Assigment 4 Working with real robots

- notes on the way to a final assigment, enough to get you started.

The aim of the final assignment is to let the students get experience in working with a small application, which solves a task on a physical robot. In this work they should use some of the topics learned in the course.

Each group will get their own physical robot to interact with. Common to each project is that it will consist of:

- a RW application.
- usage of the RW task interface to control the task.
- interfacing to the robot.
- a tool and/or sensor providing some form of interaction.

Each group has to deliverer 4 parts:

- a report, which explains the problem domain, thoughts, ideas and solution that have been found in the project.
- a separate manual that explains how to use the solution.
- a CD with the code and additional material, used to derive the solution.
- a video showing the solution in action – mpg4 (on CD) or a YouTube link.

The report has to be delivered in a printed form, and should be placed on the CD as well in pdf format.
In an appendix to the report should be stated how have written which parts of the report.
A typical report should be in the order of 50 pages (excluding appendix), written in font size 12.

The assignment has to be delivered a latest at 12.00 o'clock on the 20th January 2010, at the MMMI secretary at Niels Bohrs Allé.

An overview of the assignment for each group, the robot, and who will be the primary contact person.

Group	Task	Robot	Contact person
1	Writing in foam	Fanuc i200	Jens Cortsen
2	Building with Lego bricks	Katan 6D	Niels Jul Jacobsen
3	Parallel robot control	Dockwelder VGT	Niels Jul Jacobsen
4	Path generation for MPN	CS1200 Robostacker	Niels Jul Jacobsen
5	Open loop position control	Lynx 6	Niels Jul Jacobsen
6	Kinematic control of Humanoid	RoboNova-I	Niels Jul Jacobsen
7	Picking laundry from basket	KUKA KR3	Jens Cortsen
8	Scanning unknown objects	Panasonic SCARA	Anders Bøgild
9	Visual servoing grasping	Denso VR	Simon Falsig

Group 1 Assignment "Writing letters in the foam"

The aim of this project is to make system that is capable of "carving" out letters in foam (flamingo), using the Fanuc i200 robot setup.

Input to the system comes from a user, who in a GUI types a sentence in a given font and size. From this should be created a task description of the lines, which a robot has to follow, in order to carve this out of foam. The task description must then be translated into joint coordinates that is to be send to the robot.
The system must be able to simulate the robots movement in RWS, to verify that this can be done without damaging the robot or its tool.

Consider what elements the task format must consist of (air movement, dock movement, start tool, stop tool etc.)
As part of the assignment, specify the work area where the foam is to be placed.

Jens Cortsen is normal in charge of the Fanuc robot, so he should know the details on how to communicate with the robot, and how to "carve".

Group 2 Assignment "Building with lego bricks"

Based on a build order description from a Lego CAD program, make a system where a robot build the given 2D lego structure.

Sub tasks.
Translate the Lego CAD description into a sequence of robot orders. From this sequence make an RW program that performs the building task.
The Robot is a Katana 6D, from Neurobotics. This robot has to be modeled in RW/RWS, based on the given CAD model.
The interface to the Katana is a serial protocol that is specified in the operation manual, use this and the already given old RW Katana interface to control the robot.
The task must be simulated in RWS.

Consider how to build the setup, for the robot in such way that the task of picking up the lego bricks is easy. In a similar way consider how to place the bricks on a board.
Given only a limited amount of lego bricks – it is only fair to limit the complexity of the build plan.

Group 3 Assignment "Parallel robot control"

Make a system, which uses a joystick to program a sequence of joint positions on the Dockwelder VGT, in order to build a job. Make the joystick interface, in a way, so the user controls the TCP of the robot instead of the individual joints. The system has to be developed using RW.

Sub tasks:

- Setup the kinematics for the dockwelder robot setup in the lab.
- Make the interface between the VGT-controller and the RW application
- Interface a joystick to RW
- Make a GUI that collect the inputs into a task, that then can be executed
- Model the new structure in RWS, so a recorded sequence can be seen

Consider: how should it be possible to edit the sequence of positions, what about the speed and blend between different positions.

