

Automated Lamp Detection System Developed by LabVIEW

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Abstract: The automated detection and lighting control system is proposed in this paper. It is used to reduce the investment of human resources and reduce the incidence of misjudgment or disoperation caused by human fatigue, which will greatly help the investment cost and efficiency. This paper used NI LabVIEW's program control interface with microcontroller (MCU) and oscilloscope kit (GentryUSB) to develop an oscilloscope and logical analysis functions with automatic detection of LED lamps. The proposed system has data detection, logic analysis, waveform photo capture, lamp control, RS232 packet transmission. Its characteristic is to complete the complicated control/detection process through automation by one click to reduce the error rate and labor cost. In addition, the software and firmware are designed independently, which has extremely high function expansion flexibility and can also accept customized functions and interface custom design. It is expected to bring a lot of benefits and convenience to the laboratory or factory in the future.

Key words: Automatic system, LabVIEW, MCU, GentryUSB, LED.

1. Introduction

According to the statistics of the Ministry of Labor of Taiwan, the basic salary of Taiwanese people has increased year by year, the salary reaching NT\$23,800 in 2020 (Fig. 1). Therefore, the reduction of human resources and efficient completion of work are what enterprises yearn for. In addition, according to the KPMG report: more than 44% of chief information officers (CIOs) in the Asia-Pacific region expect that at least 20% of their current jobs will be replaced by automated methods, because the Asia-Pacific region is mainly an outsourcing center. With the increase in salary, many companies are looking for cost advantages to maintain their competitiveness [1], hoping to replace human resources with machinery to reduce costs and improve efficiency.

Automation technology existed as early as the eighteenth century, and triggered the first industrial

revolution, gradually transforming people from manual labor to power machinery. Automation makes human life more convenient, such as clocks, mass rapid transit (MRT) autonomous driving and cash machines are all products of automation.

According to statistics from IHS Market in 2018, the global industrial automation equipment (IAE) market was estimated to be approximately US\$2,022 billion in 2017 [2], which shows the vastness of the automation market (Fig. 2).

According to the Industrial Technology Research Institute (ITRI) in Taiwan's notebook assembly industry automation analysis in 2012, China's labor costs will grow by 84% in the future. However, the labor turnover rate is high and the quality is unstable. Even with the same set of processes and equipment, the production yield rate of the factory is difficult to improve. Therefore, the development of stable automation products to detect instruments and the establishment of standardized processes will help to improve the efficiency of the factory.

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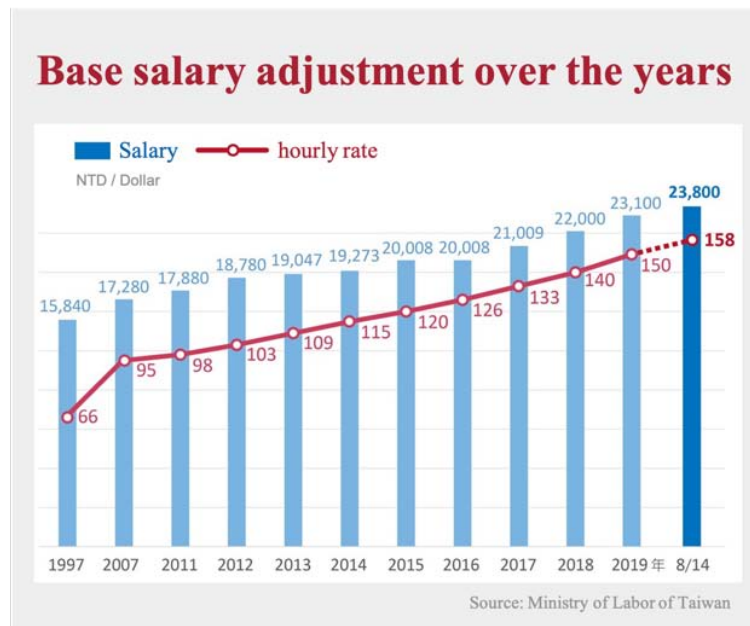


Fig. 1 Base salary adjustment over the years.

