Mittelman Observatory Image Calibration

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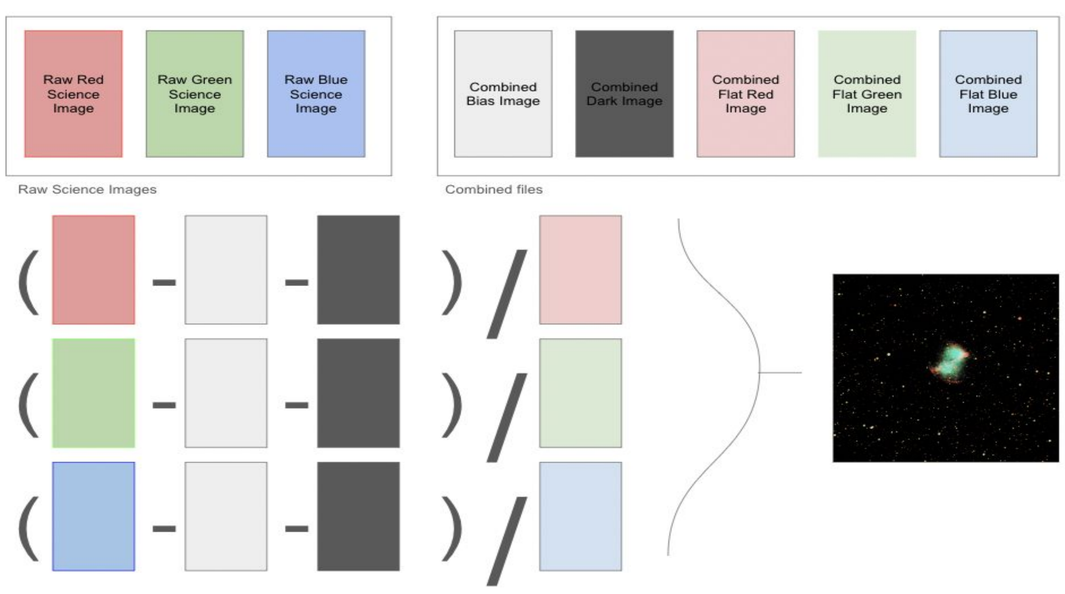
Motivation

Mittelman Observatory at Middlebury College is the largest and best equipped institution observatory in the state of Vermont. The aim of this project is to make the Middlebury telescope more accessible to Middlebury students. Many students do not know how to utilize the resources that the telescope provides, as there is currently no streamlined way to process telescope images. Students are taught to use DS9, a much older software with few resources for students to learn the platform. While newly developed AstroPy scripts for calibration do exist within the observatory, being able to run these requires a compiler and knowledge of how to run python scripts. Students will be able to utilize our webapp to take advantage of AstroPy and will be walked through the steps to calibrating their images during the process.

Telescope Image Calibration

The image calibration process begins with the combination of raw bias, dark, and flat files into combined files through a series of combination and subtraction steps. Generally, bias and dark frames can be stable for several months, so long as the temperature and exposure times match the science image, but flat images need to be taken of the twilight sky the same night as the science image.

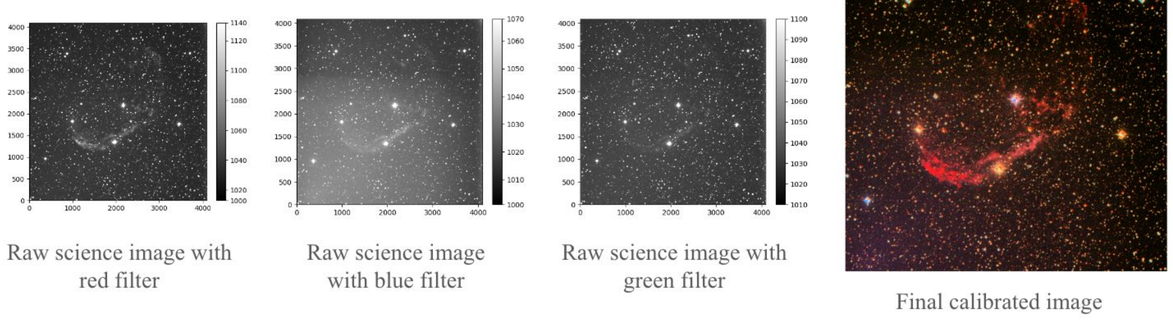


To calibrate an image, the user will upload 8 files (shown above):

- 3 Raw Science Images (Red, Green, and Blue),
- a combined Bias FITs file,
- a combined Dark FITs file,
- 3 combined Flat FITs files (Red, Green, and Blue)

Once the user has uploaded their files to our web app, the red, green, and blue science image are calibrated using the Python package AstroPy.

