Robotics 41013: Lab Assignment 2

Total Subject Weight: 35%.
Group Size: 2-3 students (all member MUST contribute meaningfully)
Proposal (group): Week 7 – 21:00 Friday 16 September
Initial Feedback Stage (individual): Week 9 – 21:00 Friday 7 October
Short Promotion Video (group): Week 11 – 21:00 Friday 21 October
Final System Demonstration (group): Week 12 Lab Class – 11:00 Monday 24 October
Final Video (group): Week 12 – 21:00 Friday 28 October

Background:

After your success in introducing the robot into their assembly of parts, your company, SafeCo, is looking to expand their product range. SafeCo wants to expand their business and are interested 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 robot, including integrated safety. SafeCo has made several real desktop robot manipulators (including their Matlab models) available for you to test your design on (see below). Your task is to model and add a new industrial robot arm that is not in the toolbox.

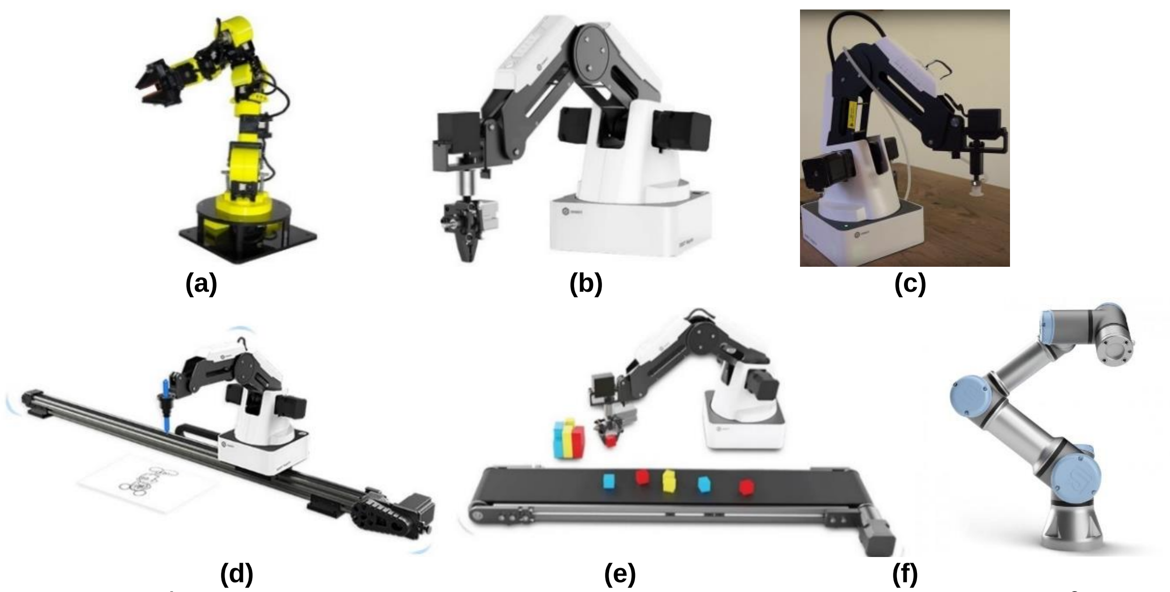

Fig 1. (a) Han's Cute[1] (previously Cyton 300e) with pincer (claw) gripper, (b) Dobot Magician[2] with pincer gripper, (c) Dobot Magician with suction cap gripper end effector, (d) Dobot Linear rail, (e) Dobot conveyor, (f) UR3

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[1] Hans Cute Robot user manual is in Canvas. Here is the ROS driver: http://wiki.ros.org/Robots/Hans-Cute
[2] Dobot Magician user manual is in Canvas. Here is our ROS driver: https://github.com/gapaul/dobot_magician_driver/wiki

SafeCo Pick-and-Place Task:

SafeCo wants you to consider a plausible application for a pick-and-place robot which can have a gripper. The application must be something outside of the traditional factory (e.g. home, kitchen, office, car, mine), and will involve the manipulation of (an) everyday object(s) in a novel way using at least 1 arm that is given and 1 new on that you create. There are likely to be possible collisions which your system must be able to detect and avoid. So, in order to pass this section, your group need to model within your simulated environment (and/or include) at least 3 forms of safety (e.g. barriers and signage, active workspace sensing, collision detection / avoidance and planning). Also, sensor data, including at least a functioning E-stop (can be simulated via a GUI) and simulated collisions, and other sensors such as cameras or laser that can feed data into your system.

Using Real Hardware OR Simulation Only

Prior to 2020, marks were allocated for using real robots in the labs. However, due to COVID and remote working, there needed to be the alternative to using real robots available to students. Therefore, if you and your partner are able to come to UTS (i.e. you are enrolled in the F2F class), you should choose the normal option and use one of the real robots (on page 1). Using real robots is a rewarding learning experience. The labs will be available to book time slots throughout the rest of this session. Your marking criteria will expect you to use a real robot. However, if most of the team cannot come to UTS to use the real robot (i.e. most are enrolled in the online class), that is fine. In that case, you should choose to use another existing model in the toolbox.

Final Submission: Detailed Task Breakdown

Due: Week 12.

System Demonstration

Build a simulated model of your chosen arm and environment (based upon your scenario).