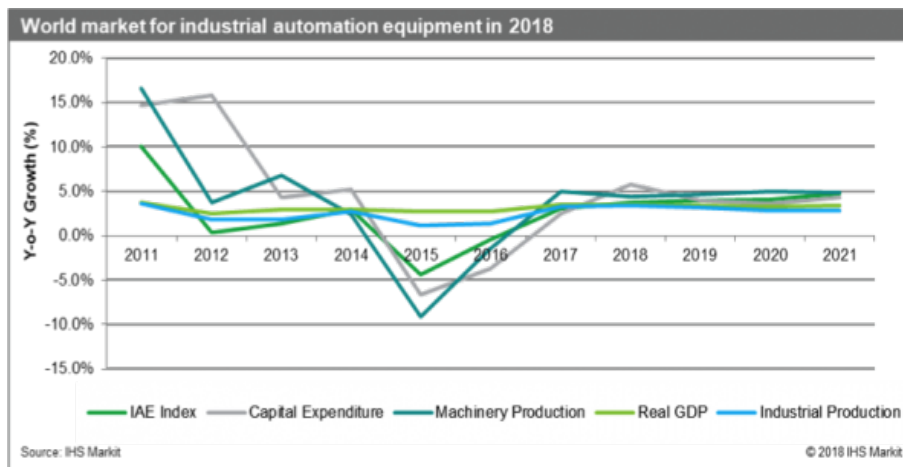


Fig. 2 World market for industrial automation equipment in 2018.

The most important thing for an automated production line is to improve the production yield rate, and automated detection and analysis is the key to maintaining the production yield rate. In the automatic detection system, accuracy, stability and easy operation are mainly required. In summary, the use of automated detection systems to replace monotonous and high-frequency manual work can not only save labor costs and reduce the occurrence of occupational injuries, but also reduce the incidence of misjudgments or disoperation caused by fatigue. In addition, combining the program control interface of NI LabVIEW to establish a graphical user

interface can make it easier for the inspector to get started without having to memorize complicated steps, it can be completed with one click of automation [3].

At present, the automation market is showing steady growth, and its application range is extremely wide. It will play an important role in various fields in the future. The self-developed automated detection system can not only customize interface and functions, but also have higher expansion flexibility [4]. It is expected to bring a lot of benefits and convenience to the laboratory or factory in the future, so this research takes this as the topic.

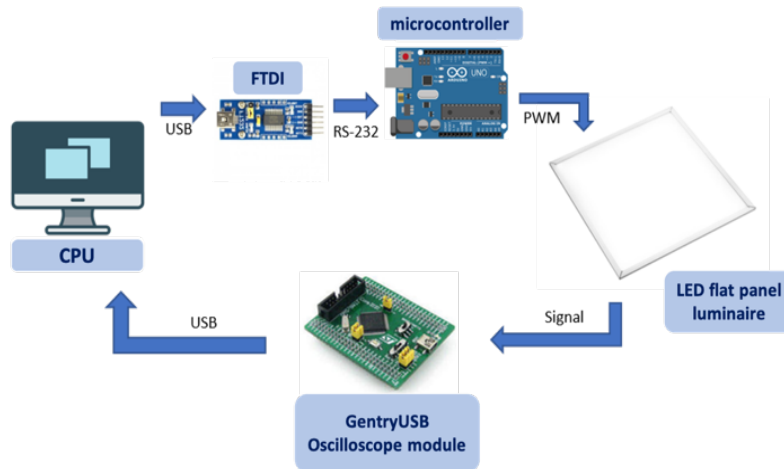


Fig. 3 Overall structure.

2. Hardware and Firmware Design

The overall structure of this research is shown in Fig. 3, with the central processing unit as the center, which mainly includes two functions: controlling lamps and detecting signals.

The process chart of controlling the lamps is shown in Fig. 5. The role of FTDI (FT232 chip) in this paper is the bridge between the central processing unit and the microcontroller (MCU). After the user sends the commands through the proposed interface, FTDI will transmit those commands and connect to the MCU through RS-232 (TX, RX, GND) protocol. When the MCU received the command from FTDI, it will analyze and process it through the internal algorithm of the MCU, and finally output the pulse width modulation (PWM) that matches the command to dimming the back-end lamps [5].

