INDIVIDUAL LAB REPORT
TEAM G- EXCALIBR

- HUAN YANG CHANG
- MANNING CHEN
- YIQING CAI
- SAMBUDDHA SARKAR
- SIDDHARTH RAINA

1.INDIVIDUAL CONTRIBUTION

THE CALIBRATION PIPELINE

Currently, work is being carried out on a pipeline to perform photometric and geometric calibration for multiple cameras after removing the fixed pattern noise from the images gathered using those cameras. The pipeline must be fully autonomous: all necessary tasks required for camera calibration must take place in a sequential manner without any human involvement. Also, methods are being devised to estimate errors in the geometric calibration technique to calculate the intrinsic and extrinsic parameters of the cameras (the camera calibration matrix) and fixed pattern noise removal (noise present in the image due to two major factors: dark signal non-uniformity and photo response non-uniformity). The various stages of calibration are explained by the images below.

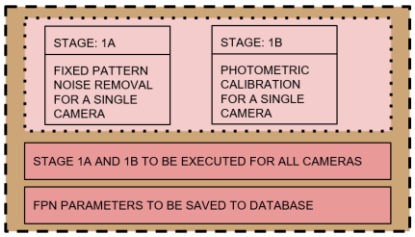

FIG 1.1 STAGE 1

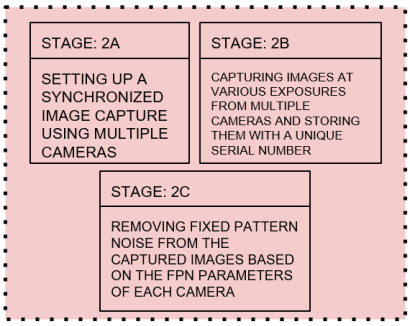

FIG 1.2 STAGE 2

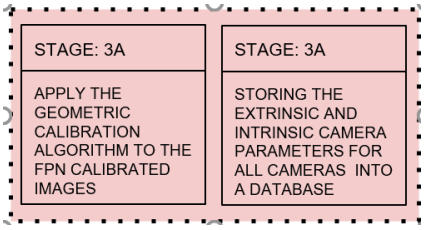

FIG 1.3 STAGE 3

SYNCHRONIZED IMAGE CAPTURE

The calibration target is to be mounted to the end effector of the Aerotech Robotic Arm. The trajectory of the calibration target must be programmed, keeping in mind the trigger points. These trigger points would be specific coordinates on the locus of the moving calibration target. As the target would encounter a trigger point in its trajectory, it would send out a pulse to the cameras. As the cameras receive this pulse they must be triggered simultaneously in order to capture the images of the moving calibration target for geometric calibration of the cameras.

Currently, we have a code for image capture from a single camera using the Emergent Vision Technologies API. This code needs changes for capturing images from multiple cameras. The desired number of cameras for simultaneous image capture is now limited to two cameras, as it is possible to connect only two cameras to a single computer. In future the aim would be to connect multiple cameras to a single system and capture images from them.

PARAMETERS FOR IMAGE CAPTURE

For the geometric calibration, multiple images of the calibration target need to be captured for the target at a given trigger position. These images have to be taken at different exposure levels for the photometric calibration. Based on the speed of the calibration target, the number of images to be captured has to be decided. If the number of images is too low, the target would be able to move fast, stopping at trigger locations for short time intervals. This would finish the process in less time but the photometric response curve wouldn't be smooth enough due to lack of images. On the other hand, if the number of images is too high, it would give a smooth photometric response function but the system would take a long time to calibrate. Also, this would increase the computational costs (more processing and storing of images). By trial and error methods, the number of images at 1000 gave satisfactory results.

REMOVING FIXED PATTERN NOISE FROM THE IMAGES

Before the geometric calibration algorithm can be applied to the images, the FPN must be removed from the images and they must be photometrically calibrated. For this I am writing a code to use the FPN and photometric calibration parameters from the database created by Mandy and Yiqing (Stage 1 of the calibration pipeline). After removing the noise, the next step is storing the images in a proper usable format for the geometric calibration algorithm to work on it.

2.CHALLENGES

PROBLEMS IN VISUAL STUDIO

I tried to implement the code in visual studios but there were many problems due to the dependencies of Visual Studio 15 and OpenCV 2. For resolving this issue, I am currently using OpenCV on Linux.

3.TEAMWORK

Our team task was divided as follows:

PETER

Peter worked on using the geometric calibration algorithm and designing methods to test the validity of the calibration

MANDY

Mandy worked on the Flat Field correction to eliminate Fixed Pattern Noise from the Cameras

YIQING

Yiqing worked on the photometric calibration algorithm and plotted the camera response function for a given camera using images of different exposure values.

SAM

Sam fixed the problems with the Robotic arm control and is now working on the motion planning for the robotic arm.

4.FUTURE PLANS

For the next two weeks, the plan is to successfully complete all the stages of the calibration pipeline and successfully calibrate multiple cameras and find their extrinsic and intrinsic parameters (camera calibration matrix) using this camera calibration pipeline.