Implementation of The Chang’E-1 Payload Integration Test System

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Abstract. The Chang’E 1 satellite Payload Integration Test System (PITS), which is used for the integration testing of the payload, is one important sub-system of the Payload System. This paper gives the technical flow of the integration testing, the framework and technical characteristic of PITS. By use of computer network and the automatic test technology, PITS has the ability to control the test flow with software and to determine the test result automatically. PITS can also process and deliver the test data automatically. Moreover, the software used in PITS can be applied for different computer platforms. It makes the whole system flexible, general and extensible to configure and manage PITS by database.

1 GENERAL DESCRIPTION

The Chang’E 1 is the first satellite of the lunar mission in China. Its major scientific objectives is as follows:

• Getting three-dimensional images of the lunar surface

• Probing useful elements on the lunar surface and analyzing the distribution characteristic of the useful elements and materials

• Probing the features of lunar soil and evaluating its depth

• Probing the space environment from the earth to the moon.

The Chang’E 1 will carry 24 lunar probing equipments. It includes three-dimensional CCD cameras, microprobe instruments and one high-energy sun particle detector etc. To guarantee the scientific equipments working correctly, a lot of tests need to be done by integration test system on the ground before it is launched.

It needs the test system have the following characteristic:

• Various types of data interfaces

• Large amount of data management and tremendous storage

• Long period of test time

• Complicated test process control

• Multi-user system capability.

In order to reduce the work of test process and increase system test efficiency, we use both computer network and the automatic test technology in the design of PITS.
2 SYSTEM IMPLEMENTATION

2.1 System Architecture

As the system requirements, the PITS should be designed to one distributed multi-tasks system, which consists of communication part and computer network. In this mode, many computers can parallel process data to improve the speed of data processing.

There are data interfaces between the PITS and other systems such as spacecraft simulator, the transmitted data, and payload users. The three interfaces must be analyzed and designed respectively.

The design of the Spacecraft Simulator is based on VXI bus. The VXI bus is an integrated, modularized and standard bus with rich functions. For example: signal acquisition, data analyzing and processing, result display, etc., are all implemented by computers. The whole test system is controlled by computer software, which makes the system more flexible for testing and controlling.

Through the transmitted data interface, PITS will receive and process data. It can also provide quick view to monitor the quality of image. There are two computers configured with data receiving card to receive and store data, one for housekeeping (HK) data real time processing, the other for image processing and quick view. These two computers work parallel and independent, backup each other for testing data integrity.

PITS provides data access for payload users. User terminals connect to PITS via the local network. There are two ways to access the testing data in the test. The first way is that the user receive the spacecraft HK data and the payload HK data in real-time via listening the multicast in the local network, The another way is that the users could inquiry and download the on-line testing data files via a Web page which is mounted on the server. All testing data files and configurations of PITS are managed by database on server.

The diagram of PITS architecture is given below:

FIGURE 1. PITS Architecture
2.2 System Components

There are three parts in Chang’E 1 PITS: spacecraft simulator, data processing and self-test. Table 1 shows these functions corresponding to figure 1.

Table 1 System function assignment

<table>
<thead>
<tr>
<th>Equipments Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>VXI test equipment</td>
<td>Spacecraft Simulator/self-test</td>
</tr>
<tr>
<td>Data receiving and processing computer</td>
<td>Transmitted data receive, process and self-test</td>
</tr>
<tr>
<td>Image quick view computer</td>
<td>Transmitted data receive, process, image quick view and self-test</td>
</tr>
<tr>
<td>Test control computer</td>
<td>SCHK data receive and process and Test control</td>
</tr>
<tr>
<td>Server</td>
<td>Data archive, Configuration management, Database</td>
</tr>
<tr>
<td>Data display computer</td>
<td>Real time data display, Users service</td>
</tr>
<tr>
<td>User terminator</td>
<td>Real time data display, Users service</td>
</tr>
<tr>
<td>Data assignment equipment computer</td>
<td>Interface converter, Data distribution, self-test</td>
</tr>
</tbody>
</table>

2.3 System Software

Figure 2 shows the frame of PITS software as requirements:

[Diagram of PITS Software Frame]

**FIGURE 2.** PITS Software Frame
PITS software consists of 9 modules, their functions are as follows:

- **Transmitted data receive/process and quick view**
  It receives, stores, processes and displays the transmitted data, including: scientific data and payload HK data. There are two modes to process these data: the real time mode and the nonreal time mode. The image data and payload HK data are processed in real time for user to monitor the status of payloads. The scientific data is processed in nonreal time to evaluated quality of transmitted data.

- **SCHK Data Receive and Process**
  It receives, stores and processes spacecraft HK (SCHK) data collected by Spacecraft Simulator. SCHK data will be sent to user terminator in real-time.

- **Real Time Data Display**
  It displays SCHK data and payload HK data in real-time. Payload users can select contents that they care about to display.

- **Spacecraft Simulator**
  It can simulate part function of the satellite platform, such as the power of the payload equipments, the receiving SCHK data, the sending telecontrol commands etc. In addition, it sends SCHK data to the module of SCHK data receive and process, then it will archive the SCHK files to database.

- **Test Control**
  It provides the implement environment for testing cases. This software module can control the test flow base on testing cases, check testing data and make testing record automatically.

- **Configuration Management**
  It can create and manage the testing cases and configurations. All the configurations are managed by the database.

- **User Service**
  It allows payload users access the testing data. Payload users can inquiry and download the on-line testing data files via a Web page. Only legal users can download and inquiry data to ensure system security.

- **Data Archive**
  It archives all testing data files to database on the server host during test.

- **PITS Database**
  PITS database store and manage all the archived testing data files and configurations.

The PITS is a data receiving and processing system based on computers and networks. The software development is very important for the PITS. Therefore, the primary responsibilities will be to use software engineering methodologies to analyze, design, implement, test, and document system software.

Besides thinking of function, performance, data interface, security, and reliability of the system software, the generality, extension of the system software must be considered carefully. So that is a very important thing to selecting appropriate programming language and software framework.
3. SYSTEM CHARACTERISTICS

The Chang’E 1 PITS is designed on the basis of other project experience, but which has its own characteristics on system framework and software development. The main characteristics are:

- Make use of automatic test technology based on VXI bus to develop spacecraft simulator witch integrated with telemetry, telecontrol, communication bus, power supply, etc. In addition, built-in self-test equipments make the spacecraft simulator check and verify itself in closed loop.

- Make use of testing language to support payload integration testing. The test flow can be controlled by software base on testing cases. This makes it flexible and easy to control testing process. PITS can check the testing data and create testing log automatically.

- Under sufficient consideration, PITS is designed flexible, general and extensive. So PITS can realize the system reconfiguration by application software for different phase and different project base on one hardware platform.

4 SUMMARY

The Chang’E 1 PITS has completed primary payload integration testing. All functions have been realized during the testing period, and the whole system works correctly and reliably, which validates the system design.

References:

