Introduction to robotics

Build a robot arm – an optional project

Each week you will be guided through a project activity to build your own robot arm. At the end of the course we will invite you to submit a video of your completed robot. A small number of participants will peer review your project and you will review a small number of others.

1) Project instructions

You will design, build and program a robot (with a minimum of two joints) which can draw a line through a number of points on a worksheet (we provide this in PDF format). Your robot's success is determined by how many points it joins with the line; how many points are joined in sequence; how quickly it completes the tasks and how accurately it stays within the boundary of the sheets.

2) You will need

a) Equipment

There are many technologies you can use to build your robot. You will need one of these robotics development kits. Here we list three:

1. The project videos demonstrate the use of the **LEGO Mindstorms NXT** kit with the older NXT brick:
   9797 LEGO Mindstorms Education Base Set
2. You can use the newer **LEGO Mindstorms EV3** kit:
   45544 LEGO Mindstorms Education EV3 Core Set
3. **Hobby robot components** such as Dynamixel AX12 servo motors, mechanical brackets and connectors, cables and an Arduino-based Arbotix control board.

Choosing your hardware option

Each week we release a short video that takes you through successive stages of building your robot project. Unfortunately we can't cover all of the options above. The first project video discusses the pros and cons of the various approaches, but after that we focus totally on option 1. Much of the content is applicable to the other options, but it will require some interpretation. If you find fellow students in the course who are taking the same approach as you, you can share tips or work together.

Your choice of technology depends on:

a) what resources you have access to (ideally borrow what you need or buy what you can afford)
b) your skill level
c) your confidence in taking a different path to the demonstration videos which are for option 1 only.

b) Software

You will need to download a custom software toolbox to control your robot. Select the toolbox

appropriate for the kit you are using:

- RWTH - Mindstorms NXT Toolbox - if you are using the LEGO Mindstorms NXT kit (model 9797)
- QUT EV3 MATLAB toolbox - if you are using either EV3 kit (models 45544 or 31313)

c) Worksheet

To be successful your robot arm must navigate the path on Worksheet 1. The worksheet is available in two sizes for you to download and print.

- Suitable for printing on A2 paper:
  A2 Robotics worksheet 1 (PDF, 82KB)
- Suitable for printing on 4 sheets of A4 paper and assembled to make an A2 path:
  A4 Robotics worksheet 1 (PDF, 1.6MB)

3) What to do

a) Build the robot arm

Watch the weekly video demonstrations and follow the instructions to develop the robot arm.

b) Test your robot

Test the success of your robot arm by placing the robot on the worksheet.

c) Worksheet rules

You will need to consider the following rules as you design, build and demonstrate your robot's capability. When you place the robot on the worksheet:

- The base of the robot must be placed inside the 200mm x 200mm grey area.
- Only the drawing tool can touch the workspace outside of the 200mm x 200mm grey area.
- Your robot can overhang outside of the 200mm x 200mm grey area but cannot touch it apart from the drawing tool.
- You are not allowed to touch your robot after it begins to move.

d) Record your robot's performance

When you are ready to record your robot completing the tasks we ask you to make a video and upload it to YouTube to share with your learning community. You can use any device to record the video however there are three requirements:

1) Your robot should be videoed from above. You should be able to see each workspace point on the worksheet in your recording.
2) The recording should be shot with one continuous take.
3) The recording should only include the robot and the worksheet. No hands etc.

4) *Peer review assessment*

This 'Build a robot arm' activity is not part of the activities that contribute to attainment of a certificate of participation. It is an opportunity for your efforts to be peer reviewed and to also provide feedback to other participants.

a) Rubric

The rubric shows the relationship between the criteria, performance measures and grades used to measure the success of your robot. It ensures everyone participating in the peer assessment has a shared understanding. It is also a great tool you can use to evaluate your robot as you develop and refine it.

	Unsatisfactory	Pass	Excellent
Function	The robot drew through only 3 workspace points or fewer.	The robot drew a line through at least 4 of the workspace points in the correct order.	The robot drew a line through all 5 workspace points in the correct order.
Speed	The robot exceeded 45 seconds to complete the course.	The robot completed the course in less than 45 seconds.	The robot completed the course in less than 30 seconds.
Performance	The drawing tool strayed out of the dashed boundary lines or the edge of the worksheet more than once.	The drawing tool strayed out of the dashed boundary lines or the edge of the worksheet once.	The drawing tool did not stray outside of the dashed boundary lines.

b) Peer assessment

A small number of your peers review your video and indicate the success of your robot. Your final grade will be either 'Unsatisfactory', 'Pass' or 'Excellent' and will be cumulated from the feedback received from your peers. Each of your peer reviewers will grant you a score from 1-3, where 1 is 'Unsatisfactory', 2 is 'Pass' and 3 is 'Excellent'.

c) How to submit your robot for peer assessment

When you are ready to share your finished robot with our learning community:

1) Secure the worksheet to a flat surface and attach your robot to the worksheet using blue tack or sticky tape if required.
2) Record your robot performing the task
3) Upload your video to YouTube. Set the video privacy action to 'Unlisted'. You should verify your URL is working correctly by trying it yourself or sending it to a friend.
4) Go to the final week of the course and start the peer assessment. You will complete a quick training exercise to learn how to review robots using the assessment rubric.
5) Type or paste the YouTube URL for your robot video in the appropriate response box when prompted.
6) When you have uploaded your YouTube URL you will be assigned 3 videos to review.
7) Your final mark will be out of 9. It is calculated as an average of the marks received from your peer reviewers. A score of 6 or above is satisfactory.

5) Help/support

We encourage you to use the discussion forum if you have a question about the project. Be sure to tag your post with #robotproject and a teaching assistant or perhaps one of your peers will respond promptly. Your post will then be available to help others who may also find the information helpful.

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