On the submission day, separate to the videos (submitted the week before), each team needs to actively participate in an online demonstration of their system working both in simulation and, if applicable, on the real robot (students should present video evidence). The simulated system must:

1) Include 2 robot arms that interact. 1 should be an existing robot arm from the updated toolbox and 1 needs to be a new one. Thus, all groups need to model, in simulation, a commercial robot arm **other than** the ones in the Toolbox. There are many robots with different capabilities, so please propose one that is suitable for your application and discuss it with a tutor.
2) Include a Matlab graphical user interface (GUI) to interact with the system. The GUI should have advanced "teach" functionality that 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 GUI-based button presses.

3) Incorporate a functional estop (can be simulated or real) that immediately stops operations. Disengaging the estop must not immediately resume the robot system but only *permit* resuming (meaning two actions are necessary to resume). For full marks your system must be able to recover/resume after an e-stop event. Using uiwait() to pause everything will be penalised.
4) Place the system in a simulated environment that includes safety hardware (e.g. barriers, warning signs/lights/sirens), and if relevant this may be implemented on the real robot as well and augmented with active sensors (BONUS) where signals are passed back to the Matlab program.
5) Incorporate safety functionality
   a) To react to an asynchronous stop signal by a user. The system will stop based upon an action from the user (e.g. simulated (or real) sensing of something/someone entering 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. Active collision avoidance will be marked higher than simply detecting a collision and stopping.
   c) To make one robot retreat from a simulated safety symbol that is held by the second robot using visual servoing and RMRC
6) Ensure the team's Matlab code is available on a code repository for tutors to access and download. The code and your understanding will be scrutinised during the individual code viva. You are expected to still adhere to the given code standard.

Video

Create a 3-minute (i.e. **exactly** 180-second) professional video. Use real-world footage, simulations, images and diagrams of robot systems to assist in describing your project in detail. Videos should be:

1) interesting to watch (and you should be proud to share later),
2) demonstrate your learning from the subject to solve your novel task,
3) include details about the planning, control, safety, user interfaces, sensing in your system
4) give details of possible extensions, such as sensors, hardware, safety, other robots that would be applicable and to give your system more capabilities

Marking Scheme:

Criteria (task)	Value
Proposal Submission **(Due week 7)** (group task) Together with a partner, present/discuss your proposal with lead tutors (Gavin, Sheila or Tony). Then the team is to submit the following details via a Google Form[3]: • Names and students' numbers of group members, • Team project title • 100-word description of the intended project • The robot you intend to use and why • The Code repository[4] URL for your code (note if your project is private, please invite tutors to join)	**2/35**
Initial Feedback Submission **(Due week 9)** (individual task) • SWMS and Risk Assessment assuming the robot is real (even if it is only in simulation) (1st attempt is marked, but resubmits are required until adequate) • Evidence of regular commits to repository to show progress • Spark+ report on participation of other team member(s)	**3/35**
1-minute promotion video of your specific project **(Due week 11)** (group task) • Create a 1-minute (exactly 60-second) 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 to everyone.	**5/35**
System Demonstration (group task with the final Spark+ used to distribute these marks):	***15/35***
Demonstration of the new robot with an existing robot completing a specified task during an online (in class time) group presentation (10-15 minutes per group): Path plan between several poses and the final joint state given a unique and safe environment (developed by each group) and the simulated model. Use RMRC, collision avoidance and a GUI where appropriate. Creatively use a real robot that mimics and/or enhances the simulation and application. Marks may be scaled to ignore the hardware portion if there is a good reason why the available hardware is not used.	*10*
Safety in Demo: (1) System reacts to user's emergency stop action (**minus** marks if no estop) (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	*5*
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[3] Google Form to submit group details of Robotics 41013 Lab Assignment #2 http://goo.gl/c5weiF
[4] There are many code repository options: e.g. Atlassian's BitBucket: http://bitbucket.org/ and Github https://github.com/

Final 3-minute video (group task with the final Spark+ used to distribute these marks)	***10/35***
Demonstrate development and learning to solve a problem with a novel robotic solution	*2*
Video has professional presentation and is interesting to watch	*2*
Includes details of 41013 Robotics learning outcomes such as robot modelling, planning and safety, and user interaction with the system.	*4*
Robotics sensing: Ideas for applicable sensors that would (1) give the robot more capability; and (2) Improve the system's safety	*1*
Evidence-based future predictions for robotics in the given scenario	*1*
Final Group Member Peer Feedback Online via Spark+ (individual task) Individual multiplier used to distribute the Demo & Final Video group task marks amongst group members. This task is not compulsory. Only needed if there is a need to distribute group marks in a non-uniform way.	X weight
Total	**Out of 35**
Bonus (1): Up to 2 bonus marks for incorporating additional hardware in your System Demonstration: e.g. for safety, collision detection, an end-effector.	+2/35
Bonus (2): Up to 2 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.	+2/35

The Final individual code viva is a separate assignment based upon the code written in this assignment. Each student will be examined closely on all the Matlab code in the repository in a viva (i.e. interview). For full marks, assessors can ask any questions about the code, bugs found or additions to the code. No robots or simulations will be used in the viva (just the Matlab code). Students may request to be examined on only a portion of the code (which they wrote); however, their marks will be reduced accordingly.