# CS/ME/EE 134 Lab 1 - SLAM

Released: April 13th, 2018 (Friday) (100 points) Due: Friday April 20th, 2018 by 5pm

## Introduction

In this lab you will be computing Simultaneous Localization and Mapping (SLAM) on data gathered experimentally in the Center for Autonomous Systems and Technologies (CAST) on a TurtleBot2 platform using the Robot Operating System (ROS) and a Hokuyo laser scanner, an RGBD camera, and the facility's OptiTrack system.

This lab is an enhanced repetition of Lab 3 from ME/CS 133(b) last term in which you will now be executing the whole procedure yourself and adding a *SLAM computation using the gmapping ROS package*. You will now be setting up the robot and ROS and executing the correct commands yourself to teleoperate, capture data, and perform the laser scan matching (i.e., you will be carrying out yourselves all the steps that were demonstrated for you during Lab 3 last term), and also performing SLAM with the gmapping package.

The ME/CS 133(b) Lab 3 guide has been posted on the CS/ME/EE 134 class Moodle page, here.

## Pre-lab work (35 points)

Before your group's lab session in CAST, practice using ROS on a virtual machine and explore the gmapping SLAM package on a sample rosbag file. Try to use your rosbag file(s) from Lab 3 of ME/CS 133(b) last term, or use another sample bag file. (You can find a sample bag file in the Lab 3 guide, in the following tutorial, or from a willing classmate. Make sure to note the source of your practice bagfile in your lab report). Include this experience in your lab write up. Do this pre-lab work individually or on a team, but you are encouraged to ensure each lab member is able to operate ROS individually.

Find and view the package documentation online to support this activity, and you may also seek help from the ROS tutorial on using logged data for SLAM with gmapping (includes a sample rosbag): link.

If you did not participate in ME/CS133(a,b), install the Virtual Machine according to the class instructions, here: VirtualMachineSetup.pdf. This step might take a while (involves a 5.6GB download, best done on campus). Refer back to the ME/CS133(a,b) ROS tutorial to review: ROS_tutorial.pdf

Log onto the Doodle poll by noon Monday 4/16 to schedule time for your group to visit the CAST center within the next few days: Doodle. A half-hour slot has been allotted for each team individually.

## During CAST session (65 points)

During the lab session with your group, collect real data on the class turtle bots in CAST like was demonstrated in ME/CS 133(b) Lab 3 and combine this with SLAM computation using the gmapping package. Record OptiTrack data while you drive the TurtleBot around. You can aid with the ROS gmapping SLAM tutorial here.

Note that you may end up expanding beyond the written instructions in order to make the experiment work and you will be expected to try to handle ROS on your own and get things working. Hence, it can be best to try to prepare with the pre-lab work and by familiarizing yourselves with the ROS environment and processes on your virtual machine prior to arriving to your session in the CAST center, in order to make the most of your time there and minimize your debugging on-site with the hardware. For this lab you may use online documentation of ROS and the gmapping package, as it is part of the purpose of the lab to help you gain practical capacity with these technologies.

You will be scheduled in the CAST center one group at a time, so during your group's lab slot you will have full access to the robot to perform this experiment. You are encouraged to work as a team to get the experiment working, and if you have time remaining you are encouraged to take turns to individually run the full operation for the experience.

## Lab write-up

Write up your group's experience in a lab report format, including at least the following topics:

Include a precise record of your execution process and setup in ROS. Include multiple images from RViz of your constructed map that express the time process of SLAM that was computed, and/or a video file showing the SLAM algorithm in action. Try to incorporate the OptiTrack data into your results and analysis, and comment on the changes along time in accuracy during the SLAM computation. Include a summary of your understanding of SLAM theory from the lectures and discuss correlations you observed from the lecture lessons to the lab sessions.

Format the report with sections on background/introduction, materials and methods, and results and discussion to help you include these points and your other write-up information. See the uploaded lab report guidelines document for more information.

## Submission

Submit your lab report and accompanying code/information through Moodle by the deadline (5pm Friday April 13th, 2018). One submission per group is sufficient– but clearly list all participants in the group (roster names help).