TOOLS FOR IMAGES AND SPICE DATA OF COMET MISSIONS.

X.-D. Zou[1], K. J. Becker[2], J.-Y. Li[1]
[1]Planetary Science Institute (1700 E Fort Lowell Rd, Ste 106, Tucson, AZ, 85719, zouxd@psi.edu), [2]Lunar and Planetary Laboratory, University of Arizona.

Introduction:

Previous comet flyby missions have obtained disk-resolved images showing the details of the comet nuclei (Table 1). Analysis and interpretation of these data rely on the accuracy of the observation geometry. The Navigation and Ancillary Information Facility (NAIF) [1] provide Spacecraft, Planet, Instrument, C-matrix and Events (SPICE) data in the form of kernels that represent a priori ephemeris for the acquired images. These kernels are used as a basis to derive geometric backplane data critical to scientific investigations. The goal of our project is to refine the SPICE data through application of established and enhanced image-to-shape model control techniques and archive as geometric backplane data and *smithed* SPICE kernels. This work will relieve investigators the time and effort required to perform complex control/bundle adjustment techniques to register images to shape models.

Discussion:

These products would provide support for scientists who conduct research and analysis of Rosetta images from possible problems, including:

（1） The standard Rosetta image orientation and complex data structure. There are different orientations and different formats for Rosetta images, which we will unify in our planned backplane product.

（2） The camera distortion. We will include it in the camera model.

（3） The uncertainy/error in SPICE data, which we will be resolved by providing *smithed* kernels.

（4） There is redundant effort in calculating the geometry for the images, including the computing effort needed for image registration to certain precision, and rendering the complicated, high-resolution shape model of 67P (SHAP7 [5] model is with 44 million facets and the 3D file is 796MB in size). The backplane data products we are producing will provide the community with high quality geometry data.

This presentation will outline the plan and current status of our project.

Outline of the plan:

We are adding ISIS image ingestion and camera model support for these missions. These contributions enable derivations of simulated image observations with current SPICE data and the shape model[2-4]. Then, we apply automatic feature matching processes to produce keypoints of each observed image and its simulation image derived from the high resolution shape model. After removal of the outliers from the keypoints matches, we use the least square approximation of the image-to-image homography (affine) matrix to determine the spatial offsets and rotation. After this step, we refine the control the data with updated ISIS tools to generate new SPICE (CK and SPK) kernels. Results of this processing procedure are appled to produce the backplane datasets as we proposed. The final step is preparation and archival of our resulting datasets including the SPICE kernels, image backplane datasets, software, and documentation.

Summary:

This project will refine SPICE data and archive geometric backplane data, which contains the geometry information of each image, including light scattering geometric angles, RADF (Radiance Factor), and spatial coordinates of each pixel for cometary image data obtained by a variety of spacecraft. The scientific community can use these data to enable robust interpretations, and save other investigators the time and effort needed to perform their own computations of sub-pixel registered viewing geometry data. This project will also add ISIS support for these missions in the form of ingestion applications and camera model software for additional geometric processing of this data. The software will be made available to the community in subsequent ISIS public releases.

Acknowledgments: This material is based upon work supported by NASA under Contract 80NSSC19K0421.

References: [1] Acton, C. et al, (1966) *Planet. Space Sci. 44,* 65-70. [2] Besse, S., et al. (2019) *In 4th Planetary Data Workshop*, Vol. 2151. [3] Fraga, D., et al. (2019) *In 4th Planetary Data Workshop*, Vol. 2151. [4] Grieger, B., et al. (2019) *In 4th Planetary Data Workshop*, Vol. 2151. [5] http://comsim.esac.esa.int/rossim/SHAPE_MODEL_DRAFTS/SHAP7_8/SPG/shap7_model_info.asc

Mission (Spacecraft)	Time	Target	Schema	Reference
Deep Space 1	9/22/2001	**19P/Borrelly**	Flyby	Soderblom et al., 2002
Stardust	1/2/2004	**81P/Wild 2**	Flyby Sample return	Brownlee et al., 2004
Stardust-NExT (Stardust)	2/15/2011	**9P/Tempel 1**	Flyby	Veverka et al., 2013
Deep Impact	7/4/2005	**9P/Tempel 1**	Flyby Impact	A'Hearn et al., 2005
EPOXI (Deep Impact)	11/4/2010	**103P/Hartley 2**	Flyby	A'Hearn et al., 2011b
Rosetta	08/2014 09/2016	**67P/Churyumov-Gerasimenko**	Orbit and land	Keller et al., 2015