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Automatic Georeferencing of Astronaut Auroral Photography: Providing a New Dataset for Space Physics

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Astronauts aboard the International Space Station (ISS) have taken tens of thousands of photographs showing the aurora in high temporal and spatial resolution. The use of these images in research though is limited as they often miss accurate pointing and scale information. In this work we develop techniques and software libraries to automatically georeference such images, and provide a time and location-searchable database and website of those images. Aurora photographs very often include a visible starfield due to the necessarily long camera exposure times. We extend on the proof-of-concept of Walsh et al. (2012) who used starfield recognition software, Astrometry.net, to reconstruct the pointing and scale information. Previously a manual pre-processing step, the starfield can now in most cases be separated from earth and spacecraft structures successfully using image recognition. Once the pointing and scale of an image are known, latitudes and longitudes can be calculated for each pixel corner for an assumed auroral emission height. As part of this work, an open-source Python library is developed which automates the georeferencing process and aids in visualization tasks. The library facilitates the resampling of the resulting data from an irregular to a regular coordinate grid in a given pixel per degree density, it supports the export of data in CDF and NetCDF formats, and it generates polygons for drawing graphs and stereographic maps. In addition, the THEMIS all-sky imager web archive has been included as a first transparently accessible imaging source which in this case is useful when drawing maps of ISS passes over North America. The database and website are in development and will use the Python library as their base. Through this work, georeferenced auroral ISS photography is made available as a continously extended and easily accessible dataset. This provides potential not only for new studies on the aurora australis, as there are few all-sky imagers in the southern hemisphere, but also for multi-point observations of the aurora borealis by combining with THEMIS and other imager arrays.