

Project Proposal

Ruiqi Ma

Title: Enhance Star Visibility and Reduce Noise in Astrophotography

Summary

Capture a series of star photos that are captured at the same position and angle and of different exposure time and different ISO. After doing image alignments, use Joint Bilateral Filter to denoise the images, using images that are of longer exposure time and lower ISO and of shorter exposure time and higher ISO.

Background

Astrophotography is loved by lots of people. However, if you want to capture the star images that are bright, colorful, and less noisy, you need to buy expensive lenses such as f/2.8 lenses. This is a huge amount of cost so it's not suitable for people who are not professional in astrophotography. This project is to give a better solution from an image processing view. With only a few images of different settings needed to capture, people don't need to buy expensive lenses, but can get good quality images only using daily lenses such as f/4 lenses.

The key part of this project is to apply Joint Bilateral Filtering. To successfully apply Joint Bilateral Filtering, it requires some good understanding of its underlying principles and set good parameters to achieve a good result. Finding the parameter that can balance the noise and star details can be tricky, due to the similar shape of a star and a noise point.

Resources

- Camera: Nikon Z6 (already got).
- Lense: 24mm, f/4 (already got).
- Image dataset: captured by my own. A series of images ranging from images of low ISO to high ISO, from short exposure time to longer exposure time (already got).
- Packages for image alignment: skimage.registration module or imreg_dft or the combination of them.
- For learning Bilateral Filtering:
 - Paris et al., "Bilateral Filtering: Theory and Applications," *Foundations and Trends in Computer Graphics and Vision* 2009
 - Paris et al., "A Gentle Introduction to the Bilateral Filter and Its Applications," *SIGGRAPH 2007-08, CVPR 2008*, https://people.csail.mit.edu/sparis/bf_course/

Goals and deliverables

The project should be able to align these images and apply some Bilateral filtering to it to make it less noisy. The result should be better than the original images. Moreover, if there's still some time, a better image that preserves more star details and much less noise should be obtained.

Schedule

5/13: project proposal
5/15: align images using skimage packages
5/17: read papers and understand Bilateral Filtering
5/20: start to implement Bilateral Filtering
5/25: midterm report
5/27: tune better parameters for Bilateral Filtering
5/30: project video
6/5: project report