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Designed and Implementation of Lunar Immersive Visualization System Based on Chang'E-3 Data of Panoramic Camera

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Abstract

In this paper, we present a lunar immersive visualization system that was developed for assisting lunar scientist to establish science mission goals in Chang'E-3 mission. Based on data of panoramic camera and star catalogue, the system enables the operator to visualize the terrain and the celestial background from the rover's point of view in 3D in combination with 4-pipe-projection system.

1. Introduction

China's Chang'E-3 lunar probe that consisted of the Chang'E-3 lander and the 'Jade Rabbit' rover successfully landed on the Moon on December 14, 2013[1]. The 'Jade Rabbit' rover contain stereo panorama camera which take images to assist lunar scientists learn Chang'E-3 rover's surroundings [2, 3]. Utilizing stereo 360-degree imagery from panorama camera of Yutu rover, we designed and implemented a lunar immersive visualization system. The system enables the operator to visualize the terrain and the celestial background from the rover's point of view in 3D. To avoid image distortion, stereo 360-degree panorama stitched by 112 images is projected onto inside surface of sphere according to panorama orientation coordinates and camera parameters to build the virtual scene. Stars can be seen from the Moon at any time. So we render the sun, planets and stars according to time and rover's location based on Hipparcos catalogue as the background on the sphere. Immersing in the stereo virtual environment, the operator can zoom, pan to interact with the virtual lunar scene and mark interesting objects. Hardware of the lunar immersive visualization system is made up of four high lumen projectors and a huge curve screen which is 31 meters long and 5.5 meters high. This system contributed heavily to establishment of science mission goals in Chang'E-3 mission.

2. System Design

Data manager module, simulate module, render module and four-chanel projectors system make up the lunar immersive virtualization system(Fig 1). Data manager module manage the Hipparcos database and panoramic images of Chang'E-3. Simulate module is key module of the system which takes the charge of time and space coordinates transformation, projection transformation and user interaction. Render module render the virtual scene. Four-chanel projector system show the virtual scene of the Moon on the huge curve screen which is 31 meters long and 5.5 meters high.

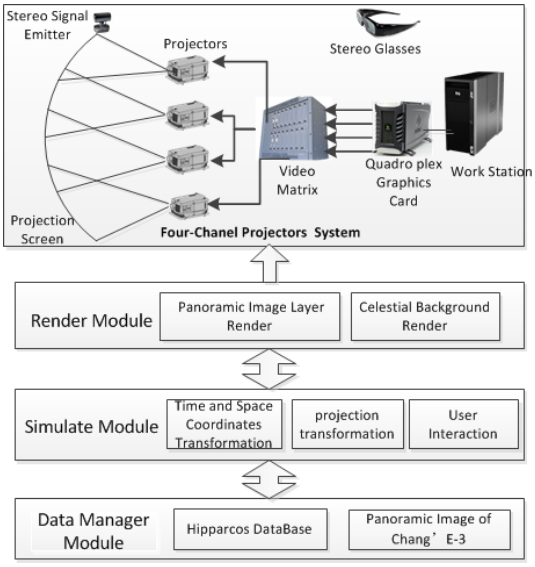

Figure 1: System structure diagram

3 Implementation

3.1 Modelling the scene

Stars and panoramic images are textured on celestial sphere based on horizontal coordinate for modelling the virtual scene of the Moon in real time. Firstly, based on Hipparcos catalogue and vsop87 program,

planets and stars are transform form Earth-centered Earth Mean Equator and Equinox of Epoch J2000 coordinate to Horizontal coordinate system according to Chenag'E-3's location(Figure 2). And then, panoramic images and celesta background are projected onto the spherical surface according to orientation and time. Celesta background layer is on the bottom layer and panoramic layer is on the top(Figure 3).

