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Abstract

Our goal is to create a high-fidelity, photorealistic, interactive Martian experience using the best available data and rendering techniques. Our approach addresses four components: A height map, surface map, noise for synthetic detail, and atmosphere. The purpose is to produce a museum quality Martian landscape.

Background

Existing interactive Martian renderers include:

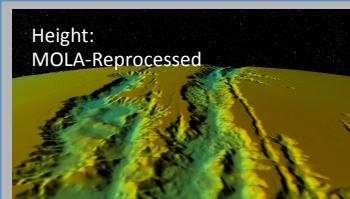
- Celestia
- Google Mars
- Microsoft World Wide Telescope

However, these programs have limitations including low-resolution surface data, lack of height data, low quality geometry generation, and simplistic or nonexistent atmospheric rendering.

We sought to improve upon the existing visualizations using Panoptic, a visualization application developed by Dr. Robert Kooima's group at Louisiana State University. Panoptic already provides museum quality Lunar visualizations at a number of installations around the United States.

Acknowledgements

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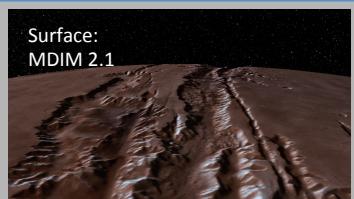
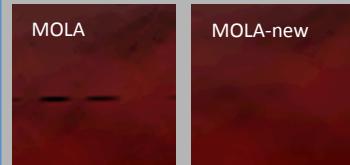


Height:
MOLA-Reprocessed

Terrain geometry is given by the 1 gigapixel Mars Orbiter Laser Altimeter (MOLA) digital terrain model captured by NASA's Mars Global Surveyor launched in 1996.

Custom image processing software was developed to resolve sensor artifacts and other technical flaws in the archival copy of MOLA.

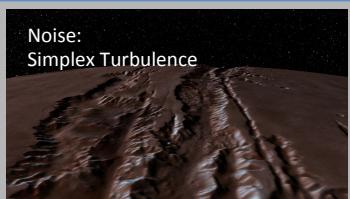
This dataset has a resolution of 500 meters per pixel at the equator.



Surface:
MDIM 2.1

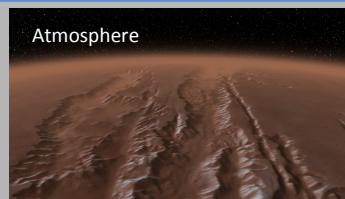
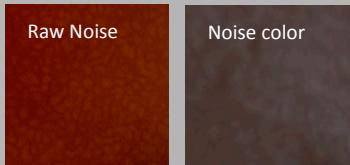
The initial Mars Digital Image Model (MDIM 1.0) comprises a low-resolution color map of Mars captured by NASA's Viking Orbiters launched in 1975. A renewed effort in 2009 remapped Viking imagery using the MOLA terrain model giving a 4 gigapixel, more accurate surface map.

This dataset has a resolution of 230 meters per pixel at the equator.



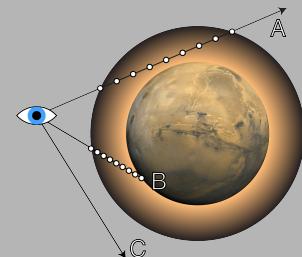
Noise:
Simplex Turbulence

Data resolution is unfortunately finite. When zoomed too deeply, pixels become stretched and the illusion of photorealism fails. To account for this we synthesize additional detail using Perlin simplex noise in a process that runs entirely on the GPU and incurs no added data load.



Atmosphere

The inclusion of the atmosphere radically improves the photorealism of planetary rendering. A volume ray-casting post-process correctly depicts the logarithmically distributed density of the reddish dust that dominates the atmosphere of Mars. There are three cases: A. Rays which pass through the atmosphere, B. Rays which strike the planet, and C. Rays which miss completely.



Conclusion and Future Work

The combination of these four components gives an image of Mars very similar to what would be seen by a person who is there, and at real-time refresh rates. This is a significant improvement on existing Mars rendering software. Future work will include the application of higher resolution overlays at locations of interest, improved fidelity in atmospheric modeling, and the design and implementation of a full-featured interactive museum exhibit.

