THE VIDEO SYSTEM OF LAUNCH VEHICLE

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ABSTRACT

XX launch vehicle has been flying onboard video system which includes video cameras, data compression devices and channel switch device for the second Chinese spaceflight. The camera is a PAL analog camera that been sampled and compressed by compression device. The compressed digital video data is combined with telemetry data into the telemetry radio channel. Lighting is provided by sunlight, or a light has been equipped when sunlight is unavailable. IRIG-B timing is used to correlate the video with other vehicle telemetry. The video system's influences to the vehicle flight have been decreased to minimum.

KEY WORDS

Launch Vehicle, Video, PAL, Compression, Telemetry

INTRODUCTION

The XX launch vehicle is used to place spacecraft in orbit. In the sixth launch for Shenzhou Six, an onboard camera is used to provide video coverage of vehicle events such as roll booster, staging, fairing separation, and spacecraft separation. The camera provides dramatic views of the vehicle rising into space and views of the Earth from orbit, as shown in Figure 1. In Figure 1, Picture (a) is the view of liftoff; picture (b) is the separation view of roll boosters; picture (c) is the separation view of the first stage; picture (d) is the separation view of the fairing; picture (e) is the separation view of the spacecraft; picture (f) is the view of spacecraft on its orbit after separation from the rocket.

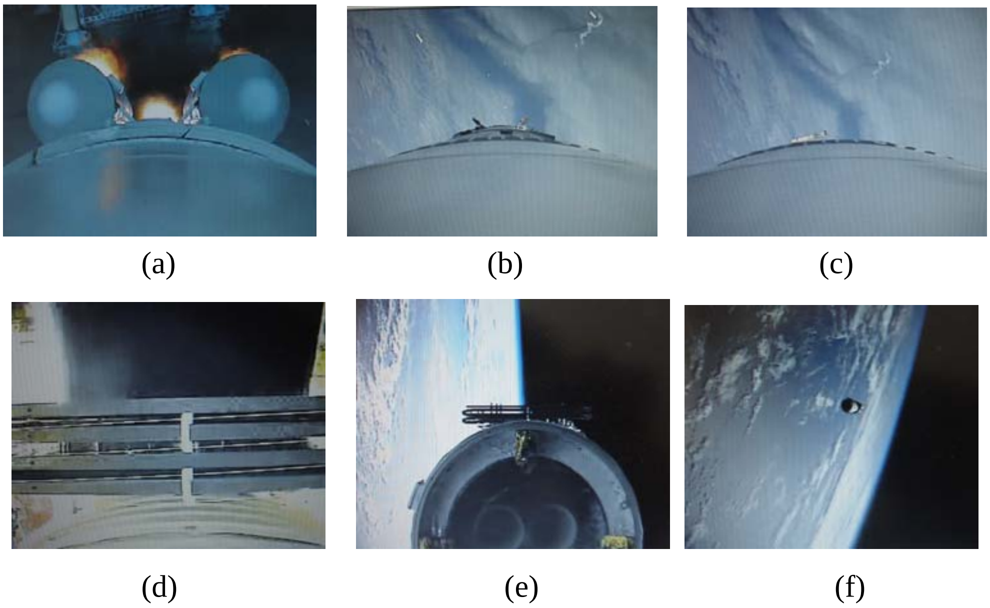

Figure 1　Pictures From the Onboard Video System

VIDEO SYSTEM DESCRIPTION

The basic video system consists of a camera and a data compression device.　The compressed digital video data is combined with telemetry data into PCM data stream.　The transmitter is used the same one for telemetry system. The video system block diagram of launch vehicle is shown in Figure 2.

