SUIT Image Derotation Report

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Motivation

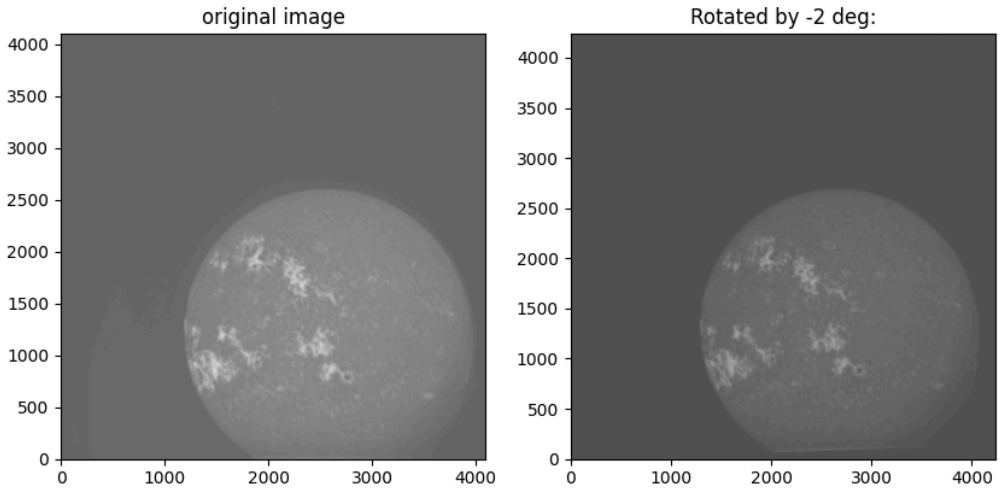
Due to variations in satellite orientation, the Solar Ultraviolet Imaging Telescope (SUIT) onboard Aditya-L1 captures images with a slight tilt (approximately 6-8 degrees) relative to the solar north. Simple derotation of these images without considering flux conservation can lead to inaccuracies, which is crucial when assigning a precise coordinate system or comparing it with other images. Moreover, it is essential to preserve the header data during this process.

Method

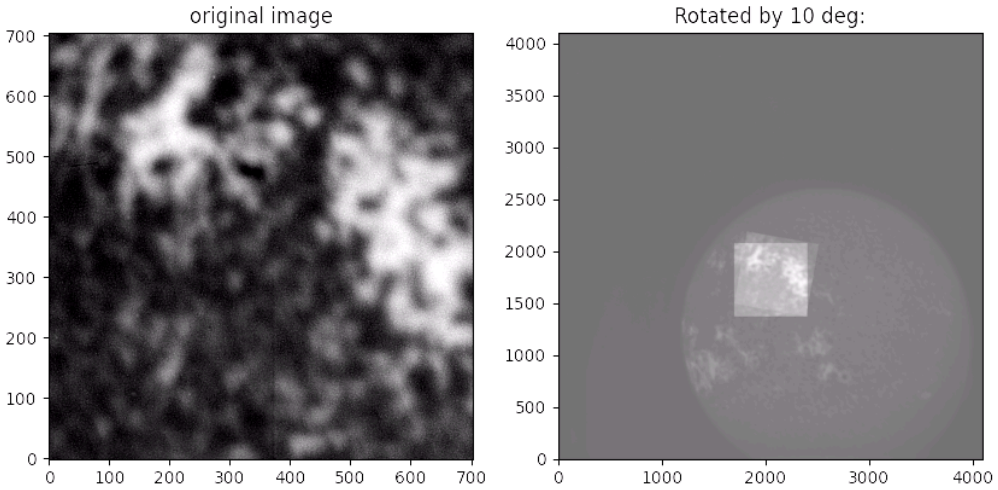
To address these challenges, we developed an algorithm that converts the image to a subpixel grid, applies the necessary rotation, and then resamples it back to the original pixel size. This approach ensures flux conservation throughout the process.

Description

The algorithm is designed to rotate both full-disc and region-of-interest (ROI) images captured by SUIT. A simple rotation matrix could achieve the rotation, but it would result in flux loss. We minimise flux loss by converting the images to a subpixel grid before rotation. While SunPy offers a rotation function, it struggles with flux conservation and ROI rotation, particularly when the rotation axis lies outside the image. Our algorithm effectively handles these challenges, allowing users to specify the subpixel scale (i.e., the accuracy level) according to their needs.



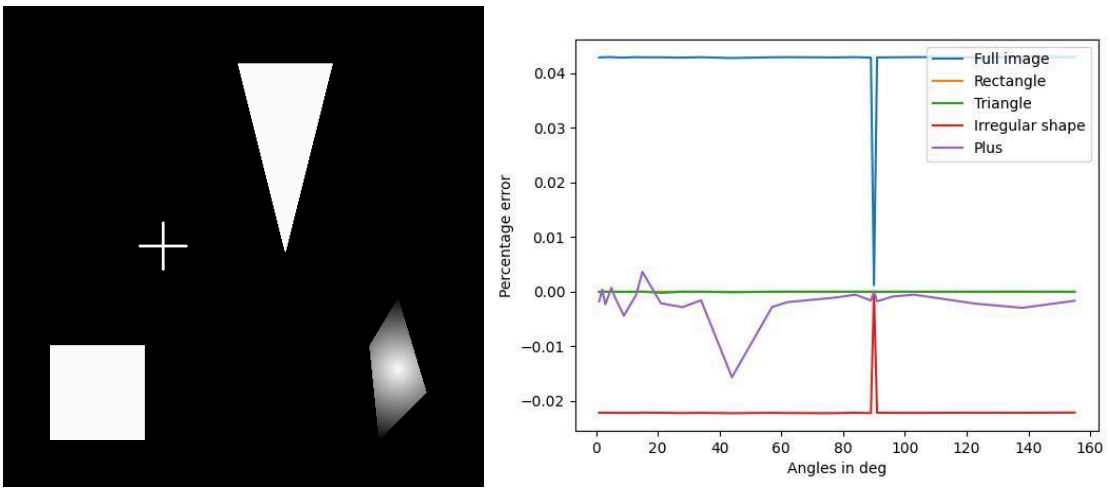
Example image for full disc rotated image



Example image for ROI rotation

Verification

To validate our method's accuracy, we generated a 4k size image with various shapes and sizes in it, rotated them at different angles, and calculated the percentage error. The error margin was found to be within 0.04%, confirming the robustness of our approach.



Left: Reference image. Right: Percentage error for different angles of rotation.

Pending Work

- Optimization of Subpixel Scale: We need to calculate the optimal subpixel scale for different rotation angles. This will involve running the code at various angles and subpixel scales to determine the best configuration for minimizing error.