The process chart of the detection signal is shown in Fig. 6. The GentryUSB oscilloscope module (Fig. 4) will obtain the measured signal through the differential voltage probe, and then send it back to the back-end system for analysis and processing, and calculate the voltage, frequency, period and other data through the algorithm of the back-end system to analyze logically. The oscilloscope made with NI LabVIEW software can not only display waveforms on the user interface in real time, but also perform logic analysis, data collection, and data creation functions.

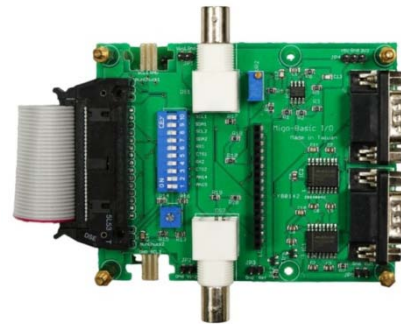


Fig. 4 GentryUSB oscilloscope module.

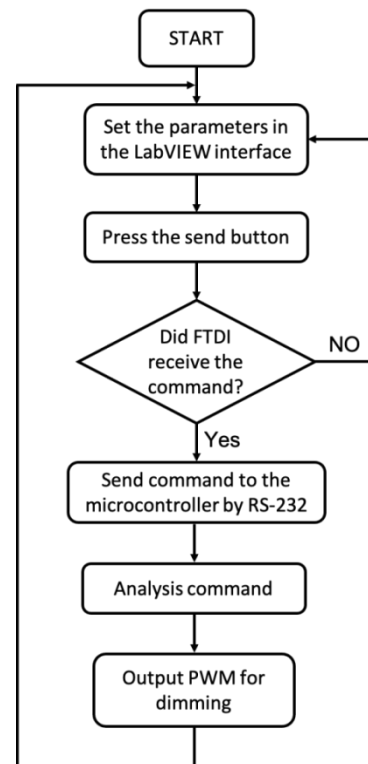


Fig. 5 The process chart of controlling the lamps.

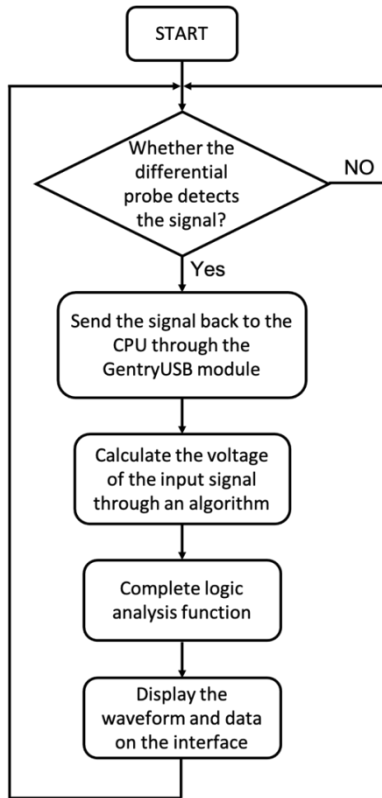


Fig. 6 The process chart of the detection signal.

3. Software Design

In this study, any computer can be used as a central processing unit. Only by installing an executable file on the computer, it can be connected to the back-end, so that users are not limited to hardware devices, and

can freely choose appropriate devices to operate as a central processing unit.

The executable file that needs to be installed on the computer is developed and designed through NI LabVIEW software. The advantage of using NI LabVIEW is that it has a graphical user interface, which makes it easier for users to get started. Fig. 7 shows the overall interface appearance, which not only can simulate the turning knob of a general oscilloscope (Fig. 8), make the use similar to the actual operation, but also display the measured waveform on the screen in real time (Fig. 9), and can perform logic analysis and decoding.

Through LabVIEW internal algorithm calculation, you can also analyze the voltage, frequency, period and other data measured by the differential probe in real time (Fig. 10). In addition, the function of controlling the lamp is also designed on the LabVIEW interface (Fig. 11). You only need to set the baud rate and input the command code. After pressing the button to send, the command will be notified to the MCU through FTDI and the function of dimming will be performed. Using FTDI to send commands to the MCU, the interface can be expanded without changes, so that the dimming function is not limited by the format, and the scalability is higher.

