

FY23 Strategic University Research Partnership (SURP)

Geological Mapping of Jezero Crater with the Ingenuity Helicopter

Principal Investigator: Francois Ayoub (398); **Co-Investigators:** Robert Deen (398), Christian Tate (Cornell University), Alexander Hayes (Cornell University)

Objectives: The objective was twofold. 1) Exploration of Ingenuity capability for mapping and terrain reconstruction of the martian surface from its navigation imagery, and 2) investigation of the state-of-the-art structure-from-motion (SfM) 3D terrain modeling techniques to be compared against in-house JPL processing tools.

Background: After successful first flights, NASA decided to continue to operate Ingenuity as a scouting mission. However, Ingenuity returns a lot of images with poor knowledge of their pointing, whereas ground tools are tailored to few images with precise pointing. This study evaluate ground tool against state-of-the-art multi-stereo techniques for terrain reconstruction.

Approach and Results: Ingenuity flight 12 (~200 ncam images) was selected for the study (figure 1). These images are delivered with estimate of 3D poses from onboard instruments. Agisoft Metashape was used to refine the poses of Ingenuity along the flight, against the ground truth basemap (HiRISE), with the selection of a few corresponding points between the two. As can be observed in figure 2, there is a significant discrepancy (~20m) between where Ingenuity “thought” it was and its actual location. In a second step, a 5cm/post-spacing terrain was extracted using Metashape SfM technique. Using the same camera poses a terrain was also extracted using in house tool (VICAR). These two DEMs, along with the basemap DEM (1m post-spacing) were compared (figure 3). We observe the overall good agreement between the three DEMs without significant discrepancies. The VICAR DEM is in good agreement with Metashape DEM, despite noisier measurements due to a less sophisticated fusion strategy of the stereo disparity maps.

Significance/Benefits to JPL and NASA: In addition to the scientific interest of providing a localized and detailed terrain model, this study illustrates the sensitivity of a flying craft to heading errors and wind events, which could be valuable information for future flying helicopter guidance design and operation. The second outcome is the validation of recent SfM technique to extract terrain on planetary bodies other than Earth; this opens the possibility to integrate modern multi-stereo techniques into operation tools, for enhanced operation, science, and safety.



