Project in Automatic Control FRT090

HT 2015

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Projects in Automatic Control

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

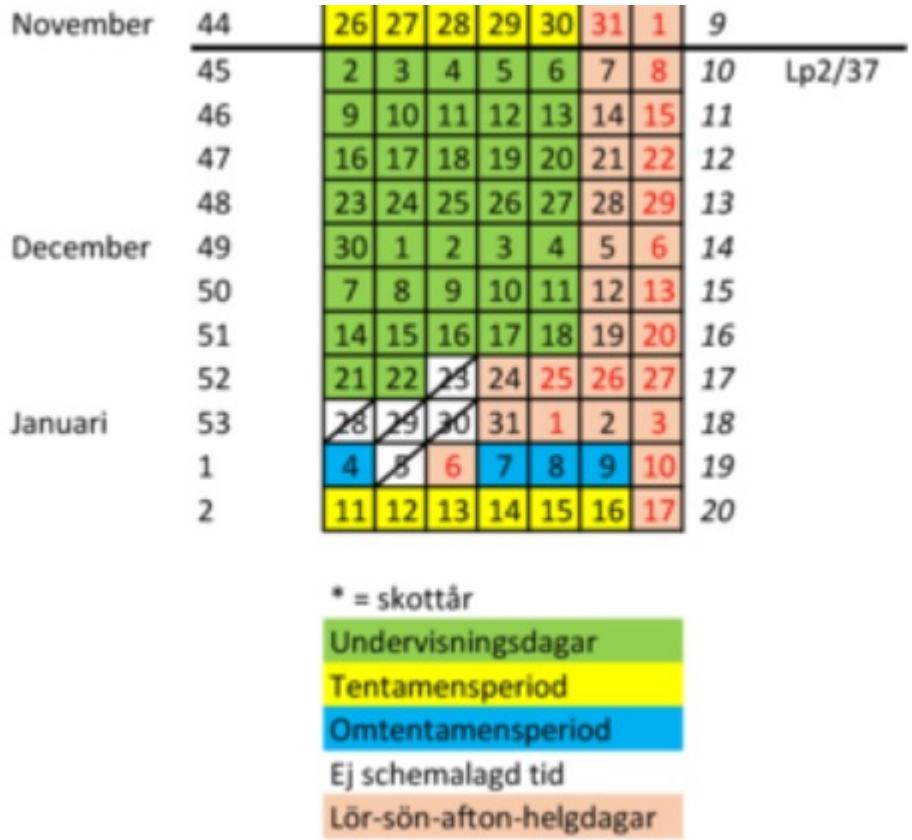
http://www.control.lth.se/Education/EngineeringProgram/FRT090.html

Time line

HT-2015 Study period 2: starts 2015-11-02 (today)

Exam period/ project presentation: 2016-01-11—01-16 (doodle)

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



Course plan

w1(-w2): Form groups and planning

Mo 2/11 Intro-meeting + git tutorial

Tue 3/11 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 4/11: group announcement on webpage

Thu/Fri/Mo: Meet project supervisor

Mo 9/11 git tutorial

Tue 10/11: deadline for submitting project plans

w2-w7 Project work include

- Feedback seminars 1
- Feedback seminar 2

Project presentations in exam week (January 2016)

» Important to fill in doodle about presentation

Project infrastructure

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

  http://en.wikipedia.org/wiki/Git_%28software%29

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

  by Anders Nilsson, Department of Automatic Control
  - **Topic: Git**

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

- 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
  - Nov 3rd (Tuesday) before 17:00
  - Send e-mail to anders.robertsson@control.lth.se
- Groups and project announcement
  - Nov 4th (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/2014_VT/LP2/FRT090_2014_VT_LP2_slutrapport_en.html

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Choose 2 student representatives from the course

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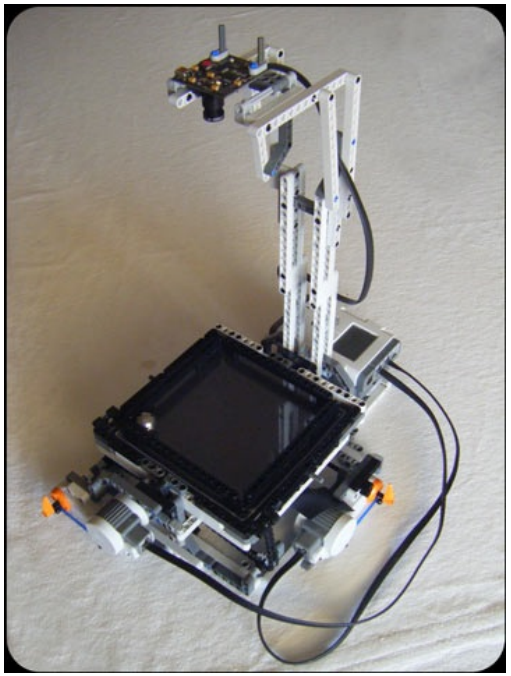
Please, help us to close the loop for better performance.

