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# Super-resolution restored HiRISE images for simulating "rover's eye" views in 3D

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## Abstract

Super-resolution restored (SRR) HiRISE images over the Mars Exploration Rover traverses have been combined with 25-cm digital terrain models (DTMs) in a 3D visualisation platform and are here compared to rover scenes. The SRR products are shown to better resolve rocks and geomorphology and approach the quality of MER Navcam images than standard resolution HiRISE images.

## 1. Introduction

Rover landing site selection for future rover missions (e.g. Mars 2020 and ExoMars 2020) requires high-resolution imaging to identify potential hazards as well as regions of scientific interest. A method of super-resolution restoration (SRR) of repeat-pass HiRISE images has previously been developed and provides additional refinement of orbital data [1]. SRR can bridge localised coverage from rovers and multi-resolution orbital coverage, and contextualise geology within a regional and global context.

25-cm HiRISE orthorectified images (ORI) and 5-12.5-cm HiRISE SRR products of the Mars Exploration Rover (MER) traverses have been combined with 25-cm shape-from-shading DTMs and visualised in the NASA DERT platform [2,3]. The SRR and standard resolution ORI images have been compared to evaluate the refinement achieved by super-resolution restoration. "Rover's-eye" scenes have been simulated in this platform and compared with Navcam mosaics from MER-A and MER-B to evaluate the utility of SRR HiRISE images for science operations and mission planning.

## 2. Methods

"Landscapes" were generated using LayerFactory, a GDAL function in DERT, to drape the SRR images and ORI on the DTMs. The DERT "camera" tool was placed at different sites along the rover traverses and adjusted for the height of the Navcam (1.4 m) to simulate a "rover's eye" view of the terrain. Multiple scenes were captured in each of the SRR and ORI scenes to cover the range of morphologies, e.g. outcrops, rocks, and hills. Midnight Planets (www.midnightplanets.com) and the Mars Analyst's Notebook (https://an.rsl.wustl.edu/) were used to select along-traverse sites and visualise the rover data, and results were compared with Navcam panoramas in Midnight Planets [4].

## 3. Results

### 3.1 MER-A at Home Plate

A 5-cm HiRISE SRR orthorectified image over Home Plate was employed. Views were captured at two sols (Table 1). Figure 1 compares the 3D models in DERT. Figure 2 demonstrates the higher detail achieved in the SRR, especially with rocks in the foreground, relative to the MER-A Navcam mosaic.

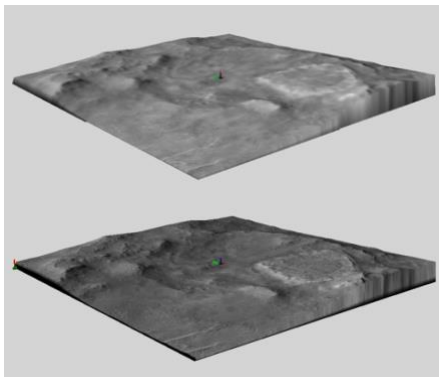


Figure 1: 3D perspective images in DERT: 25cm ORI (top), 5cm SRR (bottom) over Home Plate

Table 1: MER-A sites at Home Plate

| Sol | Number of Views |
|---|---|
| 764 | 6 |
| 1352 | 2 |

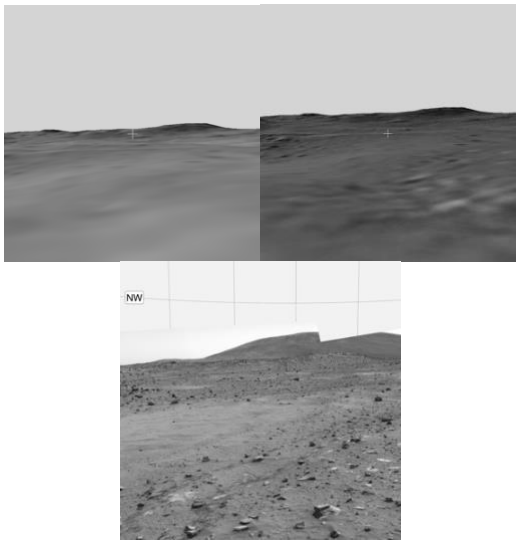



Figure 2: MER-A "rover's eye" scenes from sol 764: 25-cm ORI (left), 5-cm SRR (right), and Navcam (bottom). DERT scenes represent the fore- and middle-ground of the Navcam scene only.

### 3.2 MER-B at Victoria Crater

A 12.5-cm HiRISE SRR orthorectified mosaic over Victoria Crater was next employed. Views were captured at 4 sols (Table 2). Figure 3 compares the two 3D models in DERT. Despite a lower SRR resolution, the detail enhancement is clearer than for MER-B, as seen in the rocks in the foreground, ripples on the rim floor, and the outcrops of the rim (Figure 4).

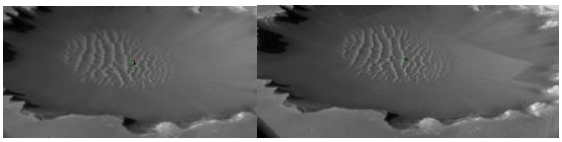
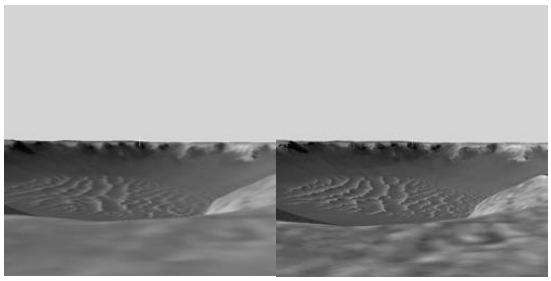


Figure 3: Close-up of the 3D models in DERT: ORI (left), SRR (right)



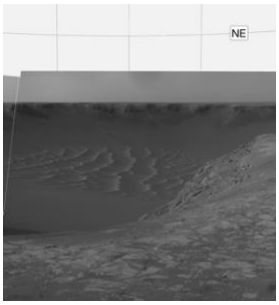



Figure 4: MER-B "rover's eye" scenes from sol 176: 25-cm ORI (left), 12.5-cm SRR (right), and Navcam (bottom).

Table 2: MER-B sites at Victoria Crater

| Sol | Number of Views |
|---|---|
| 1039 | 1 |
| 1155 | 1 |
| 1484 | 3 |
| 1676 | 2 |

## Summary and Conclusions

SRR of repeat-pass HiRISE images provides high-resolution information that displays rocks that are not visible in standard resolution HiRISE images, and thus provides information that may be useful for rover landing site selection when visualised in 3D.

The discrepancies between "camera" location to emulate Navcam scenes and the rover traverse data from the PDS—including on Home Plate, where the rover traverse is visible in the SRR—suggest that rover localisation requires refinement. These results implicate a need to perform ground-to-orbit data fusion for better contextualisation of high-resolution rover data, and 3D platforms to visualise these fused data products, in the interest of scientific analysis and mission planning.

## References

[1] Tao, Y., Muller, J.-P., Planet. Space sci., 121, 2016.

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[3] Keely, L. et al., DERT, Planet. Data Workshop, 2017.

[4] Arvidson, R.E., et al., LPSC XLI, 2010.