Yiqing Cai

Team G: The ExcalibR

Teammates:
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Individual Progress

Overview

For this stage of project, I was primarily responsible for improving the evaluation function for the projection map on camera FOVs into path planning process, trying to make the calculation more efficient. Besides, we are trying to move our simulation system to the real dome and testing whether the simulation results and the real situation matches. Now we set 4 cameras at the open area of the dome with tripods as the cameras are not yet mounted on the dome, and calculated the path based on the position and orientation of the 4 cameras. We are now in the process of experimenting and testing, trying to prepare enough materials for the SVE.

Implementation

During this stage, I made some slight changes to the evaluation function of the projection size. Finally the updated setting for the size score is that when the radius of projection is within 500 ~ 1500 pixels, the projection is valid, and when the radius equals to 800 pixels, the score equals to 1. From 500 ~ 800 pixels, the score is uniformly mapped into 0 ~ 1, the bigger the projection, the better it is. From 800 ~ 1500 pixels, the score is uniformly mapped into 0 ~ 1, the smaller the projection, the better it is. Besides, I also take into consideration the spatial information of the projection. If the center of the projection is out of the range of the camera FOV, I also set the score to be zero.

Then I calculate the score for all the possible 3D positions for all the camera FOVs. For example, if I have 2000 possible positions for calibration target and 140 cameras, the score matrix would be the size of 2000*140, each element in the matrix is the evaluation for a single projection at a specific position onto a specific camera FOV. Then I sum the score matrix along the second axis to obtain a vector of size 2000*1, each element represents the total score for a specific position on all camera FOVs. With this score, I can select positions with higher projection quality. And we don't have to do the iteration during position selection, thus the time efficiency would be improved significantly.

We also try to test on the real ABB Robot arm with the real dome setting. We set four cameras at the open area of the dome, and calculate the path based on this setting. The setting of the cameras are shown in Figure 1. All the possible positions (blue) for the calibration target (which is decided by the working space of the robot arm and the depth of field of cameras) and the selected positions (red) for calibrating the four set cameras are shown in Figure 2.