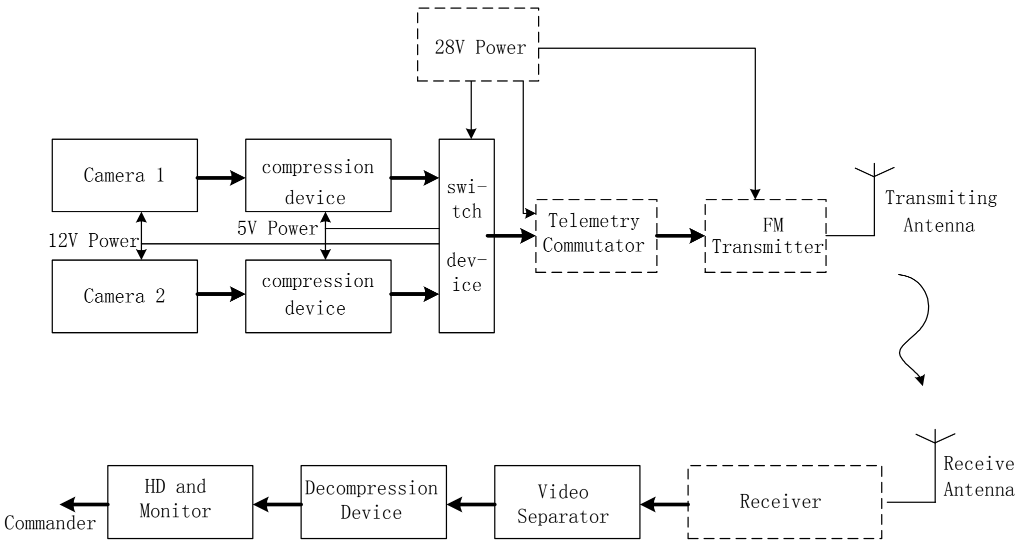

Figure 2　System Block Diagram

CAMERA SYSTEM

The camera is a small analog video camera using standard Phase Alternating Line (PAL), 625-line format with an aspect ratio of 4:3. The two cameras have been mounted on various locations on the vehicle. One is mounted external to the vehicle in the second stage for shooting the roll boosters and the first stage separations; the other is used inside the vehicle's fairing for shooting the fairing and spacecraft separations, the camera is shock-mounted to protect against shock and vibration. Figure 3 is the sketch map of the two mounted site.

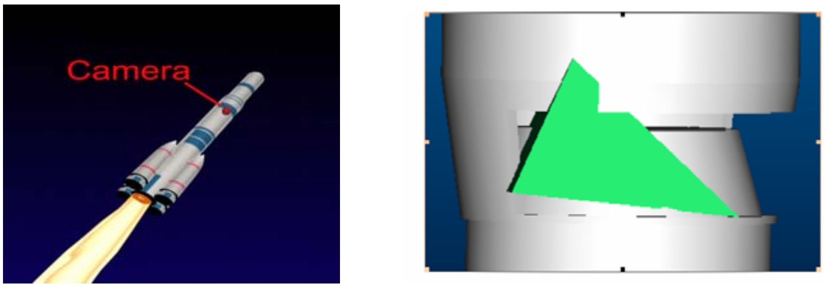

Figure 3 Camera Mounted Site Map

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In order to protect the external camera against the worse flying environment include aerodynamic, thermal loads and vibration, fairing, shock absorber and waterproof film are used.

COMPRESSION DEVICE

The video data is transmitted by telemetry transmitter. Because of limited radio channel capability, the video data must be compressed. The compression device has two modular, one is the image compression modular for compressing the video data and the other is the error control modular for correcting the transmission error bits. The block diagram is shown as Figure 4.

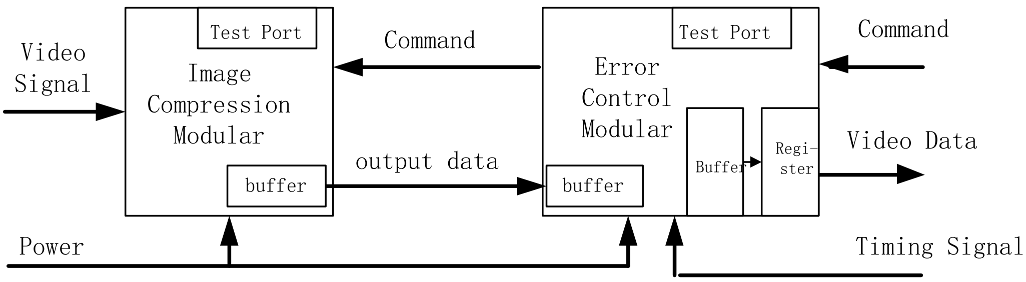

Figure 4

Compression Device Block Diagram

The image compression modular follows the MPEG-4 Standard using a motion prediction coding technique, distributing inter-frame (I-frame) image data across a series of predictive frames (P-frame) instead of transmitting the I-frame data all at the same time. The error control modular introduces interlaced code and the RS coding technology. Between the two modular, the data stream control is realized by different buffers. The timing signal is the liftoff signal from the control system.

