Preliminary Design of Visualization Tool for Hayabusa Operation. E. Nemoto1, N. Asada1, and H. Demura1, S. Kobayashi1, M. Furuya1, T. Kubota2, T. Hashimoto2, J. Saito2, 1Dept. Computer Software, Univ. of Aizu, Aizuwakamatsu City, Fukushima 965-8580, JAPAN, m5081140@u-aizu.ac.jp, 2Inst. Space and Astronautical Science, Japan Aerospace Exploration Agency, 3NISHIMATSU Construction Co., Ltd

Introduction: Hayabusa is one of the Engineering Missions at ISAS (Institute of Space and Astronautical Science). The main aim of the mission is to acquire and verify the technology required for a sample-return mission [1]. This mission will make it possible to explore the mysteries of the planet-forming substance, temperature and pressure in early solar system, or evolution with asteroid collision.

Hayabusa will arrive at the target asteroid (25143) Itokawa in September of 2005. It will bring back a sample from its surface. Observation phase consists of seven sections: cruising phase (CP), approach phase (AP), gate position (GP), home position (HP), extended observational Transition (XT), high phase angle observation (XO), and terminator observation (TO). Image for shape modeling will be taken in the gate position. In addition, we intend to get images distinguish more detailed geologic context in XO and TO.

The purpose of the development of the visualization tool is to project some data on an irregular shaped model. The spacecraft will be at risk for failure if it touches down on rough place. 3D map will be required to reconstruct the safe place to touch down on the surface and pick up some samples.

The goal of this study is to develop a tool to project some data on an irregular shaped model. As a result, the tool would contribute to design operating plans of Hayabusa.

Footprint, calculated using SPICE toolkit [2], gives us the information of the border of the field of view of an instrument projected onto a surface. To calculate the footprint, relative position information will be used as an input data.

It is appropriate to use IDL (Interactive Data Language) [3] [4] to develop such a visualization tool.

Requirements and Interface regulation: The asteroid shape will be restored with 120 pictures using the method conformed by S. Kobayashi et al. [5]. Shape model using stereo method is constructed by all adjacent images in the input datasets (pictures taken at a different light 20 kilometer away form Itokawa).

Many data of equipments such as AMICA (Asteroid Multi-band Imaging Camera), NIRS (Near Infrared Spectrometer), XRS (x-ray fluorescence spectrometer), and LIDAR (Light Detection And Ranging) are stored in each polygon. The result of shape modeling, textures, and some SPICE kernels (a data set provided in one of the NAIF standard formats that can be accessed using NAIF SPICE subroutines) are used to project those data on the irregular shaped model.

Implementation: (i) Calculation: It is required to decide the position of the spacecraft in an origin centroid coordinate using shape data and pictures. It is important for getting footprint to calculate relative position between the spacecraft and the asteroid. Mapping is required to paste textures in restored shape.

(ii) SPICE toolkit
At the moment, SPICE toolkit supports shape model. SPICE toolkit supporting plate model for irregular bodies is under development.

(iii) Polygon: A polygon object represents one or more polygons that share a given set of vertices and rendering attributes. All polygons must be convex-that is, a line connecting any pair of vertices on the polygon cannot fall outside the polygon. Concave polygons can be converted to a set of convex polygons using the IDLgrTessellator object.

An IDLgrPolygon object is an atomic graphic object; it is one of the basic drawable elements of the IDL Object Graphics system, and it is not a container for other objects.

(iv) Texture Mapping: It is possible to map an image onto a polygon object by specifying an IDLgrImage object to the TEXTURE_MAP property. The TEXTURE_COORD property defines how individual data points within the image data are mapped to the polygon’s vertices. Note that you must specify both TEXTURE_MAP and TEXTURE_COORD to enable texture mapping.

(v) Functions: “Translation” has the function that moves an object or group of objects in a specified direction. When an object is selected, a bouncing box appears around the object.

The multiple-axis scaling mouse pointer for 3-D objects is a three-headed arrow displayed when the mouse pointer is positioned over a corner of a 3-D object's data space. Dragging the constrained scaling pointer scales the object a fixed distance along all axes in the direction of the drag.

“View Zoom” increases or decreases magnification at a specific point in the iTool window. This is similar to moving the observer’s "eye" closer to or farther away from the object. Clicking with the mouse specifies the point of interest, and dragging the mouse makes it possible to zoom in or out.

The iTools provide a number of ways to rotate graphical objects (“Rotating”). 3-D objects can be rotated freely or along an axis using the mouse. In addition, both 2-D and 3-D objects can be rotated left or right in 90-degree increments, or they can be rotated by a specified number of degrees.

Figure 1 shows draw/mouse events in the left hand window. Its purpose is to move a red marker to the mouse position and translate the model to the eye position in the
right window. It also allows a right mouse event to rotate the view by 360 degrees.

Summary: At the present time, external function such as translating, scaling, rotating, zooming, view panning have been developed.

Internal function including calculating footprint, superimposing some data on each polygon etc. will have been developed by May of 2005 when the rehearsal in preparation for the procedures is supposed to be held.

When the tool for visualization asteroid is finished implemented, it will be possible to project same data acquired by AMICA, NIRS, XRS, LIDAR, and footprint etc. to irregular shape polygon model. As a result, the tool will contribute to the sample return mission.


Figure 1: Sample Image Visualization Tool: The region which is enclosed in yellow line means the view border of the field of view of an instrument projected onto a surface (footprint). The region enclosed in red line means a polygon.