Study of Centrifuge and Target Effect Integrated Performance Testing System for Fuze

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Abstract: Fuze detection is an important link to evaluate the quality of the fuze. In order to solve the problem that the traditional methods cannot fully and accurately detect the comprehensive performance of the fuze, the centrifuge and target effect integrated performance testing system of the fuze is developed based on PLC. Firstly, the feasibility of testing system is deeply analysed; then the overall design of the system is completed, and framework and function of the system is given based on it. Finally, in view of the entire system,the working mechanism is determined, it is of some reference value for the fuze study method and system development.

1. Introduction

As a control device to control the timely initiation of projectile, the performance of fuze seriously affects the overall quality of ammunition, and determines the safety of ammunition storage, service support and operational effectiveness to play the role of ammunition effectiveness[1]. How to scientifically and effectively detect the comprehensive performance of fuze has always been a hot topic.

With the rapid development of control technology, as one of the most advanced computer industrial control systems, PLC has been widely used in military engineering[2]. Bring good technical and economic benefits to military departments. Therefore, it is a practical method to use PLC to study the comprehensive performance detection system of fuze centrifugal and target action.

At present, there are two main problems in fuze detection. First, fuze detection mostly adopts sub-item and static detection methods, which cannot accurately obtain detection data; Secondly, the research of fuze dual-environment dynamic detection system is seldom involved. Although it has some applications, it has low precision and poor automation ability. In order to solve the above problems, this paper starts from the urgent need of fuze comprehensive performance testing and bases on the actual situation. According to the actual and structural characteristics of the Ammunition Fuze in the troop, a comprehensive performance detection system for centrifugal and target action of the fuze is developed based on the platform of PLC control system. The structure of the system is briefly described, and the functions of each subsystem are reasonably allocated. On this basis, the operation mechanism of the detection system is designed.

2. Feasibility analysis

PLC is a control system based on the idea of digital logic operation. It regards the established control system as a “brain” and every device in the control system as a module of the system. Each module can use advanced technology in its own field to design and develop independently to the greatest extent. The modules designed and developed can provide multiple network communications for the operation of the PLC system. Layer interface service not only guarantees

high efficiency and accuracy of system operation, but also effectively separates three aspects of system function control algorithm program implementation, equipment operation management and bottom information exchange and transmission. It is convenient to improve the operability and expansibility of follow-up system [3,4]. The integrated performance detection system of centrifuge and target interaction is a very complex distributed integrated structure. Therefore, the application of the standard framework of PLC universality can realize the interoperability and interconnection of each module of the system, and make each component have certain expansibility. Through the comprehensive integration of each component of the detection system, the construction of the detection system can be realized.

3. System Overall Design

3.1 System Composition and Function

The design of a comprehensive performance test system for fuze centrifugal and target action based on PLC can be divided into five parts: pre-dump energy storage transmission subsystem, target action subsystem, safety protection subsystem, PLC measurement and control subsystem and man-machine interaction interface. As shown in Figure 1.

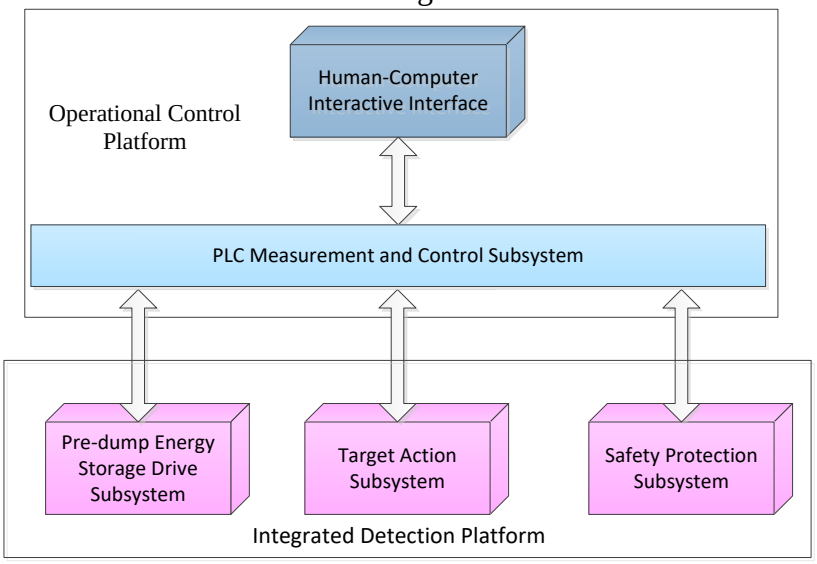

Figure 1 Overall structure of the system

Combining with the design concept of miniaturization and modularization, the pre-dump energy storage subsystem, target action subsystem and safety protection subsystem are integrated into a comprehensive detection platform, and the PLC measurement and control subsystem and human-computer interaction interface are integrated into an operation and control platform. The accurate, fast and effective control information transmission and interaction between the subsystems in the system are realized by PLC, which makes the system have the characteristics of high integration, perfect function and automatic control.

3.2 Integrated Detection Platform

3.2.1 Pre-dump Energy Storage Drive Subsystem

Pre-dump energy storage transmission subsystem is an important part of fuze dynamic simulation test, which is used to simulate the rotating centrifugal environment of the fuze in ballistic flight process. On the one hand, the subsystem is used to realize the pre-dump energy storage process, transfer the stored energy to the fuze in an instant, realize the high-speed rotation of the fuze in a short time, simulate the fuze's rotational acceleration process in firing, and overcome the problem a long time of centrifugal force climbing. On the other hand, it receives the control instructions of the PLC measurement and control subsystem in real time, realizes the accurate control of the fuze rotation speed, and meets the needs of the fuze centrifugal environment.

