Robotics 41013: Lab Assignment 2

Total Subject Weight: 45%.
Group Size: 2
Proposal (group): Week 7 – 21:00 Friday 8th May
Initial Feedback Stage (individual): Week 9 Lab Class – 18:00 Tuesday 19th May
Video Trailer Submission (group): Week 11 – 21:00 Friday 5th June
Final Demonstration (group): Week 12 Lab Class – 18:00 Tuesday 9th June
Final Video (individual): Week 12 – 21:00 Friday 12th June
Final Viva (individual): assessment Period (after week 12). Bookings essential

Background:

After your success in introducing the robot into their assembly of parts, your company, SafeCo, is looking to expand their product range. SafeCo want to expand their business and are interesting in investigating the possibility of selling small robot systems to customers for use in the home, office or workplace. Management wants your team to spend a few weeks investigating the application of a small-scale pick and place manipulator, including integrated safety. SafeCo have made a small robot manipulator available for you to base and test your design on. YOU ARE NOT LIMITED TO THIS SELECTION. YOU CAN PROPOSE ANY ROBOT (tutors reserve the right to discussed proposed robots).

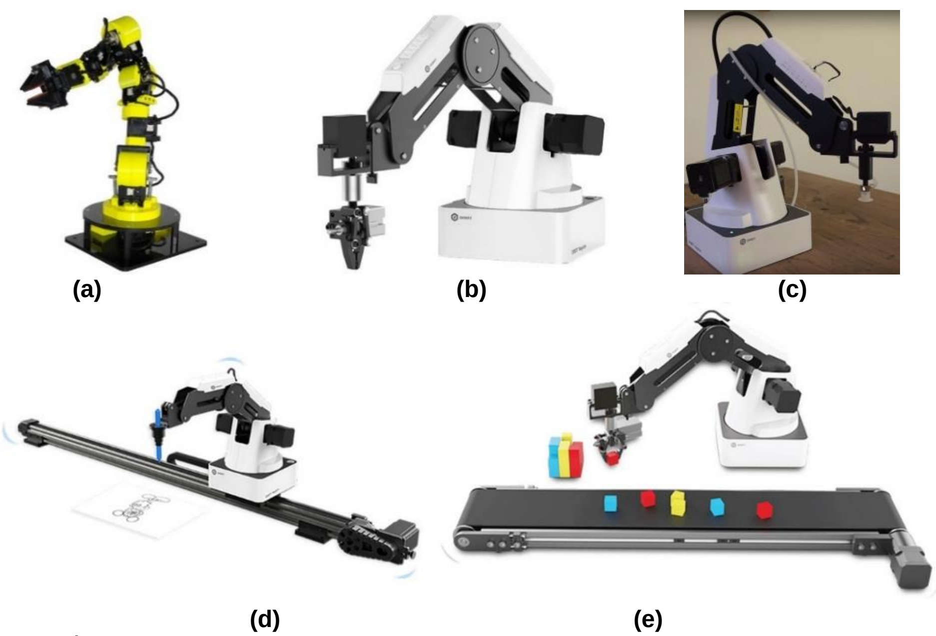

Fig 1. (a) Han's Cute[1] (previously Cyton 300e) with pincer (claw) gripper as the end effector, (b) Dobot Magician[2] with a pincer gripper end effector, (c) Dobot Magician with a suction cap gripper end effector, (d) Dobot Linear rail, (e) Dobot conveyor

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[1] http://en.hansrobot.com/prod_view.aspx?TypeId=10&Id=174&FId=t3:10:3

SafeCo Pick-and-Place Task:

SafeCo wants you to consider a plausible application for a pick-and-place robot which can either have a pincer gripper or a suction cap gripper. The application must be something outside of the traditional factory (e.g. home, kitchen, office, car), and will involve the manipulation of (an) everyday object(s) in a novel way. There are likely to be possible collisions which your system must be able to avoid. So, you need to include at least 3 forms of safety (e.g. barriers, active workspace sensing, signage, collision detection, collision avoidance and planning) modelled into your environment. Also, sensor data (at least an E-stop and simulated collisions, and maybe RGBD camera data) should feed into your system.

Overview Lab Assignment #2

Due in Week	Milestone	Worth	Description
7	Proposal	2%	Team submits the following details via a Google Form[3]: • Names and students' numbers of group members, • Team project title • 100 word description of intended project • The robot you intend to use and why • The Code repository[4] URL for your code (note if you make the project private please invite tutors to join)
9	Initial Feedback Stage	5%	• SWMS and Risk Assessment for real robot (1st attempt is marked, but resubmits are required until adequate) • Regular repository commits for evidence of progress. • Spark+ report on participation of other team member(s)
11	Short Promotion Video	8%	• Create a 1-minute video promoting your system, include footage and details of the system's purpose, its features and the system working. • Upload to a sharing platform (preferably YouTube), then share the link on the discussion board.
12	Final Demo + Video	40% + 25%	Final demonstration (**see detailed task breakdown**) Final 3-minute video (**see detailed task breakdown**)
A1-A2	Final individual code viva	20%	Each student will be examined closely on all the code in the repository in a viva (i.e. interview). For full marks assessors can ask any questions about the code, or bugs found or added to the code. No robots will be used in the viva (just simulated code). Students may request to be examined on only a portion of the code (which they wrote); however, their marks will be reduced accordingly.

