Design and Experimentation of a Publicly Available Asteroid Detection Algorithm.

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Introduction.

For amateur astronomers, getting useful science out of their observations is not straightforward due to inaccessibility of tools. Only after probing into the depths of the scientific community do methods of conducting practical science come to light. Our goal is to develop an easily accessible program dedicated for night sky observation with a specialization in asteroid tracking. This will include automatic data processing and detail the procedural guidelines on efficient search methods.

While building the groundwork for this project, we have determined the inefficiency that lies within manually searching for near-earth asteroids. We have experimented with manual image correction and panorama stitching, a technique that an average amateur astronomer would use uninstructed. As a solution, we have written a code that can automatically process data for use in building composite images to search for any anomalous motion in astronomical pictures.

The Etscorn Observatory

Celestron C14

- 14 inch (355.6mm) Schmidt cassegrain OTA.
- 0.39 arcsec resolution (rayleigh).
- 3910 mm focal length.

Paramount ME

- Calibrated to 27 arc second pointing accuracy.
- Capable of stable tracking for 400 seconds.

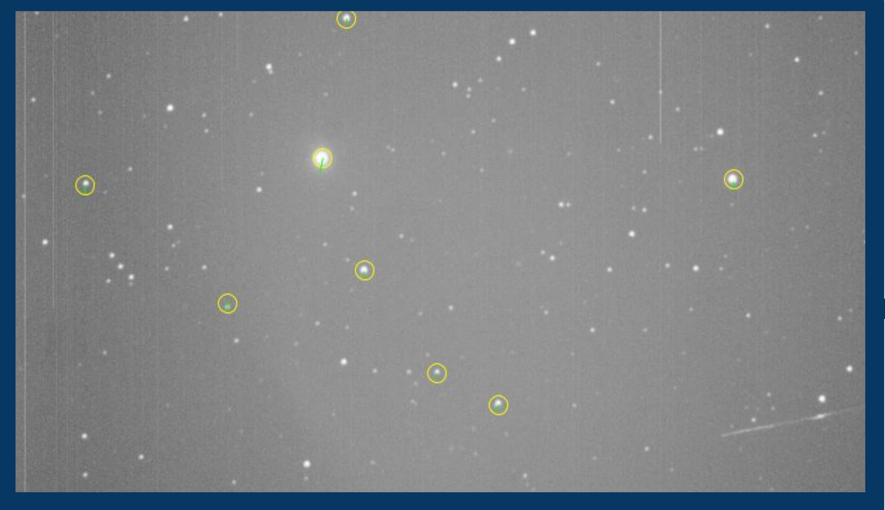
SBIG STL 11000M

- 11 MP sensor array.
- 9 micron pixels.
- 0.55degree x 0.833degree Field of view

Methods.

Data collection

Alignment



Stars are automatically selected in order to determine rotation and/or translational motion.