1. 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
-
- Possibility to robot extension

2. Bitcraze/Crazyflie

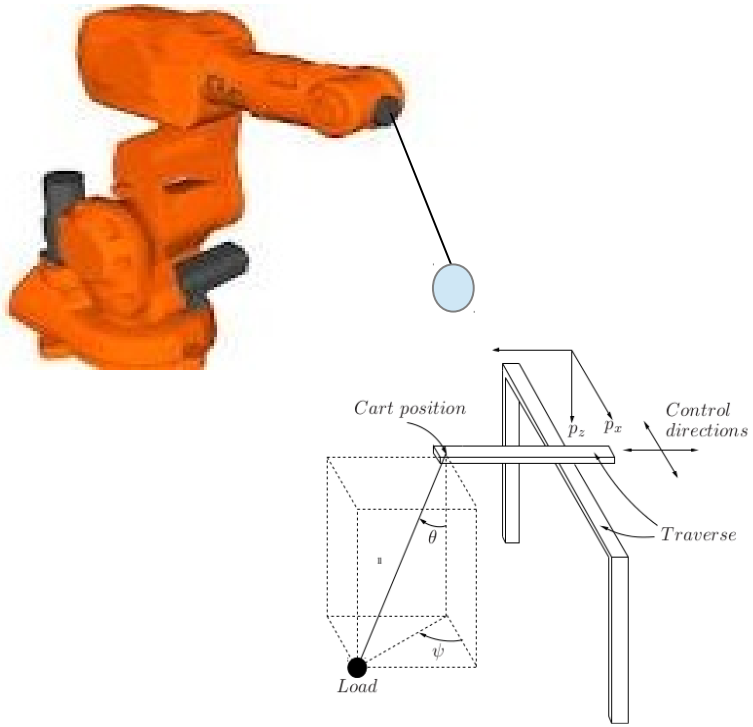
Crazyflie/Miniature quadcopter

Using kinect sensor for trajectory generation and feedback control for pick-and-place operation.