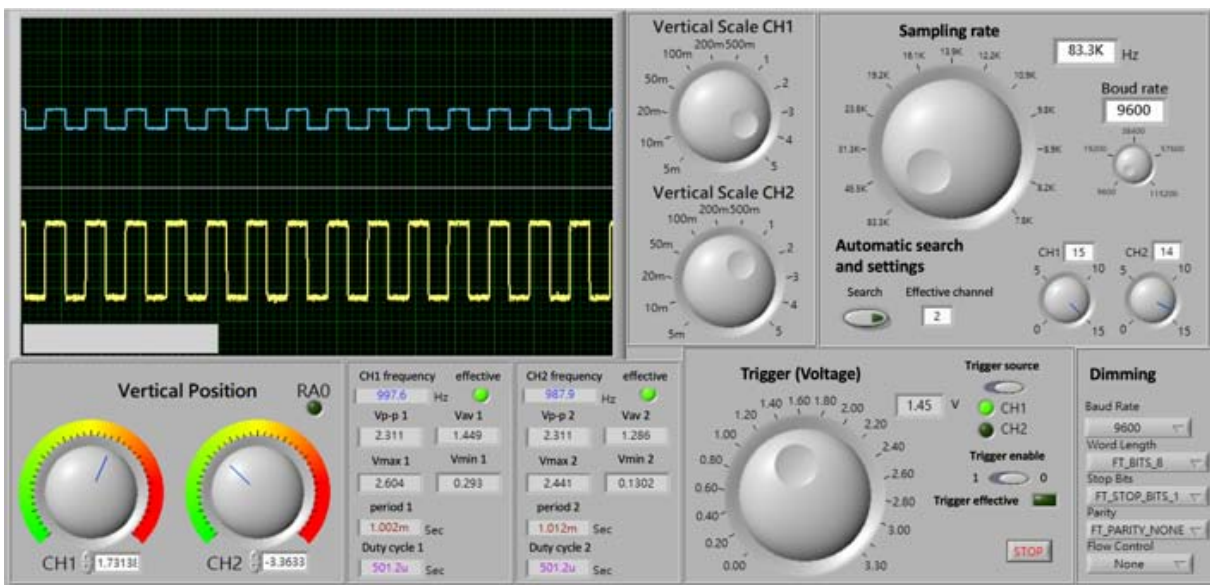


Fig. 7 Oscilloscope overall interface.

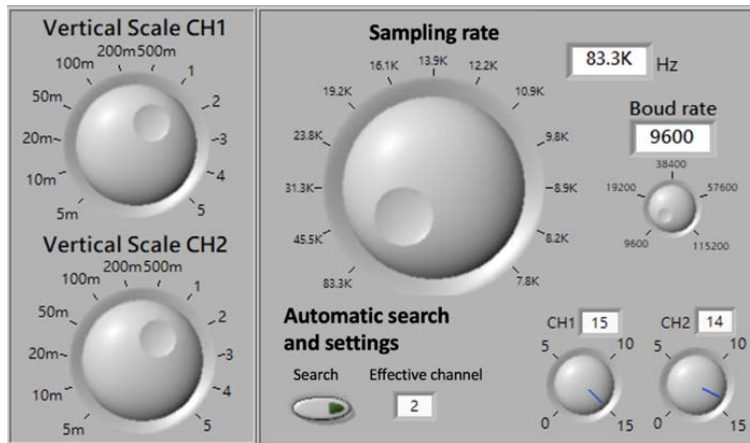


Fig. 8 The turning knob of the oscilloscope.

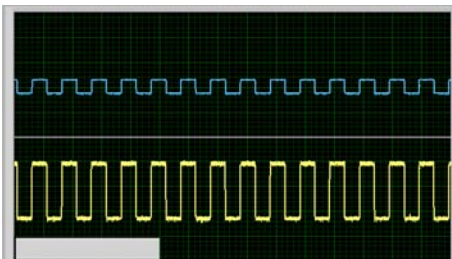


Fig. 9 The measured waveform.

