-defined region of attention, the camera should still be recording in that area.



Robot gripper interface



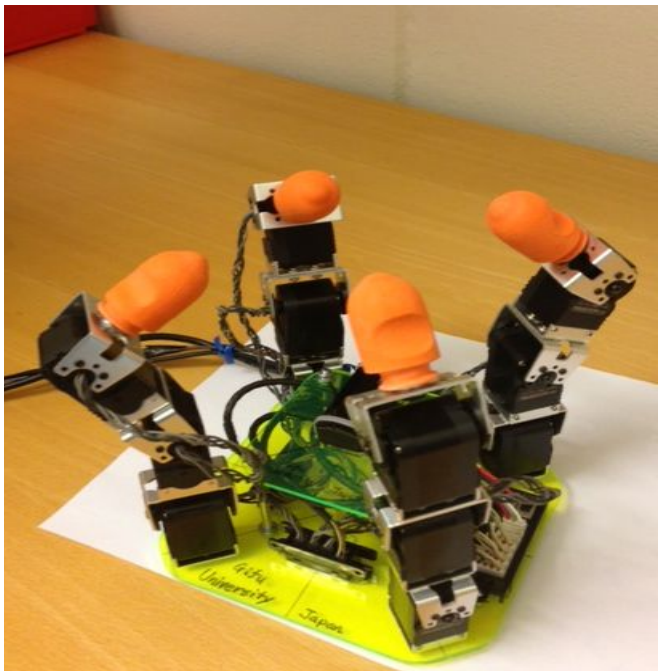


Model and control interaction of forces for each finger

Simulation of dynamics to “haptically show” shapes

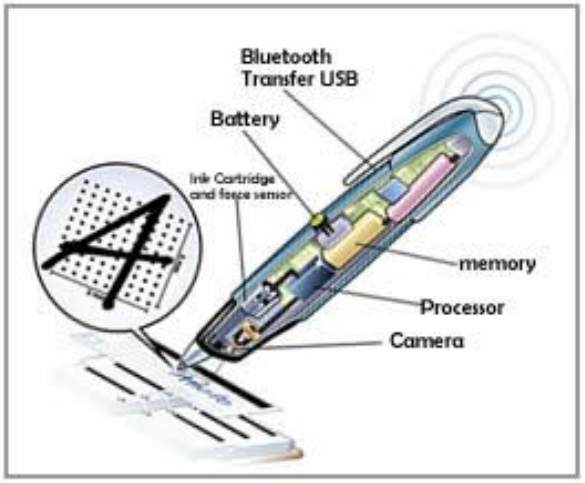
Teleoperation

Each finger has three links/servos



Online control of robot with Anoto pen

A digital pen with recording or online streaming can be used to both program or jog a robot in an intuitive way. The pen drawing motion from the surface should be projected to more general surfaces, like e.g., cylinders. When writing, some of the motion may be too fast to reproduce. The project will also consider multi-path and trajectory generation for multivariable systems of how to slow down some actuators along a path without deviating from it.