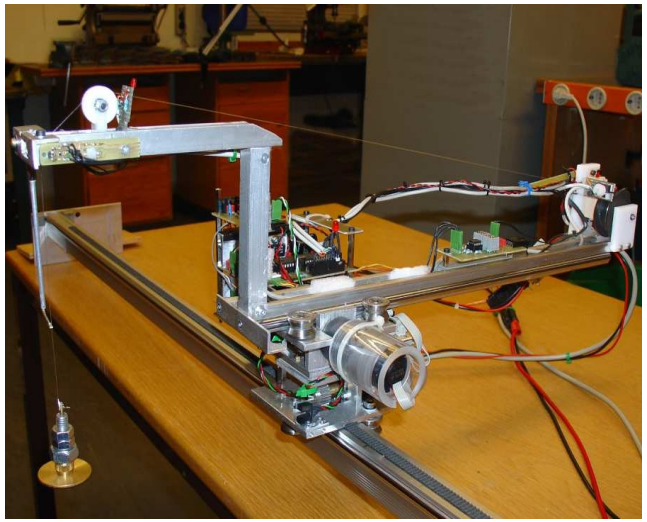
http://www.bitcraze.se/crazyflie/

3. Robot crane

Path planning and control along trajectory



Compare lab 3 in Multivariable control

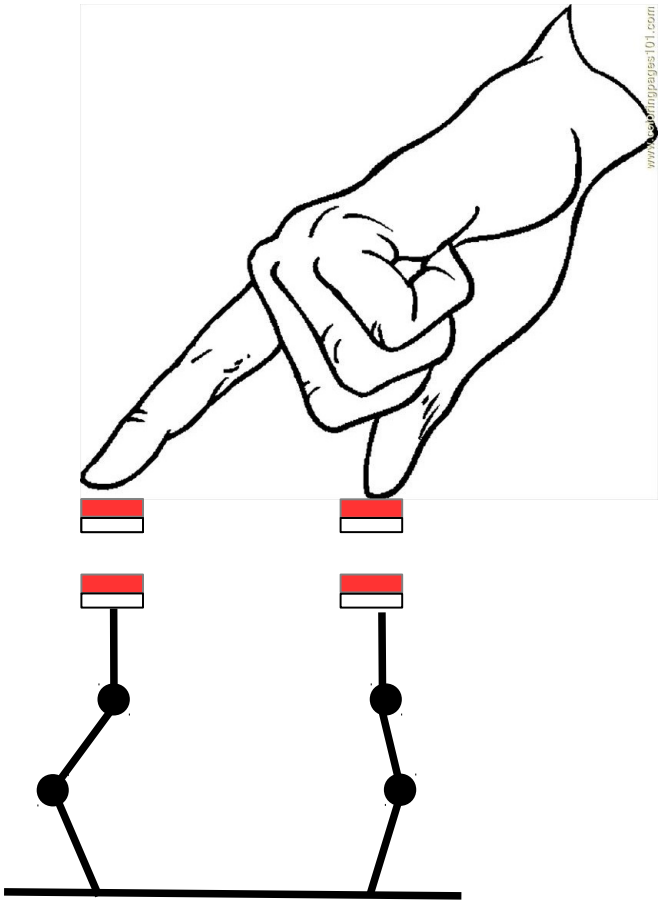


3. Crane / Robot cont'd

Prerequisite: Multivariable control

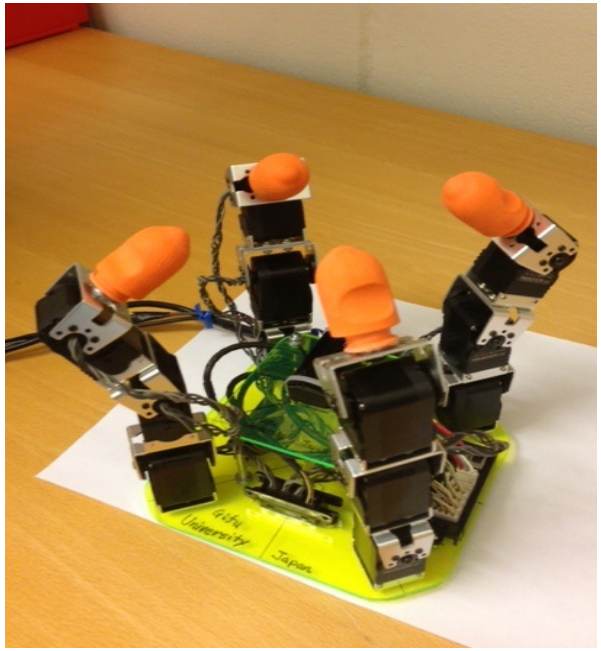
http://www.youtube.com/watch?v=08K_aEajzNA

4. Robot gripper interface



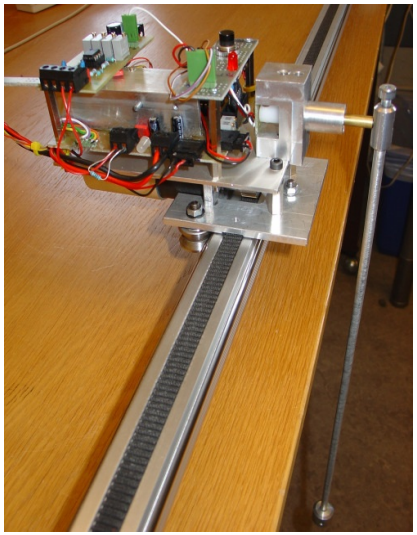
Model and control interaction of forces for each finger
Simulation of dynamics to “haptically show” shapes

