Design and Implementation of Aerial Rocket Launcher Detection System

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Abstract. According to the launch control principle, application features and testing requirements of a certain type aerial rocket launcher, a detection system is designed based on PC/104 embedded computer. The realization method, the configuration of the software and hardware is explained in detail. The hardware platform such as embedded computer and related function boards are the foundation of the detection system, the application software is accomplished in VC++6.0 environment with modular design approach. The testing process and the handling mechanism of sending and receiving data are determined. Multi-threading technology is adopted to achieve real-time detection. The detection system integrates the data management, real-time data processing, preservation and displaying the results, achieving the detection task scheduling and controlling. The detection system can test the working condition of a certain type aerial rocket launcher reliably and improve the efficiency of equipment support effectively.

Introduction

The aerial rocket launcher is an important part of the airborne aerial rocket weapon system, the main function is hanging, carrying and launching the aerial rocket to attack the ground targets[1, 2].

Because of the complexity of the flight environment and the adverse effects of various factors during combat, the launch and control system of the aerial rocket launcher should be test regular to make sure it in good working condition.

The embedded computers and related functions card are used to driver the aerial rocket launcher to run, in order to collect the real-time data which is used to test the parts of the aerial rocket launcher, the detection system is significance to ensure airborne aerial rocket weapon system reliable operation, avoid rockets detention and other failures occur, launch the rocket properly and pinpoint accuracy, and improve the reliability of the aerial rocket launcher.

The Hardware Design

The functions that the hardware system realizes include: simulating the airborne aerial rocket launch control management system to drive the aerial launcher to run; managing the test platform and the control mechanism of aerial rocket launcher apply the signal conditioning mechanism to communicate, as the host machine to send control commands and receive the responses parameters of the aerial rocket launcher; measuring analog signals and detecting the test system reliability etc.

The core of system controlling and data processing is a microprocessor. With high stability, high efficiency and other advantages, the embedded system receives more and more applications to the measurement and control field. According to anglicizing the test requirement of the aerial rocket launcher function parts, fully take into account the cost control requirement, in meeting all test tasks and under certain expansibility, the detection system is set up that the embedded PC104 was selected as the control core of the system and matching related function and signal conditioning unit to build the system. The software controls the detection system to achieve the test task scheduling management, data controlling, acquisition, processing, and display.

The PC104 embedded computer system compatible with standard PC and PC/AT architecture in software and hardware, it is an optimized, small, stacked structure embedded industrial computer bus standard[3-5]. The PC104 computer with the small structure, stack connection, easy bus driver and high reliability can improve the testing performance in complex environment; fully meet the need of high-reliability requirement of the aerial rocket launcher detection system. The hardware components of the detection system are shown in Fig.1.
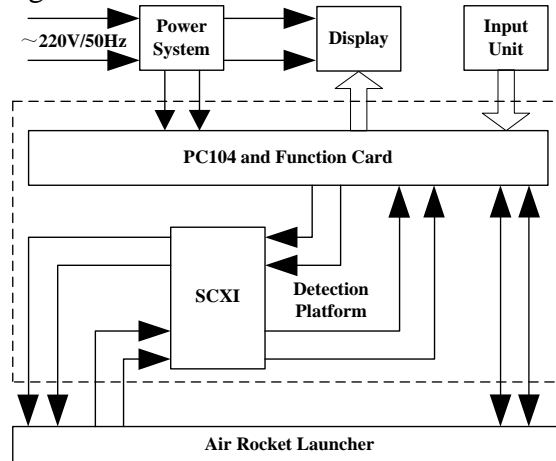

Fig.1 System working schematic

The power system provides power to meet the need for each unit of the detection system; Inputting an operation instruction by the input means, according the operating instruction PC104 computer and related function board real-time send control instruction to the aerial rocket launcher by the signal conditioning unit matching and conditioning, and real-time receiving the responding command of the aerial rocket launcher; the function boards convert the analog signal of the aerial rocket launcher into digital signals; comparing the actual acquisition value and theoretical reference value to determine the function parts of the aerial rocket launcher working properly or not; finally, the test results output to the display unit, the display unit displays a visual indication the whole testing process and the testing results.

Software Implementation

The functions that the software system realizes include: managing the function board, signal conditioning board and other hardware resources; running the testing software, managing and scheduling the testing task based on the testing process; testing and faulting location aim at the function of the aerial rocket launcher; real-time receive and process data; developing easy-to-use HMI for operator.

