Space 2006
19 - 21 September 2006, San Jose, California

AIAA 2006-7435

Automated 3D Surface Reconstruction from Orbital Imagery

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[Abstract] The Intelligent Robotics Group at the NASA Ames Research Center is developing automated software for Digital Elevation Model generation from orbital imagery. A prototype system was developed for work with Malin Space Science Systems and is currently in use generating 3D models of the surface of Mars. Previously, production of 3D terrain models from orbital imagery required considerable human intervention to achieve useful results.

I. Introduction

THE Intelligent Robotics Group (IRG) at the NASA Ames Research Center (ARC) has been developing 3D surface reconstruction and visualization capabilities for planetary exploration for more than a decade. First demonstrated during the Mars Pathfinder Mission, the IRG has delivered tools providing these capabilities to the science operations teams of the Mars Polar Lander (MPL) mission and more recently the Mars Exploration Rover (MER) mission. A critical component technology enabling this work is the Ames Stereo Pipeline (ASP). ASP generates high quality, dense, texture-mapped surface models from stereo image pairs.

Although initially developed for ground control and scientific visualization applications, the IRG has adapted its surface reconstruction technologies to a variety of applications including use onboard its "K9" research rover for hazard avoidance and navigation. The most recent adaptation of the ASP resulted from interactions with scientists during the MER mission. For long-range mission planning, detailed knowledge of planetary topography is invaluable. To this end, MER scientists inquired if the ASP could be used to generate Digital Elevation Models (DEMs) of the area surrounding the landing sites from orbital (and descent) imagery. Some minor modifications to the ASP resulted in a proof of concept demonstration. A 3D surface reconstruction of the area near the MER-A landing site was generated from orbital and descent imagery (see Fig. 1).

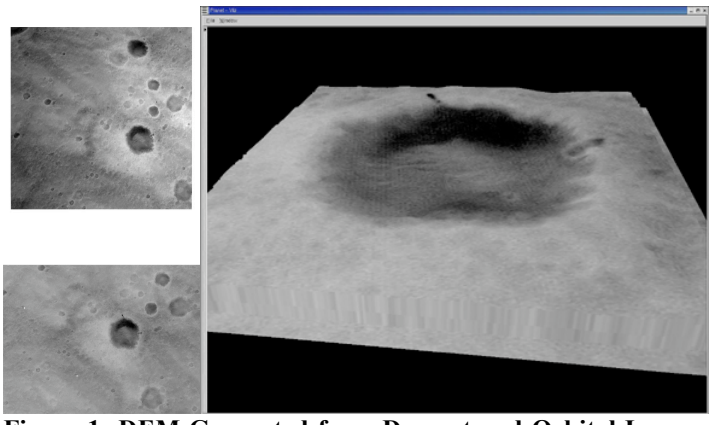

Figure 1. DEM Generated from Descent and Orbital Images. *The 3D model on the right was generated from the orbital and descent images on the left.*

Such DEMs are also useful in other phases of mission planning, and this proof of concept demonstration led to a collaboration with Malin Space Science Systems (MSSS) on a Mars Critical Data Products (CDP) funded project to produce high resolution DEMs from Mars Global Surveyor (MGS) Mars Orbiter Camera Narrow Angle (MOC-NA) images for landing site selection. Although, the concept

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