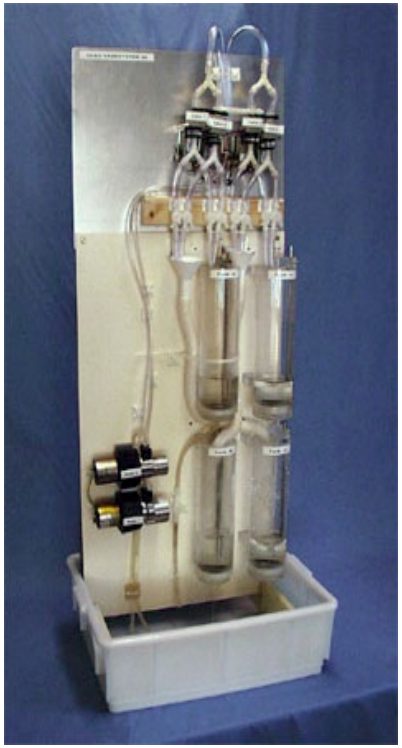
Each finger has three links/servos



5. Python or Julia in Control

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





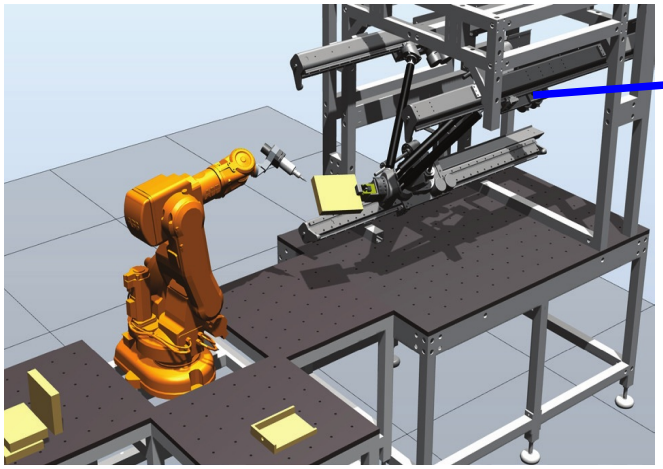
6. Balancing bag

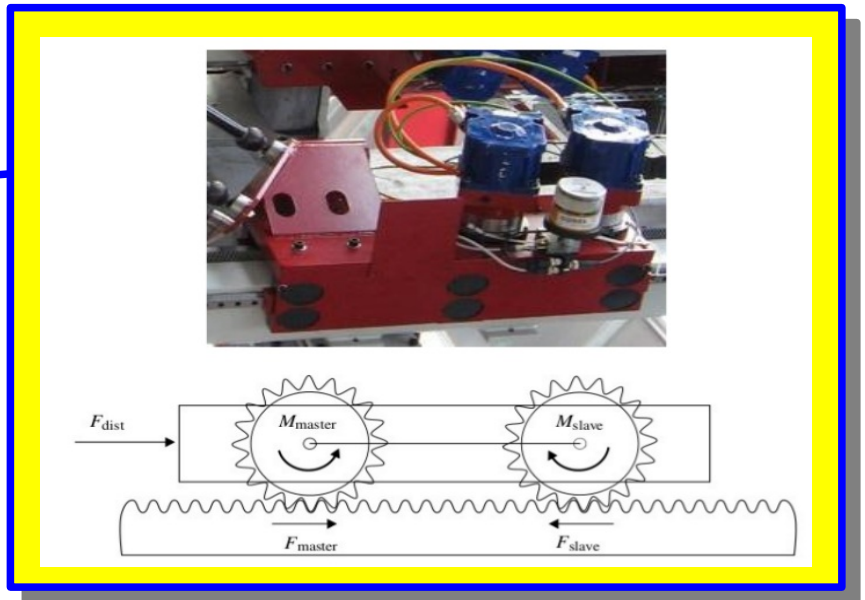
Model and design actuation, sensing, and control to get a bag balancing on one of its corner.

7. Dual motor control with industrial servo control

Within one of the research project at the department of Automatic Control parallel kinematic robots use linear guides with dual motor control for backlash reduction to achieve very high accuracy and repeatability.

Task: Implement dual motor control in industrial servo controller Beckhoff TwinCAT 3





8. Control of Medical Infusion Pump

A current research project aims at achieving closed-loop blood pressure control in intensive care. As part of this project, computer control of a clinical infusion pump needs to be established.

The objective is to write a Python program, which enables control of a Carefusion Alaris TIVA pump.

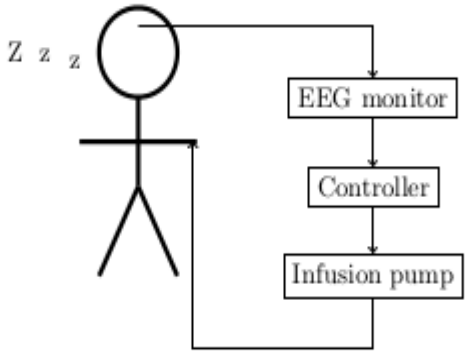
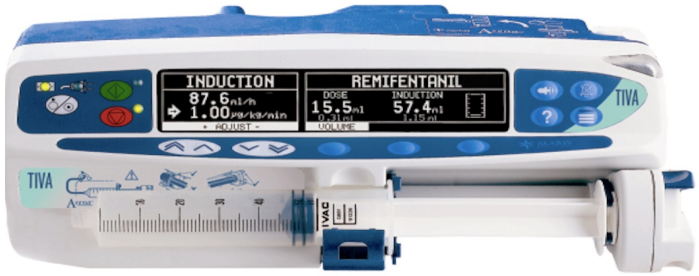


Figure 1: Schematic drawing of closed-loop anesthesia control system.



