MATEC Web of Conferences **63**, 01038 (2016) DOI: 10.1051/matecconf/20166301038
MMME 2016

Design of comprehensive general maintenance service system of aerial reconnaissance camera

Xu LI[1,a], Xiang Bin YU[1], Ye ZHAN[1] and Yan ZANG

[1] *Aircraft control Department, Air Force Aviation University, Changchun, China*

Abstract. Aiming at the problem of lack of security equipment for airborne reconnaissance camera and universal difference between internal and external field and model, the design scheme of comprehensive universal system based on PC-104 bus architecture and ARM wireless test module is proposed is proposed using the ATE design. The scheme uses the "embedded" technology to design the system, which meets the requirements of the system. By using the technique of classified switching, the hardware resources are reasonably extended, and the general protection of the various types of aerial reconnaissance cameras is realized. Using the concept of "wireless test", the test interface is extended to realize the comprehensive protection of the aerial reconnaissance camera and the field. The application proves that the security system works stably, has good generality, practicability, and has broad application prospect.

1 Introduction

The aerial photographic reconnaissance is an important guarantee to win the local war in new era so our army has improved and developed a series of reconnaissance aircraft. However, due to the reasons of different manufacturers of airborne reconnaissance camera, vary types and models, different protection demands of internal and external and serious technical barriers, a comprehensive and universal security equipment has not been formed. Therefore, based on the working principle, control process and interface definition of various types of reconnaissance camera and the protection demands of internal and external, a design scheme of a general security system based on PC-104 bus architecture and ARM wireless test module is proposed with ATE design ideas and the wireless test concept.

2 Demand analysis

The optical imaging camera is mainly used for the aerial reconnaissance camera. At present, there are six kinds of middle-low altitude frame camera, high altitude frame camera, middle-low altitude panoramic camera, middle-low altitude CCD camera, middle-high altitude CCD camera, infrared line scanner. Although these cameras are with different kinds, different manufacturers and different technical standards, the basic principle, the camera interface and the work flow are so similar.

2.1 Basic principle analysis

From the composition structure, these cameras can be divided into 3 parts of optical imaging, electronic control and data storage. The optical imaging part is the basic core of the camera, which use the optical devices in the focal plane to form an image. The camera electronic control is the control core for camera, which achieves the automatically adjusting, calculation and controlling for lens, focal length, roll compensation, heating and task parameters and determines camera working status through receiving the operation instructions of aircraft reconnaissance management system, and flight parameters. At the same time, it feed-back the real-time status and self-test results to airborne reconnaissance mission processing system through the data communication interface. Data storage is used to store the image data, which is stored in different storage modes, such as film storage, hard disk storage, data recorder and so on.

2.2 Camera interface analysis

The camera interface consists of two types of power interface and data communication interface. 28V DC power is mainly used for camera working and heating and three phase 115V/400Hz AC power is also needed to provide with some cameras at the same time. The data communication interface mainly completes the interaction work with the aircraft reconnaissance and management system and the inertial navigation system and the cameras all use ANRIC 429 serial communication. Due to the large current consumption of camera, the power interface and the data communication

[a] Corresponding author: dlixut@aliyun.com

interface are connected with the independent cable to avoid interference.

2.3 Work flow analysis

The camera work process can be divided into 5 stages: temperature control or work waiting, starting self-test, re-ready, being ready, taking pictures. When entering the " temperature control or work waiting” state after power on automatically, the camera configures the equipping and hanging scheme and set the parameters of camera photosensitive and loading amount. After receiving starting self-test instruction, the camera enters the "starting self-test" state. And it reports the self-test results and returns to the "temperature control or work waiting "state at the end of self-test. After receiving the instruction, the camera enters the "re-ready" state. At this point, the flight parameter information received by camera is in the effective range and the camera is ready and enters the "being ready" state. At this time, the camera can take pictures after receiving the instructions. When the camera receives the instruction of stopping taking pictures, it will be back to the "being ready" state and returns to the "temperature control or work waiting" state. The camera operating process can be controlled by the serial communication interface of ANRIC 429.

2.4 Maintenance demand analysis

In the past, the various types of aircraft reconnaissance camera equipment mainly use the working way of out-position. This way needs the maintenance personnel first remove the camera, and then sent to the dedicated security center for the maintain security. The demolition and transport will consume a lot of time, which can’t meet the time requirements of rapid take-off and continuous operation on the field. At present, the field support of aerial reconnaissance camera is used the equipment after equipped to test. But because of being no complete simulation of the camera work conditions for the self-test equipment, many failures can’t be found in time, which gives the flight training and operational risk. In order to completely eliminate such problems, the protection of equipment must support in situ.