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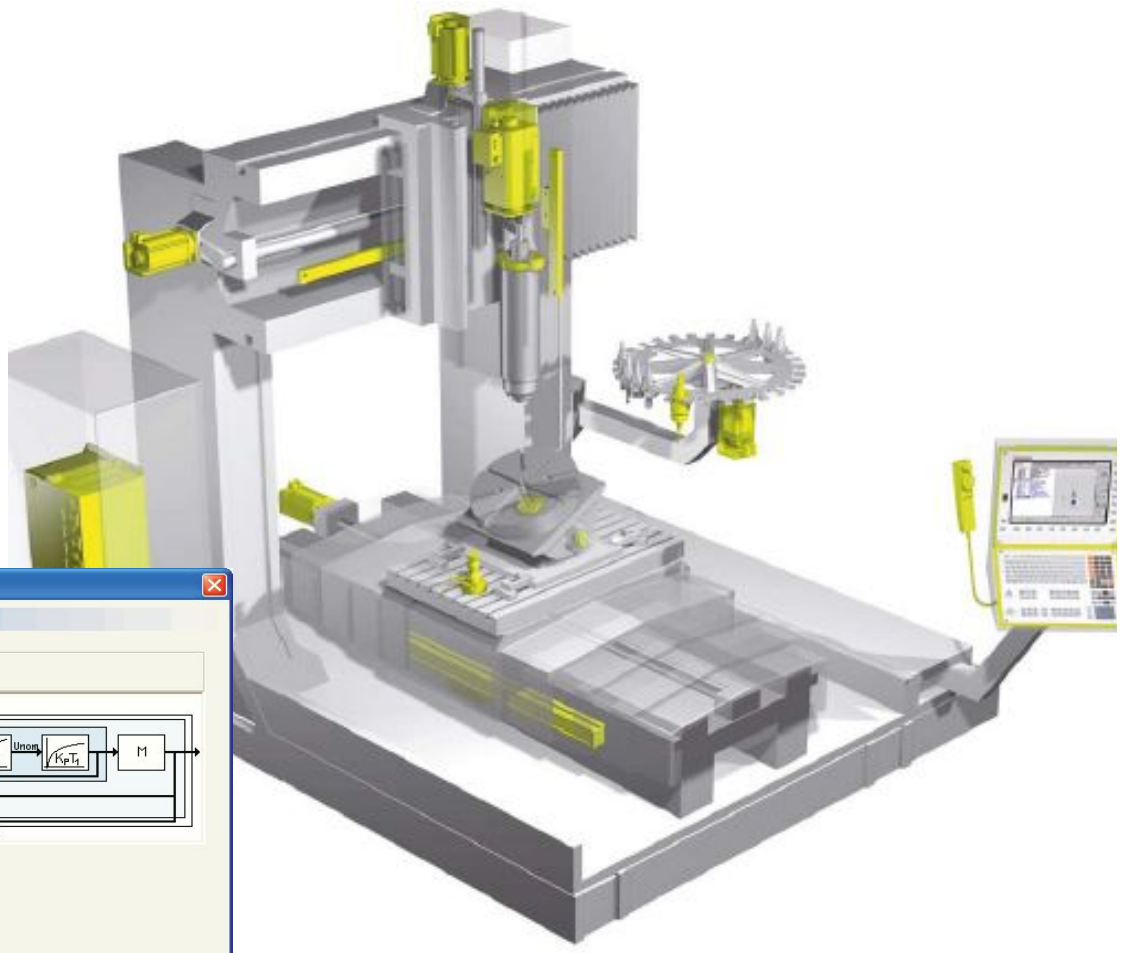
Balancing bag

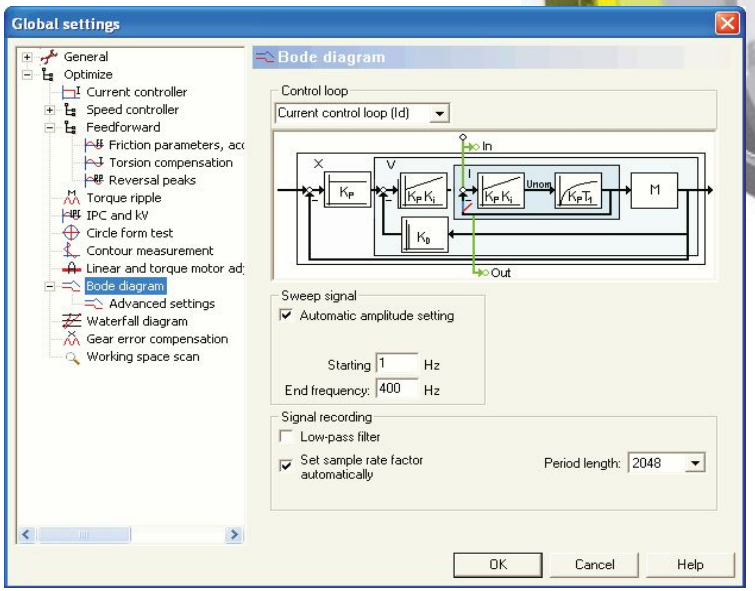
Model and design actuation, sensing, and control to get a bag balancing on one of its corner.

