Yiqing Cai

Team G: The ExcalibR

Teammates:
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Individual Progress

Overview

For this stage of project, I was primarily responsible for developing the evaluation function for the projection map on camera FOVs. 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. With intuitive scores for projection size and coverage distribution, we would be able 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 generate the projections for all the 3D positions on all camera FOVs. The 3D positions are all sampled within the constraints of ABB robot arm. By removing 3D points with the totally overlapped projections on all camera FOVs, we can see clearly from the visualization that the overlapping is improved and number of points are much smaller than the original case.

For now, the three most important factors I take into consideration is the size of projection, the coverage distribution and the overlap, where the size and coverage is vital to the geometry calibration process and overlap is closely relevant to the efficiency of operation. So firstly, I would focus on the size and the coverage distribution.

For the size of projection, the unit is based on pixels, and the image is 3000 by 4096 pixels in size, so I consider the radius of projections of 200 ~ 1500 pixels to be valid, and within the valid range, the bigger the projection, the better it is. If the projection size is invalid, I set the score to be zero, otherwise, the score is proportional to the radius of the projection within the range of 0 to 1. So at last, for a specific 3D position, I would have a vector of size scores, and the number of elements would be the same as the number of cameras, the sum of the vector would be the final score for the 3D position.

As for the distribution, it is a global variable. I divide the camera FOV into 12 sub-areas, for each sub-area, I calculate the coverage of it. Then I would have 12 numbers within the range of

0 to 1 for a camera FOV. Then I calculate the variance of 12 numbers and consider it as the score of coverage distribution. In order to scale it into 0 to 1 and make it monotonic increasing, I apply the sigmoid function and use the negative of sigmoid with a suitable translation and scale.

Figure 1 below shows the sample evaluation for 2 camera FOVs with projections.

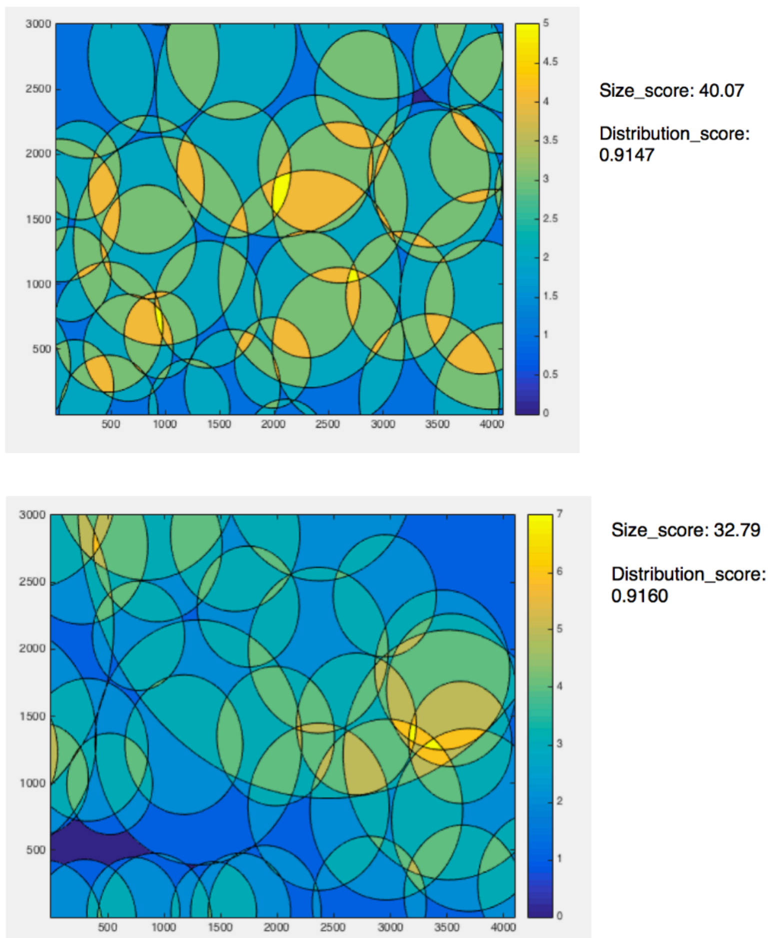

Figure 1. sample evaluation for camera FOVs with projections

Having the evaluation function above, we can then apply it to the optimization problem. And how to get the global optimized solution which combines the size and distribution is a challenging problem as I mentioned below in the challenges.

Challenges

The main challenges I faced during this task were:

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. And to be honest, it's almost impossible to get the optimist solution. So the method I am going to try is to decide a suitable number of points, and try to maximize the score for both 2 evaluation functions with a fixed number of points.

Teamwork

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

Member	Tasks
Huan-Yang Chang	Shortening the path given a fixed set of 3D points and simulate in RobotStudio
Man-Ning Chen	Testing on linear mapping function models for color correction
Yiqing Cai	Developing evaluation function for projections of calibration target
Sambuddha Sardar	Building the blender rendering pipeline and export pattern data
Siddharth Raina	Collecting data and plot the noise model

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 building the blender rendering pipeline and export pattern data for every surface of calibration target. Peter was working on shortening the path given a fixed set of 3D points and simulate in RobotStudio. Mandy was working on testing on linear mapping function models for color correction. I was working on developing evaluation function for projections of calibration target. Sid is trying to work on other kinds of sensor noise except for the FPN and PRNU we dealt with last semester, collecting data and plotting the noise model. 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 designing the effective evaluation function for projections of calibration target. Now I have two single evaluation functions for evaluating the size and distribution, and I have to combine them together and find out how to apply them on the projections to select the good 3D positions for the calibration target. The problem will them become how to select M points out of N (M << N, M is a fixed number) with the highest score of both size and distribution.