SWITCH DEVICE

The switch device has two functions in the video system. One is power supplying for cameras and compression device, the other is channel switching for the two cameras.

The switch device runs on the vehicle 28-V batteries and outputs 12-VDC and 5-VDC powers for the cameras and compression devices. The camera draws about 150mA (external without light) or 250mA (internal with light) when operating, but the switch device should be capable of delivering more than this to enable camera startup current. Otherwise, the switch device enters current limit when power is applied and the camera does not turn on. The compression device draws about 450mA.

Limited by the capability of telemetry radio channel, only one cameras video signal can be transmitted at the same time. The switch device plays a role of switching the two video signals in one channel. The detail scheduling is shown as Figure 5.

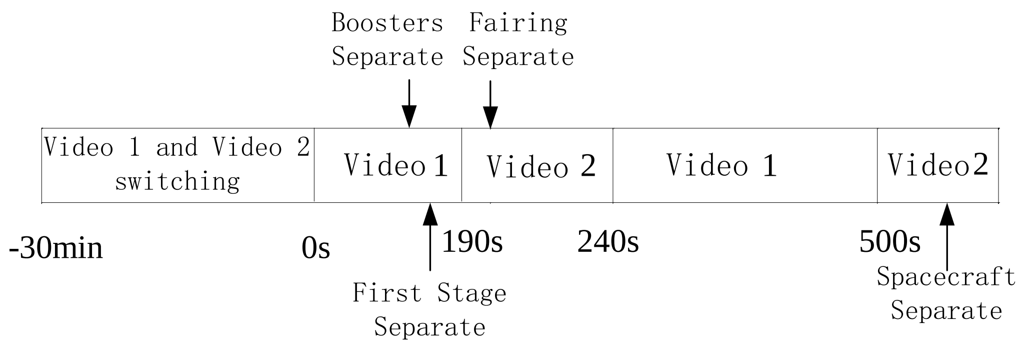

Figure 5 Switching Scheduling

CHANNEL CONSIDERATION

Video data after compression is switched into the telemetry commutator, which discards of nine vibration parameters for video data. These vibration parameters have finished their tasks in the last five flights or can be replaced in functions by other sensors. After commutator, video data as one part of telemetry PCM stream is transmitted by telemetry FM transmitter. On the ground, the telemetry receiver demodulates the telemetry signal. The video data is selected from the PCM stream by the video separator and decompressed by the decompression device. Finally, the video is displayed on the monitor and recorded on the hard disk.

LIGHTING CONSIDERATION

The best lighting source is sunlight entering the camera from the side. When the camera faces the payload with the sun directly behind the camera, reflections off the spacecraft thermal blankets can adversely affect picture quality. In the video system design, the Sun in the field of view of the camera is to be avoided. The frame provides a remarkably good picture.

On vehicles one camera has been placed inside the fairing, where there is no sunlight before fairing separation. When the fairing is separated, the camera is immediately exposed to bright sunlight. The first frame is totally washed out, but details start to appear in the next few frames. It takes several seconds for the camera automatic gain control (AGC) to adjust to the increased light and provide a good picture. The camera has an AGC to adjust for changing light levels. Some lights are mounted around the camera which can well solve the imaging problem in the dark background and dark-to-bright rapid change environment.

TIMING

An Inter-Range Instrumentation Group (IRIG-B) time signal is used by telemetry system. The liftoff signal with IRIG-B time signal is added to the video data. Then the Society of Motion Picture and Television Engineers (SMPTE) time code is used for video telemetry. This enables time correlation of the video with the other vehicle telemetry.

INFLUENCE ANALYSIS

Because video system is a new added system for vehicle, its influences to the vehicle including reliability, security, environment, structure, aerodynamic, power supply and so on, have been decreased to minimum. Some required changes concerning the commutator and dictate convertor have no influences on their inherent functions. The nine discarded parameters don't belong to the key parameters, so there are no influences on system reliability and security. The same for new added ground equipments, there are no influences for telemetry data receiving.

CONCLUSIONS

Video system has been flown on the rockets. The video not only shows an impressive view of the climb into space, but also aids in engineering analysis of the vehicle flight.

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