

A GIS-ORIENTED ANALYSIS TOOL FOR IRREGULAR SHAPED BODIES. N. Hirata¹, Y. Fujii¹, Y. Joukou¹, H. Demura¹, N. Asada¹, S. Abe², M. Ishiguro³, K. Kitazato⁴, R. Nakamura⁵, and M. Abe⁴ ¹The University of Aizu, Ikki-machi, Aizu-Wakamatsu, Fukushima, 965-8580, Japan, ²Graduate School of Science, Kobe University, 1-1 Rokkodai-cho, Nada-ku, Kobe, 657-8501, Japan, ³Department of Physics and Astronomy, Seoul National University, Seoul 151-742, Korea, ⁴National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba 305-8568, Japan, ⁵The Institute of Space and Astronautical, Japan Aerospace Exploration Agency, Sagami-hara, Kanagawa 229-8510, Japan, Corresponding author's e-mail address: naru@u-aizu.ac.jp

Introduction: In this report, we describe a GIS-oriented tool that is developed to analyze data of irregular shaped bodies such as asteroids. Target users of this tool are not only researchers in planetary science but also people involved in education and public outreach activity

A number of observations of solar system small bodies are performed by both earth-based observatories and spacecrafts in the recent decade. Since various instruments are used for these observations, many kinds of data are published. Spatial resolutions of the data also become better, and a variety of mapping data is now available for many small bodies. The asteroids Itokawa and Eros, observed by HAYABUSA and NEAR-Shoemaker, are good examples of such bodies [1-5]. The geographical information system (GIS) is a powerful tool to handle digitized map data. It can integrate map data in which observed values are associated with particular locations on the surface of a target body. GISs and GIS-oriented tools are now widely used in various research fields studying the Earth and other large bodies such as the Moon and Mars. Available GISs cannot be applied to small bodies directly, because most of them have very irregular shapes [6]. Usual GISs support only spherical bodies of which coordinate is a simple longitude and latitude system. Even though the longitude and latitude coordinate is valuable for descriptions of surface features, it is not the unique identifier on the irregular shaped bodies. A vector from the body center may intersect the body surface three or more times on the irregular shaped bodies.

A shape of an irregular shaped body is usually represented as a polygon model that consists of polygon plates. Thus, the polygon IDs can be used as the unique identifiers to represent locations of surface features on the body. If the polygons are too large for precise representations of fine features, the rectangular coordinate system on the plane that includes a particular polygon can be used supplementary. We

adopt this idea for our tool. Such a treatment is common for 3D computer graphics.

Implemented Functions: Basic requirements for the tool are as follows; 1) manipulation of the shape model of the target body, 2) store and display of map data on the shape model, and 3) analysis of the data. The current version of the tool is implemented functions to satisfy these requirements. As we consider multi-platform availability, this tool is developed with OpenGL for 3D visualization and the Gimp Tool Kit (GTK) that provides GUI frameworks. It supports many platforms such as MS Windows, Solaris, Linux and MacOSX. We perform functional tests of the tool with data of Itokawa.

Manipulation of the shape model. This tool can render and display the shape model with shading (Fig. 1). The rendered model can rotate, zoom and move by mouse operations. The most detailed shape model of Itokawa consists of 3,145,129 polygons [7-8]. Because this model is too large for real-time rendering by common computers, we use a reduced-resolution version of the shape model (49,152 polygons) together with the high-resolution model. Users can choose a viewpoint of the display arbitrarily with the reduced model, then switch to the original model for detailed investigation.

Users can turn on or off a shaded display mode. The shading conditions can also be change by mouse operations arbitrarily. Users can investigate fine surface features at shading conditions that were not accomplished at actual observations. The longitude and latitude grid is displayed as guidance for users. When the shape model is loaded first, the tool automatically prepares the grid data.

Manipulation of map data. Map data is a set of data that are associated with particular locations on the surface of the shape model. The tool currently supports a set of scalar data associated with the polygon IDs. Thus, map data should be prepared for the shape models of individual resolutions. Scalar values are primarily physical data such as reflectance and

composition of surface material, geopotential, and slope angles. However, flags that indicate locations or boundaries of surface features can be treated with the same framework. For Itokawa, a slope angle map, a geopotential map, and a near-infrared reflectance map are now available [9]. We are also preparing a visible brightness map produced from camera observation data by the Hayabusa mission. As the format of map data is a simple text table, users can easily produce one's original map data.

