Project in Automatic Control FRT090

2011

Department of Automatic Control
Faculty of Engineering
Lund University

Projects in Automatic Control

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

Course plan

- w1 Form groups and planning
  - Tuesday March 15th group announcement
  - Friday March 18th deadline for project plans
  - Tutorials
- w2-w5 Project work
  - Feedback seminars 1 and 2
- 3 weeks of holiday and exams
- w6-w7 Project work
  - Feedback seminar 3
  - Presentations in w7 or the week after

Project infrastructure

- Version control system – Subversion
  - Version control
  - Collaborative development
  - http://subversion.tigris.org/
- Project management – Trac
  - Wiki documentation
  - Ticket-driven development
  - http://trac.edgewall.org/
- **Tutorial Wed. March 16 10:15-12:00, Lab B**

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 sub tasks and a suggested allocation of the project resources to key tasks.
- A time plan

Hints for project planning

- Break project into manageable subtasks
- Establish dependencies between subtasks
- Estimate time required each subtask (manhours/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.

Feedback seminars

- Three feedback seminars with different themes
  - Modeling (April 6th 10:15-12:00)
  - Design (April 15th 10:15-12:00)
  - Implementation (May 18th 10:15-12:00)
- Hand in written mini-report two days before seminar
- All groups prepare presentations
  - Choices of methods
  - Results
  - Lessons learnt
- 3-4 groups get to present
- Emphasize feedback between groups and knowledge transfer

Examination

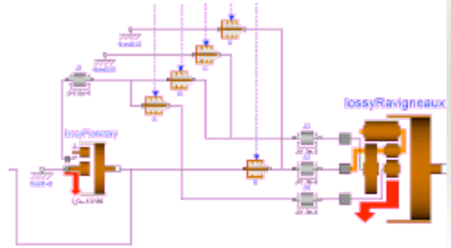
- Complete project task
- Active participation in feedback seminars
- Oral project presentation
- Participation in demo session
- Written report

Project allocation

- Course participants submit:
  - Desired projects
    - Rank first, second and third
  - Proposals for project groups
  - March 14th (today!)
  - Send e-mail to johan.akesson@control.lth.se
- Groups and projects announcement
  - March 15th (tomorrow!)
  - See the course home page

1. Lego Robot with Modelica/ Dymola

- Build a self-balancing robot with Lego Mindstorms
- Physical modelling using Modelica
- Model calibration
- Control design
- Automatic code generation
- User interaction and animation
- Get in touch with the industry



4students

2. Lego NXT + Android

- Design and build self-balancing robot using Lego
- Implement controller on NXT, several language options
  - NQC, Java
- Receive reference inputs over Bluetooth

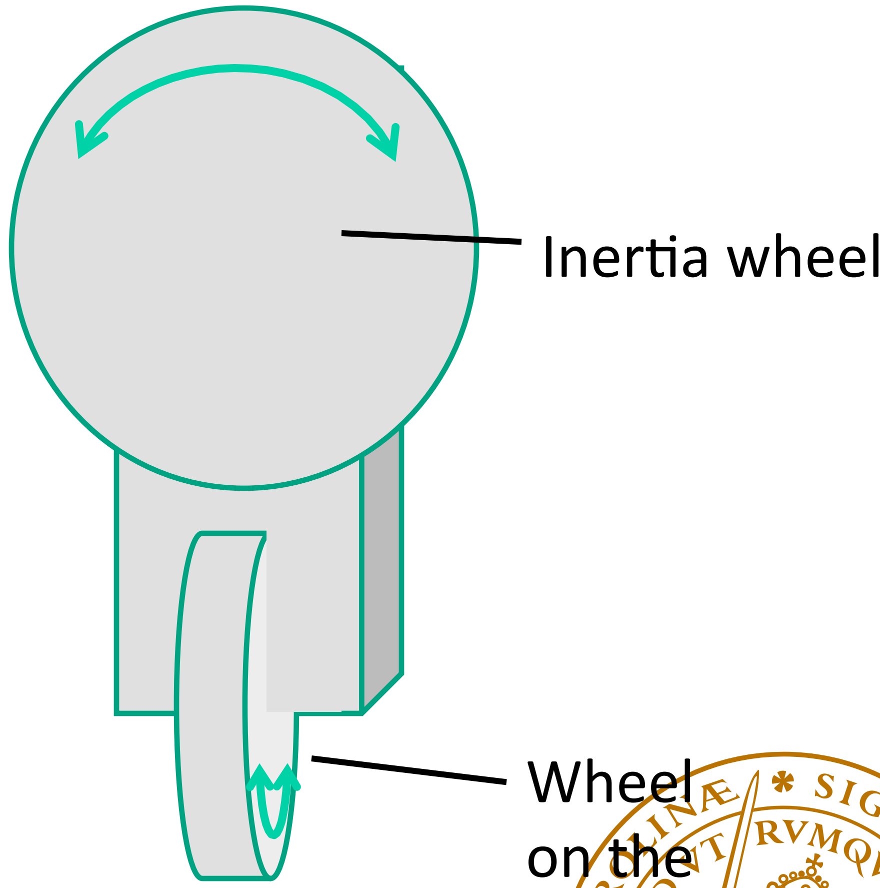
- Write Android application to control the NXT over BT
- Android
  - Linux based Open Source O/S
  - Smartphones/tablets
  - “Java”-based application layer

