A Simulated Training Instrument for Testing Equipment

Yong Wu¹,*, Lei Lei¹, a, Jian Hu Zhang¹, b, XiaoYan Ruan¹, c, Jun Zhang², d

¹Ordnance NCO Academy of Army Engineering University of PLA, Wuhan 430075, China;
²The 78618 unit, Chengdu 610100, China)

*Corresponding author e-mail: 704301733@qq.com, 570853154@qq.com,
b750224145@qq.com, 55026020@qq.com, 461975241@qq.com.

Abstract. The number of certain testing equipment is small, and the teaching task undertaken by colleges and universities is heavy. The equipment works for a long time, which affects the training effect of teaching. To solve this problem, a simulator for testing equipment is developed. The simulator adopts modern technologies such as computer, automatic test, micro-electronics, automatic control and virtual instrument. It combines computer, target simulation, virtual instrument and data acquisition and processing to form a fully functional and cost-effective simulation maintenance training system.

1. Introduction

A testing equipment is mainly used for fast detection of the optical and electrical properties of the sighting guidance device, and for fast detection of the main performance of the thermal imaging sighting device. It diagnoses the fault of the faulty equipment, locates the fault at the level of replaceable spare parts, and restores the performance of the equipment by replacing spare parts or adjusting axes. Due to the small number of supporting testing equipment and the large number of teaching tasks undertaken by colleges and universities, the overload operation of the equipment directly affects the service life of the testing equipment, thus seriously affecting the teaching and training effect. In order to solve this outstanding problem, an economical, efficient and convenient training simulator for testing equipment is developed [1].

2. System block diagram

The simulator of testing equipment (hereinafter referred to as "simulator trainer") adopts modern technologies such as computer, automatic testing, micro-electronics and automatic control, virtual instrument and so on. It organically combines computer, target simulation, virtual instrument and data acquisition and processing to form a fully functional simulation maintenance training system, which conforms to the development of modularization, automation and intellectualization of testing equipment. Direction.

As shown in Figure 1, the simulator consists of an analog laser parameter detector[2-3] (hereinafter referred to as "laser parameter detector"), an analog MRTD (minimum resolvable temperature difference) (hereinafter referred to as "MRTD detector"), an analog laser power meter (hereinafter referred to as "laser power meter"), an analog detection adapter (hereinafter referred to as "detection adapter"), the simulation sighting guidance device (hereinafter referred to as "sighting guidance device").
device") and the integrated processor. The simulator mainly simulates the working process of the testing equipment, and uses bus testing equipment to detect the key signals. It judges the correctness of students' operation and scores them.

3. Hardware of the system

3.1. Main hardware modules

The simulated shell and components make the appearance and structure of the simulator the same as the actual installation. A circuit board is designed in the sight guidance device for communication, control and display between the main control circuit board and the integrated processor. The sight is equipped with a micro display screen, which is used to simulate and display the observed image. Laser parameter tester, MRTD tester, test adapter and laser power meter are reformed to make the internal structure identical with the installation, interface and operation. The internal circuit board components are redesigned to realize the excitation generation and detection of key signals. STC89C52RC is a low-power and high-performance CMOS 8-bit microcontroller. It has 8K-byte programmable Flash memory, 512-byte RA, 32-bit I/O port, built-in 4KB EEPROM, three 16-bit timers/counters, four external interrupt structures and full duplex serial ports. In addition, STC89C52RC can be reduced to 0 Hz static logic operation, and power saving mode can be selected. STC89C52RC's smallest system is a single-chip computer with ROM/EPROM in the chip. Its smallest system is simple and reliable. It only consists of clock circuit, reset circuit and power circuit. A single-chip computer control board is made and placed in the main control computer to control the simulator and judge the fault. The software is developed by C51 language of single chip computer, and communicates with serial port of single chip computer by USB interface of industrial computer, thus realizing the control of single chip computer by main computer.

3.2. Partial unit circuit

3.2.1. Partial Fault Setting Circuit. 74HC373 is an 8D data latch with state output. Data input D0-D7 is set to "0" or "1" through resistance row RP1. When the S1 signal of the three-state control terminal OE is low and the LE of the latch terminal LE is high, the corresponding digital signal can be output at the output Q0-Q7 and output to the P1 port of the single chip computer through the data bus PA0-PA7. As shown in Figure 2, the dial switch S1 is set as "off" state, D0 is set as "1", and the output terminal of 74HC373 is Q0-Q7, which outputs corresponding digital signals to the single chip computer through the data bus PA0-PA7, which can represent the fault code of this circuit board.
3.2.2. Serial Communication Circuit between USB Interface and MCU. The USB interface module uses chip CH340, which is a serial to USB interface communication circuit. It can realize USB to serial port, USB to IrDA infrared or USB to print port. The chip has a full-speed USB device interface and is compatible with USB V2.0. The peripheral components only need crystals and capacitors. The serial port application program under the Windows operating system on the computer side is completely compatible and needs no modification. The interface of RS232, RS485 and RS422 is provided by an external level converter. Using CH340 to design the USB interface circuit can realize the conversion between USB and serial port without knowing any USB protocol and writing any firmware program, and can use the existing driver, which is easy to develop and use quickly. The industrial computer communicates with the single-chip computer through the serial port of USB interface, thus realizing the control of the single-chip computer by the main computer. The principle is shown in Figure 3.