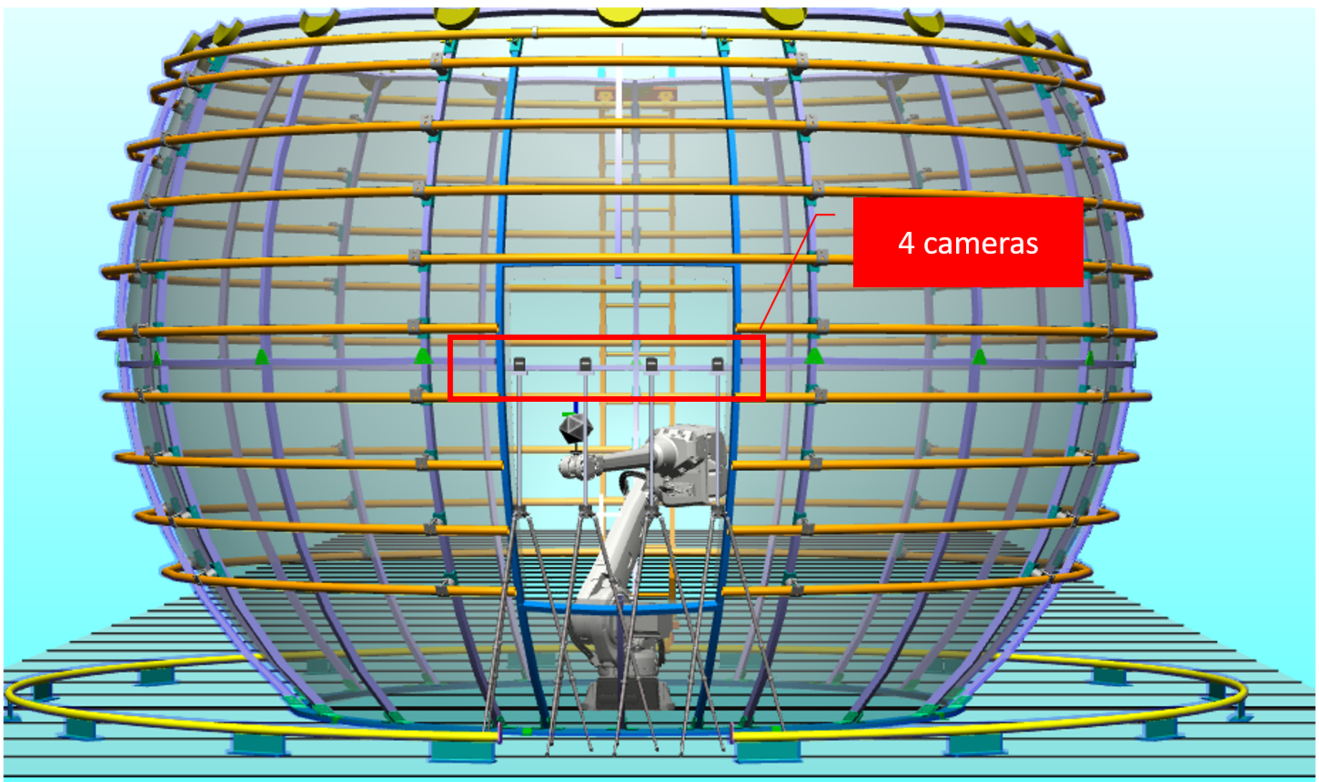

Figure 1. four cameras setting at the open area of the real dome

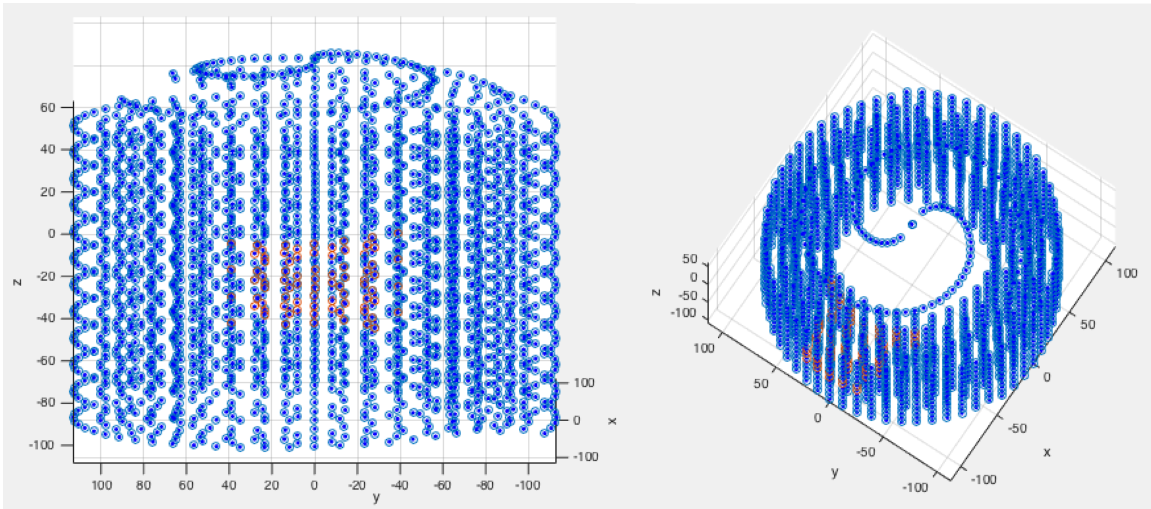

Figure 2. All possible positions(blue) and selected positions(red) for calibration target

Based on these selected positions for the calibration target, we should be able to get great coverage of the camera FOVs during data collection. Figure 3 is the visualization of projections based on simulation.

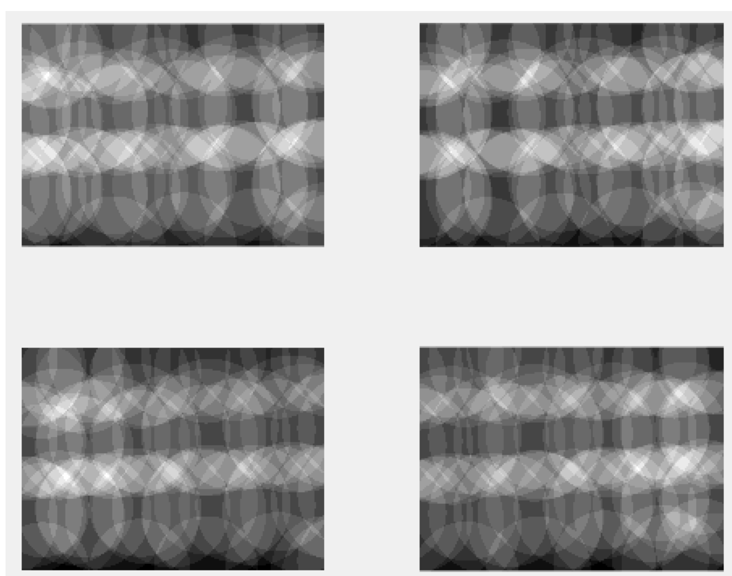

Figure 3. Visualization of projections on camera FOVs

However, when we tried on the real case and collected data, the images we got were very different from what we expected. Figure 4 shows the images we get from 4 different cameras, many images are not focused and the size of the projections are not ideal as expected.

