Deblurring and Enhancing Astrophotographs Using PSF Based Digital Image Processing

Group Number: 19

Weekly Report 7

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1 Introduction

Until last week, we had implemented a different PSF extraction methodology and modelled the PSF of the image as the average of the individual PSFs of the star in the image. This gave us a significantly better output than using the simple Gaussian PSF. We also modeled another PSF where the PSF of each stamped stars, was fit to a 2D Gaussian function to obtain the parameters. However, the simple averaged, stacked PSF gave us mich better results. In the last week, we performed deconvolution on the stamps and and finally implemented color mapping, marking the end of our project.

2 Methodology

The methodology used so far included modeling a PSF that was better fit to an instrument. We used 4256 images to set our PSF. We checked conservation of flux and even performed chi squared test. However, there is no specific test to check the effectiveness of the PSF, except the visually checking that the source appears exact point like. We also performed deconvolution and color mapping. For color mapping, we applied contrast stretching per RGB channel. We then performed normalization to get values in desired range. Then, we finally stacked the three images to obtain the final RGB output. The code can be found in the file Group19.py uploaded on Github.

3 Results

The images shown below are the result generated by implementing the PSF pipeline.

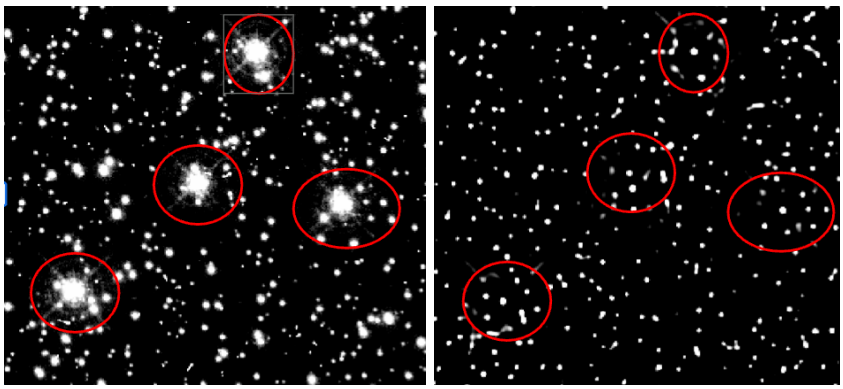

Figure 1: PSF Stacking + Deconvolution

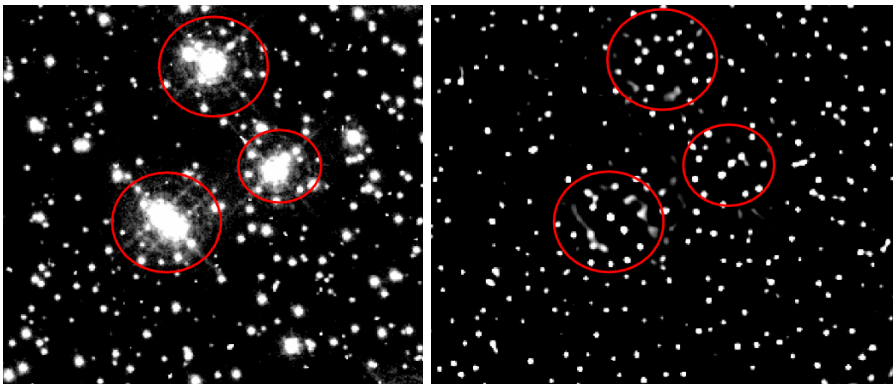

Figure 2: PSF Stacking + Deconvolution

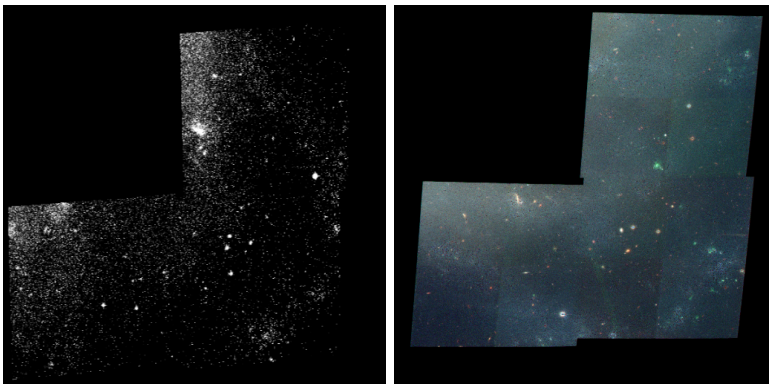

Figure 3: Color mapping

The flux was conserved proving that the PSF estimation was good.

4 Problems Faced:

- There was still residual left after the PSF removal because the PSF of an image is not homogenous, however we have used a homogenous, average based PSF for the entire image which leaves residue.
- Color mapping still had imperfections due to the difference in PSF implying that the color correction did not happen effectively, however that might be due the difference in estimated and actual PSF.
- No specific method available to compare PSF quantitatively.

5 Conclusion

As a result of our work, utilizing instrument based PSF deblurring methods gave a significant increase in the recovery of the details of the astronomical images compared to implementing a simple Gaussian PSF. After the Richard Lucy deconvolution aided in recovering the fainter features of the images. Since, the PSF and deconvolution was now just applied on masked stars, the output had minimized noise. The flux was conserved after the PSF was removed. Color mapping was implemented, which also gave a better output visually as compared to stacking using Gaussian PSF and Gaussian estimated average PSF. A total of 4256 FITS files were used to set the parameters for an estimated Gaussian PSF for deblurring as well as color mapping. The robustness of this model can be enhanced by further expanding the dataset.