Figure 2 Partial Fault Setting Circuit

Figure 3 Serial Communication Circuit between USB Interface and MCU
4. Software of the system

4.1. Overall Software Architecture
The testing software is developed on the platform of VC++, and the block diagram of the software design is shown in Figure 4. The software consists of control module, data processing module and input and output module. The control module completes the control of the control equipment and the bus test equipment. The data processing module processes the bus test equipment's return signal for display equipment. The input and output module communicate with the MCU through the serial port of the USB interface, thus realizing the control of the MCU by the master computer, completing the input data processing of the control equipment, and outputting the control data for stimulating the conditioning circuit. The output device is used to display all kinds of information in real time, and the operation interface is identical with that of the detection device.

![Figure 4 Software architecture block diagram](image)

4.2. Software Function Module
The main functions of the simulator software system include laser parameter detection, electrical signal detection, MRTD detection, data management and so on. The flow chart of the software function module is shown in Figure 5.

![Fig. 5 Flow chart of software function module](image)

Laser parameter detection module controls the sighting guidance device and laser parameter detector through analog serial communication, and assists the inspectors to complete the laser parameter detection of the analog sighting guidance device. The detection contents include the detection of simulated optical axis misalignment, coordinate detection of simulated feature points, diameter detection of linear region of simulated laser information field and energy uniformity detection of simulated spot. The test result and qualified range are displayed on the test interface.

The electric signal detection module collects analog electric signal voltage and time sequence through high-speed data acquisition card, the detection port of the sightseeing guidance device and the signal socket of the detection adapter, and assists the inspectors to complete the electric signal detection.
The MRTD detection module collects the MRTD image output from the sighting guidance device through the digital image acquisition card, records the MRTD temperature difference input by the user, and assists the inspectors to complete the MRTD detection.

Data management module is used to assist users to manage and view detection records and data [4-6]. The data module uses MySQL to store data. MySQL is currently the most widely used open source database system, one of the important reasons is that MySQL is very fast. In addition, MySQL has the characteristics of stable operation, easy learning and high cost performance. Although MySQL is not as powerful as Oracle, SQL Server and other commercial database systems in transaction processing, view, stored procedures, triggers, sub-queries, but its fast and massive data storage performance meets the needs of data management design of simulation trainers. MySQL is mainly an implementation of client or server architecture. Its important components include mysqld server daemon and many different data terminals and databases. It has very flexible and secure permission system, password encryption; provides ODBC interface for Windows, which can be linked through Access, and provides a variety of ODBC drivers for third-party developers; uses the largest table size of new MyISAM in MySQL up to 8 million TB; supports multiple languages, but does not support Chinese.

5. Conclusion
The test results show that the test equipment simulator can meet the following requirements: 1. The power supply has good adaptability and can work normally when the input voltage is AC220V (+10%); 2. The operation method is the same as that of the test equipment, and the operation interface is the same; 3. It can give the evaluation of operation correctness and cable connection correctness; 4. It can set up the fault of the sighting guidance device and realize the performance detection and judgment of the sighting guidance device; 5. It has the function of automatic evaluation and scoring.

References
[1] LEI Ling yi, Zhang Yi, Li Cui. Servo Control System of Self-propelled Artillery Simulation Trainer, J. Ordnance Industry Automation, 2017,36(11): 19-22.
[2] SUN Ce, HAO Qun, YAN Zhen-gang. A High Speed Test and Analysis Method for Information Field Parameters of Beam Riding Guidance, J. ACTA ARMAMENTARII, 2017,38(11): 2111-2116.
[3] LI Na, WANG Hong. Parameter testing system for laser-beam riding guided sighting instrument , J. ESE JOURNAL OF OPTICS AND APPLIED OPTICS, 2010,3(3): 286-289.
[4] Huang Xing . Application of VC in MySQL database interface , J. Electronic Test, 2017,(7): 59-60.
[5] LI Yanqing, CHEN Jian, YANG Xiuzhi. Multithreaded engine based on MySQL database [J]. Journal of Fuzhou University (Natural Science Edition) .2015,43(5): 627-630.
[6] Information on https://www.mysql.com/