3. LEGO Unicycle

- Balance in the forward direction with a wheel on the ground
- Lateral balance with an inertia wheel
- State estimation with gyros and accelerometers
- Programming with e.g. NXC

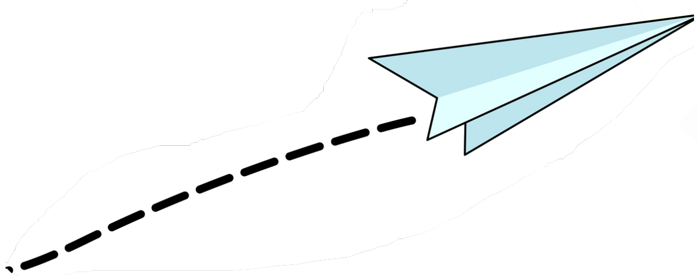
http://www.youtube.com/watch?v=OnRV-ggJmQ4

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



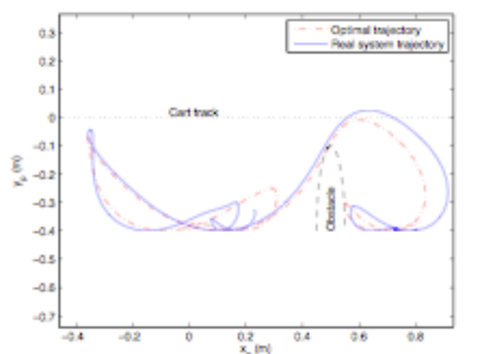
4. Servo controlled laser tracker

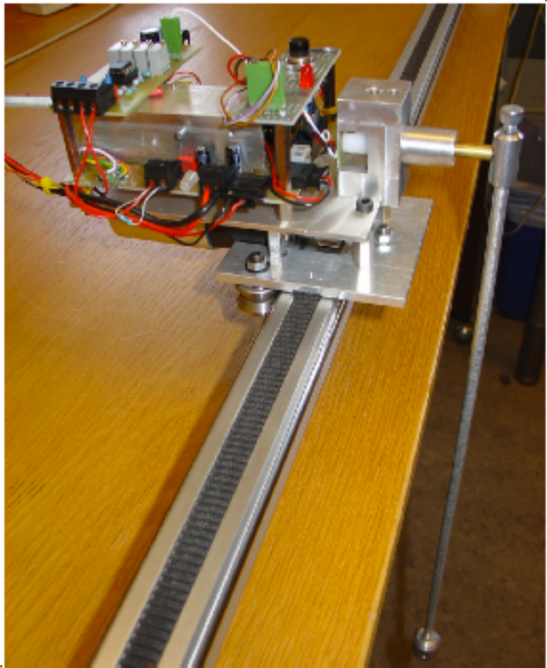
- Tracking platform built form laser pointer and RC servos
- Control based on visual feedback
- Implement on AVR
- Attempt to track moving target (e.g. paper aeroplane)
- Automatic calibration



5. Nonlinear MPC of pendulum

- Nonlinear MPC control of linear pendulum, using pre-generated swing-up trajectories
- Challenge is to shorten optimization time
- Prototype in Python, final implementation in C++