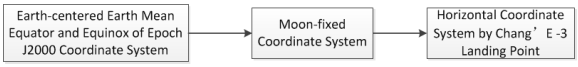

Figure 2: Space and time coordinate transform

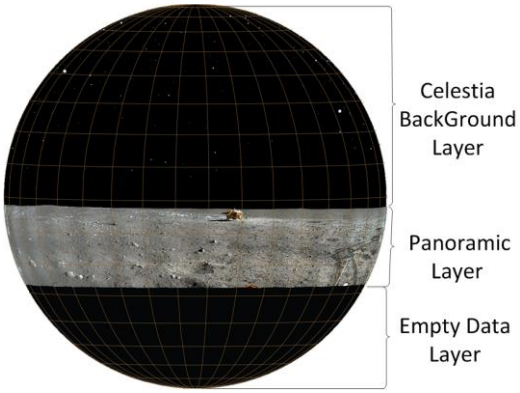

Figure 3 : Projected on celestial sphere

3.2 Reprojection to view plane

Utilizing Gnomonic projection, cylindrical and stereographic projection , the virtual scene of the Moon is reprojeected from spherical surface to view plane for the operator to see on the screen(Figure 4).

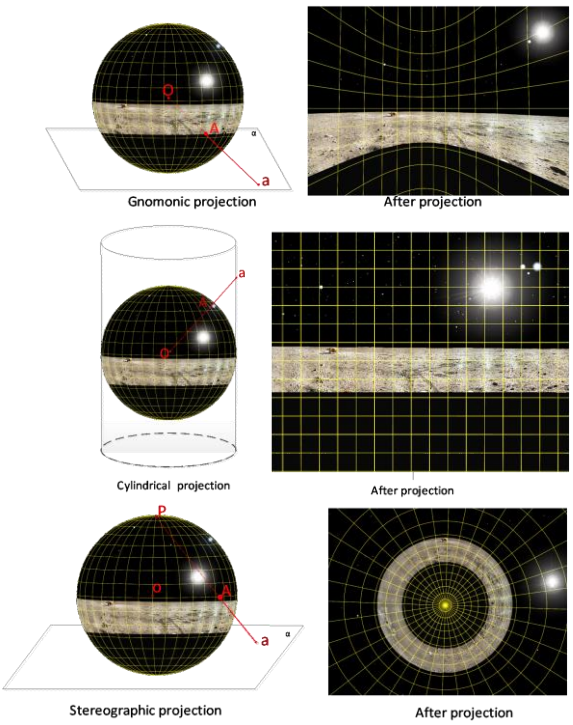

Figure 4: Gnomonic projection , cylindrical and stereographic projection methods

4. Result

We create a virtual scene of the Moon surface by this system(Figure 5). The system not only contributed heavily to Chang'E-3 mission, but also plays an import role in science popularization about the Moon after Chang'E-3 mission.

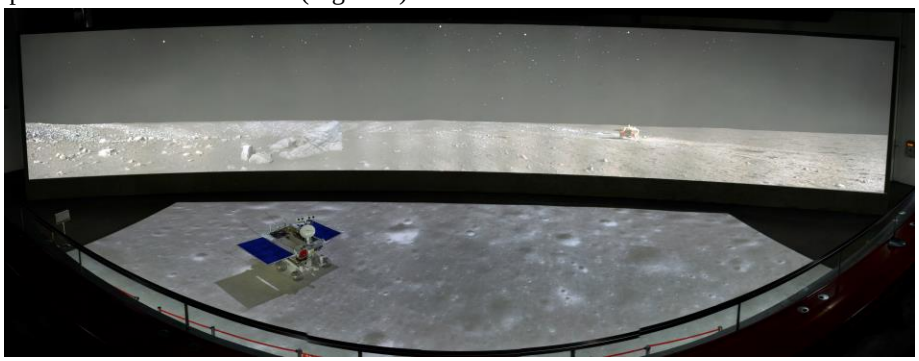

Figure 5: Scene created by lunar immersive visualization system with model of Yutu and ground screen

Acknowledgements

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References

[1] Wu Weiren, Zhou Jianliang, Wang Baofeng, Liu ChuanKai.: Key technologies in the teleoperation of Chang'E-3 "Jade Rabbit" rover, Science China, Vol. 44(4), pp. 425-440, 2014

[2] Ye Peijian, Rao Wei.: Application of photoelectricity technology for deep space exploration in China, Spacecraft Recovery & Remote Sensing, Vol. 32(2), pp.1-11, 2011

[3]Wu Fanlu, Liu Jianjun, Ren Xin, LiChunlai.: Research on panoramic mosaics method of Chang'E-3 Pancam Images, Acta Optica Sinica, Vol. 34(9), pp. 1-8,2014