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UK NASA 3D-RPIF: A European facility for extracting, analysing and visualising DTMs from HiRISE and CTX

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Abstract

The NASA RPIF (Regional Planetary Imaging Facility) network of 9 US and 8 international centers were originally set-up in 1977 to "*maintain photographic and digital data as well as mission documentation and cartographic data. Each facility's general holding contains images and maps of planets and their satellites taken by solar system exploration spacecraft. These planetary image facilities are open to the public. The facilities are primarily reference centers for browsing, studying, and selecting lunar and planetary photographic and cartographic materials. Experienced staff can assist scientists, educators, students, media, and the public in ordering materials for their own use.*" In parallel, the NASA Planetary Data System (PDS) and ESA Planetary Science Archive (PSA) were set-up to distribute digital data initially on media such as CD-ROM and DVD but now entirely online. The UK NASA RPIF was the first RPIF to be established outside of the US, in 1980. A new 3D facility has been established to provide access to geoscientists in the UK and on the European mainland. This 3D facility consists of a stereo PC Windows workstation running BAE Systems SOCET® and ESRI's ArcGIS, and a separate Apple MacPro desktop with twin 30-inch screens with ITTvis ENVI®, USGS ISIS 3.x and Fledermaus 3D. NASA MRO HiRISE and CTX stereo data can be processed into 3D DTMs and associated orthorectified images using the stereo workstation using ISIS routines developed at USGS. This system provides a very powerful facility for European scientists to process these unique data as well as training to learn how to process and use such data.

1. Introduction

There is an increasing need to utilize 3D DTMs of the surface of Mars both to correct for optical and terrain relief distortions introduced by imaging systems [1]; for landing site assessment, especially related to engineering considerations of safety [2] and for scientific applications related to understanding the role of water in shaping present-day martian surface features [3]. Stereo Photogrammetry is a long established technique for deriving such DTMs from stereo optical imagery. Since the early 1990s, automated photogrammetric software has been developed and applied to martian imagery [4] to extract DTMs initially from serendipitous Viking Orbiter imagery [5]. The ESA Mars Express High Resolution Stereo Camera (HRSC) experiment allowed the extraction of DTMs [6] in a manually intensive program to create DTMs from all of HRSC's stereo images [7, 8] which will eventually cover most of Mars. These 50-200m DTMs will provide the regional context necessary to interpret the surface geomorphology of Mars [3].

To study in detail the formative processes, especially related to water flow, that shape the martian surface it is necessary to achieve higher spatial resolution than even the 30m achievable with HRSC imagery [1]. The NASA ConTeXt (CTX) camera [9] should eventually provide global 5m imagery whilst the NASA HiRISE camera [10] will be able to obtain around 1% of the planet at resolutions down to 25cm. Around 10% of these images have been obtained in stereo (loc.cit.). This means that there are many thousands of stereo images ready for reduction into DTMs. No systematic program currently exists in the US to process all of these stereo images into DTMs. Therefore there is an opportunity for geoscientists around the world, given the necessary tools, to create such DTMs.

The UK NASA 3D RPIF is an attempt to provide such tools for geoscientists in the UK and on the European mainland to process such DTMs from CTX and HiRISE data. We describe the reasons for our choice of DTM processing system and the hardware and software facilities which have been established.

2. RPIF 3D Facilities

Although UCL developed a general purpose processing system for stereo imagery of Mars in the early 1990s [4] which more recently was adapted to HRSC [6] as well as CTX and HiRISE [1], the system remains bespoke and currently requires a great deal of experimentation to generate high quality products. NASA has sponsored the development of software [2] using the USGS ISIS system to process TDI (Time Delay Integration) HiRISE imagery into image products suitable for processing into DTM products using the commercial SOCET® photogrammetric software [11]. The overall photogrammetric process stars with EDRs and SPICE kernels, correcting for distortions due to the TDI images including jitter in future [12] and using SOCET® to improve knowledge of pointing and update the SPICE kernel as well as DTM creation and orthorectification of imagery. The key reason for choosing the USGS system was the excellent documentation previously cited and the growing number of scientists within the US who have experience in the use of such a system. Unfortunately the cost of the software to non-university users is prohibitively high and the training necessary to use this software is extremely expensive.

Training is provided annually for interested users and in July 2009 the first training workshop, which is a mandatory pre-requisite for access, was held to enable prospective users training in the new RPIF 3D facility. Since then around half the trained users have booked and used the system to create DTM products.

The hardware employed consists of a Dell dual-processor (running at 2.5 GHz) with 4 GB-RAM and 1000 GB-diskspace with stereo output to a CRT screen, a 27-inch (1920 x 1200 pixel) display and a 3D mouse. The installed software includes ESRI® ArcGIS® v9.2; ITTvis® ENVI/IDL v 4.6, BAE Systems SOCET® v5.4 and iView3D to display Fledermaus visualization files.

In addition to the stereo workstation, a Mac quad G5 (running at 2.8 GHz) with 4 GB-RAM and 1000 GB-diskspace with dual 30-inch (2560 x 1600 pixel displays) includes software from ITTvis® ENVI/IDL v 4.6, FLEDERMAUS v6.7.0, GRASS v6.4 and USGS ISIS v3.x to manipulate and process derived HiRISE and CTX DTMs and fuse them with MRO CRISM and other datasets. In addition to these systems, the RPIF also includes a MagicPlanet® spherical projection display and a portable Geowall for display of stereo products created using the RPIF-3D at exhibitions.

3. Summary and Conclusions

The UK NASA RPIF 3D facility will allow UK and other European scientists access to the latest hardware and software for generating very high resolution DTMs and orthorectified images from the NASA MRO HiRISE and CTX cameras when pre-programmed stereo acquisitions have been made.

Users wishing to use the stereo DTM creation system need to go on a training course. These users should email “rpif3d-requests@mssl.ucl.ac.uk” with subject “Request for Training” and places will be allocated on a first-come-first-served basis. Users who wish to visit the RPIF and the RPIF-3D facility should send an email to p.grindrod@ucl.ac.uk.

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