A Tool for the Visualization of Small Body Data

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Introduction: It is currently difficult for small body scientists and researchers to quickly analyze and interpret data returned from small body missions due to the large amounts of data returned and the fact that such data are often in difficult to understand formats. These challenges are enhanced by the typically odd shapes of small bodies such as 433 Eros or 25143 Itokawa, where the ellipsoid-based data integration and analysis tools are not well suited.

This paper describes a new software tool called the Small Body Mapping Tool (SBMT), which was developed to facilitate the analysis of small body data (Figure 1). It is meant to be an easy to use tool for quickly searching and visualizing such data. This paper describes the overall design of the SBMT as well as the datasets that are currently supported.

Design Overview: The Small Body Mapping Tool provides an intuitive user interface that makes use of modern interactive 3D graphics and visualization algorithms. It runs on all major operating systems including Mac, Linux, and Windows and is designed to facilitate adding new data or making other changes and quickly pushing these updates to the user. To achieve this, the SBMT is written primarily in the Java programming language for cross platform support and uses the Visualization Toolkit (VTK) for 3D rendering and visualization, an open source, cross-platform visualization library containing many advanced geometry algorithms [1].

Due to the large amounts of data involved, the SBMT does not store all data on the user's local machine but instead communicates with a remote server over the internet to fetch data. Data files are only downloaded as needed and are then cached on the user's machine to avoid repeated download of the same data. In addition, the server hosts an SQL database backend for indexing the data and performing searches on the datasets as requested by the user.

Shape Models: The SBMT was originally designed to show shape models of the asteroid Eros, and most of the work to date has been done in visualizing data from the NEAR mission. In addition to Eros, three other small bodies are supported: Deimos, Itokawa, and Vesta. When viewing any of these shape models in 3D, the user can easily interact with the model by navigating around the model with the mouse. Rotating, spinning, panning, and zooming in and out are all supported.

Two of the asteroids, Eros and Itokawa, can be viewed at four resolutions levels, where the lowest resolution shape model consists of about 50000 plates or triangles, and the highest one consists of over 3 million plates. Other options include overlaying a latitude/longitude coordinate grid as well as coloring the small body based on elevation, slope, gravitational acceleration, or gravitational potential.

MSI Data: The SBMT provides the ability to search and display imagery acquired by the NEAR Multispectral Imager (MSI) which took over 100000 images of Eros between January 2000 and February 2001. While this imagery has been available to researchers on the Planetary Data System (PDS), it is difficult to perform a search for a particular image.

The SBMT provides the capability to search through all the MSI images based on specified criteria. Options are provided for selecting ranges in time, resolution, incidence, emission, and phase. The user can also interactively select a region of the asteroid and restrict the search to that region. These search criteria are submitted to the SQL database engine on the server and a list of matching images are returned to the user.

Matching images can then be viewed in a standard image viewer but more importantly can be mapped directly onto the Eros shape model and viewed from the vantage point of the spacecraft when the image was acquired. In this procedure, known as texture mapping, the image is literally painted onto the surface of the asteroid [2]. An example of an image texture mapped on Eros is shown in Figure 1.

NIS Data: The SBMT is also able to search and display the footprints of NEAR Infrared Spectrometer (NIS) data. Several hundred thousand spectra were taken of the asteroid between January and May 2000, with each spectrum consisting of 64 channels between 812 nm and 2708 nm. Like the MSI search functionality, the user can search for spectra from a database by specifying various criteria and displaying the selected footprint directly on the asteroid. Individual spectra can also be plotted on a 2D graph. Several NIS footprints are shown on the Eros shape model in Figure 1.

NLR Data: The final NEAR dataset currently available in the SBMT is that acquired by the NEAR laser rangefinder (NLR). About 16 million data points were acquired during the mission and the user can search in both time and space for selected data points. Several NLR data points are shown on the Eros shape model in Figure 1.

Drawing Shapes: In addition to the viewing of NEAR mission data, the SBMT supports the interactive drawing of various structures directly on the asteroid. This allows researchers to analyze and measure structural features on asteroids, such as craters or linear structures. Currently, it is possible to draw paths, circles, and individual points on any of the incorporated shape models.

Future Work: Future work includes improving and enhancing existing functionality as well as adding support for more shape models and datasets acquired from other missions. Researchers interested in gaining access to the SBMT are welcome to contact the authors.

