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ABSTRACT SUBMISSION FORM

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Title of the Paper Construction of a 3D Measurable Virtual Reality Environment Based on Ground Panoramic Images and Orbital Imagery for Planetary Exploration Applications
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ABSTRACT(more than 300 words) [5]

Planetary exploration usually consists of orbital and lander/rover missions. Orbital images map the planet globally and provide geometrical and spectral information for landing-site selection, precision landing, and various scientific researches. Ground (lander/rover) images provide more detailed information of the landing site for daily mission operations such as close-up investigation of scientific targets. Visualization of these orbital and ground images and their derived products is essential to support mission operations and scientific researches, as well as education and outreach.

As one of the most popular earth viewers, Google Earth has included Moon and Mars orbital data, which enables the user to fly anywhere on Moon and Mars and view them from any view angles with multiple resolutions. Simple measuring functions such as length and heading are also provided. Panoramic images can be linked to the orbital images at locations where the panoramas were taken by lunar astronauts or Mars rovers. NASA World Wind, an open source earth viewer, has similar functions and includes more planets in the solar system. Overall, these viewers have very powerful and easy-to-use functions of viewing and browsing, but the measuring functions are limited, in particular, no measuring function is provided for panoramic images. This paper presents a method to construct a three-dimensional (3D) measurable panorama and integrate it into a globe viewer based on NASA World Wind. The method is implemented using ground panoramic images acquired by Spirit rover of the Mars Exploration Rover (MER) mission and HiRISE (High Resolution Imaging Science Experiment) orbital images of Mars.

Panoramic images acquired by the rover's Pancam (Panoramic Camera) or Navcam (Navigation Camera) at different azimuth and elevation angles are automatically registered, seamlessly mosaicked and projected onto a cylindrical surface. This is accomplished by the open source program Hugin with our new developments to incorporate the images' exterior orientation parameters. We developed new functions for reverse calculation from the panorama back to the original image. This is a critical step so that the 3D information associated with the original stereo images can be retrieved or computed. We also developed a panorama viewer which can project the cylindrical panorama to perspective views on the fly and let the user measure the 3D coordinates, distance, heading, slope etc. In the Planetary Data System (PDS), along with the original stereo images of the MER rovers, most of the derived 3D data are also provided and can be retrieved through the left image of the epipolar-resampled stereo pairs. For those stereo images without 3D information available, the panorama viewer locates the original stereo pair and computer the 3D information through image matching and space intersection in real time. The technique of 3D measurable panorama represents a novel enhancement of the traditional panorama and can be a very valuable tool for planetary exploration applications.

Based on stereo HiRISE images of the Spirit rover landing site, we produced a high resolution DEM and orthophoto and overlaid them on the Mars surface in World Wind. The 3D measurable panoramas are then integrated into World Wind with hotlinks to the HiRISE orthophoto to construct a measurable virtual reality (MVE) environment. More Mars data and lunar data will be processed and put into the MVE system for test and validation; relevant functions will be further improved. The techniques developed in this research can be used in visualization and measuring the orbital and ground images for planetary exploration missions, especially rover missions.