

# Research of the CCD Aerial Camera Manipulator System

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## Abstract

Manipulator is the corollary equipment of the CCD aerial camera, which is mainly used to manage and control the main system of the aerial camera, receive the feedback information of the main system, and display the video image of the land object almost real time, and its performance will directly influence the working state of the CCD camera. The applications of the PC104 bus technology and the ARINC429 bus technology in the subsystem of the aerial camera manipulator are concisely introduced in this article, and the working flow of the display manipulator, the composing and working principle of the system are mainly discussed. Through the test-fly, the manipulator system could run stably, with advantages such as strong anti-jamming and high reliability.

**Keywords:** Manipulator system, PC104, ARINC429

## 1. Introduction

The display manipulator subsystem is the corollary equipment of the CCD aerial camera system, and its performance will directly influence the work of the CCD camera. The manipulator adopts the ARINC429 bus to realize the communication between the aerial camera and the plane system, and its main task is to confirm the working state and working mode of the system, collect and dispose the system operators' behaviors, complete the bus control and operation control of the system, complete the information processing and the organization of the image and character data information, control and manage the working flow of the aerial camera.

## 2. Design of the manipulator planning

### 2.1 Design principles

First, the virtual instrument technology is adopted to complete the design of the manipulator system, and the system could work reliably and stably in the manipulator work mode and the simulator work mode.

Second, the PC104PLUS bus standard of the embedded system is adopt to design the system high effectively, eliminate the redundancy, and realize higher performance in less volume.

Third, the modularization design method is adopted to design the system. The modules have relatively independent function, and they are linked by the bus, and the maintenance of the system is convenient.

### 2.2 Working principle of the manipulator system

The manipulator system is composed by the main-control computer module, the power-supply module, the camera monitoring communication system, the PAL standard image collection system, the carrier task communication system, the image display and monitoring system and the input module. The working principle frame figure of the system is seen in Figure 1.

The main-control computer is the core and control part of the whole manipulator system, which can independently manage and control the main system of the aerial camera. It could produce encouragement signals, measure and check the testing channels in the manipulator system, and offer other assistant equipments to measure and test the control orders and collect the result, and dispose the testing data of the manipulator system, input and export signals, save testing data, and display the testing result.

### 3. Hardware design of the display manipulator

The box of the manipulator system is made by the aluminium alloys, with reasonable figure design, light quality, and convenient carrying. The PC104 bus cascade structure is adopted in the manipulator, and the bus backboard and the flashboard channel are eliminated, and the pins on the super layer and the holes of the bottom layer are used to link the PC104 bus modules.

#### 3.1 Camera monitoring communication system

The camera monitoring communication system is the channel to transfer the data and orders of the manipulator and the aerial camera main system, and it also collect the working state of the camera and transfer the control orders.

- (1) Receiving the state information and data of the aerial camera main system.
- (2) Transferring the control orders to the aerial camera main system.

The aerial-carrier task communication system adopts the ARINC-429 communication standard, and collects the fly height, the fly speed, the latitude, the longitude, and the real fly state parameters to the main-control computer. On the ARINC429 bus, the bus level is modulated by the bipolar return to zero, and the data are transferred by the 32-bit series character format. It includes 8-bit zone (defining the types of the data, such as the longitude data and the latitude data), 1-bit parity check bit, 2-bit status bit, and 21-bit data character (ARINC, 1991). The composing of the series character is seen in Figure 2.

The pulses sent by the ARINC429 include three levels, i.e. the high level, the middle level, and the low level. The hardware of the system adopts the HS3182 and the HS3282 of HARRIS Company to generate 429 difference signals, control the pins to link with the CPU CS and part address lines by EPGA (Hou, 2000), and read and write HS3282, and generate TTL difference level, and generate the communication level through the drive of HS3182. The terminal signal pin of HS3282 of HS3282 is linked with the interrupt pin of CPU, and if there are data need to be receipted by CPU, the interrupt will occur, and the structure is seen in Figure 3.

#### 3.2 PAL standard image collection system

The image collection system is composed by the PAL standard real-time image grabbing card based on the PC104 bus and the signal adjusting board. The image grabbing card supports the video input, collects, and displays the input information, and it can collect 8-bit color video signals real time. The signal adjusting board could adjust and shape the output signals, and make signals accord with the signal format of LCD screen.

#### 3.3 Design of the input system

The input module is the input interface that the operator controls the manipulator system, and it could input various orders, and set up shooting mode, exposure time, fly height, fly speed, and shooting quantity. The manipulator is input by the mode of keyboard.

### 4. Software design of the display manipulator

Following functions could be accomplished by the manipulator software.

#### (1) Working state control

The manipulator collects and disposes the system operators' pressing actions, confirms the working state and working mode of the system, organizes the data transmission and reception, realize the task control, transfer and control of the manipulator, dispose the information and organize the data information of image characters by the LCD displayer.

#### (2) Data transmission and reception

According to the system state, relative data are organized as 429 bus data frame to send to the main-control system of the aerial camera, and the software could also receipt the feedback information from the main system of the aerial camera, and realize the monitoring of the working state and the failures of the aerial camera.

