EPSC Abstracts
Vol. 9, EPSC2014-225, 2014
European Planetary Science Congress 2014

Scientific data products and data pre-processing system of Chang'E-3

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Abstract

The payload of Chang'E 3 (CE-3) has been providing critical observations of the Moon, and the observation data have been processed and distributed to various users by the ground research and application system (GRAS). In this paper, the CE-3 data products are presented, including the classification and definition of the data. The pre-processing system is also introduced.

1. Introduction

The Chang'e 3 mission incorporates two major components –Lunar Soft-Landing Vehicle (Lander) and Lunar Surface Exploration Vehicle (Rover). Both of them are equipped with scientific payload. The payload on rover are the Panoramic Camera (PCAM), Active Particle Induced X-ray Spectrometer(APXS), Visible and Near-infrared Imaging Spectrometer(VNIS), and Lunar Penetrating Radar(LPR) while the payload on lander are Terrain Camera(TCAM), Landing Camera(LCAM), Moon-based Ultraviolet Telescope(MUVT), and Extreme Ultraviolet Camera(EUVC).

We use PDS3 (Planetary Data System) [1]as the CE3 data storage standard. This paper describes how these data are processed to generate different types of data products, and the data pre-processing system is introduced.

2 Classification and definition of CE3 data product

CE3 data product are categorized into three levels including level 0, level 1 and level 2, as detailed in Table 1. Level 0 data are further divided into levels 0A and 0B. All the instruments on board share the same definitions of level 0A, 0B and level 1 data, while the level 2 data definitions vary among different instruments.

Table 1: Definition of the data levels

Data level	Data description
Level 0A	After channel processing, unpacked, and marked in time code with the payload
Level 0B	Based on level 0A data, but with further ordering, optimal splicing, de-replication, source package header removal, to generate data blocks for specific science payloads. Moreover, the TCAM, LCAM, MUVT are decompressed.
Level 1	Based on level 0B data, but with the raw measurements converted to useful physical quantities, framed by detecting cycle(a Lander detecting cycle is an Earth Day, and a Rover detecting cycle is a period of time from a scientific exploration mission planning start to end)
Level 2	Usually divided into L2A, L2B, L2C. L2A mainly include system calibration. L2B mainly include geometric positioning. L2C vary according to the different users' requirements. See Table 2

Table 2: The level 2 data processing of payloads

payload	Data level	Data processing
PCAM /TCAM	L2A	Dark current calibration, relative radiometric calibration and normalization.
	L2B	Add the geometric information include observation vector of image four corner points and the center point, camera center position, camera rotation angle, solar incidence, solar azimuth, mast pitch angle and mast yawing angle.
	L2C	Based on level 2B data, conducted a colour restoration and colour correction process.
LPR	L2A	Normalization according to cumulative number of channels, gain removal, and DC removal.
	L2B	Add the position of reference point that relative to the current position; Add the attitude of reference point that relative to the current attitude;
	L2C	Band pass
VN	L2A	Pepper noise subtraction, dark

IS		subtraction, temperature calibration, flat field and radiance conversion using preflight and in-situ calibration coefficient.
	L2B	Add the instrument's parameters: focal length, pixel size, principal point position. Add the rover location and center point location. Add the geometric information include the center point and four corner points' incidence angle, azimuth angle and phase angle.
APXS	L2A	Working distance calculation, energy calibration, and dead-time correction.
	L2B	Add the geometric information include rover longitude, rover latitude, rover elevation, and rover attitude.
LCAM	L2A	relative radiometric calibration
	L2B	Geometric distortion correction and the information include grid point longitude and latitude spacing with 32*32pixel, center point incidence angle , center point azimuth angle, center point phase angle, solar incidence angle, and solar azimuth angle.
EUVC	L2A	radiometric calibration, geometric distortion correction, image re-sampling, dark current calibration, image rotation, Image cropping, stray light deduction.
	L2B	Add the geometric information include camera observation vector in solar magnetospheric coordinate system.
MUVT	L2A	Overscan correction, stray light deduction, and flat field calibration.
	L2B	Add the geometric information include gimbal azimuth, gimbal pitch, right ascension and declination in J2000

3. CE3 data pre-processing system

CE3 data pre-processing system(DPS) is an important segment of CE3 ground research and application system (GRAS). Figure 1 shows the DPS structure. A probe-to-earth link has been established in two ground stations: Beijing and Yunnan. Firstly, we receive raw data from these ground stations, and the raw data are framed synchronized, RS decoded, and Descrambled by hardware to form frame data. Secondly, the frame data are prepared through the data exchange service. Thirdly, the frame data are unpacked, decoded, merged, sorted and de-duplicated. Finally we choose the best frame according to the data quality, producing level-0 (L0) data.

Especially, we designed a workflow management system to complete the level-2 data processing. There is a workflow designer that scientists and engineers can describe data processing, defining its output/input and monitoring its sequence. A workflow engine can complicate and execute the processing sequence. The level 2 data processing tasks includes radiometric calibration, geographical location, probe and solar zenith, and azimuth calculations, image geometric correction, and so on. However, specific processing contents may vary according to different payload.

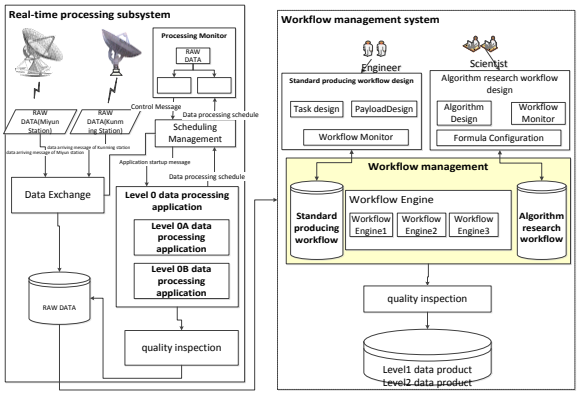

Figure 1: DPS structure sketch

4. Summary and Conclusions

Currently, CE3 Rover has successfully finished its major mission, and the Lander keeps on receiving scientific data. In the next task period, GRAS will provide a complete set of scientific data for further research.

Acknowledgements

CE3 is the results of the joint efforts of the launch vehicle system, the satellite system, the measurement and control system, the launch site system as well as GRAS. The authors wish to express grateful thanks to all the system members of the CE3 mission.

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