Mobile Robotics EECE5550 – Fall 2022

No matter if this is your first time or 100th using the Bash command line interface (terminal) on Unix/Linux. Try to complete this:

https://ryanstutorials.net/linuxtutorial/

Instructions for Setting Up Computing Environment

In order to complete the lab assignments and course project, we will be using the following computing environment over the course of this semester:

- Operating System: Ubuntu 20.04 LTS
- Programming language: Python 3 with numeric libraries such as NumPy and SciPy.
- Robotic toolbox: Robot Operating Software (ROS) version Noetic

It is important to note that while you are free to use other operating system for assignments that does not require ROS, you need to use Ubuntu for assignments involving ROS as it is only operating system that ROS officially supports. It is possible to install ROS on another operating system, however, they are experimental, thus, not recommended. If your current system is not Ubuntu 20.04, you can follow the instructions below to install Ubuntu and the rest of the tools.

Installing Ubuntu

Windows

If you are currently using Windows machine, you have three options to install Ubuntu on your machine:

1. *Install Ubuntu as a Virtual Environment.* This is the safest and perhaps the easiest way of installing Ubuntu on a Windows machine at the cost of reduced hardware resources for Ubuntu. We will be using a specialized software called VMWare that can run Ubuntu as a program without leaving Windows at all. First go the https://neu.onthehub.com and sign in with your NEU credentials. Search for VMWare and download VMWare Workstation Pro 16.x from the results. After it is downloaded, install the software on your machine. Follow the instructions at this link to install Ubuntu 20.04 using VMWare: https://ubuntu.tutorials24x7.com/blog/how-to-install-ubuntu-20-04-lts-on-windows-using-vmware-workstation-player

2. **NOT RECOMMENDED:** *Remove Windows and natively install Ubuntu*. This way get rids of the Windows completely and replace it with Ubuntu 20.04. Follow this option **only** if you do not want to use Windows as your daily operating system. For this option you will need an USB drive with at least 4GB of size. Please follow the instructions at this link: https://itsfoss.com/install-ubuntu/ for replacing Windows with Ubuntu 20.04

3. **NOT RECOMMENDED:** *Dual-boot Windows and Ubuntu.* In this option, you will see how to install Ubuntu alongside with the Windows. This allows you select the operating system when you boot your computer. Note that this option is slightly more

complicated and can result in data loss in your Windows so make sure to back up your important files prior to this installation. Please follow the instructions at this link: https://itsfoss.com/install- ubuntu-1404-dual-boot-mode-windows-8-81-uefi/

MacOS

If you are using MacBook Pro or MacBook Air, the best way to install Ubuntu is to install it as a Virtual Environment. It is important to note that this **only works for Intel-based Mac machines**.

Install Ubuntu as a Virtual Environment. To install Ubuntu on a Mac machine, first go to https://neu.onthehub.com and sign in with your NEU credentials. Search for VMWare and download VMWare Fusion 12.x Pro from the results. After it is downloaded, install the software on your machine. Follow the instructions at https://graspingtech.com/vmware-fusion-ubuntu-20.04/ to install Ubuntu 20.04 using VMWare on your Mac.

What is ROS?

From ROS website: The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms.

The ROS has been the de facto software framework for building and deploying robotic applications. It has several purposes but the most important one is that it provides a common API for scientists and practitioner to write robotic software so that we can easily use their implementation. For an example, you might be building a control software that allows cars to follow lanes. You might want to only focus on the control algorithm and not deal with 'lane detection' problem. If someone already wrote a program for this task, you could go ahead and integrate their solution easily to your program. The main goal of the ROS is to prevent reinventing the wheel every time you start a new robotic project and let you focus on the parts that you are interested to improve.

