The Importance of Geodetically Controlled Data Sets: THEMIS Controlled Mosaics of Mars, A Case Study

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Why Control?

Ο Geodetically controlled products are foundational data products.
  ○ Errors / uncertainties are quantified at local scales.
  ○ Tied to a legitimate base map.
  ○ Updated kernels are generated

Ο When do you want to use a controlled product?
  ○ Geologic mapping
  ○ Entry, landing, and descent evaluations for lander mission
  ○ Mission planning and coordination
  ○ Change detection studies
  ○ Fusion of multiple data sets
Iapygia
14.8 S, 72.9 E

10 pixel (~1 km) shift
Iapygia
14.8 S, 72.9 E

10 pixel (~1 km) shift
Elysium
15.4 N, 162.4 E

16-20 pixel
(~1.6 to 2.0 km) shift
Elysium
15.4 N, 162.4 E

16-20 pixel
(~1.6 to 2.0 km) shift

10 km
THEMIS Instrument

♦ Spatial scale of 100 m per pixel

♦ Sensor type = Line-scan imager

♦ Mapping priority was to obtain global coverage, not with the intention of generating a controlled product.

♦ Images were acquired both during the day and at night.
Methods and Data

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- This is one of the first global controlled products made with ISIS3

- Software

  - Jmars to identify and constrain THEMIS image list.
  - ISIS3 to generate the control network.
  - Davinci to process THEMIS data and generate the controlled mosaics.
  - ArcGIS to visually inspect each mosaic.

- Ground Control

  - Current accepted ground data source for Mars is the MOLA DEM.
  - Tied to the Viking MDIM network, which is tied to the MOLA DEM.
Workflow Overview

- Identify suitable images by constraining on various parameters (Jmars)
- THEMIS image processing (ISIS3/Davinci)
- Assemble the control network (ISIS3)
- Run bundle adjustment (iterative process in ISIS3)
- Tie to ground (ISIS3)
- Write out updated image and spacecraft kernels (ISIS3)
- Generate controlled mosaics (davinci)
Workflow: Control Network Assembly

- Two processes were used to generate the control networks:
  - Utilizing existing points in the merged network
  - Creating new points and measures

- Merge these two networks into a single, cohesive network that we pass to the bundle adjustment program.
Utilizing Existing Points from the Merged Network

Creating New Points and Measures
Workflow: Bundle Adjustment

◊ Evaluate the health of the network
  ◊ Identify images with zero or few points
  ◊ Identify islands

◊ Run bundle adjustment
  ◊ Evaluate the results
  ◊ Remove high residual measures
  ◊ Re-evaluate the health of the network
  ◊ Re-run bundle adjustment

◊ We tie the network to the Viking MDIM, which is tied to MOLA.
Accuracy

- Horizontal accuracy is **60-390 meters**
- 0.6 to 3.9 pixels

If you do not control your data, you have no idea about the accuracy of your product.

Elysium Planitia - Daytime IR (upper) and nighttime IR (lower); 3.7 N, 138.0 E
Product Availability

- Products that are available from:
  - PDS Annex
    http://astrogeology.usgs.gov/
  - Custom layer in Jmars.

- Products:
  - Kernel files describing these improvements for each image in the control network.
  - Controlled, orthoprojected daytime IR and nighttime IR mosaics of Mars at 100 m/pixel scale for the ±65° latitude region of Mars.

- Image mosaic formats:
  - GeoTiff format with available ISIS3 and PDS3 labels.

- Final mosaics will be available in September 2018.
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