3.2.2 Target Action Subsystem

It is mainly used to simulate the impact process of the Ammunition fuze on the target, and realize the detection of the impact end effect of the fuze under the action of centrifugal force. On the one hand, the target impact energy is set, and the impact energy parameters are calculated according to the actual test requirements to ensure the reliability of the impact. On the other hand, the target action time is precisely controlled to ensure the effective match between the target action environment and centrifugal environment, so as to realize the comprehensive performance detection of fuze.

3.2.3 Safety Protection Subsystem

The system mainly completes three aspects of security protection functions: Firstly, the jet energy produced during the fuze firing is released and detonated to ensure the effective release of the explosion when the fuze is in operation; Secondly, effective vibration and noise reduction to reduce the harm of system noise to personnel and equipment; Thirdly, when the fuze performance test is carried out, if the set parameters exceed the threshold of safety protection and abnormal operation, the system will protect itself to avoid equipment damage.

3.3 Operational Control Platform

Operational control platform, as the main control Party of the system, is mainly responsible for the control and management of the whole system.

3.3.1 Human-Computer Interactive Interface

The window of information exchange between man and machine is mainly used to set the initial state parameters of the system and the test parameters of different types of fuzes, to select the operation mode, to monitor the operation status of each subsystem of the system and to execute the start, end and emergency stop of the whole system.

3.3.2 PLC Measurement and Control Subsystem

It is the core component of the whole system, and its measurement and control performance determines the level of automation and intellectualization of fuze performance detection. It is mainly used to complete the automatic measurement and control function of the system integrated detection platform, to realize the precise control of the pre-dump energy sub-system and the target action sub-system, and to ensure the efficient operation of the detection system.

4. Design of System Operation Mechanism

According to the system function allocation, in order to achieve effective information exchange among the subsystems, the operation mechanism of the detection system is designed as shown in Figure 2.

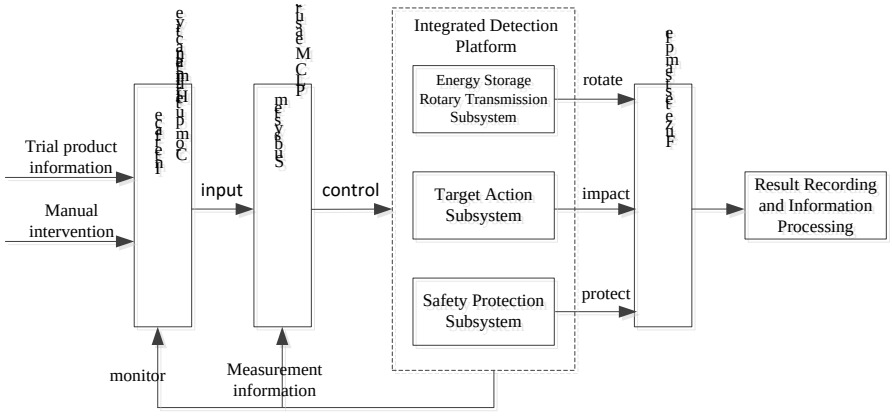

Figure 2 Operation mechanism of fuze centrifugal and target function comprehensive performance detection system

According to the fuze test sample information and test standard, the parameters of rotating acceleration and impact energy of target action are set by manual intervention. After receiving the parameters of man-machine interface, the PLC measurement and control subsystem forms the input instructions, and the subsystems start to run after receiving the instructions.

Firstly, the energy storage rotary transmission subsystem rotates the fuze test sample according to the control instructions issued by the PLC measurement and control subsystem. When the rotation speed error occurs, the measurement error information of the energy storage rotary transmission subsystem is transmitted to the PLC measurement and control subsystem through negative feedback for automatic error compensation, which ensures the accuracy of the rotation speed. At the same time, after receiving the target impact energy control instructions from the PLC measurement and control subsystem, the target impactor completes the energy storage process, and the real-time target impact energy measurement values are transmitted to the PLC measurement and control subsystem for measurement and control, so as to ensure that the target impactor has the impact energy required by the test. After the time set by the constant speed rotation of the fuze, the PLC measurement and control subsystem sends control instructions to the target action subsystem in time, releases the target impactor instantaneously, and acts on the fuze in the high speed rotation state, then simulates the process of centrifugal force and target force when the fuze meets the target, thus completes the comprehensive performance test of the Fuze under the dynamic action, and carries out the follow-up conclusion and records the information processing.

In the whole test process, manual setting parameters and real-time measurement data of each subsystem are transmitted to the artificial interactive interface for display and background storage, which not only achieves the purpose of real-time monitoring of the detection system, but also can be directly invoked in future demand, providing reliable data support for system debugging, maintenance and performance evaluation of fuze test samples.

5. Conclusion

This paper uses PLC to design and develop the fuze centrifugal and target function comprehensive performance detection system, through the system reasonable division and distribution function, and in-depth analysis of the system operation mechanism, to provide an effective and feasible method for the development of the fuze comprehensive performance detection system. Because this paper focuses on the design process of the comprehensive performance testing system of fuze centrifugal and target action, the specific subsystems are only briefly summarized, but the design and research methods and theories are universal, which has certain military reference value for promoting the rapid development of the fuze testing system of ammunition. In the future research, the system components and the specific programming development of PLC measurement and control will be studied in depth.

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