CH1 frequency	effective	CH2 frequency	effective
997.6 Hz	<input checked="" type="checkbox"/>	987.9 Hz	<input checked="" type="checkbox"/>
Vp-p 1	Vav 1	Vp-p 2	Vav 2
2.311	1.449	2.311	1.286
Vmax 1	Vmin 1	Vmax 2	Vmin 2
2.604	0.293	2.441	0.1302
period 1		period 2	
1.002m Sec		1.012m Sec	
Duty cycle 1		Duty cycle 2	
501.2u Sec		501.2u Sec	

Fig. 10 Oscilloscope related data.

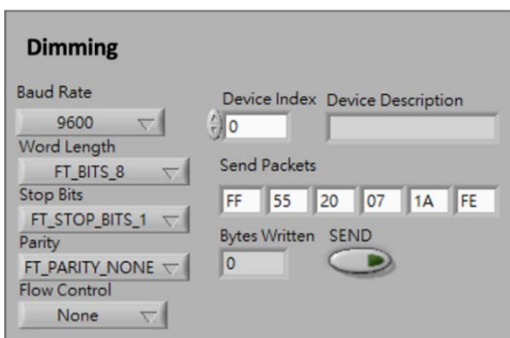


Fig. 11 Dimming function.

4. Measurement Result

When using the automatic detection function, in

order to achieve the requirement of unmanned detection, when the signal is triggered, the system will automatically complete the logic analysis and store the data to achieve the functions of automatic detection, logic analysis, and data set creation. The result of the oscilloscope designed using the proposed system is shown in Fig. 12, and it can be seen that the result is equivalent to the Tektronix oscilloscope (MSO54) in Fig. 13. When the signal is triggered, it will automatically save the triggered waveform and the data decoded by logic analysis. Next, the system will automatically store the triggered data in a preset location with a specified name for easy searching in the future.

When using the dimming function, FTDI needs to be used as the communication bridge between the central processing unit and the microcontroller. After connecting to FTDI, the system will automatically determine the FTDI model. Next, the user only need to set the baud rate, enter the specified command, and press the transmit button once the MCU receives the command, it will decode and send PWM for dimming.

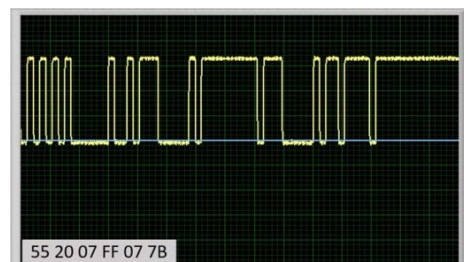


Fig. 12 Logic analysis and waveform (our system).

