

Working Modes and Exploration Program for Optical Cameras of China's First Mars Mission

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Abstract

Mars is a planet in the solar system that is closer to the Earth and has the most similar natural environment to the Earth. It has always been the first choice for humans to go out of the Earth and Moon system for deep space exploration.

China's First Mars Mission (HX-1) will be launched in 2020 with an orbiter and a lander rover. Through surround detection, Mars' global and comprehensive detection will be carried out; through patrol detection, high-precision, high-resolution detection for focus areas on Mars surface will be carried out. To achieve the scientific goal of studying Martian morphology and geologic structure characteristics, HX-1 is equipped with multiple optical cameras. This paper introduces the technical specifications and working modes of these optical cameras, as well as their on-orbit detection plans in combination with the exploration task.

1. Introduction

A total of three optical cameras are equipped on HX-1, including Moderate Resolution Imaging Camera (MoRIC), High Resolution Imaging Camera (HiRIC) mounted on the orbiter and Navigation and Terrain Camera (NaTeCam) mounted on the Mars rover [1]. Their installation location is shown in Figure 1.

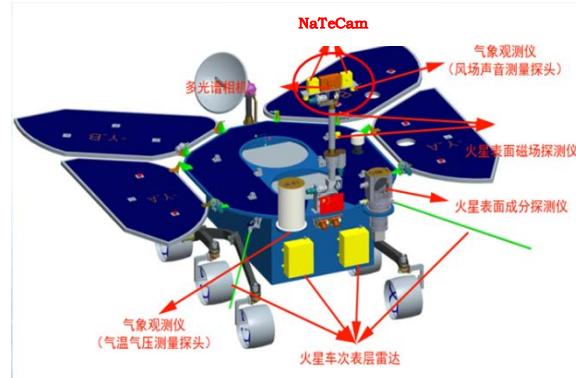
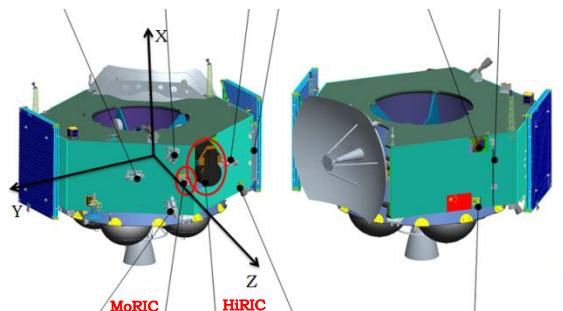


Figure 1: Installation location of optical cameras.

1.1 Exploration task

Table 1: Exploration task of optical cameras

payloads	Exploration task
MoRIC	<ol style="list-style-type: none"> 1) Production of the Martian global remote sensing image; 2) Exploration of the Martian topography, geomorphology, and its change
HiRIC	<ol style="list-style-type: none"> 1) High resolution observation of key areas on the surface of Mars; 2) Exploration of the topography and its change of Martian surface; 3) Exploration of the Martian local topography and its geological structure
NaTeCam	Exploration of the Martian terrain, including its slope, undulation, roughness, and so on

1.2 Working modes

MoRIC is a frame type imaging camera with 4 working modes including standby, health check, onboard calibration and static imaging.

HiRIC also has 4 working modes including imaging, health check, thermal control, and focusing.

NaTeCam is a pair of stereo cameras with working modes of topographic imaging, navigation perception, and onboard calibration.

2. Scientific Exploration Program

HX-1's mission track can be divided into six orbital segments [2], as shown in Figure 2. There are different scientific exploration programs for optical cameras in each orbital segment.

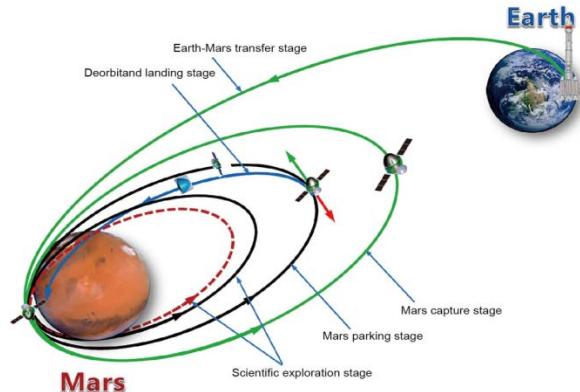


Figure 2: Orbit design of HX-1.

2.1 MoRIC

- Transfer orbit phase: image the Earth, Moon (Earth and Moon system), Mars and other possible objects.
- Parking orbit phase: choose opportunity to image the preselected landing sites (three-dimensional) when the orbit altitude is lower than 800km.
- Tracking and Data Relay orbit phase: choose opportunity to image the actual landing site (three-dimensional) when the orbit altitude is lower than 800km
- Mission orbit phase: image Mars surface when the orbit altitude is lower than 800km and the solar elevation angle is greater than 5° ; onboard Calibration, once per month.

2.2 HiRIC

- Parking orbit phase: choose opportunity to image the preselected landing sites (three-dimensional) with high resolution when the orbit altitude is lower than 800km;
- Tracking and Data Relay orbit phase: choose opportunity to image the actual landing site (three-dimensional) with high resolution when the orbit altitude is lower than 800km;
- Mission orbit phase: image area of interest on Mars surface when the orbit altitude is lower than 800km and the solar elevation angle greater than 10° .

2.3 NaTeCam

- Image with 360° view before the separation of Mars rover from landing platform;
- Image with 360° view at the first scientific detection site;
- Image in front of Mars rover at each scientific detection site obtaining 5 pair of images used for navigation;
- Onboard calibration.

3. Summary and Conclusions

In this paper, the exploration tasks and working modes of HX-1 optical cameras is introduced. Their exploration programs are also designed to provide the basis for the detection of the optical cameras and the acquisition of the expected detection data after the mission is implemented.

Acknowledgements

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References

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- [2] GENG Y., ZHOU J. S., LI S., et al. Review of first Mars exploration mission in China (in Chinese). *Journal of Deep Space Exploration*, 5 (5): 399-405, 2018.