Yiqing Cai

Team G: The ExcalibR

Teammates:
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Individual Progress

Overview

For this stage of project, I was primarily responsible for integrating the evaluation function for the projection map on camera FOVs into path planning process. My goal is to have an effective evaluation method of projections in order to decide whether a specific 3D position for the calibration target is good or not. In order to make the optimization problem more intuitive, I set the number of points to be 200 and try to select good positions for the calibration target and plan the path for ABB robot arm wisely. We are doing the simulation in RobotStudio for the whole dome setup and calibration process, so the generated points will be the input to the RobotStudio.

Implementation

During the last stage, I was able to develop intuitive scores for projection size and coverage distribution. The evaluation for the size is for a single projection, however, the evaluation for the coverage distribution is for the whole image. How to get the global optimized solution which combines the size and distribution is a challenging problem. So I decide the number of points to be 200 and try to maximize the score for both 2 evaluation functions with a fixed number of points, which makes the optimization problem more intuitive.

Also, I made some slight changes to the evaluation function of the projection size. Instead of set the score to be proportional to the radius of projection within the valid range, now I prefer a medium size projection. So when the radius of projection is within 200 ~ 1500 pixels, the projection is valid, and when the radius equals to 700 pixels, the score equals to 1. From 200 ~ 700 pixels, the score is uniformly mapped into 0 ~ 1, the bigger the projection, the better it is. From 700 ~ 1500 pixels, the score is uniformly mapped into 0 ~ 1, the smaller the projection, the better it is.

Then I just randomly select 200 points out of all the possible positions selected along the original path, and iteratively find a best combination of points according to the evaluation function. After several sets of experiments, I found that this method is better than simply remove the points with total overlap in the following perspectives:

1. this method prefers projections with medium size, so the remaining positions contain less invalid projections for geometry calibration.
2. as the number of points is fixed, it is more intuitive and also simpler to evaluate the quality of the projections.
3. we can set the specific number of points as we want.

Figure 1 below shows several sample sets of projections on 4 camera FOVs and the set with red star indicates the best selection of 200 positions of calibration target.

