Low-cost Computational Astrophotography

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Motivation: Astrophotography is a popular hobby that can be quite expensive due to the equipment involved. Long exposure times are required to capture faint celestial bodies, and the earth's rotation causes objects to "move" during exposure. To compensate for this, photographers use moving camera mounts to keep objects steady in the frame. We hope to be able to use computational techniques to remove the need for these rotating mounts, and instead post-process these long-exposure images.

Goal and Methodology

Goal: Gather long-exposure image data, perform modified PSF calculations, apply image deblurring/denoising techniques to enhance image quality.

Plan of Action

1. Create photo dataset (self-taken + online) with varied parameters such as exposure, foreground/background elements, and illumination
2. Enhance images using polar-based PSF modification [1], Richardson-Lucy deblurring [2], maximally sparse optimization [3], and more
3. Evaluate algorithm based on qualitative visual analysis, time efficiency, and metrics such as noise level in dark regions and edge sharpness

Dataset and Initial Results

- 20 varied long-exposure images, self-taken (issue: weather) + online
- Image segmentation between stars, sky, and foreground using thresholding
- Convert rotating stars to polar coordinates given center location to calculate modified PSF, sum and convert back to cartesian
  - Issue: if center is not in image, we must calculate it based on the curvature from star streaks, but could run into problems with limited star streak length

Original image

Stars segmented

Stars in polar grid