#### (3) PAL standard image collecting and data processing

The software could collect the video signals transmitted by the CCD aerial camera, and display them on the LCD displayer to be referred by operators when adjusting the camera.

By the manipulator keyboard, the operators send orders to the main-system of the aerial camera, and realize the control and management of the working flow. The manipulator collects and disposes operators' actions, confirms the working state and working mode of the system, organizes the data block transmission and reception, realizes the control, transfer, and management of the bus task, and controls the system operation, and accomplishes the

information processing and the organization of the image character data information. The VC++ is adopted in this system to accomplish the design of the system software, and the working flow of the system is seen in Figure 4.

## 5. Conclusions

The PC104 bus and the modularization design mode are adopted in this article to complete the design of the manipulator system. The system could not only collect the fly state parameters such as the fly height, speed, longitude, latitude, and real course of the carrier task system, which could be used for references to shoot pictures, but also simulate the carrier equipment to communicate between the 429 bus interface with the aerial camera. It adopts the simulation experiment to replace the real fly test, tests the shooting quality, and reduces the experiment period. This system works stably and reliably, with strong anti-jamming ability, and it could be applied in the complex electromagnetic environment of the carrier system, and ensure the aerial camera to exactly accomplish the aerial shooting task.

## References

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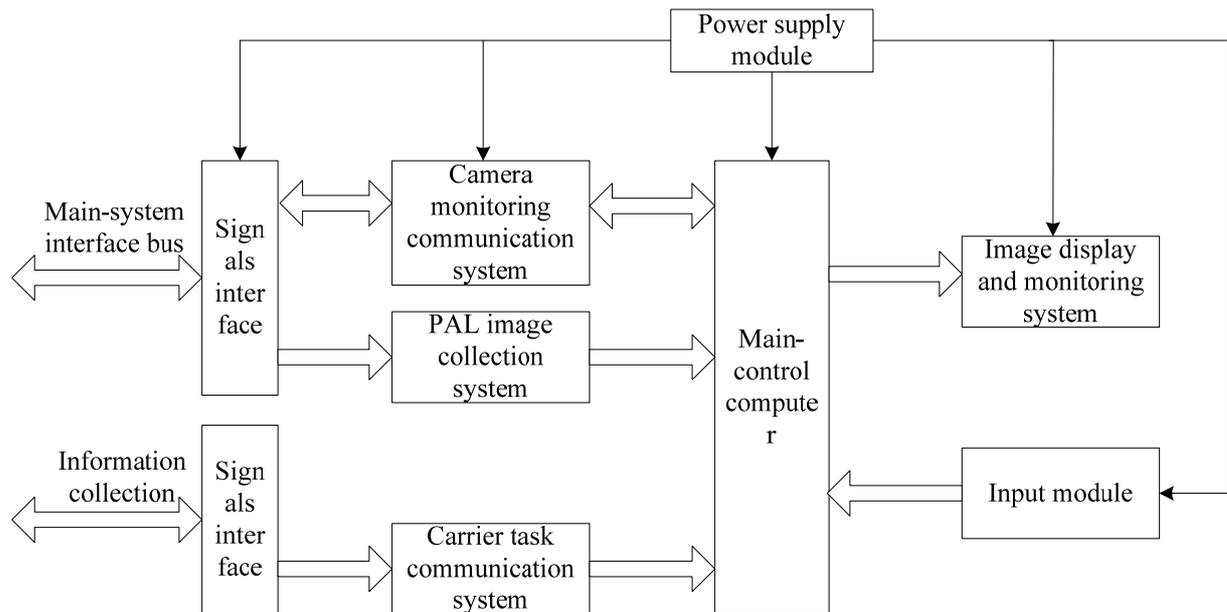


Figure 1. Working Principle of the System

32	31	30	29	11	10	9	8	1
Parity check bit	Symbol state bit		Data character	Source, target identification code		Symbol		