Commissioning of industrial control system

Industrial control system servo control for CNC-machine at IKDC

Servo control, tuning, calibration

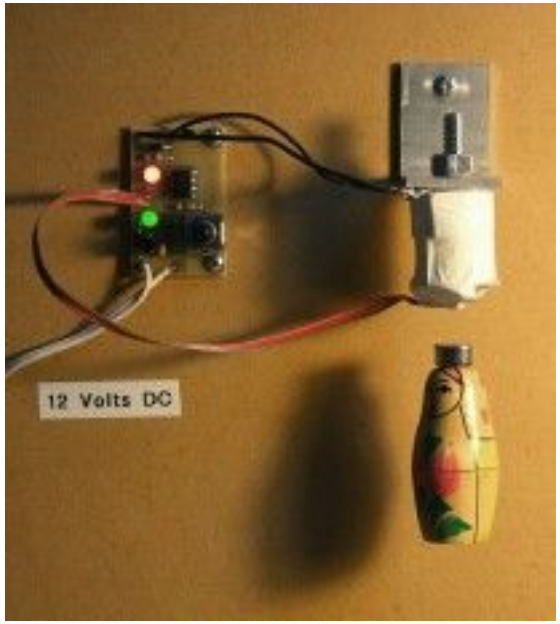




Levitating magnet

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.

Modelling, design and implementation of acceleration profiles

"Hövding - an airbag for cyclists"

The project is about modelling and in an experimental setup measure and reproduce characteristic acceleration profiles (possibly scaled in time) for a number of accident scenarios triggering the airbag.

http://www.hovding.se/videos

Open controller for high-quality 3D-printer

Replacing the commercial 3D-printer controller with a fully open control system gives a large number of exciting opportunities to use this high-quality 3D-printer in research, education and production. New algorithms for material deposition paths have to be developed as well as extended capabilities to change process parameters as acceleration, speed chamber and nozzle temperatures

