INDIVIDUAL LAB REPORT

SIDDHARTH RAINA

TEAM G – EXCALIBR

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1.INDIVIDUAL CONTRIBUTION

VALIDATION OF FIXED PATTERN NOISE REMOVAL

Mandy and I have developed an algorithm to remove the fixed pattern noise from raw images due to noise in the CMOS sensor. For this, our first step was to get the averaged dark and the averaged flat-field image. The averaged image is the mean value of pixels in successive frames of a given scene. This was obtained by capturing a video and slicing its frames. Instead of the mean, the median value can also be used to obtain the averaged image. The averaged image serves two advantages: firstly, the effect of the random noise is greatly reduced by averaging the images. Secondly, if any outliers exist (one of the frames has pixels of very high values), they get averaged out and their effect is averaged out in the final image.

Fig 1. Averaged Dark Image taken using the EVT HS12000N Camera

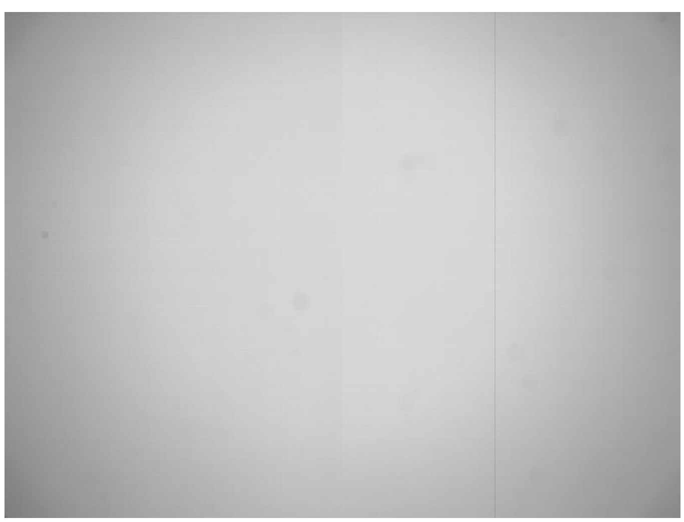


Fig 2. Averaged Flat-Field Image taken using the EVT HS12000N Camera

After getting the averaged dark and averaged flat-field images, we found out the gain and bias matrices from these images. For the bias matrix, we simply used the pixel values of the averaged dark image (dark current). For the gain matrix, we used the formula:

$$G = m/(F-D),$$

where m is the median pixel value of F-D, F is the averaged flat field image and D is the averaged dark image. The averaged images have been shown in Fig.1 and Fig.2.

IMAGE VARIANCE

The next step is the validation of the FPN correction of the images. Currently, I am exploring different methods to quantify our results for fixed pattern noise reduction. One such method is to calculate the image variance. The variance of the corrected image must be lower, due to the absence of random noise and dark noise components. This can be seen in the figures below.