Installing ROS Noetic

Once we have ubuntu installed, we will follow the official instructions for installing ROS Noetic on Ubuntu 20.04 which can be found at http://wiki.ros.org/noetic/Installation/Ubuntu Note that ROS installation requires you to use the Terminal. If you are not familiar with using Terminal on Ubuntu, please read this crash course on using Terminal: https://missing.csail.mit.edu/2020/course-shell/ and complete https://ryanstutorials.net/linuxtutorial/

Installing NumPy and SciPy

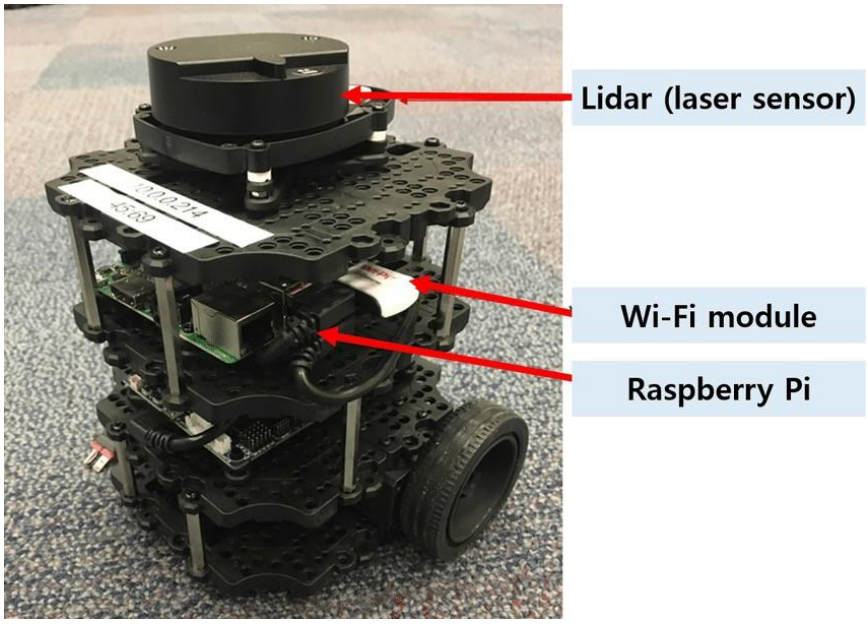
NumPy and SciPy are the two essential Python libraries for scientific computing. They provide methods for linear algebra, probability, calculus and optimization. To install them on your Ubuntu you can follow the instructions at https://automaticaddison.com/how-to-install-pip-on-ubuntu-20-04/ Make sure you install both of for Python 3.

ROS Resources

- http://wiki.ros.org – Official documentation
- http://answers.ros.org – Stack overflow for ROS
- https://industrial-training-master.readthedocs.io/en/foxy/ – Unofficial tutorials
- http://Github.com – Countless ROS packages

Computing Environment and Hardware

- Operating System: Ubuntu 20.04
- Python 3 with Numpy, Scipy, Jupyter Notebooks
- Robot Operating System version Noetic
- Robot: Turtlebot 3



Bringing up the TurtleBots

The TurtleBots will be given to you as assembled but there are a couple of steps before you can start using them. In these steps, you will install the Ubuntu 20.04 on the Raspberry Pi with the given SD card and install the drivers for the motors. Please go to this link. and follow sections 3.1, 3.2 and 3.3. To get a feel for the TurtleBots, feel free to follow section 3.5 and 3.6 to bring up the bots and perform basic operations.

Some safety notes

The TurtleBots use LiPo batteries. You will receive a charger for these batteries. Please follow the instructions here to safely charge the batteries. You should never leave the battery plugged into the charger for a long time. Also, for better battery life, unplug the batteries from the robot when you are not using it. Finally, do not charge and use the robot at the same time. The battery should be unplugged from the robot while charging.

- **https://emanual.robotis.com/docs/en/platform/turtlebot3/overview/** - TurtleBot 3 tutorials
- **https://github.com/ROBOTIS-GIT/turtlebot3** - ROBOTIS e-Manual for TurtleBot 3