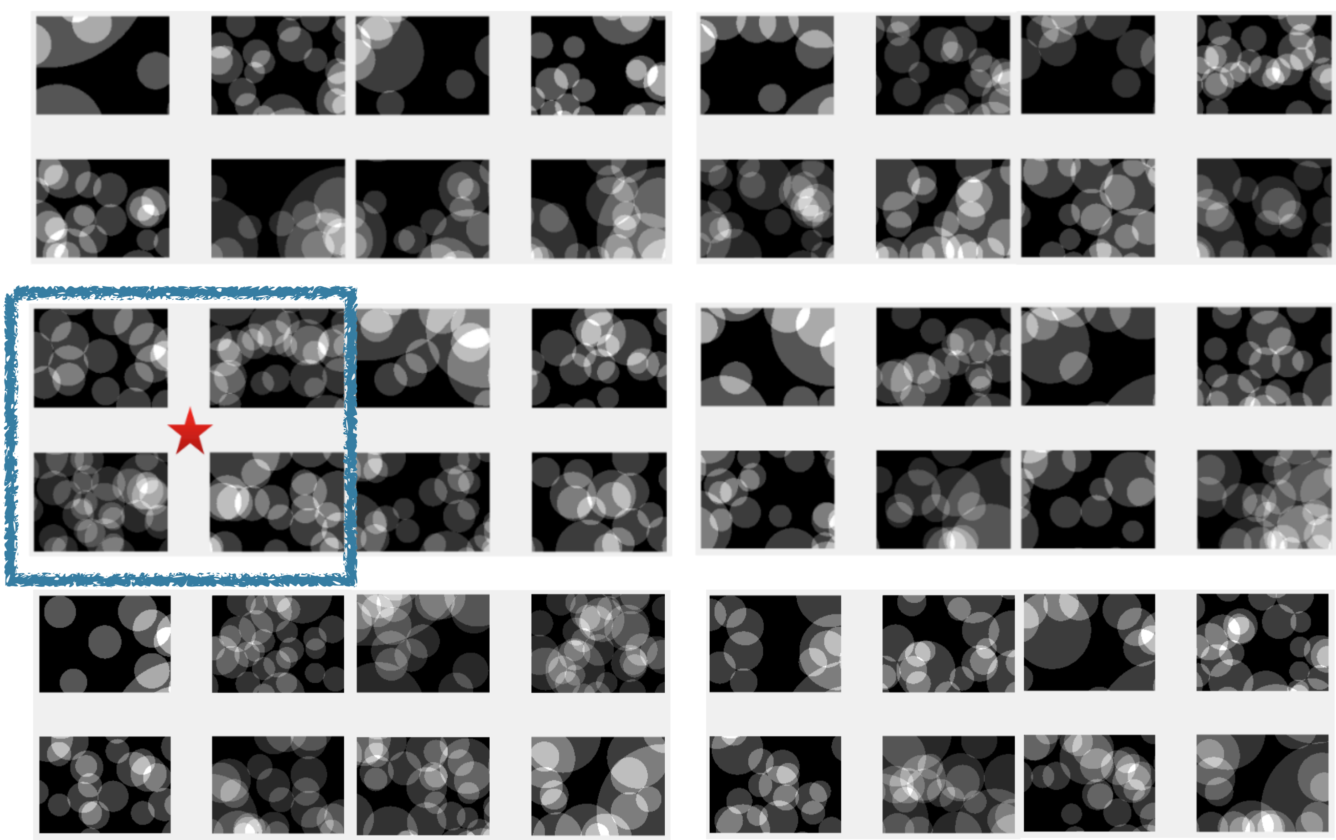

Figure 1. sample sets of projections and best selection(with red star)

We can see from the figure that the final selection of 200 positions obviously has better size of projections and better coverage on all camera FOVs, thus this method would definitely be an optional for the path optimization process.

However, the method still has some shortcomings. As the selection is totally random, it might not be robust enough when applying to 140 cameras. Besides, the methods can achieve better results through relatively more iterations, but then the time efficiency would be a problem.

Challenges

The main challenges I faced during this task were:

As the selection of positions is totally random, we need a lot of time of iterations to get an optimal solution for the combination of positions. This would definitely take a lot of time, especially for large number of cameras. And it is difficult to guarantee that the random selection is able to satisfy the coverage requirements for all the camera FOVs, as our final goal is to calibrate 140 cameras at the same time. So my following task will focus on finding out a way of giving score to a single positions based on its projection quality on all camera FOVs.

Teamwork

Work undertaken by each team member is as follows (see Table 1):

Member	Tasks
Huan-Yang Chang	Working with real ABB robot arm and trying to control it with given path
Man-Ning Chen	Testing on polynomial mapping function models for color correction
Yiqing Cai	Integrating evaluation function into path optimization process
Sambuddha Sardar	Mapping pattern data of calibration target and generating virtual images
Siddharth Raina	Analyzing the noise model and the calibration method

Table 1. Team co-work

Our team worked with great coordination during execution of the second stage of this project. We communicated during the entire task and solved problems together. Sam was working on the mapping pattern data of calibration target and generating virtual images. Peter was working with real ABB robot arm and trying to control it with given path. Mandy was working on testing on polynomial mapping function models for color correction. I was working on integrating evaluation function for projections of calibration target into path optimization process. Sid is analyzing the noise model and the calibration method. We faced many difficulties but we worked them out eventually as a team.

Future Plans

From now on, my task will be still focused on finding out a way of giving score to a single positions based on its projection quality on all camera FOVs. If this method could work out well, we just need to calculate score for each positions once then select positions who score higher. This will definitely improve the time efficiency and meanwhile guarantee the quality of projections for geometry calibration. When Sam is done generating virtual images, we can test on the geometry calibration procedure and decide the optimal path and path optimization method based on the reprojection error we obtain.