Quantitative analysis of digital outcrop data obtained from stereo-imagery using an emulator for the PanCam camera system for the ExoMars 2020 rover

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Jan-Peter Muller, Yu Tao – UCL Mullard Space Science Laboratory
- PanCam stereo camera on 2 m rover mast
- Collect imagery of rock outcrops encountered along rover traverse
- 3D processing and rendering allows for the extraction of quantitative geological data
  - Dimensions
  - Layer dips
  - Grain size
- These data are used to:
  - Reconstruct the geological history
  - Selection and context of contact science
  - Focus the search for life

Drill < 2 m depth
Terrestrial data collection

Utah desert, ~12 km outside Hanksville, November 2016
MURFI 2016 Rover Trials

- Rover developed by Oxford University Robotics Institute
- Image data collected using the Aberystwyth University PanCam Emulator (AUPE3)
- Testing ExoMars-like mission procedures
  - Operations – Mission Operations Centre – Harwell UK
  - Instrument testing and data collection
- Panoramas and 3D Ordered Point Clouds (OPCs)
  - Processed by Joanneum Research
    - Automated ftp based processing service
  - 3D data rendered in PRo3D (VRVis, Vienna)
- Additional validation data collected
Aberystwyth University Pancam Emulator (AUPE)

50 cm fixed baseline

RWAC = Wide Angle Camera
HRC = High Resolution Camera
LWAC = Low Angle Camera
UKSA-funded rover analogue trials – Utah Desert, USA.

Scale bars are 2 m
Conclusions

• 3D reconstruction and geological analysis of stereo imagery in PRo3D is highly advantageous in gaining a quantitative understanding of ancient surface processes on Mars.

• The MURFI field trials provided an opportunity to collect ‘Mars-like’ rover imagery in a mission scenario and ground-truth the observations.

• Further work will concentrate on the development of new geological tools and assessing the limitations of the camera system as well as PRo3D.

• Testing and validation of these techniques is ongoing for the upcoming ESA ExoMars 2020 Rover and NASA Mars2020 Rover missions.
3D geological analysis of Mars using rover stereo-imagery

Foothills of Mount Sharp, Gale crater, Mars.
PRo3D – real time rendering and interpretation of OPCs

Dingo Gap – Mars Science Laboratory Curiosity Rover – Sols 528 – 540 (1 Sol = 1 Martian day)
PRoViP – 3D processing workflow

MSL Mastcam (2 different focal lengths)

Navcam – SGM stereo matching

Mastcam – different focal length in each eye (100 mm right, 34 mm left) – requires HVFM matching

1. Pre-registration of M100 and M34 using feature matching

2. Artificial stereo-pair creation by up-sampling M34 into M100 geometry
PRoViP – 3D processing workflow
MSL Mastcam

3. Dense matching using HFVM matcher (Joanneum Research)

4. Image metadata (PDS Labels, SPICE kernels) used for triangulation and global registration of data

5. Conversion of results to Ordered Point Clouds (OPCs) for PRo3D
Geometric Triangulation Uncertainties
Range Resolution comparison.
Matching accuracy: 0.25 pixel

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<th>Distance [mm]</th>
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<th>MSL MastCam-L</th>
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