[2] http://www.dobot.cc/downloadcenter/dobot-magician.html?sub_cat=73#sub-download

[3] Google Form to submit group details of Robotics 41013 Lab Assignment #2 http://goo.gl/c5weiF

[4] Atlassian's BitBucket web-based Git hosting service: http://bitbucket.org/

Extreme-Difficulty Option (can be in a group of 3)

There is the option to take on the extreme difficulty option and you can work in a group of 3 students, with additional scrutiny during the Viva. This will require that you undertake one of the extended options that is expected to require significant unassisted use of ROS:

- Mobile Manipulation (e.g. Dobot on a Turtlebot unstructured navigation, pick and manipulate),
- Multirobot Collaboration (e.g. gripper design/manufacture and two UR3 robots doing handover or working together **without** direct communication). Sensor integration is a must for this task.
- Another highly-challenging option that is negotiated with the tutors.

Final Submission (demo + video): Detailed Task Breakdown

Due: Week 12.

1) Build a simulated model of your chosen arm and environment (based upon your scenario)
2) On the submission day, separate to the video (submitted the week before), each team needs to demonstrate the system working both in simulation and if possible on the real robot. The simulated system must include a user interface, safety hardware (e.g. barriers, warning signs/lights/sirens), and this may be implemented on the real robot as well and augmented with active sensors whose data is read and controlled in Matlab.
3) Incorporate safety
    a) To react to an asynchronous stop signal by a user. The system will stop based upon an action from the user (e.g. press an emergency stop button, and/or sensed to enter an unsafe zone).
    b) To prevent collisions. When a simulated object (that you make and control) is placed in the path of the robot, it will stop until there is no predicted collision or move to avoid the collision.
    c) To make the robot retreat from a simulated safety symbol using visual servoing and RMRC
4) Include an advanced “teach” Matlab GUI which allows jogging the robot. It should include both individual joint movements (like the Toolbox’s “teach”) plus enable [x,y,z] Cartesian movements. A valid addition is to use a joystick or gamepad instead of a GUI to send commands to your system.
5) Create a 3-minute (i.e. exactly 180-second) professional video. Use real video, simulation, images and diagrams to assist to describe in detail your project, robot system, findings, and reflections. The video should be both interesting to watch, and demonstrate your learning to solve your novel task. Ideally you should also include details about planning, control, safety, user interfaces, sensing (both already-included as well as possible extensions, such as sensors that would be applicable and give the robot more capabilities)
6) Ensure the team’s Matlab code is available on a code repository for tutors to access and download. On the submission date, the code will be downloaded and marked against the given code standards (see UTSOnline).

Marking Scheme:

The assignment is worth 45% of the subject, half will be a group mark which is then assigned used Spark+, the other half will be an individual mark based upon your own report submitted via TurnItIn. All reports are to be written individually. Bonus marks are available for incorporating additional hardware or sensors into your system.

Criteria (task)	**Weight (%)**
Proposal Submission **(Due week 7)** (group task)	**2%**
Initial Feedback Submission **(Due week 9)** (individual task)	**5%**
1-minute promotion video (trailer) of your specific project **(Due week 11)** (group task)	**8%**
System Demonstration (as a group with Spark+ used to weight these marks):	***40%***
Demonstration of specified task in class and group presentation (10-15 minutes per group): Path plan between several poses and the final joint state given a unique environment (developed by each group) and the simulated model. Creatively use a real robot that mimics and/or enhances the simulation and application.	*28%*
Safety in Demo: (1) System reacts to user's emergency stop action (2) Trajectory reacts to simulated sensor input (e.g. light curtain) (3) Trajectory reacts to a forced simulated upcoming collision (4) Make the robot retreat from a simulated safety symbol using visual servoing and RMRC	*12%*
Group final 3-minute video *(group task)*	***25%***
Demonstrate development and learning to solve a problem with a novel robotic solution	*5%*
Video has professional presentation and is interesting to watch	*5%*
Includes details of 41013 Robotics learning outcomes such as robot modelling, planning and safety, and user interaction with the system.	*10%*
Robotics sensing: Ideas for applicable sensors that would (1) give the robot more capability; and (2) Improve the system's safety	*3%*
Evidence-based future predictions for robotics in the given scenario	*2%*
Code Viva (individual task)	**20%**
Total	**100%**
Bonus (1): Up to 5% bonus marks for incorporating additional hardware in your System Demonstration: e.g. for safety, collision detection, an end-effector.	+5%
Bonus (2): Up to 5% bonus marks for having the system (real or simulated) react to **real RGB-D sensor data** in your System Demonstration. Require a combination of calibration, mapping, object recognition, image processing.	+5%