Background subtraction

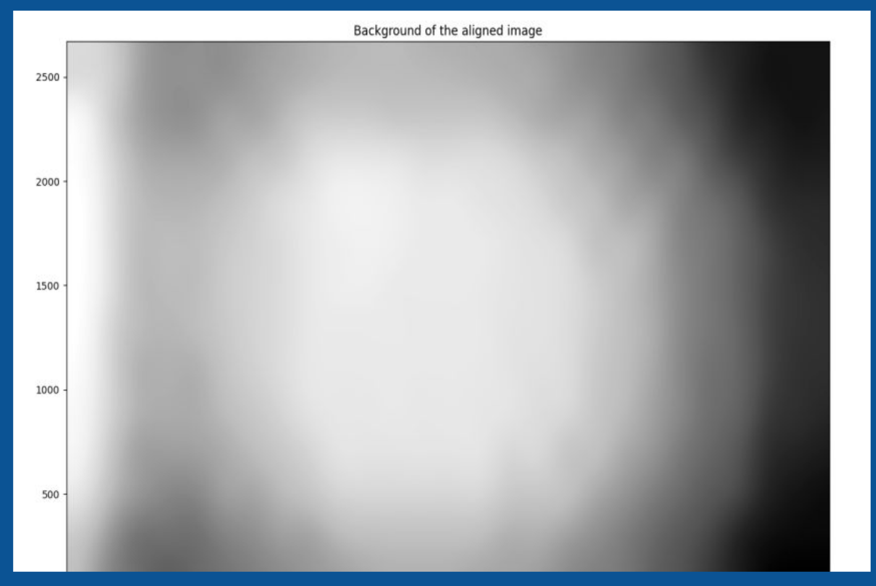
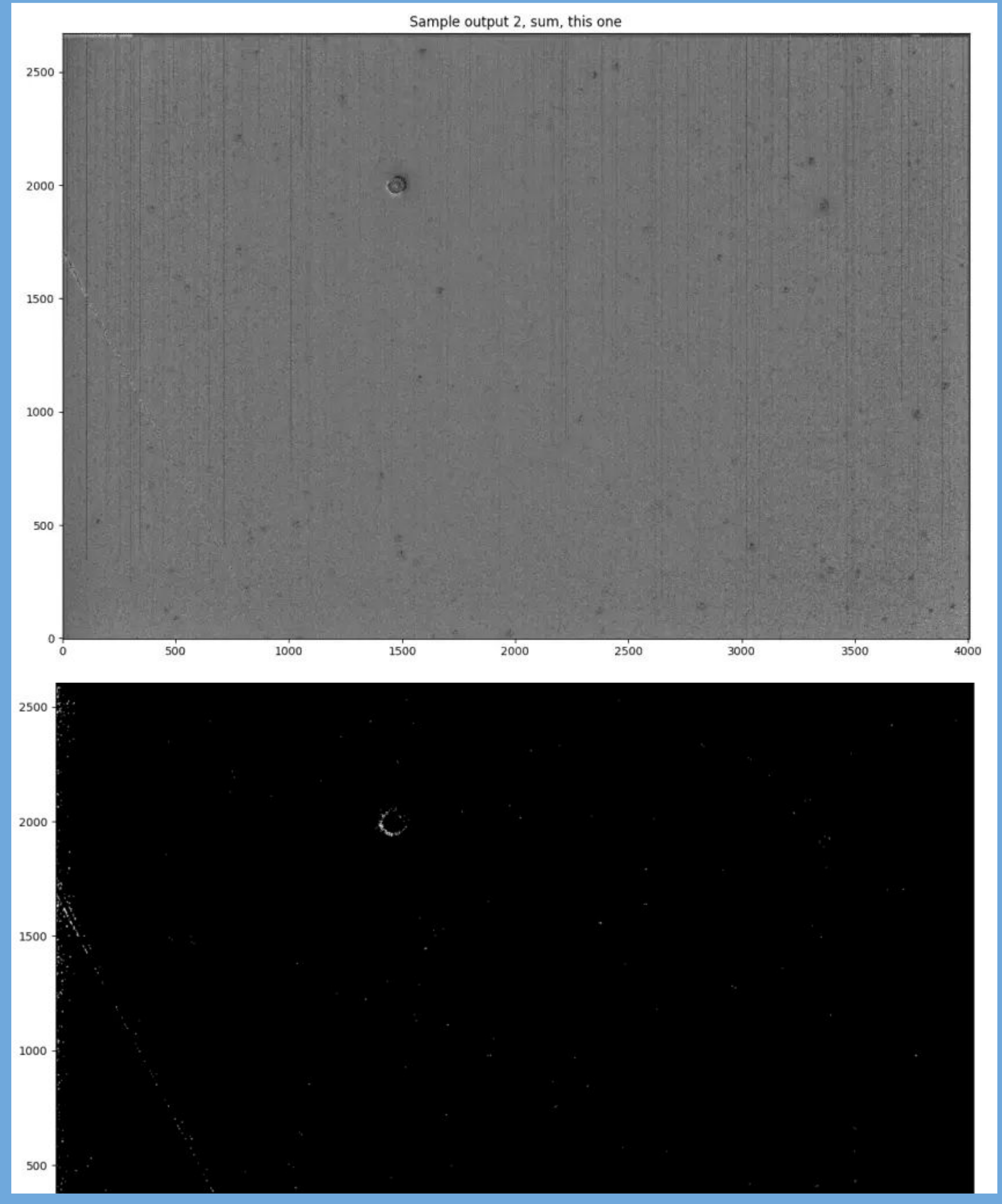


Image background are subtracted from the scientific frames.

