The PRoViDE framework for the quantitative geologic analysis of reconstructed Martian terrain and outcrops

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PRoViDE Framework

- Processing of co-registered images results in accurate 3D reconstructions of Martian surface areas and rock outcrops
- Use a GIS to visually query a unique geospatial data base
  – Including 3D products

PRoViP
Image processing
3D vision mass production

PDS Input
MER, MSL imagery

PRoDB
Geospatial data base

PRoGIS
Data Selection

PRo3D
Geologic Assessment

Selected 3D Product

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Digital Outcrop Models (DOM)

• Using multi-layered ordered 3D point clouds (OPC)
• Multi-resolution meshes are generated and rendered from OPCs in real-time
• Enables remote geology
  • Virtual exploration and interactive visual analysis of accurate Martian DOMs
• 3D is important to fully comprehend structures


**PRo3D Overview**

- Fluent navigation within huge geospatial data sets
- Study structures from various perspectives and zoom factors
  - Save them as bookmarks
- Measure the surface and DOMs using a variety of interactive tools
- Annotate 3D surfaces and delineate geological units
PRo3D – Display Multiple Data Sets

- Explore fused surface reconstructions
- Rock outcrops are embedded into terrains reconstructed from orbiter imagery (HiRISE)
- Study DOMs in their larger geological context
PRo3D – Measurements

• Derive the real dimensions of geological structures

• Interactive 3D tools to:
  – Get accurate terrain coordinates
  – Distance from viewpoint to selected surface point
  – Distance between two points
  – Delineate structures by polylines and get their length
  – Dip and Strike of beddings and fractures

Pos: [3376388.23, -325122.08, -121275.04]
Bear.: 15, 27
Dist: 15, 11
Mark bedding contact with polyline

~10 cm

Dist: 1.14
Bearing: 232.90
Pitch: -29.49
Pos: [-2490135.36, 2285881.17, -271414.14]
Color-coded dipping angle
(0°-90° → red-blue)

Dip direction
Strike direction
Labelling
Best fit plane

Dist: 1.14
Bearing: 232.92
Pitch: -29.49
Pos: [-2490135.36, 2285881.17, -271414.14]
- Detect paleoflow directions
- Understand geometrical relationship between geological units
Shaler (Gale Crater)
Geologic Interpretation
Garden City Vein Systems
Conclusions

• Evaluated on two use cases:
  – Victoria Crater, visited by the MER-B Opportunity Rover
  – Shaler (Gale Crater), visited by MSL Curiosity Rover

• PRo3D provides a methodology and technique for a more systematic analysis of DOMs

• PRoViDE framework will be used during the Exomars Rover and MSL 2020 Rover missions