Each polygon is displayed with a color that is assigned according to a scalar value of the map data. Users can choose a rainbow color map or a grayscale map, and modify color map parameters by sliders appeared in the window. The tool can manage multiple map data. Users can open and load an available map data, and select a map to be displayed with the shape model from the loaded maps.

Functions for analysis. The tool offers several functions to analyze the displayed shape model and maps. One can choose a plane cutting the model arbitrary, then extract all attributes of polygons on the plane including 3-D locations, 2-D locations on the plane and map data as a text table. An external tool can visualize this cross sectional data for further

investigation. A user map data is also created by this system. A blank map is prepared at first. Then users can select polygons by mouse operations, and give scalar values to them. This function is also used to mark surface features while comparing camera data and the shape model with map data.

Summary: We developed a GIS-oriented tool to analyze data of irregular shaped bodies such as asteroids. This tool provides functions to manipulate the shape model of the target body, store and display of map data on the shape model, and analysis of the shape model and the map data. This kind of software will enable high-level analysis on small bodies and rich graphical representation of results of the analysis.

References: [1] Fujiwara A. et al. (2006) *Science*, 312, 1330-34. [2] Saito J. et al. (2006) *Science*, 312, 1341-44. [3] Demura H. et al., (2006) *Science*, 312, 1347-1349 [4] Thomas P. C. et al. (2002) *Icarus*, 155, 18-37. [5] Bussey D. B. J. et al. (2002) *Icarus*, 155, 38-50. [6] Buczkowski, D. L. (2007) *Icarus*, 193, 39-52 [7] Gaskell R. et al. (2006) *AIAA paper* 2006_6660. [8] Hayabusa Project Science Data Archive: <http://hayabusa.sci.isas.jaxa.jp/> [9] Kitazato K. et al. (2008) *Icarus*, in press.

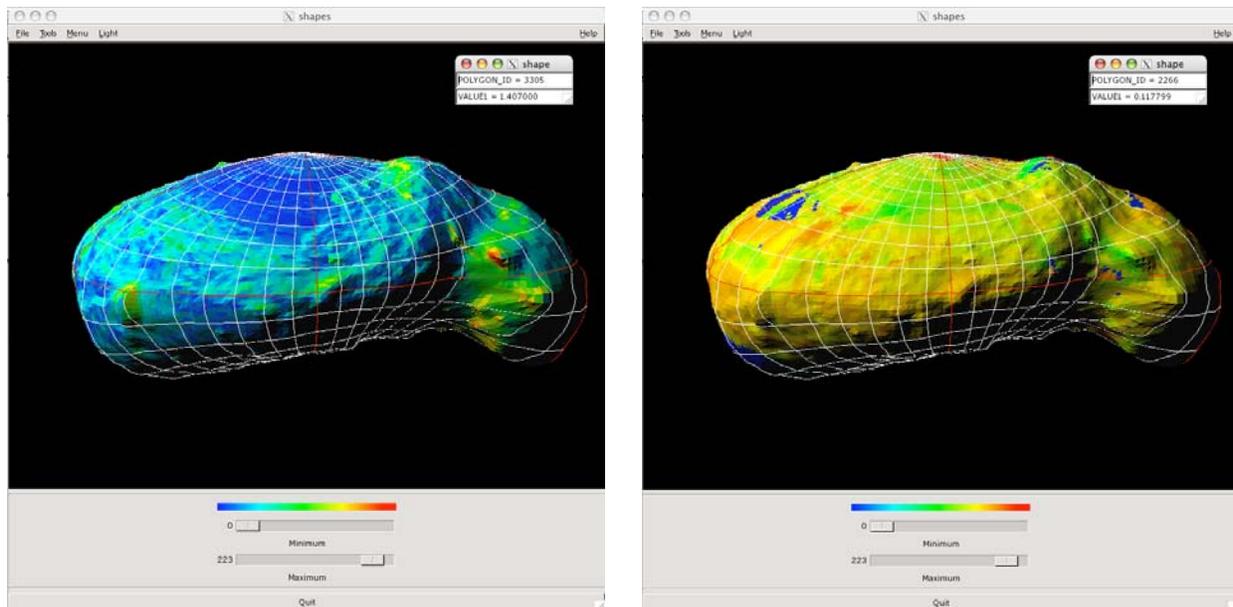


Figure 1. Snapshots of the developed tool. Slope (left) and near-infrared reflectance (right) are mapped onto the shape model of Itokawa with the longitude and latitude grid. Sliders to modify color map parameters are appeared in the bottom of the window. A polygon ID and a scalar value of the displayed map data