Ames Stereo Pipeline

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- Automatic Stereo Correlation (matching all pixels between two images) for large satellite images.
- Multithreaded and can be used across multiple machines. Works on high-end workstations to super computers.
Example DEM Mosaic of Jakobshavn Glacier produced by D. Shean U of W using Ames Stereo Pipeline

3-5 m/px
2500 sq. km
6 input images
Example DEM of an unnamed crater created from Mars Reconnaissance Orbiter imagery using Ames Stereo Pipeline.
History

- Ames Stereo Pipeline (ASP) has a lineage dating back to the 1997 Mars Pathfinder / Sojourner Mission.
- October 2009 ASP v1 rewritten for satellite support and open-source released (NASA Open Source)
- June 2012 ASP v2 includes support for DigitalGlobe and open-source released (Apache 2 license)
How it works

- Ames Stereo Pipeline is a set of command line tools.
- Designed for computing clusters and super computers.
- UNIX derived platforms (Linux, Mac OS X, etc)

```
~PR31TR/Stereopipeline/data/CTX(branch:master) > stereo *cal.cub run/run -s stereo.nonmap
Warning! Your current config file enables debug logging. This will be slow.
  --> Detected 1515 cube files. Executing 1515 stereo pipeline.

Creating output directory: "run"
Using "stereo.nonmap"

[ 2013-Apr-01 14:53:53 ]: Stage 0 --> PREPROCESSING
  --> Computing statistics for the left image
    left: [ lo:0.8566257 hi:0.130602 m: 0.6925+34 s: 0.8137999 ]
  --> Computing statistics for the right image
    right: [ lo:0.8616242 hi:0.1437177 m: 0.899642 s: 0.8132815 ]

  Processing Left
  Processing Right
  Building Descriptors
  Found interest points:
    left: 7503
    right: 6103

  --> Matching interest points
    Forward: [ ************************************************** ] Complete!
    Backward: [ ************************************************** ] Complete!
    Matched 256 points.

  Inlier cluster:
  Triangulation Err: 12.222 + 3.7716 meters
  Altitude: -1723.63 -> 72.7998 meters
  Reduced matches to 255

  --> Aligning right image to left using homography:
    Matriix:3x3((1.23383,0.00608278,-677.459)(-0.00033956,0.99707,1341.66)(-5.24698,-07,-
2.741928-09,1))

  --> Normalizing globally to: [0.8566257 0.1437177]

  --> Writing normalized image: run/run-L.tif

  --> Writing normalized image: run/run-R.tif

typical output on the terminal when using Ames Stereo Pipeline.
```
Typical User Operation

- In the simplest operation, the user only runs two commands from ASP.
  - The **stereo** command creates a point cloud.
  - The **point2dem** command converts the point cloud to DEM of your chosen projection.
Ames Stereo Pipeline can use existing DEMs to speed up its work.

This operation is achieved by “map projecting” the input images prior to stereo correlation.
Our Past Applications

- We’ve used ASP to create 40 m/px DEMs from 3000 stereo pairs of the Moon (captured by Apollo 15, 16, and 17).
  - 40 m = approx. the length of 3 school buses end-to-end
  - The final mosaic covered 20% of the Moon

- These were all processed in a single week using the NASA Ames Pleiades Supercomputer
Autonomous Processing Earth Imagery

- We currently have a 60% success rate with processing DigitalGlobe stereo pairs into DEMs **without human input**.
- Can automatically produce DEMs with 5 m/px resolution
  - 5 m = approx. length of a Toyota Camry

Anchorage, Alaska
Typical Performance

- With DigitalGlobe stereo imagery subsampled to 1 m/px, we can process a stereo pair in about 5 hours.
- Performance changes with the amount of parallax in the imagery.
- Processing cost is 5 minutes of CPU time / square km. (on NASA Pleiades supercomputer, 3 GHz Xeon processors)
Stereo is Available

Alaska Stereo
Current collection as of March, 2013
Software License

- Ames Stereo Pipeline v2 is available as open-source
  - Worldwide release (no country restrictions)
  - Can be freely reproduced and distributed, with or without modifications
- Apache 2 license
  - http://www.apache.org/licenses/LICENSE-2.0.html
Source Code

- Our C++ code repository is hosted on Github.
- Ames Stereo Pipeline is part of the NASA “Neo Geography Toolkit”
- Available to download, copy, modify, collaborate, …

github.com/NeoGeographyToolkit/StereoPipeline
Prebuilt Binaries

irg.arc.nasa.gov/ngt/stereo

- Most Linux Distributions
  - 32 and 64-bit versions, RHEL 5+, SuSE, Debian
- Mac OSX 10.6+
- We do not support Windows
Additional images & technical

Lunokhod.org

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