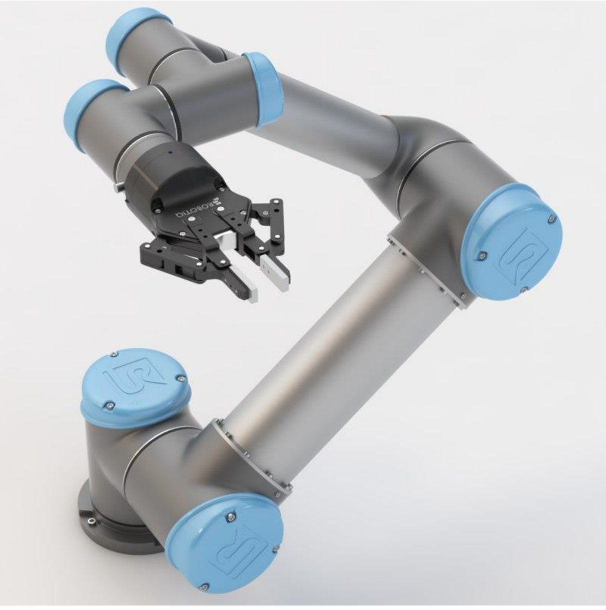
The University of Western Australia
Dept. of Electrical, Electronic and Computer Engineering
Professor Thomas Bräunl

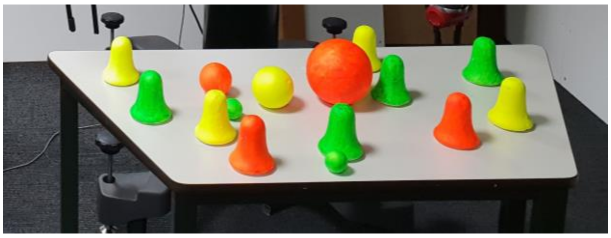
Robotics

GENG5508

Group Project	**Manipulators**	**Weeks 7-12**

Pick and place





Each group will be assigned a robot manipulator (either UR5 or UR5e) for this project.

Tasks to complete

Implement a **Python** program that allows the manipulator to sort objects of various sizes, shapes, and colours into buckets.

- Locate & identify objects of different types (shapes and colours) placed in a pre-defined area.
- Compute world coordinates of objects from the camera coordinates.
- Sort objects by colour (*i.e.*, pick up all objects of a specified colour and drop them in the corresponding bucket).
- Communicate task progress and problem states to the operator.
- Program the manipulator to move smoothly and quickly.

Bonus tasks:

- Find the bucket locations automatically.
- Let the manipulator pick up objects placed on a non-level surface.
- Allow the operator to place objects and buckets outside the manipulator's initial field of view and have the robot search for objects and buckets.

Mid-project assessment (10% of project mark)

To ensure teams are making progress with the project, each team will be asked to demonstrate the following tasks during their **Week 10** consultation session:

1. Run a program that picks up an object from a fixed location (*i.e.*, no real-time image processing required). It should do the following:
    a. Move the robot to a predefined starting pose.
    b. Ensure gripper is open.
    c. Move the robot to the known object location.
    d. Close the gripper.
    e. Lift the object to some predefined location.
2. Apply colour thresholding for one colour to an image captured from the robot camera containing three objects with different colours. The output should be a binary image showing the locations of the object with a particular colour.
3. Draft pseudocode outlining the pick and place program. The pseudocode should be written using Python-like syntax.

Successful demonstration of these tasks will be awarded **0.5 marks each** (out of 15 for the entire project).

Getting started

The UR5/UR5e manipulator used in this project consists of three components:

- The Universal Robots UR5/UR5e arm;
- The Robotiq Wrist Camera; and
- The Robotiq 2F-140 Adaptive Gripper

A third-party library for programming UR5 with Python can be found here:

https://github.com/SintefManufacturing/python-urx

A short guide on getting started with this, as well as how to capture images from the camera, can be found on the unit website:

http://robotics.ee.uwa.edu.au/courses/robotics/project/general/python-urx_GettingStarted.pdf

Image processing in Python can be done using opencv:

https://docs.opencv.org/master/d6/d00/tutorial_py_root.html

General information on UR5/UR5e can be found in the relevant User Manual:

UR5: https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/UR5_UserManual.pdf

UR5e:
https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/UR5e_UserManual.pdf

Additional information on controlling the gripper and camera can be found in the relevant user manuals:

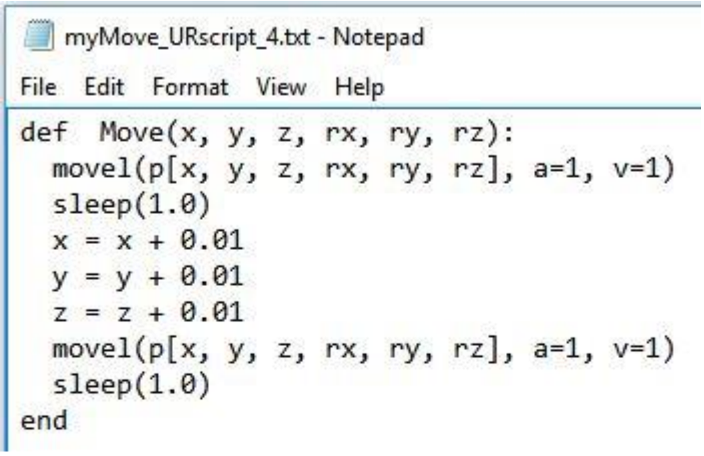
https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/Camera_UserManual.pdf

https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/Gripper_UserManual.pdf

The underlying code running on the UR5/UR5e is written in the URScript language. Information on program structure, basic commands, and device interfacing can be found in the URScript Manual:

UR5: https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/UR5_ScriptManual.pdf

UR5e:
https://robotics.ee.uwa.edu.au/courses/robotics/project/ur5/UR5e_ScriptManual.pdf



```
def  Move(x, y, z, rx, ry, rz):
  movel(p[x, y, z, rx, ry, rz], a=1, v=1)
  sleep(1.0)
  x = x + 0.01
  y = y + 0.01
  z = z + 0.01
  movel(p[x, y, z, rx, ry, rz], a=1, v=1)
  sleep(1.0)
end
```

Additional tutorials covering PolyScope GUI and URScript programming can be found here:

http://www.zacobria.com/universal-robots-knowledge-base-tech-support-forum-hints-tips/

Robot simulation software is available on computers in computer room 1.51:

https://robodk.com/