National University of Singapore
EE3305 Robotic System Design, Part 2
AY 2022/2023, Semester 1

Instructor 1 Information
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Course Description

This module will introduce the mobile robot systems' architecture and key components such as various sensors and actuator technologies. Various locomotion mechanisms adopted by robotic systems will be discussed. The module will also introduce basic principles of robot motion control. Robot Operating System (ROS) will be utilised for simulation in virtual environments.

Course Goals and Learning Outcomes

Upon completion of this course, students should be able to:

1. Analyse motion of different locomotion mechanisms
2. Understand key working principles of selected sensors and actuators used in robots; and select appropriate sensors and actuators for a robot system to achieve a given task
3. Apply basic robot motion control principles (strongly related to Part 2)
4. Utilise ROS for mobile robot simulation in a virtual environment (strongly related to Part 2)

References

1. About Robot System Design: Maja J. Mataric, The Robotics Primer, MIT Press, 2007. Chapter 10 - 19. Online sources: http://roboticsprimer.sourceforge.net/wiki/index.php/Main_Page
2. About Robot Operating System: http://wiki.ros.org/

Assessment

Item of Assessment	**Important Dates**	**Weightage**
Project 1 (PID Control)	Choose <u>one</u> of these days to attend the lab: 12, 13, or 14 October 2022, 2.00 – 5.00 pm Report and video submission on: **30 October 2022, 23.59**, via Canvas Code submission on: **30 October 2022, 23.59**, via Canvas	 Report and video: 10% Code: 10%
Project 2 (Path Planning)	Choose <u>two</u> of these days to attend the lab:	

	19 - 28 October 2022 (note that 21 - 24 October 2022 are holidays), 2.00 – 5.00 pm Report and video submission on: **6 November 2022, 23.59**, via Canvas Code submission on: **6 November 2022, 23.59**, via Canvas	Report and code: 10% Code: 10%
	Submitting PPT for presentation: **7 November 2022, 23.59**, via Canvas 3-minutes presentation on (a pair of students to choose one slot): 8 November 2022, Tuesday (10.00 am – 12.00 pm) 10 November 2022, Thursday (12.00 pm – 2.00 pm)	Presentation: 10%
	TOTAL	**50%**

Project 1 (PID Control)

In this project, students are expected to demonstrate the ability to:

- Setup Gazebo environment according to requirements
- Apply a PID control in Robot Operating System (ROS)
- Tune PID control gain and explain the rationale
- Present and analyse the performance of the system

Project 2 (Path Planning)

In this project, students are expected to demonstrate the ability to:

- Setup gazebo environment according to requirements
- Apply a control system in a path planning problem
- Apply a path planning algorithm in Robot Operating System (ROS)

Course Outline

Week	Tuesday	Thursday	Remarks
7		**29 Sep, 12.00 – 13.00** 1) Introduction to the Module (Part 2)	
8	**4 Oct, 10.00 – 12.00** 2) Introduction to ROS Introduction to Project 1 and Project 2	**6 Oct, 12.00 – 13.00** 3) Control	
9	**11 Oct, 10.00 – 12.00** 3) Control	**13 Oct, 12.00 – 13.00** 3) Control	Students doing Project 1
10	**18 Oct, 10.00 – 12.00** 4) Path Planning	**20 Oct, 12.00 – 13.00** Project Clarification	Students wrapping Project 1 Students doing Project 2
11	**25 Oct, 10.00 – 12.00** 4) Path Planning	**28 Oct, 12.00 – 13.00** 4) Path Planning	Students doing Project 2
12	**1 Nov, 10.00 – 12.00** 5) Robotic Applications	**3 Nov, 12.00 – 13.00** 5) Robotic Applications	Students wrapping Project 2
13	Presentation on 8 or 10 Nov (Students to choose the slot)		

Classes and Project Work

Classes are in-person at LT2. Classes are recorded. The recording of the class is available at Canvas > Videos/Panopto. Lab sessions are in-person at Control & Simulation Lab (E4A-03-04). Lab sessions are not recorded.

Project work will be utilizing Robot Operating System Noetic Ninjemys (ROS Noetic). ROS Noetic runs best on Ubuntu 20.04. Students are to book lab sessions. The link for booking will be announced.

Submission of Work

Students are expected to plan and manage their workloads and to ensure they do not lose work through IT malfunction or poor planning. An assignment will be considered late if it misses the deadline without advance permission. Late submissions are reflected in the marks that students receive for the respective assignment.

Presentation

The presentation is a maximum of 3 minutes, followed by Q&A.
Students are to book the presentation slot. The link for booking will be announced.

Student Conduct

The Code of Student Conduct promotes an environment that facilitates intellectual pursuits, supports student and community development, and enforces civility and personal responsibility. Information about Code of Student Conduct in NUS can be found in https://nus.edu.sg/osa/resources/code-of-student-conduct.

Absent Policy

Students are expected to attend classes, lab sessions and presentations, unless there is a valid reason. Prior approval is required. Absence due to Covid-19 follows Registrar's Communications on 25 February 2022 or as updated by the University.

Self-Installation of ROS

Students can choose to also install ROS in their own machine. Students should still come to the lab for Project 1 and Project 2 for us to see that you are doing the project.

Please note that due to the high variability of personal machines, we may not be able to support queries pertaining to personal machines.

Students can do the one of the following to get access to ROS Noetic:

1. Machine/laptop with Ubuntu 20.04 Operating System

   Students may have a machine/laptop with Ubuntu 20.04 as the operating system. Students can install ROS Noetic on Ubuntu 20.04 from http://wiki.ros.org/ROS/Installation.

2. VirtualBox

   Students may have a machine/laptop with Windows (if using PC) or iOS (if using Mac) as the operating system. Students can opt to install VirtualBox. Students can download VirtualBox from https://www.virtualbox.org/. After installing VirtualBox, install Ubuntu 20.04 on the VirtualBox (follow one of many sources online, such as https://linuxconfig.org/how-to-install-ubuntu-20-04-on-virtualbox). After installing VirtualBox, install ROS Noetic on Ubuntu 20.04 from http://wiki.ros.org/ROS/Installation.