

AiGIS: A 3D-GIS FOR VISUALIZATION OF MAP AND SHAPE OF IRREGULAR-SHAPED SMALL BODIES. N. Hirata¹, H. Demura¹, M. Ichikawa², T. Endo², Y. Ishihara³, H. Sato³, and H. Otake³, ¹ARC-Space, the University of Aizu (Aizu-Wakamatsu, Fukushima, 965-8580, Japan, naru@u-aizu.ac.jp), ²Aizu Laboratory Inc., ³JLPEDA/ISAS/JAXA.

Introduction: Recently, many exploration missions to small bodies are planned and being operated. Also, Earth-based observations reveal the nature of many more small bodies. A variety of remote sensing data including the shapes, color spectra and other geologic information is available. The geographical information system (GIS) is a powerful tool integrate map data in which observed values are associated with particular locations on the surface of a target body. The GIS and GIS-oriented tools are now widely used in various research fields that study the Earth and other large bodies such as the Moon and Mars. However, datasets of irregular-shaped bodies are hard to handle with usual GIS software. They support only spherical bodies with geographical coordinate system (by longitude and latitude), which is not the unique identifier on the irregular-shaped bodies.

We proposed a concept of 3D-GIS that uses 3D representation of the body shapes to solve this problem about ten years ago [1, 2]. The shapes of irregular-shaped bodies are usually represented by a polygon model. Thus, the polygon IDs can be used as the unique identifiers to represent locations of surface features on the body instead of the latitude and longitude coordinate system.

Several research groups have released their own implementation of the 3D-GIS concept; SBMT (Small Body Mapping Tool) by APL/JHU [3], MATISSE (Multi-purpose Advanced Tool for the Instruments for the Solar System Exploration) by ASDC [4] and Small Body Geophysical Analyses Toolbox (SBGAT) [5]. Here we introduce our latest 3D-GIS implementation, AiGIS, in this paper.

Technologies: While the original version of the tool was developed by C++, we rewrote completely by Java with cross-platform capability. The latest version of AiGIS runs on macOS, Windows, and Linux. Java Binding for the OpenGL API (JOGL) [6] is used to access to 3D graphics APIs offered by OpenGL. JFreeChart provides a capability to generate charts [7]. AiGIS is designed as a stand-alone application, thus no connection to the remote data server is required.

Implemented Features: AiGIS keeps all basic functions implemented in its early versions [1, 2]; Display and manipulation of shape models, Visualization of map data on a shape model, and Functions to analyze the shape model and map data.

The latest version also has extended capabilities of these features and several new ones.

Display and manipulation of the shape models. Polygon-based 3D models of a target body are displayed in the main pane of AiGIS. AiGIS supports a 3D model with the Wavefront 3D Object (OBJ) File format (.obj). The OBJ file format is commonly used to store shape data of small bodies, and other tools for small bodies also support OBJ files. The shape model can be rotated, zoomed, and translated by mouse operations.

In many cases, polygon models with multiple and hierarchical resolutions are available for a particular body. A high-resolution model is suitable for a detailed investigation of the surface features, and a low- and medium-resolution models are used as a reference of geophysical properties such as slope and geopotential maps. AiGIS can load two different models (e.g., high and low resolutions) for the target body at once, and user can select a preferred model to be displayed. Use can switch the models with the same viewing geometry to easily compare two models. The real-time rendering (e.g., rotation and zoom) automatically display a model with lower resolution to reduce loads.

Lighting condition of the shape model is also controllable by mouse operations with a hot key (Shift Key + Mouse operation). A marker pointing to the light source is displayed with the hot key and helps users to set lighting condition.

Visualization of map data. Map data on AiGIS is a set of data that are associated with particular locations on the surface of the shape model. Local slope angle estimated from the gravity vectors and the normal vectors at a particular location could be a map data, for example. AiGIS supports a map data set of scalar data associated with the polygon IDs in a text format.

AiGIS can load map data as many as the memory space allows, and user can select a map to display on the shape model. Polygons of the shape model are displayed with a color that is assigned according to a value in the selected map with the look-up table. Users have two choices on the look-up table; a rainbow color map or a gray scale map, and can modify color/gray scale assignment parameters.

As the concept of map data is the same as that of plate data in SBMT, compatibility of data file is considered between two tools. AiGIS map data and

SBMT plate data are easily converted each other by a simple shell script.

Display of plot with graph map data. While a map data store a single value for each polygon, “graph map data” (polygon-assigned multiple dataset) can handle multiple values, such as reflectance spectra of the surface materials. On AiGIS, a graph map data file is always paired with a map data. When the map data paired with a graph map data is selected to display, a plot sub-window pops up. Once user clicks on a polygon of the displayed model, the stored graph data is plotted. As user clicks other polygons, new plots are overlaid on an existing sub-window. Source data of the displayed plot can be exported as a text data. Time tagged sequential data with ISO 8601 style date and time information is also acceptable as a graph map data in AiGIS.

