

ME-GY 7863 C: Special Topics in Robot Perception Assignment 2

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Aerial Mapping from Sherlock's Balloon

As you already know, Sherlock has been tracking Professor Moriarty for investigating his potential involvement regarding a recent series of abnormal malfunctioning of YouDrive's perception system. To do this discreetly, Sherlock had designed a balloon-based monitoring system which can stay up in the air for a long time. The balloon is equipped with a high-resolution and non-distortion camera which is controlled so that it is always parallel to the ground plane on a same height. However, due to the trade-off between ground resolution and field of view, in each frame, the camera can only observe a small area of the ground. Since this is a home-brew balloon, high-accuracy GPS/IMU system is not available. To create a map that is of both high resolution and large field-of-view, VSLAM is necessary. Since you, the CTO of YouDrive, had helped Sherlock last time, it is natural for him to come to you again. 41 continuous frames of images taken by the system in operation are given to you as the testing data. And your job is to come up with a solution that can generate the trajectory of the camera and create a high-resolution visual map of the ground plane. Note that time-efficiency is not important in this stage. High accuracy of the map is more critical for Sherlock.

Based on the background information and the testing images, finish the following tasks, and submit a PDF report with your codes (testing images should NOT be submitted) for the last task:

1. *Identify the state space and how to parameterize the states. (10 points)*
2. *Identify the measurement space. (10 points)*
3. *Identify the prediction function. (10 points)*
4. *How to find the initial states? And what is the optimization objective function (i.e., "bundle adjustment")? (10 points)*
5. *What methods/algorithms are suitable for automatically establish the prediction function, and what are their advantages and disadvantages? (10 points)*
6. *If the camera is not always parallel to the ground, which answer(s) to the above questions will change? And what would the change(s) be? (10 points)*
7. *Write codes to process the 41 images based on your answers above. Plot the initial states as well as the optimized states properly. (40 points)*