The calibrated science images are then combined to create a colour image. The output of the script is a png file of the telescope image.



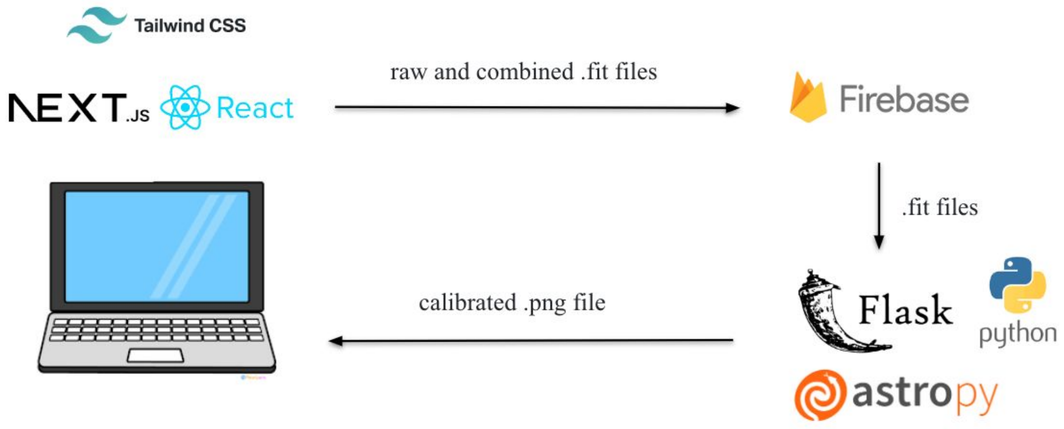
Raw science image with red filter

Raw science image with blue filter

Raw science image with green filter

Final calibrated image

Our Framework



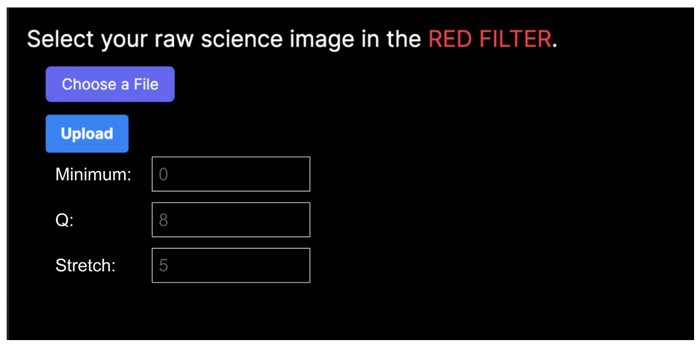
Frontend:
We used the Next.js React framework to develop our web application, with Tailwind CSS for styling. We created individual pages for the image calibration process, gallery, a section detailing how to complete the calibration process and a section explaining our motivation behind this project.

Backend:
In the backend we created python scripts that utilize the AstroPy library. These scripts are integrated with our frontend using Flask. Additionally, we use Firebase to store the gallery images and the .fit files that are uploaded as a part of our calibration process.

Results and Future Work

This fall we were able to successfully create our web application with a functioning pipeline to calibrate telescope images starting with the raw science images and five combined files. We also implemented a gallery for students to upload their own images and share with peers, and a tutorial explaining the process.

To expand this project, we would like to have the option to extend the pipeline and start with the individual bias, dark, and flat files and perform the combinations. This would allow students to solely use our platform to calibrate their images. Additionally, there are certain parameters that have been set to default values for our pipeline (such as the softening value and the stretch parameter). In the future allowing users to change these values could be beneficial and allow students to customize their images. In future, the web app could also be expanded to allow for the further analysis of the images, perhaps allowing users to investigate individual pixels.



Acknowledgments

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