3 Hardware structure design

On the basis of in-depth analysis and summary of all kinds of aerial reconnaissance cameras, we put forward the overall design objectives of "portable design, multi model general, internal and external field", which is based on the in-depth communication with the maintenance personnel and the comprehensive understanding of the protection needs.

3.1 Portable design

In the past, most of the aviation reconnaissance camera support equipment is based on industrial control mechanism, the equipment volume, the weight is large and the carrying capacity is inconvenient. So we are seriously on the PC-104, CAN, VXI, PXI and other bus architecture based on the combination of security needs, development costs and other considerations, the final selection is that the PC-104 bus architecture build a security system. Using PC-104 bus stacking design greatly reduces the test equipment volume. At the same time, the technology and method of the high density multilayer signal conditioning board, the built-in touch screen, and the small ICA package are used for the first time to realize the design of the 4U box. Compared to the previous airborne reconnaissance camera inspection instrument, the size is about 8 times smaller and easy to carry, which improves the mobility.

The integrated security system for aerial reconnaissance camera is a portable box structure, which can be divided into two parts, the interface panel and the control resource. The layout of the various parts and sub modules are shown in Figure 1. The interface panel is mainly the machine-machine interface, man-machine interface of the security system, which consisted of the ICA connector, the built-in touch monitor, USB interface, LAN interface, WLAN antenna, system power switch, external power insurance and other parts. ICA connector is used for the wired connection of security system and measured camera when checking the camera in infield. The built-in touch monitor is used to display the test software, test data, receive the user's operating instructions and provide the man-machine interface for the testing process.

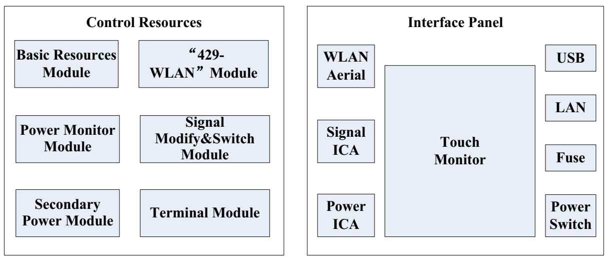

Figure 1. System Layout Diagram

The control resource is the core of the system, which is based on the PC-104 bus construction and consisted of the basic resources module, 429-WLAN conversion module, signal conditioning control module, power monitoring module, power supply module and terminal module two module and other functional modules. The basic resources module includes PC-104 computer, C429 communication card and multi-function data acquisition card, which constitutes the basic test resource of the system. They mainly complete the ANRIC 429 data transceiver and analog quantity, the amount of the collection and transmission. They use the PC-104 stacking characteristics to stack together through the installation of the screw from the bottom up, greatly reducing the volume. The 429-WLAN conversion module can realize the bidirectional conversion between ANRIC 429 bus data and 802.11B data, which provides the conditions for the field in situ test. The signal conditioning control module mainly completes the testing signal processing and the switching control work of basic resources, which consists CamTester circuit board, DC contactor and AC contactor. CamTester circuit board includes the rolling door control circuit, the internal and external ANRIC 429 switching circuit, the computer power supply circuit, AC and DC voltage conditioning circuit and other functions. The power monitoring module is used in the infield test to monitor the camera power supply voltage and phase sequence and the current and appear abnormal promptly to cut off power and give the alarm prompt, which is mainly consists of CamTesterPow circuit board, AC and DC voltage sensor and AC DC current sensor. The CamTesterPow on the circuit board comprises the circuit of AC DC voltage monitoring circuit, AC and DC current monitoring circuit, rolling shutter door consumed current measuring circuit, 115V / 400Hz three-phase alternating current phase sequence measuring circuit function. It also equipped with different specifications of the fuse which control of the device is not less than the consumption of the allowable value.

3.2 Universal design

The "classified switching" technology makes the hardware resources of the system are divided into three levels: resource establishment, resource expansion and resource management. Firstly, the hardware resource based on PC-104 bus is built by using PC-104 bus equipment series and standardization. The resource expansion is carried out by using the terminal module and the relay matrix, and the ICA interface and the special cable are connected with the camera. The resource management is responsible for the system software. System software is responsible for data analysis, processing and related calculation, output, display, etc. The signal format conversion of the camera and the receiving channel is completed in the signal processing control module. In this way, different types of cameras can be connected to the hardware resource through different connecting cables, and all the test resources are available to it. Different control software is run according to different objects and the control software makes the distribution according to the needs which achieve general safeguard is for multi class multi camera.

3.3 Integrated design

Learning from the "wireless test" concept, a special field working module is developed. The external field working module can be used in in situ docking with the external field aerial camera, and the camera's ANRIC 429 data is converted to the data of the wireless local area network. Therefore, the real-time data is achieved exchanging between the integrated security platform located in the infield and the located in the field of aviation camera through the construction of wireless local area network, which meet the design requirements of the inside and outside the field of comprehensive test.