Multi display pane mode. The main panel of AiGIS can be divided into two or four panes, and different models or different map data displays are

assigned to each pane. Viewing geometries can be spontaneously synchronized in all panes. This mode helps user to make cross comparison among various map data and models.

Acknowledgement: AiGIS is an open source software and open to public at a website of ARC-Space/University of Aizu (<https://arcspace.jp/>). Precompiled executables for supported platforms, a source code package, and sample data are available. Comments and questions are welcome to the authors e-mail address (see author information).

References: [1] Fujii Y. et al. (2007) *LPS XXXVIII*, Abstract #1521. [2] Hirata N. et al. (2008) *LPS XXXIX*, Abstract #1584. [3] Kahn, E. G. et al. (2011) *LPS XLII*, Abstract #1618. [4] Zinzi A. et al. (2016) *Astronomy and Computing*, 15, 16-28. [5] Bercovici B, McMahon J. (2017) *DPS meeting #49*, id.111.11. [6] <http://jogamp.org/jogl/www/> [7] <http://www.jfree.org/jfreechart/>

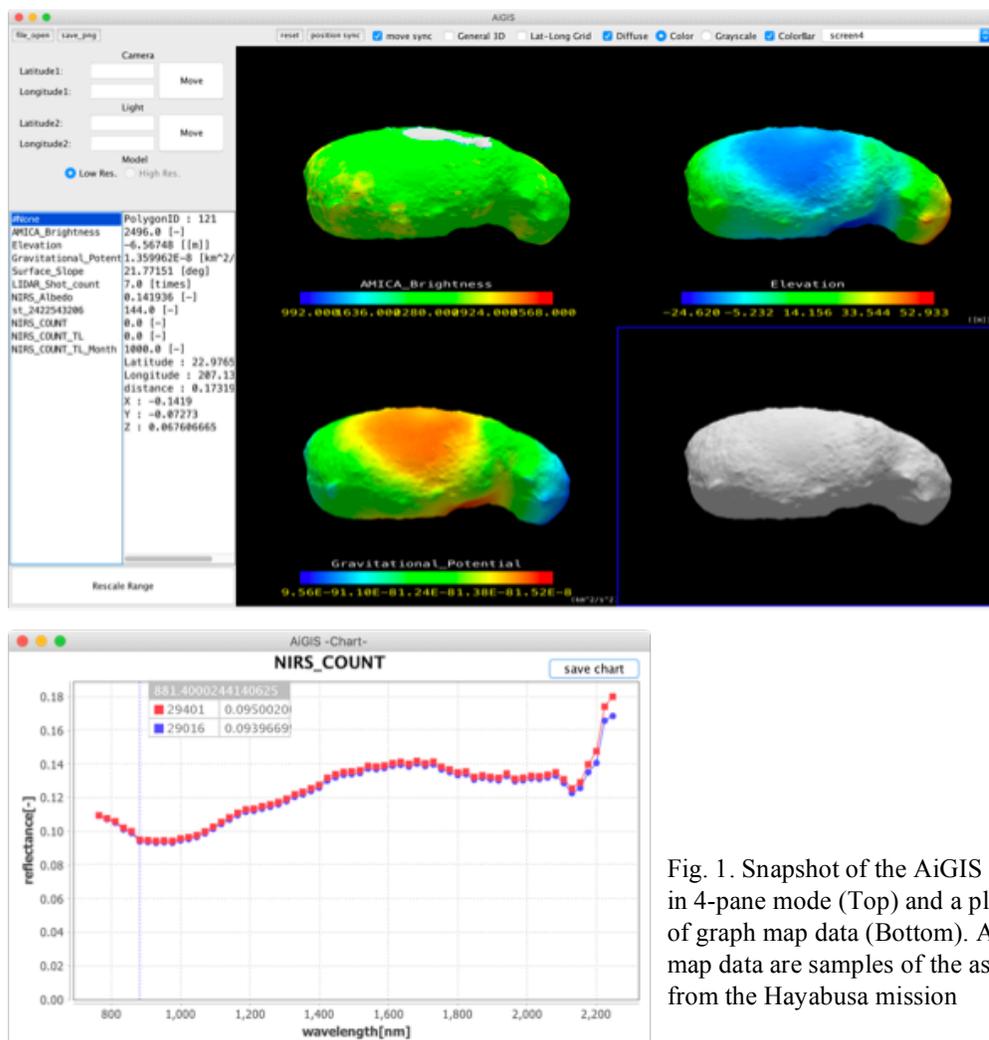


Fig. 1. Snapshot of the AiGIS main window in 4-pane mode (Top) and a plot sub window of graph map data (Bottom). All shape and map data are samples of the asteroid Itokawa from the Hayabusa mission