41014 Sensors and Control for Mechatronic Systems – Projects for Autumn 2020

Projects form 50% of the assessment for the subject. You will be assigned a project based on your preference and your skills. You need to **form a group of 3** and submit your preferences as a group. You are encouraged to find another project at similar level (closely related to sensors and/or control) that is suitable for you (If this is the case, please write a description of the project and send it to Liang Zhao Liang.Zhao@uts.edu.au before 6:00pm, 23 August 2020).

Schedule:

17 August 2020 --- Project list distributed with a short description.

- Students are required to submit their choices in the order of preference as a group (minimum 2 choices) through UTSOnline Discussion Board (Forum **Group project selection in 2020**) before 6:00pm, 23 August 2020. The projects will be allocated mostly based on your choices and your skills.
- Students are expected to contact the supervisor responsible for the project through email if they need any further information or have any questions about the project.
- If it is difficult to form a group of 3, group of 2 students is acceptable.
- As the current situation, we allow any student who would like to work on the project individually.
- Projects assignment will be available by 24 August 2020.

30 August 2020 – 6:00PM

- Proposal (5%): Submit a document **PER GROUP** on the scope, deliverables, proposed approaches, related references of the project. Submission should be a single PDF file (within 5 pages) and through email to the supervisor as well as Liang Zhao Liang.Zhao@uts.edu.au.
- Students are expected to contact the supervisor responsible for the project and develop the proposal.

20 September 2020 – 6:00PM

- Mid-review report (5%): Submit a document **PER STUDENT** on the works done so far of the projects.

11 October 2020 – 6:00PM

- Code (10%): Submit the code developed in the project **PER GROUP**, with a description of the code (structure of the code, readme) and also the individual contribution to the code (e.g. 30%, 30%, 40%).
- Video (5%): Submit videos **PER GROUP** as the project demo to the supervisor which demonstrate what has been achieved in the project, with a readme document of a short a description of the video and the individual contribution to the video.

19 October 2020 – 12:00AM

- Project teaser presentation (10%): 5 mins presentation followed by 2 mins Q&A **PER GROUP**. The mark will be only based on the per review by the other students.
- Submit the slides and videos used in the presentation and the individual contribution to the teaser presentation.

20 October 2020 – 6:00PM

- Final Report (15%): Provide a proper documentation (including necessary flowcharts) of the project and a written report **PER STUDENT**.

The mark of each student will be based on the performance of the group as well as their individual contribution. It will depend on the difficulty of the project, the amount of work involved, the quality of the work, and the presentation skills etc.

Brief description of the projects

Short descriptions of the projects offered are given below. For the details of any particular project, please email the corresponding supervisors.

Since some of the students cannot/would not like to get access to the real robots and the group cannot discuss and debug together face-to-face. There are two options for the students to work on some of the projects: a) As-real robot simulator will be used; b) real robots or sensors will be used in Mx Studio. For the group with three students, please meet/discuss/debug via teleconference instead of meeting face-to-face.

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Fetch Robot Projects: **The groups which work on the Fetch Robot related projects may be selected to represent UTS:CAS to demo their works with Fetch Robot in the future (e.g. UTS Open Day). There are two options to work on the Fetch robot projects: a) The project will be FULLY carried out in Fetch Simulator. B) When the algorithms are working well in simulations, they will be tested using the Fetch robot.**

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Group Project 1: Fetch robot following the path

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

Using the learnt and state-of-art control algorithm to control the Fetch robot to follow the path of the guider in front. Both depth images and RGB images can be used to the control. Special designed artificial markers or patterns can be put on the back of guider.

Target: The Fetch robot follows the guider in front moved in the office and corridor environment with a certain distance.

Necessary skills: Linux, ROS, C++ programming

Preferable: basic computer vision and control Skills

Group Project 2: Fetch robot grasping

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

Control the Fetch robot to grasp the object on the table, e.g. can of coke, box of cookies, using the robotic arm and hand by using visual servoing method. Depth images and/or RGB images can be used for the visual servoing. The end-effector of the robot arm has been calibrated with the RGB-D camera.

Target: The Fetch robot grasps different interested objects on the table without falling down.

Necessary skills: Linux, ROS, C++ programming

Preferable: basic computer vision and control

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DoBot Robot Mechatronics Studio Projects. **These Dobot robot projects can only be done on the real robots. There is NO simulator option on the Dobot projects.**