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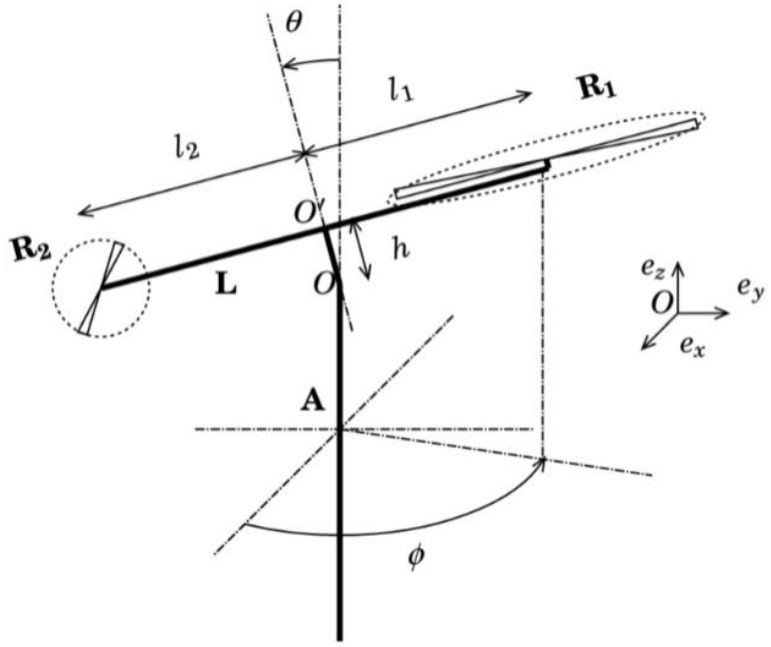
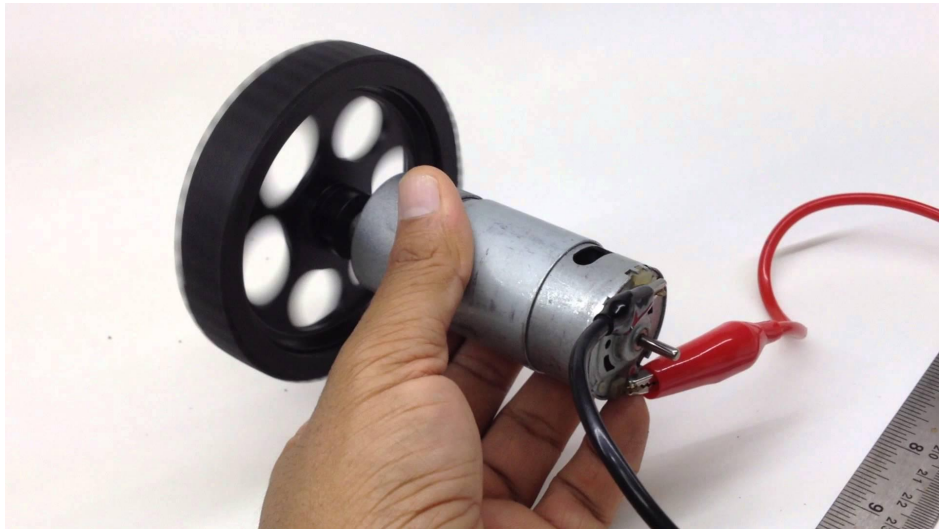
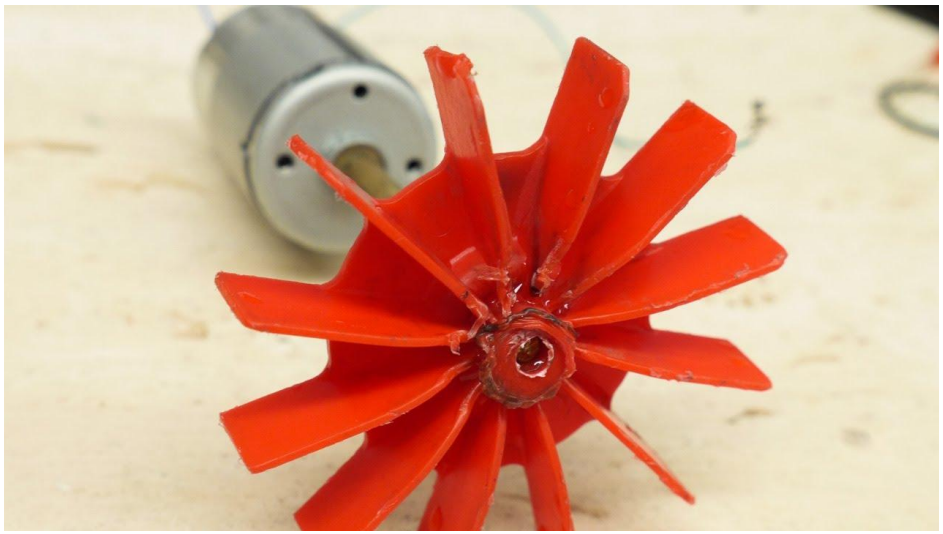
Control of the ETH helicopter

- LQG controller
- Create Simulink interface for simulation and control
- If successful, replace Lab 3 in FRTN10
- Prerequisite: FRTN10 Multivariable Control