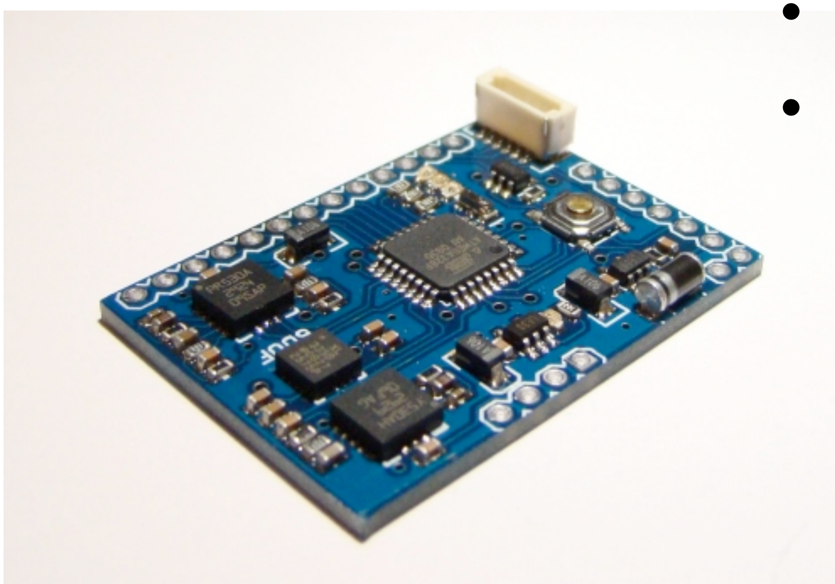




4 students

6. Inertial Measurement Unit, IMU

- Combine accelerometer/ gyro measurements to try and estimate movement/ position
- Evaluate performance/ limitations



- Key topics
  - Rigid body dynamics
  - Sensor fusion / Extended Kalman Filter
  - Quaternions
  - Embedded C-programming, Atmel AVR microcontroller.

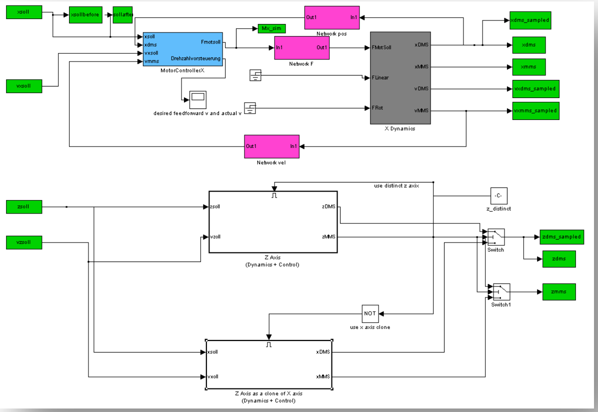
2 students

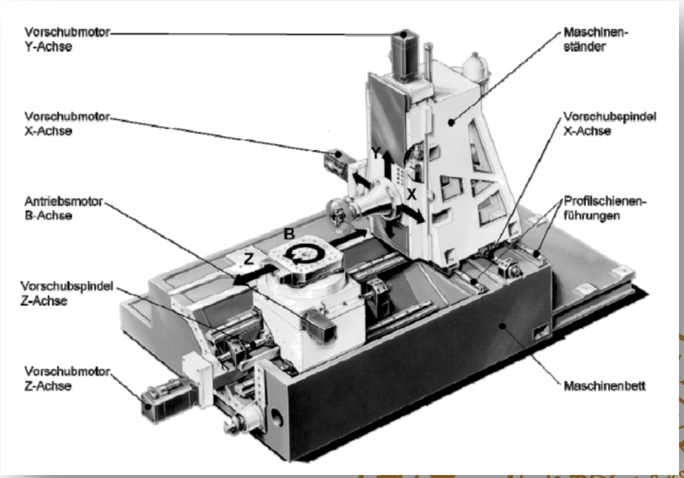
7. Quadcopter

- System identification
- Use a joystick or (your own) Android phone as a remot control
- Path tracking
- C programming API

8. Networked Control over PROFINET

- TrueTime
  - Simulink toolbox for simulating networked embedded control systems
  - Developed here
- PROFINET
  - Fieldbus protocol from Siemens
  - Time-triggered + event-driven communication
  - Supported by TrueTime
- “Cutting-the-circle” benchmark
  - NC machine
  - Used in the EC CHAT project
  - Simulink model available
- Task
  - Controller implementation
  - Evaluation of control performance when control loop closed over PROFINET
  - Implement delay compensation strategies
- Two person project - simulation only

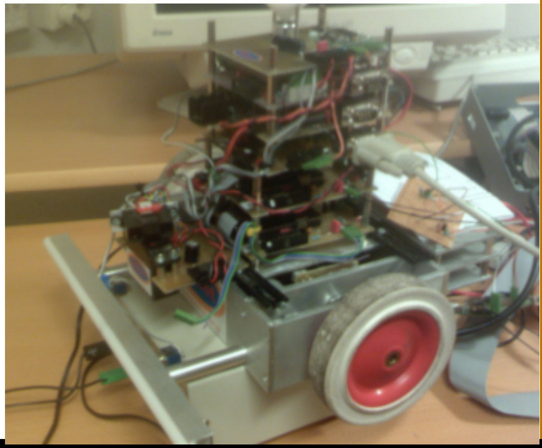




2 students

9. Localization of robot

- Localization of mobile robot
- Robot control
- Sensor communication
- Signal processing
- AVR C programming



4 students