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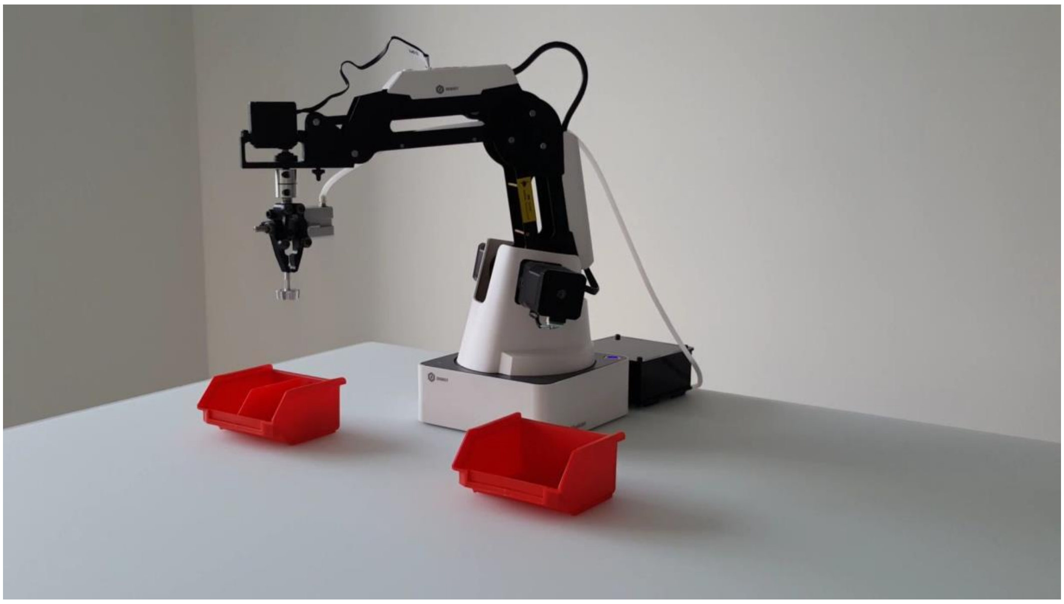
Group Project 3: Control and grasping for the DoBot Robot

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au), Dr Gavin Paul (Gavin.Paul-1@uts.edu.au)



This project aims to control the UTS remote lab DoBot robot.

http://www.dobot.cc/dobot-magician/product-overview.html

There will be an Asus Xtion pro sensor to monitor the robot, the data collected could be used to identify the object and decide the way points for the robot.

Necessary skills: MATLAB, ROS

Group Project 4: Hand-eye calibration for the DoBot Robot

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au), Dr Gavin Paul (Gavin.Paul-1@uts.edu.au)

This project aims to calibrate the relative pose between camera-end effector, pattern-end effector or robot base-global RGB-D sensor.

http://www.dobot.cc/dobot-magician/product-overview.html

There will be an Asus Xtion pro sensor to monitor the robot, pattern will be provided as well for calibration. The data collected could be used to calculate the relative poses for robot/camera.

Necessary skills: MATLAB, ROS

Group Project 5: 3D reconstruction using RGB-D camera and EM sensor

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

This project aims to implement an efficient 3D dense reconstruction of the indoor environments by using RGB-D camera and the electromagnet tracking system. First the calibration between the EM sensor and the RGB-D camera has to be done to obtain the relative pose between the two sensors. Then, at each frame, the pose of the RGB-D camera can be provided by the EM sensor. At last, when performing the 3D reconstruction, the point cloud at each frame will be transformed back to the global (EM field generator) coordinate frame and fused together.

Necessary skills: MATLAB/C++ programming

Preferable: basic knowledge on sensors and coordinate transformation

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Group Project 6: Robot following a straight line by observing a square using Turtlebot

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

This project aims to control the robot to follow a straight line by using the information observed from a sensor on-board the robot. Suppose there is a square in front of the robot, and there is a sensor which can observe the positions of the 4 corners of the square in the current robot coordinate frame. Control the robot to follow a straight line which is perpendicular to the square. Use Turtlebot Robot/Simulator and design the environment to control the robot with noise in the observation.

Desirable skills: Matlab programming, localization

Group Project 7: Turtlebot robot following each other

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

Using the learnt and state-of-art control algorithm to control the Turtlebot to follow the path of the guider Turtlebot in front. Both depth images and RGB images can be used to the control. Special designed artificial markers or patterns can be put on the back of guider.

Target: The Turtlebot follows the guider Turtlebot in front moved with real Turtlebot Robots/in Turtlebot Simulator with a certain distance.

Necessary skills: Linux, ROS, C++ programming

Preferable: basic computer vision and control Skills

Group Project 8: Visual servoing of a handheld monocular camera

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

The aim of this project is to use visual servoing techniques to control a handheld camera. The students can choose any pattern, and design any desired position on the image. Then, hold the camera with hand, and when moving the camera, the algorithm can online indicate which direction the camera should move.

Desirable Skills: MATLAB/C++ programming, image processing, visual servoing

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G**roup Project 9: Visual servoing of a handheld RGB-D camera**

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

This project is the same as Project 7, but using an RGB-D camera.

Desirable Skills: MATLAB/C++ programming, image processing, visual servoing

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Group Project 10: 3D control and path planning for the surgical robotic catheter in the aorta based on ultrasound

Supervisor: Dr Liang Zhao (Liang.Zhao@uts.edu.au)

Use state-of-art control and path planning methods to control the surgical robotic catheter following the centerline in the 3D environment of aorta. Real-time intravascular ultrasound images can be used to provide the distances from the robotic catheter to the vessel wall.

Target: Control the surgical robotic catheter following the centerline by using the phantom experiments dataset.

Necessary skills: MATLAB/C++ programming

Preferable: basic path planning and control