Group 4 Assignment "Path generation for MPN"

Given the MPN CS1200 RoboStacker make a system in RW, which can execute a series of position on the RW (=job), from a given input format (xml?)

Sub tasks:

- The input format can include, time, position, joints position, tcp, tool command etc.
- How the communication to the robot is done, have to be established
- Make the system, so a simulation of the job can be seen
- Make a GUI in RW, that gives an user the ability to download programs, get status of the robot, abort execution etc.

Consider:

- how to add a tool to the robot, so the job is simplified to taking a stack of pallets from one place and place them on a conveyor.
- Is it possible to simulate the TG of the real robot in RW

Group 5 Assignment "Open loop position control"

The small Lynx 6 robot is controlled with simple RC servo's, than don't give a position feedback is the set position isn't reached, leading it to be an open loop control. In order to make the robot controllable a visual servo feedback is to be added.

So the assignment is to make a visual servo system in RW for the Lynx 6 robot.
The RC servo' of the Lynx has to be controlled either by a system developed in the embedded course or by a SSC32 controller with a serial interface. The chosen controller must be interfaced to RW. The visual input comes from a firewire camera, placed on a fixed mounting pointing toward the area that the robot has to be controlled in.

As inspiration are given two articles, one on the kinematics of the Lynx, and one on a visual servo system for also control of the Lynx.

Consider a good way to track the tool of the Lynx robot. And what types of task should the robot done with the tracking.

Group 6 Assignment "Kinematic control of Humanoid"

Make a plug-in to control the Humanoid robot RoboNova from RW. The RoboNova robot is a small robot, which uses RC-servos for its actuation.

Sub tasks:

- make a kinematic model for the RoboNova in RW
- make a 3D model of the Robot for RWS, based on the part description
- make an interface to either upload or directly control the robot
- make a task interpreter to add a more abstract robot language to control the robot. This could be a macro like language
- make a GUI in RWS to support the programming of the robot

Here is a link to the robot:
http://www.lynxmotion.com/Category.aspx?CategoryID=91

You can download info and manuals from this site as well.

Group 7 Assignment "Picking laundry from basket"

Use the KUKA KR3 in RoboLab to make a system in RW, that makes it possible to pick laundry from a basket.

To grasp the laundry, either a gripper interfaced in the embedix course, or a pneumatic gripper should be used. The laundry is primary towels in the metal basket. When picking up the laundry it should be placed on the table which the robot is also placed.

Sub tasks:

- make or use an interface between to the KUKA robot and RW
- get the gripper to work and interfsce it to RW
- consider if a laser distance sensor is to be used, if so interface it to the system
- develop a strategy for picking the laundry from the basket, in order to avoid "hole digging"

Additional, discuss: what are the Workspace of the robot with respect to the given job, and what problems does this give – and how to solve it.

Group 8 Assignment "Scanning unknown objects"

Using the Panasonic SCARA robot in RoboLab, make an application that can scan an unknown object placed in a given area in front of the robot.

There already exists a TOS-net interface to controlling the robot from RW, use this as a staring point.
On the tool of the robot is placed an ultrasound distance sensor, use this sensor as the basis for the scanning of a new object.

Sub tasks:

- there should be a RWS simulator that show how the strategy works
- the output from a scan must be converted into a STL files that can be saved

Consider different strategies for how to scan an unknown object, put som limit to the size of the object – what are the resolution and the cone from the ultrasound sensor.

Group 9 Assignment "Visual servoing grasping"

Used the new Denso robot in RoboLab, to develop a visual servo system that are able to find and grasp objects.

Use the Prisholm three finger hand to catch object on the floor in front of the robot. The user should give a rough position of the object to be picked, so that it is in the visibility of the web-camera on the hand – then the system should track the correct position and try to grasp the object.

Sub tasks:

- make an interface between the bCap and RW
- make a state machine to determine the robots mode
- make a RWS interface showing the movement of the robot and the hand

Consider:

- how to determine a successful grasp
- the distance to the floor is not constant, how to compensate for this (to camera positions, stereo vision etc..)