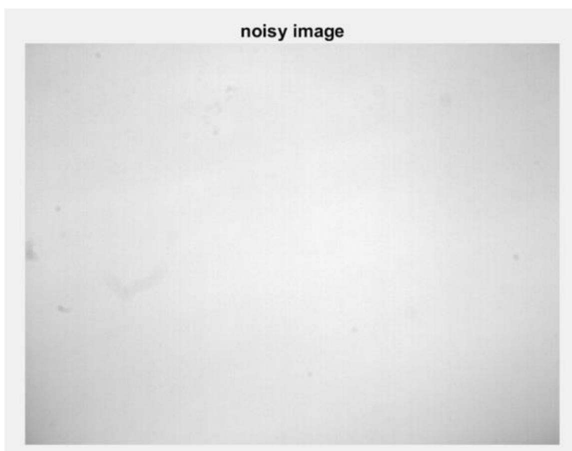


Fig 3. Noisy Image Variance = 147.1256

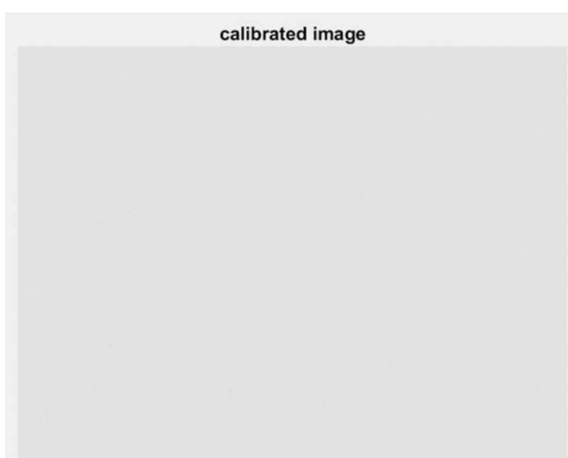
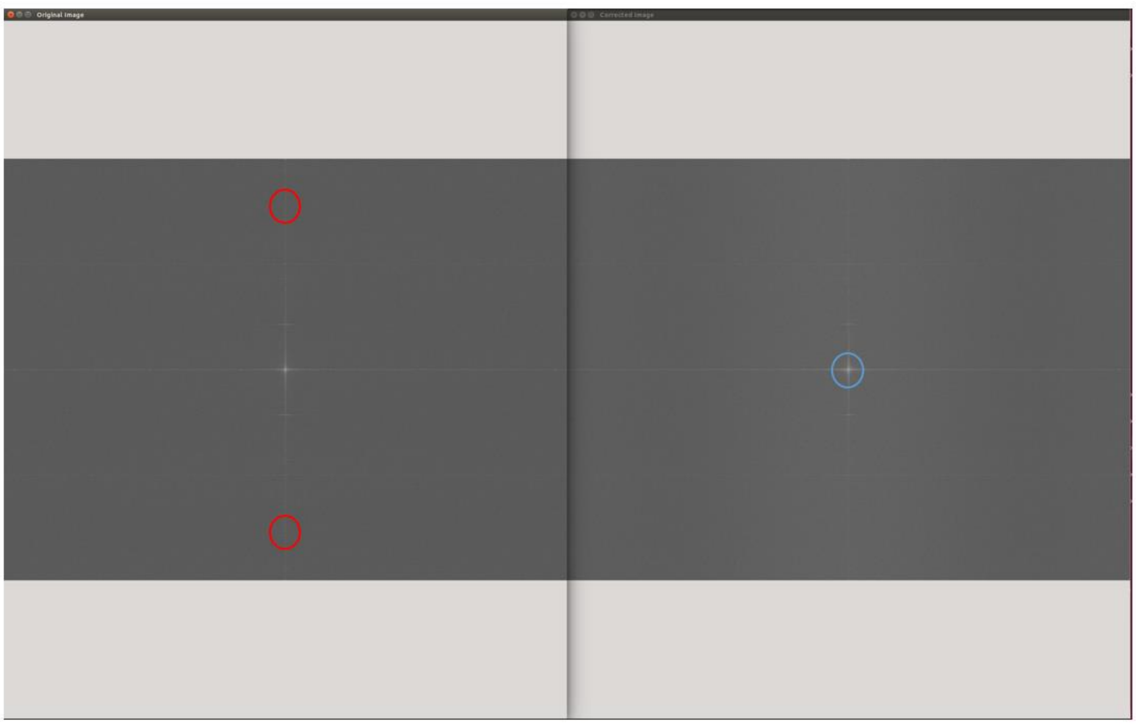


Fig 3. Corrected Image Variance = 4.83

FAST FOURIER TRANSFORM

Another method to quantitatively measure the fixed pattern noise correction is to perform the Image Fast Fourier Transform and compare the results. The image FFT decomposes the image into a sum of a series of sinusoidal variations in brightness. It is an effective tool to capture the spatial frequency, magnitude, and phase. The fixed pattern noise in the CMOS sensors is like vertical lines. These lines would be reflected by certain frequencies in the FFT plot of the images. A successful validation method would be the removal of these frequencies in the FFT plot of the corrected image.



◯ High Frequency noise present in the original image but removed in case of the corrected image

◯ Denser at the center: More low frequency components in the corrected image

Fig 5. Image FFT

2.CHALLENGES

DIFFICULTIES IN OBTAINING THE AVERAGED FLAT FIELD IMAGE

One of the difficulties faced by me was in capturing images without reflection for obtaining the averaged flat-field image. For this Oculus has purchased a non-reflective surface which can be used to obtain the averaged flat field image without reflection.

VISUAL STUDIOS AND OPENCV DEPENDENCIES

One of the challenges faced by me was the complexity of using OpenCV with visual studios. Migrating to Linux was a good solution as the dependencies between OpenCV and Linux are much simpler to handle.

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 weeks, the plan is to successfully complete all the stages of the calibration pipeline for a successful demonstration of the Fall Validation Experiment. Also, the FPN correction algorithm has to be fine-tuned in order to give satisfactory validation results.