Quantitative Comparison of Proprietary and Open-Source Georeferencing Tools for Use with Astronaut Photography

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The Crew Earth Observations (CEO) Facility within the Earth Science and Remote Sensing Unit at NASA's Johnson Space Center supports the acquisition, analysis, and curation of astronaut photography of Earth's surface and atmosphere. Astronauts on the International Space Station (ISS) respond to requests from CEO to acquire imagery of scientific and education targets, to include high profile targets in response to activations from the International Charter for Space & Major Disasters (also known as the International Disaster Charter, or IDC) and NASA's Disasters Program. CEO facilitates the acquisition of astronaut photography in response to IDC events and delivers georeferenced data products to the United States Geological Survey (USGS) for distribution to the disaster community. Using GeoRef, an internal web-based tool developed in collaboration with NASA's Ames Research Center, CEO generates data packages of georeferenced imagery, uncertainty images for assessing control and tie point accuracy, and metadata documenting raw and processed data.

Operational experience with the Georef software identified vulnerabilities to internal code and server errors that can significantly increase time of data production. As such, CEO developed a backup procedure in case the GeoRef software experiences front-end or back-end errors. A system using OSGEO's open-source QGIS software combined with a semi-automated pipeline using the object-oriented Python language and the Geospatial Abstract Library for generating metadata is quantitatively compared to GeoRef's data package for quality and productivity. Root Mean Square Error (RMSE) provides a standard measurement of data quality as it relates to ground error. Assessing RMSE measurements generated from georeferenced astronaut photographs acquired with different obliquity and focal length offers a comprehensive accuracy assessment of the software's transformation algorithms. This assessment will indicate the software's ability to produce data products with the least ground-error or highest data quality regarding ground accuracy. In addition, a comparison of the software's efficiency in generating a data package that includes georeferenced images, metadata, and uncertainty images for measuring tie/ground point error was performed.

Initial results, based on the comparison of three nadir-facing astronaut photographs acquired with a 95mm focal length, reveal the QGIS-based system's average RMSE is 2.36 (pixels) suggesting its georectification system produces data products that meet and perhaps improve upon Georef solution's average RMSE of 32.99 (pixels). However, the QGIS system was unable to reproduce two unique Georef data products, uncertainty images for measuring tie and control point errors and a translated un-warped image. In addition, the Georef software is designed to accept handheld camera pose information from a hardware component (Geosens) scheduled for deployment on the ISS in late 2018; this information is intended to provide increased accuracy and auto-registration capability for astronaut photographs.

Future work is expected to determine the QGIS-based georectification system's potential as an open-source alternative (and operational backup) to Georef for georeferencing the full range of resolutions and viewing angles unique to handheld digital camera imagery in support of ISS disaster response activities.