Really tiny demo process





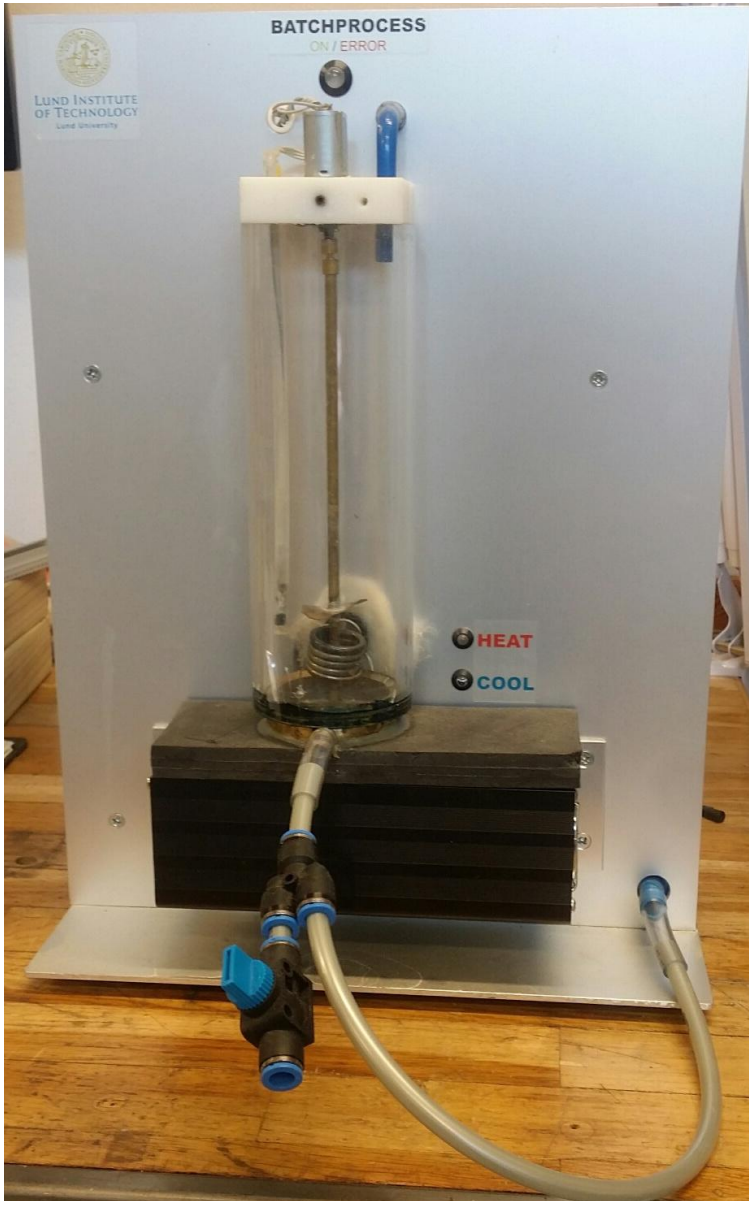
Design a really tiny demo process for education

Main components: DC motor, microcontroller

Power and communication via USB

Control of position or velocity from Matlab/Simulink

Batch tank in continuous operation



Multivariable lab process with two pumps, heating, cooling, mixing, used in FRTN25 Process Control

Investigate if the process can be run in continuous mode

- Secondary outlet
- Possibility to add flow sensor and flow control loop
- Simultaneous control of level, temperature and (simulated) chemical reaction

Balanduino on rocky road

Train the Balanduino robot to complete a difficult track as fast as possible

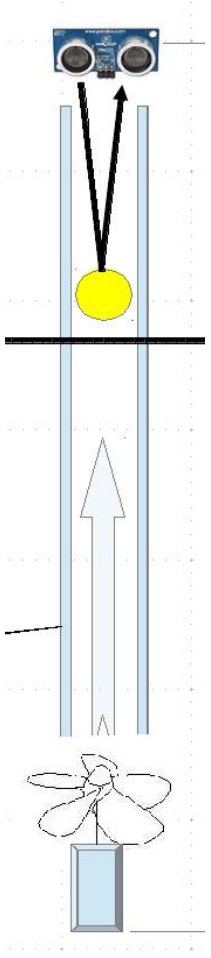
Use learning or optimization algorithms

Adaptive control with XC05

Industrial controller with adaptive control functionality based on a Raspberry Pi embedded-control.

Possible processes are a double or a quadtank system, or design and control of a ball-in-tube process

Pre-requisite: Multivariable and/or predictive control



First Control XC05

Your own ideas

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

Note: Projects in “Image analysis” running in parallel.

http://www.ctr.maths.lu.se/course/newimagean/2016/