Infusion pump

9. Optimization and Software Interfacing for Mobile Robots

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

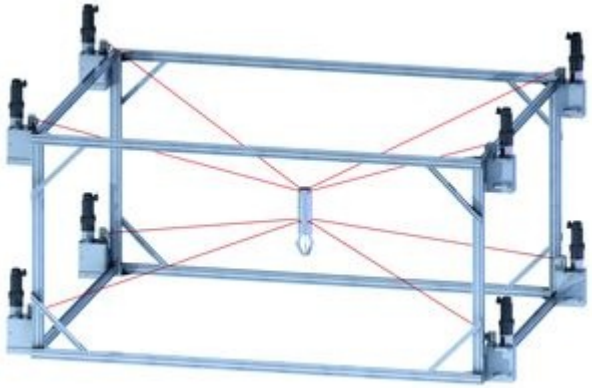
- Visual based docking
- Study navigation (SLAM)
- Motion planning

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

10. Cable robotics

Building and controlling a cable robot

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



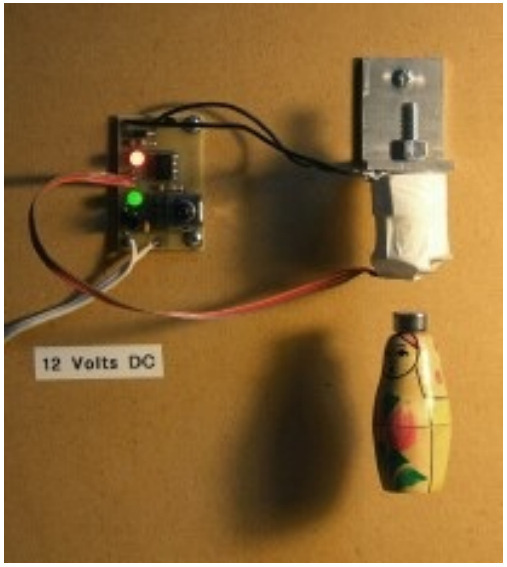
Step 2: Planar “lecturing robot” (4 wires), drawing on white board

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

11. Electronics

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

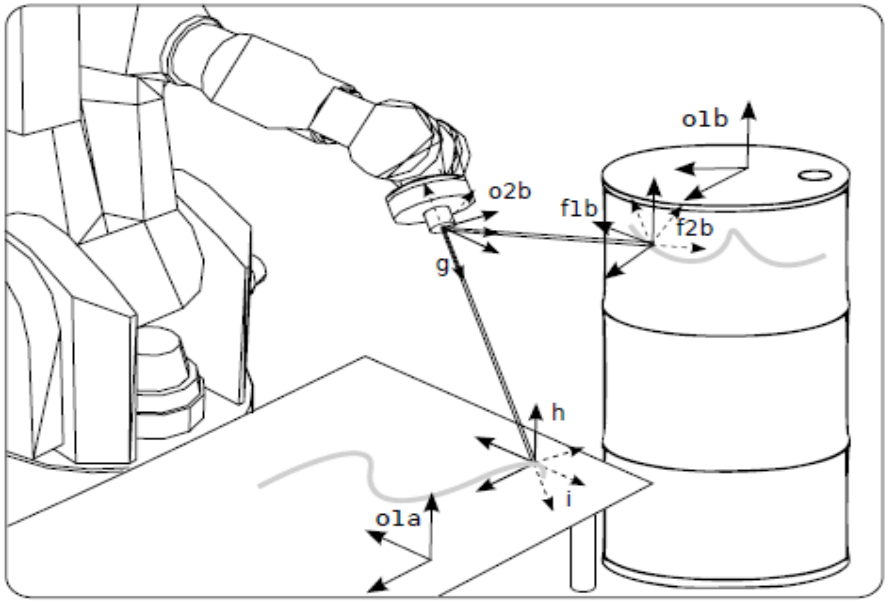
Example: High-performance levitating magnet system (control current for electro-magnet to get object with magnet to levitate at desired height.)



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

12. Task specification in robotics

iTaSC (instantaneous Task Specification using Constraints) is a framework to generate robot motions by specifying constraints between (parts of) the robots and their environment.
Typically you can specify several simultaneously tasks.
Project: Apply “dual tracking task” for an industrial robot.



13. Gripping and handling

Motion planning for robust pick-and-place operations with robot using work space sensing (kinect camera, point cloud library, ROS).

Example: pick, analyze and solve Rubik's cube with

14. Own project ideas

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