（1）Detection software

Detection software is an object-oriented visual programming in Visual C++6.0 environment based on Windows XP operating system[6]. The software adopts modular design, which includes testing software, communication protocols and board driver. The function of the detection software is scheduling and management the detection process, completing user management and data management etc. The communication protocol is a communication protocol between the function board and the aerial rocket launcher, determines the communication standards, communication encoding format and communication control flow, the testing software obtains the data by decoding the received data according the encoding format. Board driver includes the drive program of all the function boards and the interface library that available to the application. The detection process is shown in Fig.2.
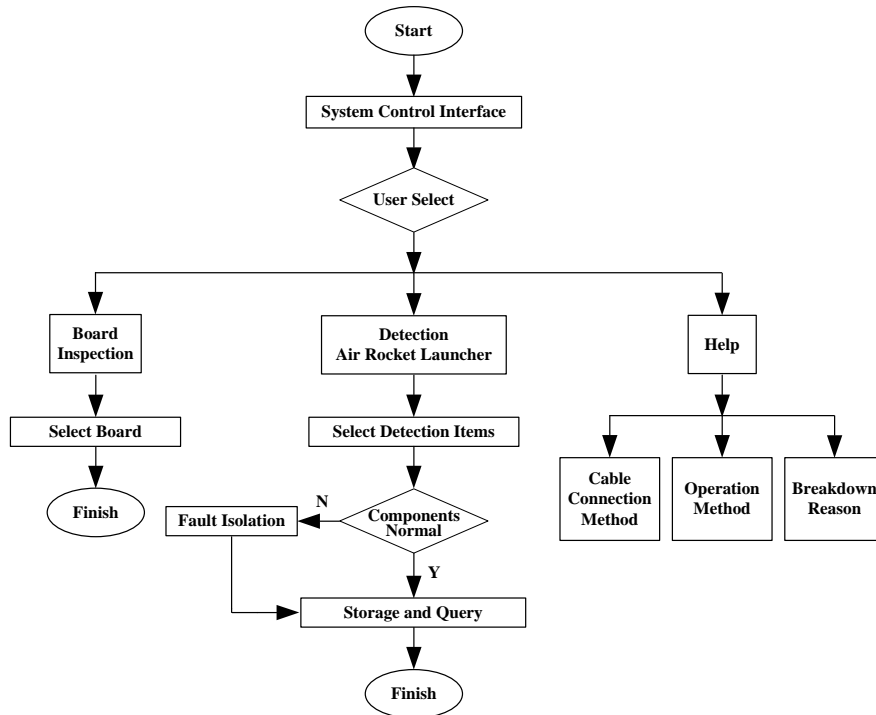
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              │ System Control Interface │
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                    ◇ User Select ◇
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Fig.2 detection procedures

（2）Multithreading

The host computer needs to real-time receive and process the feedback command of the aerial rocket launcher. But the Windows XP operating system is non-real-time operating system, in order to ensure the integrity and reliability of the data processing, adopts multithread to process the data[7], mainly include three threads: the first one is responsible for the loop of the overall system message; the second one reads the data from the function board and sends data; the third one organizes the testing function, converts to the corresponding message to process, completes the testing of the corresponding function, while the test results are displayed on the display and saves to the database.

When the software is initialized, it creates a user interface thread and two data receiving thread. The user interface thread is responsible for handling the interface, including response to user input and various event messages.

The serial data receives the FIFO in each channel of the thread loop testing, when the FIFO data is greater than or equal to the data frame, it receives the data.

The data receiving thread adopts query mode to monitor the FIFO in board channel, in order to reduce the burden on the CPU and process data effectively, inserts Sleep function in the data receiving thread, validated found. When the Sleep function parameter is selected 5ms, it can significantly improve the CPU load, and can receive data effectively.

The preemptive multitasking scheduler in Win32, the system allocates a certain amount of time slice to each thread, then the control will be transferred, the task switching can occur anytime when the task is running, the execution order can not be guaranteed. When the data receiving thread and the user interface thread need access the shared resources, unpredictable errors may occur, therefore, adopts the event object to synchronization the data receiving thread and UI thread. The synchronization principle is shown in Fig.3.
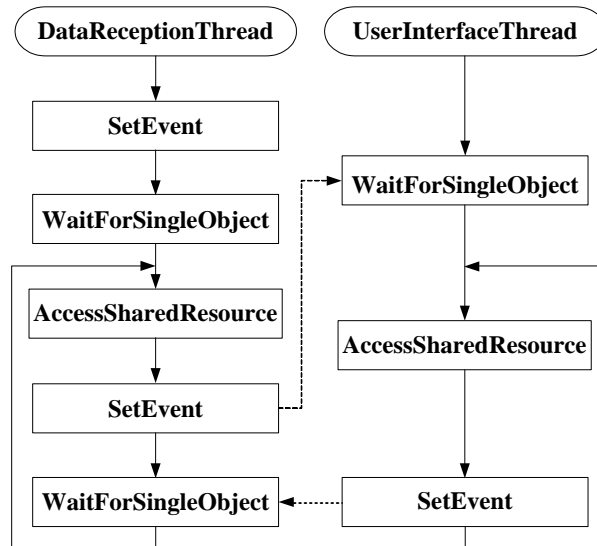
Fig.1 thread synchronization schematic

Conclusion

Based on the analysis the detection requirement of aerial rocket launcher, the design and implementation methods are described for a certain type of aerial rocket launcher detection system. The detection system applies the PC104 embedded computer as the control core, adopts multi-threading technology, designed a testing software, improves the timeliness and accuracy of the detection process. The practical application shown that the detection system is designed reasonable, reliable, high precision, easy operation and maintenance, fully meet the detection requirement of the aerial rocket launcher, greatly improved the equipment maintenance and support capability.

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