References: [1] W. Schroeder, et al. (2006) *The Visualization Toolkit: An Object-Oriented Approach To 3D Graphics, 4th Edition* Kitware, Inc. [2] J. D. Foley, et al. (1990) *Computer Graphics: Principles and Practice* Addison-Wesley.

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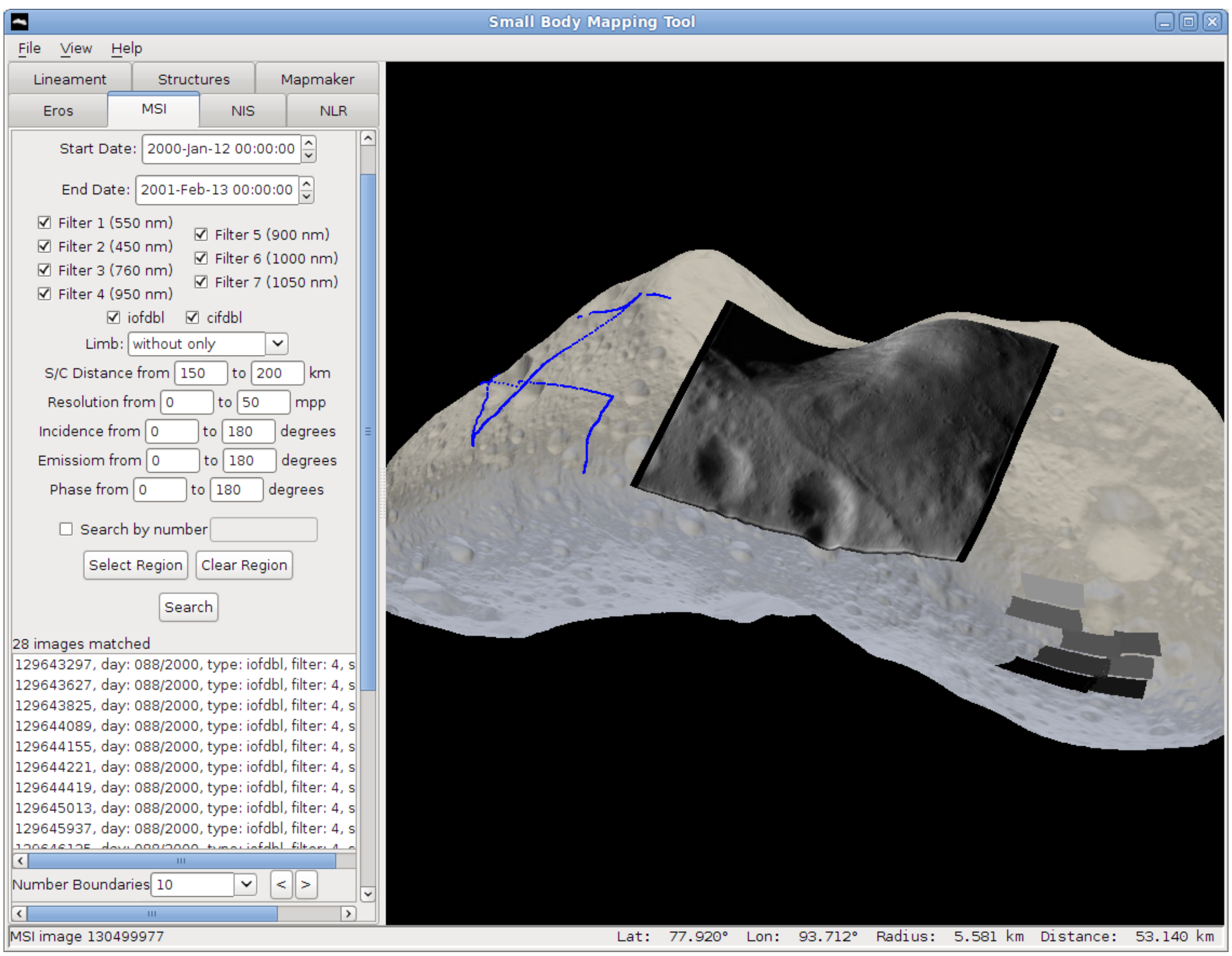

Figure 1: Screenshot of the Small Body Mapping Tool showing (from left to right on the Eros shape model) NLR, MSI, and NIS data.