CMSC 828T
Vision, Planning and Control in Aerial Robotics
Homework 1: SLAM using GTSAM
Due on 11:59:59PM on Oct 3rd, 2017

Prof. Yiannis Aloimonos, Nitin J. Sanket,
Kanishka Ganguly, Snehesh Shrestha

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1 Introduction

Homework 1 will be a "toy-problem" of Project 2. You will be given a set of assumptions, MAT files with all the observations, your starting location, and noisy odometry reading. You will write a SLAM (Simultaneous Localization and Mapping) algorithm using GTSAM to solve for landmark computed locations and all the poses of the steps you/ your robot took in this process.

To learn more about GTSAM and the prerequisites, please refer to:

- CMSC 828T Lecture 10: Factor Graph Based Filtering Using GTSAM
  https://cmsc828t.cs.umd.edu/
  https://www.youtube.com/watch?v=o6jEKbnqvTU
- For further reading, please refer to:
  https://research.cc.gatech.edu/borg/sites/edu.borg/files/downloads/gtsam.pdf
- Pre-requisites you need to know before you learn GTSAM are:
  Bayes Net: https://alliance.seas.upenn.edu/~cis520/dynamic/2017/wiki/index.php?n=Lectures.BayesNets
  HMM: https://alliance.seas.upenn.edu/~cis520/dynamic/2017/wiki/index.php?n=Lectures.HMMs*

Please Note something about the bearing angle used by GTSAM. This can be a bit confusing. Typically bearing is the angle between the robot's orientation and the map north or some fixed axis. However, in GTSAM, bearing angle is the angle made by the robot's current pose and the vector joining the robot to the landmark with some ID `idx`.

1.1 OS Platform

While GTSAM is supported on Mac OS, Windows, and Linux. We will only support Linux officially. However, you are free to use any OS that best suits you.

2 Task

You will be given a set of noisy observation measurements of landmarks and odometry data. All the given data will be in `HW1.mat` file. You will use this GTSLAM pipeline to compute an optimized estimate of the landmarks and odometry poses.

You will write a function `SLAMusingGTSAM(Odom, ObservedLandMarks, StartingPose)` where the input will be:

- `Odom`, which is a $N \times 3$ matrix where N is the number of odometry measurements made
- `ObservedLandMarks`, which is a list of structures with each structure which has Locations (a list of noisy observations of each landmark) and Idx (ID of each corresponding landmark)
- `StartingPose`, which is pose (X, Y, Th) of the assumed starting pose, where X, Y are the location and Th is the orientation. The Th is the angle with respect to the x-axis.

Your expected output will be:

- `LandmarksComputed`, which will be a N x 3 matrix where N is the number of rows and each row denoting ID, X, Y values where ID is each landmark ID and X and Y are their corresponding X and Y coordinates. Please make sure this matrix is sorted in ascending order by ID number.
- `AllPosesComputed`, which will be M x 3 matrix where M is number of steps taken plus the origin and each row is X, Y, and Theta where X and Y are the coordinates and the Theta is the orientation.

2.1 Additional Given

You are also given `AllPoseIdeal` and `StartingPose` for you to be able to write and debug your code. For evaluation, we will be using different starting pose.

2.2 Assumptions

- All values are axis aligned
- Robot poses are defined with respect to the X-axis (horizontal, to the right in images)
- We have bearing and range information for measurements
- We have full odometry for measurements

- The robot and landmarks are on a grid, moving 2 meters each step
- Landmarks visible to the robot are in a 2 meter radius from the robot

3 Grading

We will be using some new landmarks and odometry data with your function. Your grade will be determined by the total error in your computed pose.

3.1 Submission

Please submit your code via CMSC 828T submit section. You should create a folder called `code` and copy `SLAMusingGTSAM.m` into it, zip it, and submit `code.zip`. Please note the zip file needs to be `.zip` format. Any other format is not valid.

Please note:

- Do NOT add or submit any sub-folders.
- Do NOT submit any visualization code. If you have any either remove them or comment them out.
- Do NOT print out any outputs. If you have any debug code printing outputs to the console, please remove them or comment them out.
- Only include the files that are listed below and any new dependent m-files you might have created.
- Do NOT submit any other files that are not necessary and was created only for your testing/ debugging.

Your submission should contain:

- A README.txt detailing anything we should be aware of.
- A LateDays.txt with just the number of late days you would like to exercise for this submission.
- All necessary files inside one folder `code` such that we can just run the automated testing script to see your results. The expected files for this assignments are:
  - `SLAMusingGTSAM.m`
  - And any other new m-files you might have created that is necessary for running your code.

4 Collaboration Policy

You can discuss with any number of people. But the solution you turn in MUST be your own. Plagiarism is strictly prohibited. Plagiarism checker will be used to check your submission. Please make sure to **cite** any references from papers, websites, or any other student's work you might have referred.