SUIT Feature Tracking software

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Motivation: For a high cadence imaging and data transfer constraint, SUI T had to choose the small region of interest observation mode. Region of Interest (ROI) should be cut out from the full 4K image, and the position has to be uploaded to the satellite at least a day earlier. For this, predicting the active region position and converting it into SUIT CCD coordinates is required.

Method:

The rotation rate at a heliographic latitude θ is calculated by the formula

$$\omega(\theta) = A + B \sin2(\theta) + C \sin4(\theta) \quad [\text{unit} = \text{micro rad/s}]$$

where A, B, and C are constants that depend on the model: Sunpy diff.rot function uses 'Howard' as the default model (A=2.894, B=-0.428, & C=-3.70). This rotation rate is applied to reference coordinates to predict the coordinates.

The heliographic coordinates are converted to SUIT ccd frame using a set of equations mentioned below:

P_angle=(90)*np.pi/180

SUIT_CCD_x=(Tx*np.cos(P_angle)+Ty*np.sin(P_angle))/0.7

SUIT_CCD_y=(Tx*np.sin(P_angle)+Ty*np.cos(P_angle))/0.7

Where the P angle is taken at 90 degrees since SUIT CCD is rotated at 90 degrees, in CCD coordinate calculations, 0.7 is considered, which is the CCD plate scale.

Software development and Features:

Software application GUI is developed in PyQt5. Most of the packages are used from the Sunpy module.
A few additional features are added to the software based on the requirement.
Current Features:
- A button is added to download AIA/SDO Near Real Time (NRT) images, and the target feature can be selected just by mouse-clicking. The mouse pointer also shows the ROI size (customisable) so that planning becomes

easy.
- Batch mode is added to generate multiple points for a given time range.
- The software also accounts for disc rotation and shifts in satellite pointing.
- The software can generate a log file for all entries so that input and output can be traced back.

Verification:
The method was verified using plotting predicted coordinates and observed ROI coordinates.

Here is an example plot for one day, June 13 2024.
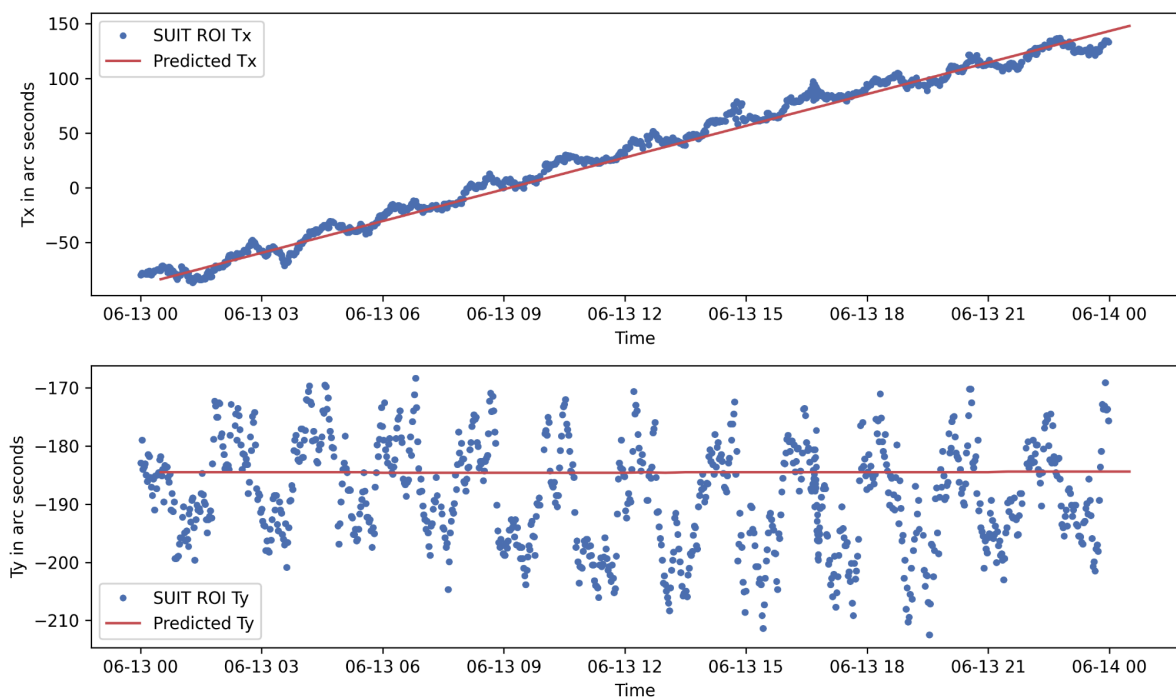
The red line is the software's predicted ROI centre coordinates (Tx and Ty). Blue points are observed in ROI centre coordinates.
The observed ROI centre varies around the predicted ROI centre due to satellite drift.

Known issue:
- Satellite drift: The Sun centre on the CCD keeps varying around the designated value due to satellite drift. The variation is approximately ±13 arc seconds.