Figure 2. Data Unit Composing of ARINC 429

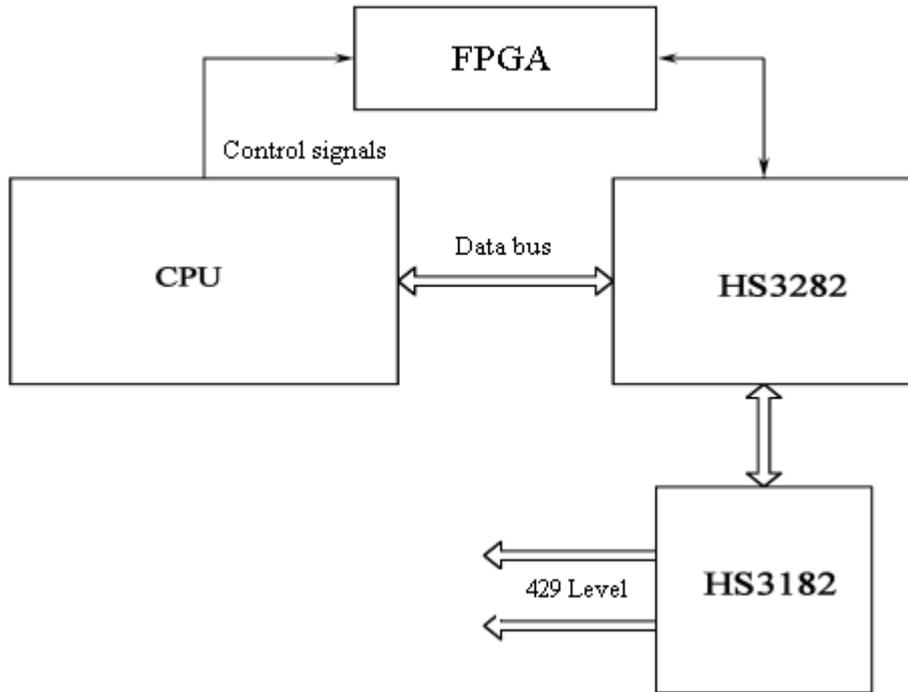


Figure 3. Hardware of Communication System

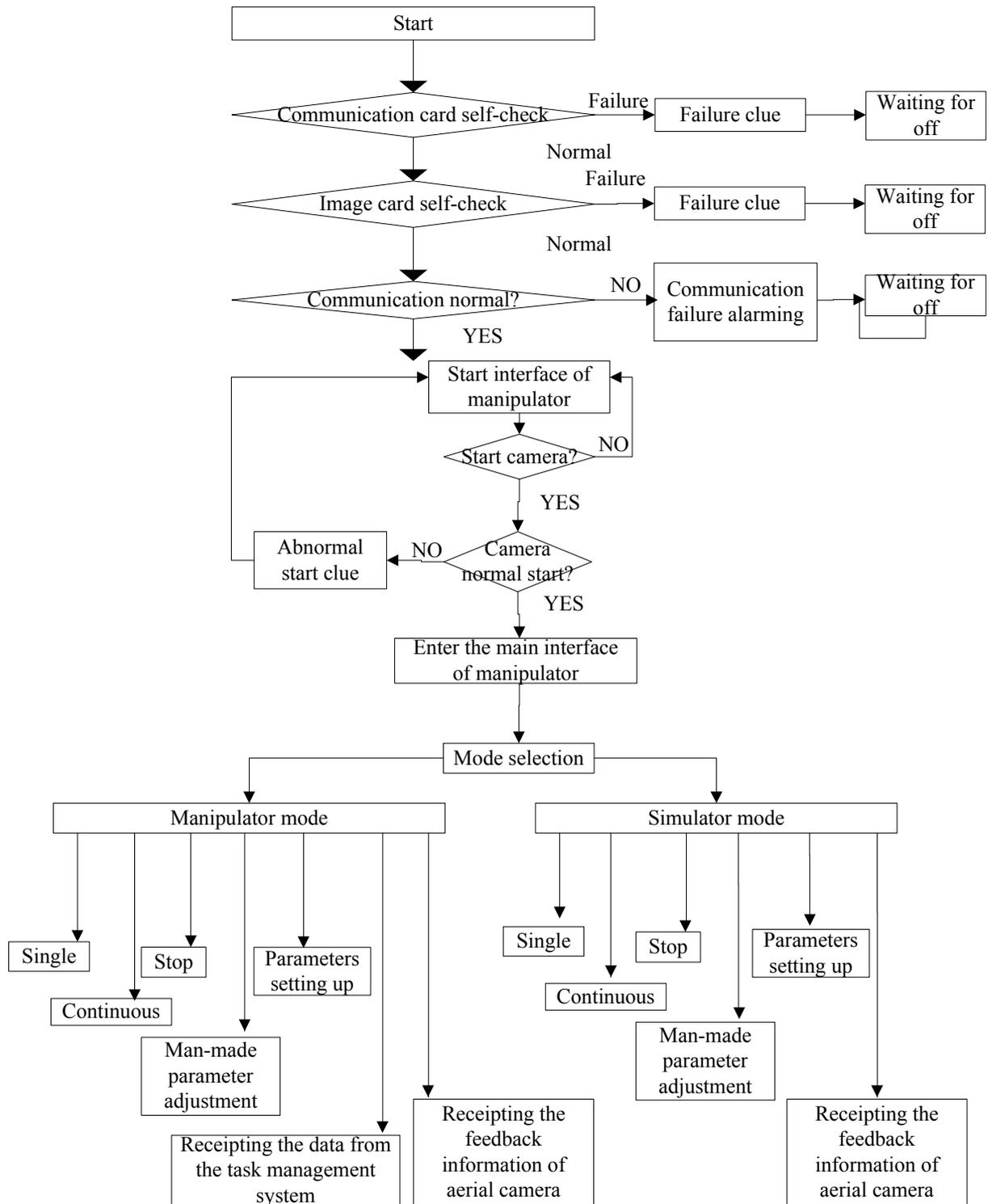


Figure 4. Working Flow of System