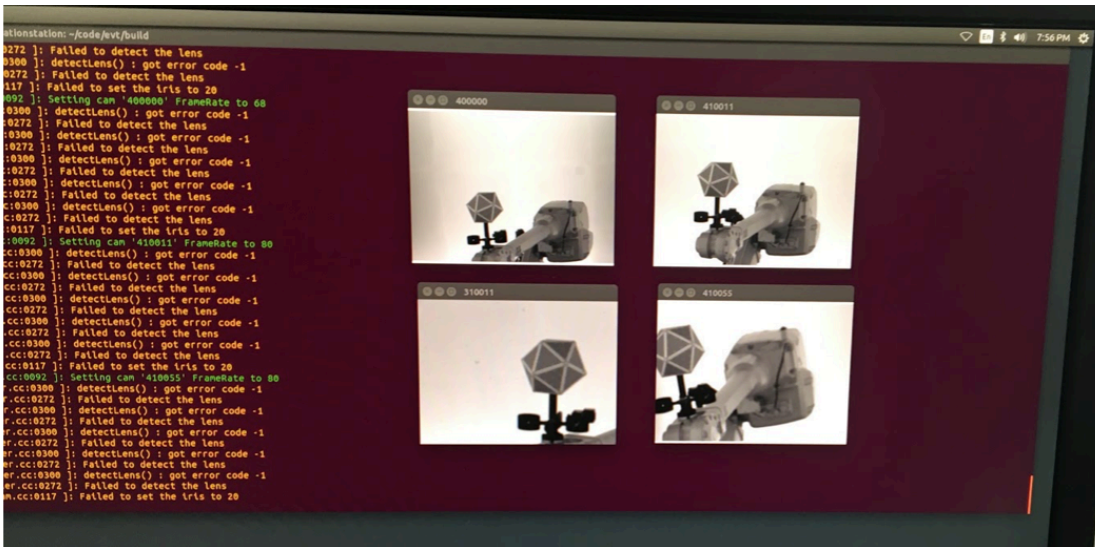

Figure 4. Sample images collected during experiments in the real dome setting

The differences might be caused by the wrong settings in the real case and wrong modeling in the simulation. Also we found that we must take the depth of field of cameras into consideration because we don't want to re-focus the cameras during data collection. Besides, we found that some of the cameras we are using have the different focal length from simulation, so the size of projections varies and depth of fields are not identical. So we would have to test on more accurate camera settings and re-calculate the optimized path based on the adjusted models and parameters.

Challenges

As we are trying to test on the real ABB Robot arm in the real dome now, we have to deal with the differences between the real world and simulation cases. For example, it is hard to set the camera at a specific position and make it look at a certain direction. Although it doesn't have to be perfect as we are doing calibration to get the exact position and orientation of the camera, the error still can not be too big as we are planning the path for the calibration target relying on this setting. Otherwise, we won't have enough information of where the field of view of the camera can cover. Besides, the calibration target must be moved within the depth of field of the camera in order to let the camera focus. So we might have to adjust the working space of the ABB Robot arm and modify the Original path for position sampling based on the real environment and real cameras.

Teamwork

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

Member	Tasks
Huan-Yang Chang	Testing on real ABB robot arm and verifying the optimized path
Man-Ning Chen	Testing on polynomial mapping function models for color correction
Yiqing Cai	Testing on real ABB robot arm and verifying the optimized path
Sambuddha Sardar	Rendering and generating virtual images in Blender
Siddharth Raina	Analyzing the noise model and building sensor noise calibration pipeline

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 rendering and generating virtual images in Blender. Peter and I was working with real ABB robot arm and trying to testing on it and verifying the optimized path, collecting valid images for geometry calibration test. Mandy was working on testing on polynomial mapping function models for color correction. Sid is analyzing the noise model and building sensor noise calibration pipeline. We faced many difficulties but we worked them out eventually as a team.

Future Plans

From now on, my task will be focused on improving the camera settings in the real dome experiments and matching the real situation to the simulation results. We will set the cameras with a more accurate method, move the calibration target within the depth of field of cameras, and collect images with focused calibration target of appropriate size. If we can get images as we expected, we can test the geometry calibration algorithm and get re-projection error to evaluate the designed path and robot simulation results.