The external field module is constructed using the ARM chip with the internet communication interface, which is mainly consisted of ARM main processing chip circuit, relay circuit, power module, camera interface and other functional modules. The principle and information interaction are shown in Figure 2. The ARM main processing chip completes the conversion of ANRIC 429 and the wireless LAN format data, through the DO channel, the relay circuit controlling the communication interface of the camera. The external field working module is connected with the camera by the communication interface of the camera, and the power supply of the camera is provided by the aircraft power supply.

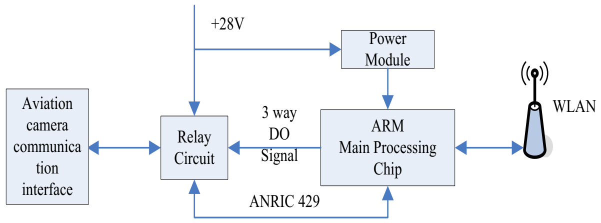

Figure 2. Field Work Module Principle Structure Diagram

4 Software sturcture design

Because the control logic and working process of the cameras are similar, the “virtual system” technology and the multi-level packaging technology are introduced to make the hierarchical, modular and interface design for the system measurement and control resources in order to save the software development cycle and improve the robustness and maintainability of the software system. The “virtual system” is based on the hardware driver, the general algorithm and the general function module. The system forms the hierarchical measurement and control resource in the multi-level package. Each package is actually a specific function, which provides the interface definition for the development of the.h file format. The developers only need to test the needs of the corresponding interface file to achieve the required resources for the control. At the same time, as long as the function of the module is modified, the module and above all calls are achieved. Using multi-level packaging technology to hide the complexity in the entity and providing the simple, refined, diverse access external interface improve the system's maintainability and scalability.

The virtual system is divided into three levels. The top level is the system monitoring program module, which is used to allocate, initialize and monitor the whole device function and hardware resource. The second level is the main control program and the function sub module for each test item for realizing the function of each module, including the conversion of the communication protocol, the collection of the power signal, the relay control, data preservation, etc. The underlying program includes the hardware board driver, the camera work condition data packets and other independent public process algorithm. Each level contains a variety of functional modules and sub modules. The software architecture is shown in Figure 3.

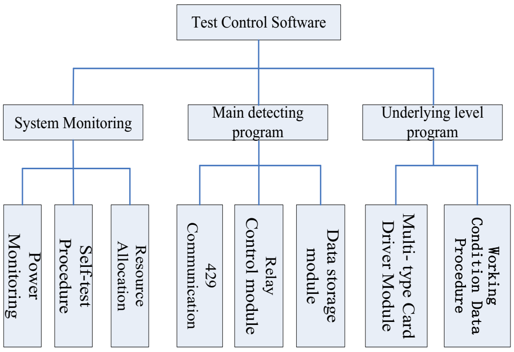

Figure 3. Characteristic curve of vacuum bellows

5 Conclusion

In this paper, a comprehensive general security device for aerial reconnaissance camera is designed based on PC-104 bus architecture. The use of hardware resources are divided into three levels of resource establishment, resource expansion and resource management by using the “classified switching” technology. Through the scheduling of the system software, the general protection of various types of aircraft reconnaissance cameras is realized. Using the concept of "wireless test", the special field working module is developed, which can realize the comprehensive protection of the aerial reconnaissance camera and the field. Using the "virtual system" technology, the measurement and control resources are formed and a comprehensive control of the test system is achieved through the multi-level packaging of the basic resources. At present, the security platform has been applied in some aviation troops, the effect is good.

References

1. Zhong Li-ping. General ATE Frame Design of Weapon Support System [J]. Automatic Measurement and Control. 2007,Vol.26,No.3: 84- 85.
2. SUN Yan-jun, YAO Qin, DU Xin-min, Xia Rui. The Design Projeet of Aero-Device ’ s Wireless Test System[J]. Journal of Projectiles,Rockets,Missiles and Guidance. 2004,Vol.24,No.3: 184- 186.
3. Li Xu, Zhan Ye, Chang Limin, Zang Yan. Design of Comprehensive General Support System for Airborne Inertial Platform. 2013 International Conference on Mechatronic Sciences, Electric Engineering and Computer（MEC 2013）. 223-226.
4. FANG Wei,WU Jie,GAO Guo-zhao. Unified Virtual Systems Management Model Based on CIM Modeling [J]. Computer Engineering. 2011 Vol.37,No.16: 270- 272.
5. FANG Li,CHEN Xiang-ping,WU Liang-kun. Research on Frame of Interface Test System Software Based on Components [J]. Instrument Technique and Sensor. 2011, No.8: 50- 54.