A Method to Integrate Point Clouds Derived from Multiple Stereo-Pair Images R. Suda[1], Y. Mori[1], H. Demura[1], N. Asada[1], and N. Hirata[1], [1]University of Aizu, Fukushima 965-8580, Japan.

Introduction: Image-based 3D reconstruction is popular in computer vision. Stereo camera systems taking a wide field of view (FOV) at once have advantages in a reconstruction of a wide 3D surface and in a maintenance-free system because of few movable parts. The more FOV is widely, the harder to rectify the whole FOV at once, although it is easier to rectify a part of the wide FOV than the whole FOV. This research proposes a new method, which regards a wide FOV as a cluster of narrow FOVs, and verifies the method based on the image with a narrow FOV.

Methods: Figure 1 shows the input stereo image [1] of asteroid Itokawa captured by AMICA (Asteroid Multiband Imaging Camera) on Hayabusa. One of the stereo images is divided, reconstructed to 3D surfaces as point clouds, and integrated the point clouds into a set of point cloud.

Figure 1: The stereo images of Itokawa
The image identification code of these image ST_2423026558_v (left) and ST_2423034734_v (right). Each image shows 1024x1024 pixels.

Dividing images: Both the left and right images are divided into 25 pieces of images which have 50% overlap with the adjacent images. Each divided piece keeps information of connections as not only the adjacent images but also 2D points called as tracking points, which are on the overlap. Two point clouds are combined guiding with the corresponding tracking points.

Reconstructions: The divided stereo images are reconstructed to the 3D point clouds. In case of the defective reconstruction, related information is excluded, for example the piece of image, the tracking points, the point cloud. The tracking points are redetermined to correspond the point clouds.

Integration: The remained point clouds are integrated to a set of point cloud. Procedures to combine two point clouds consist of 2 steps which are rough transformation based on the tracking points and fine transformation by Iterative Closest Point algorithm [2].

Results: Figure 2 shows the divided pieces of left one shown in Figure 1. The point clouds are reconstructed from the not pale images of Figure 2. Other images are defective to reconstruct 3D surfaces. Figure 3 shows the integrated point cloud.

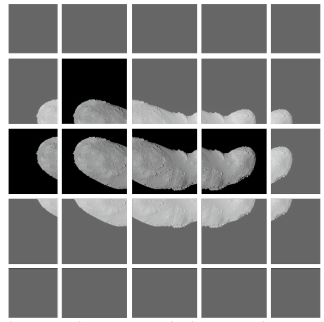

Figure 2: The divided pieces
The pale pieces are defective to reconstruct 3D surfaces.

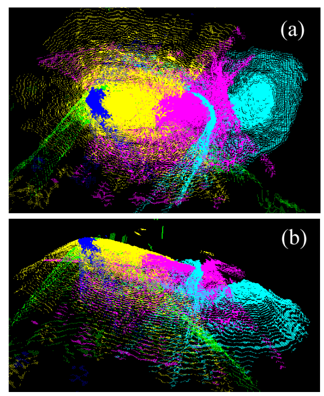

Figure 3: The integrated point cloud
Point clouds before integration show different colors. The point cloud with different viewpoints is displayed in (a) and (b).

Summary: All reconstructed point clouds are integrated to one successfully. This research does not note the accuracy of the reconstructions. Although some noises are found around Itokawa, the rough outline and surfaces seem to be consistent except for the noises. This method is helpful to implement the stereo camera systems which are wide angle cameras, fisheye cameras, and omni cameras. Future work is to focus on two topics. One is improving the accuracy of reconstruction with the removal of the noise. Another is implementing how to choose which points in case of each data set of point clouds overlapped.

References: [1] Hayabusa Project Science Data Archive, http:// darts.isas.jaxa.jp/ planet/ project/ hayabusa/ index.html. [2] T. Masuda, Guide of the most advanced computer vision, *Adcom media,* 2010, p.33 – 61.