Histogram stretch and display

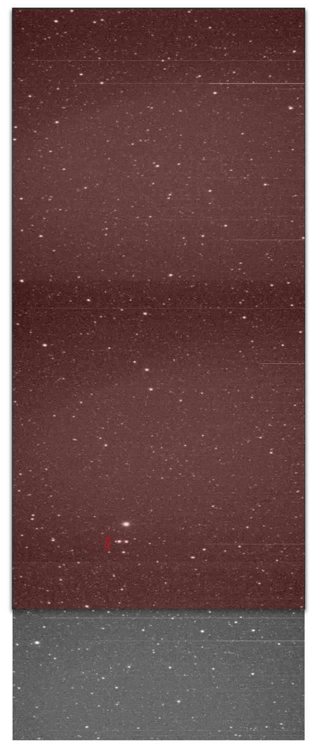
Corrected images are displayed for the user.

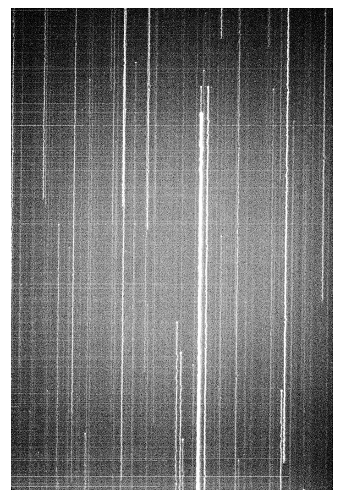
Subtraction of stacked images



Subtracted images yield white pixels in the direction of motion and highlight any changes in the two images.

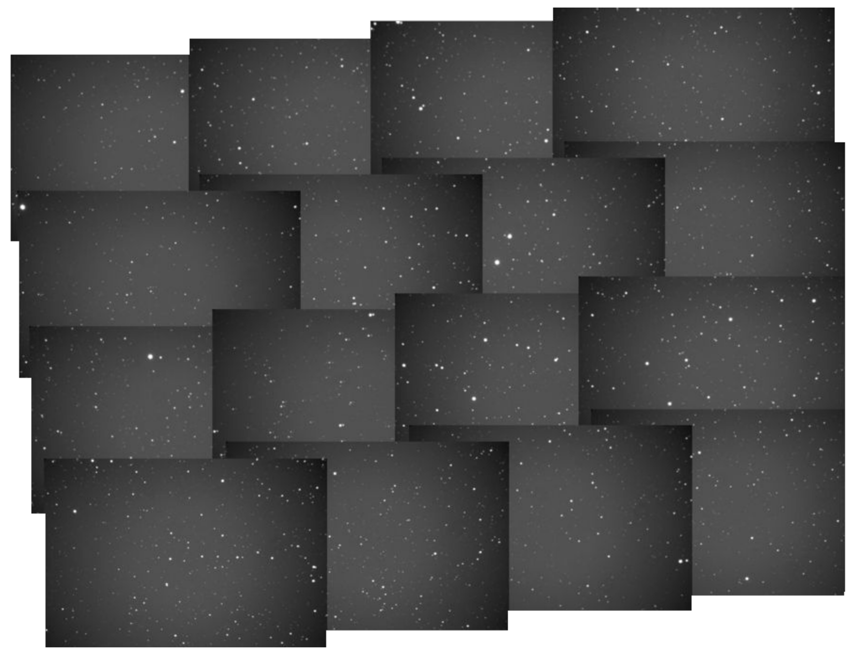
Drift Imaging v. Panoramic Imaging.





Drift imaging shown above uses the earth's rotation to create streaks of stars on the detector.

Any streaks that are found to not be parallel with those of the background stars can be assumed as moving with respect to the background.



Panoramic imagining combines individual exposures. These images are stitched together and a single image is produced.

This method has the benefit of lower limiting magnitude with the drawback of the necessity of follow up observations

Results.

After reviewing the process of development these four items are abundantly clear.

1. 150 second exposure times was found to yield the lowest limiting magnitude of 16.8 for the time spent observing. Averaging 650.9 seconds for every square degree.

2. Panoramic imaging for faint asteroids is preferable as the limiting magnitude can be extended by varying the exposure. However one can expect to have the instrument collecting light for ~61% - 67% of the total observational time.

3. Drift imaging is preferable for covering large sections of sky. This method was by far the most efficient averaging 193 seconds per square degree. Unfortunately by covering so much area the limiting magnitude is drastically reduced to 13.24.

4. By using single frames with subtraction stacking, an image that clearly shows motion can be rendered. With the ease of use of these frames, automatic detection becomes a trivial task