Figure 1

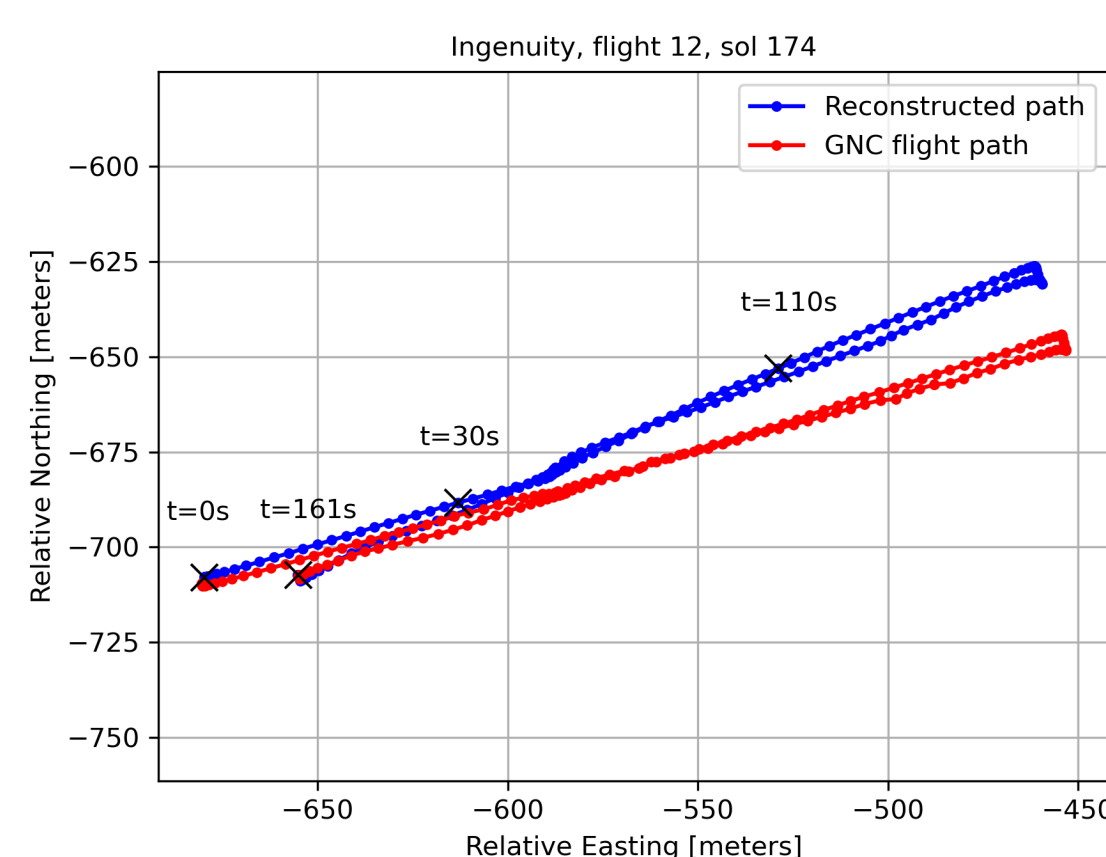


Figure 2

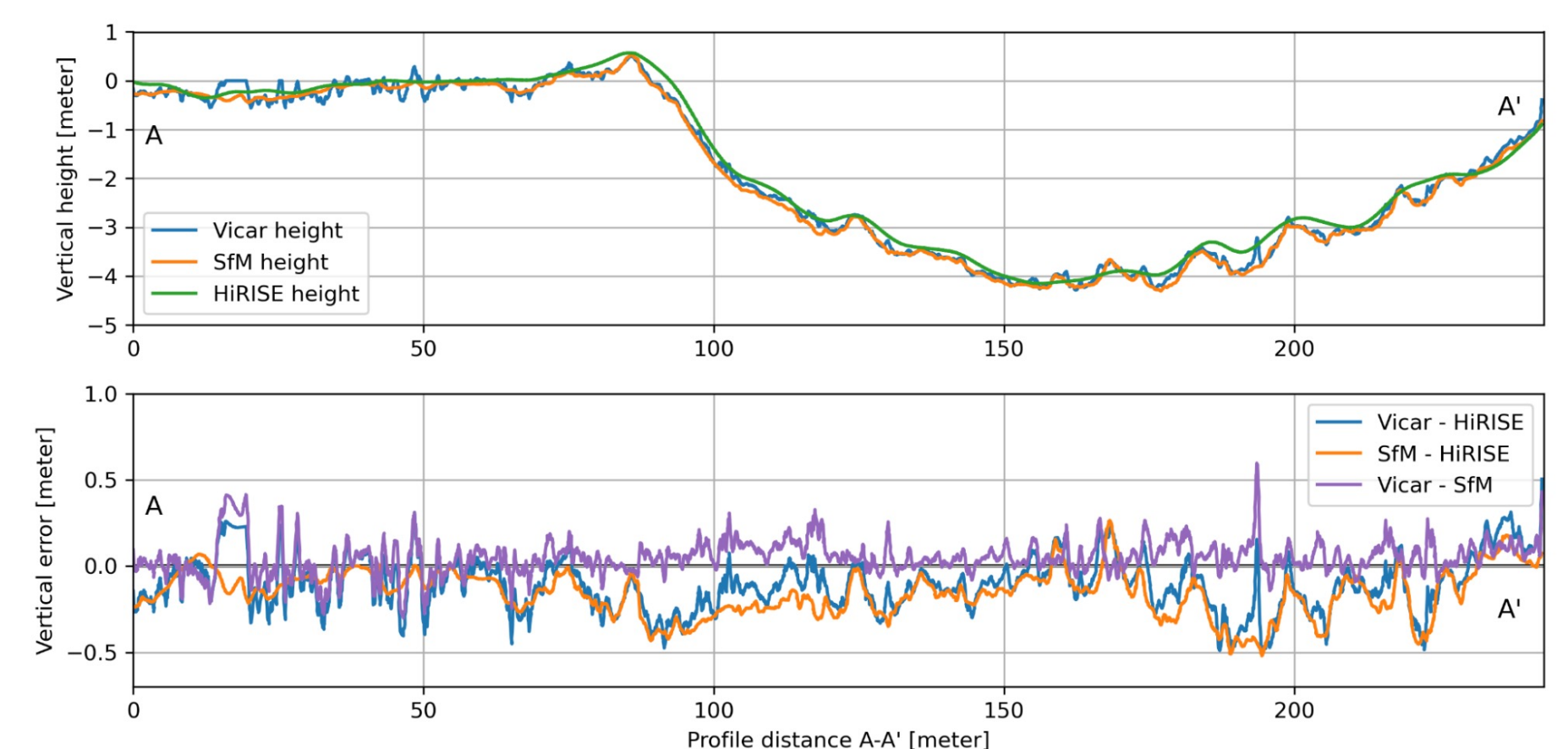


Figure 3

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

www.nasa.gov

Clearance Number: CL#00-0000
Poster Number: RPC#
Copyright 2023. All rights reserved.

References:

http://www-mipl.jpl.nasa.gov/vicar_open.html

Agisoft PhotoScan Professional (Version 1.4.5) <http://www.agisoft.com/downloads/installer/>

PI/Task Mgr. Contact Information:

Francois.ayoub@jpl.nasa.gov (818) 354-3330