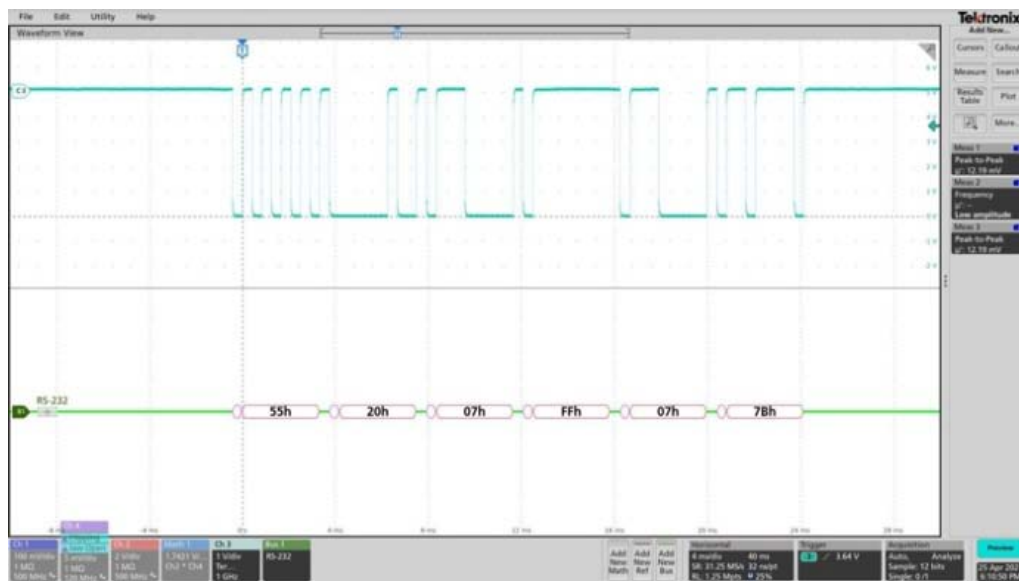


Fig. 13 Logic analysis and waveform (Tektronix).

As shown in Fig. 14, after the user interface has set the parameters and sent the command, the command received by the MCU is intercepted by XCTU. Fig. 15 shows that the command received and the command sent by the central processing unit are correct. After verifying that the command is sent correctly, the lamp can be controlled by the internal algorithm of the microcontroller. The following uses different dimming commands to control the panel light and verify it with an illuminance meter: if the brightness of the lamps is cut into 255 levels, if the “Recall max level” command is executed, the maximum brightness level of 254 (99%) as shown in Fig. 16 will appear; after “After the “Down” command is used for dimming, it will reduce the brightness level to 170 (67%) as shown in Fig. 17; finally, use the “Off” command to turn off the luminaire to reduce the brightness level of the luminaire to 0 (0%) as shown in Fig. 18. This paper used a handheld illuminance meter (UPRTek MK350N) to verify the brightness change. The illuminance meter is measured at a distance of 60 cm from the lamp. When the brightness level is 254, the illuminance is 2,481 lx; when the brightness level is 170, the illuminance is 281.6 lx; when the brightness level is 0, the illuminance is 22.39 lx (22.39 lx is the ambient illuminance).

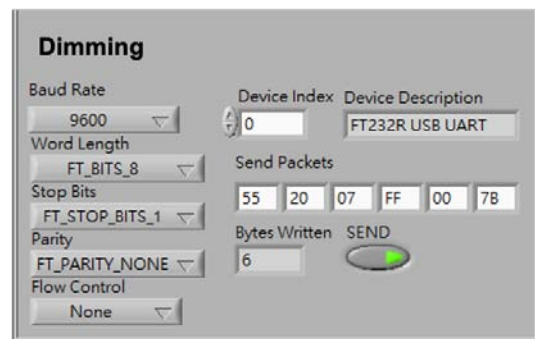


Fig. 14 Dimming-user interface to send command.



Fig. 15 XCTU intercept command result.

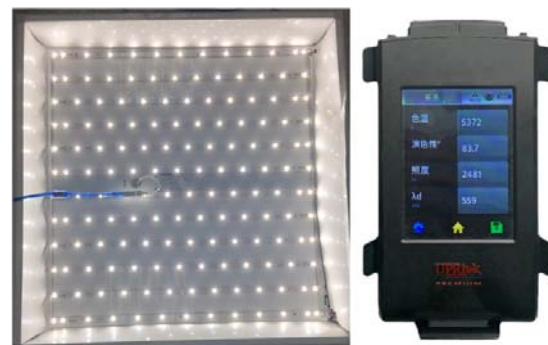


Fig. 16 Dimming measurement result of brightness level 254 (99%).

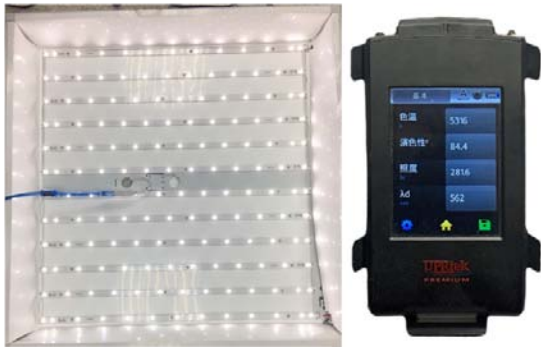


Fig. 17 Dimming measurement result of brightness level 170 (67%).



Fig. 18 Dimming measurement result of brightness level 0 (0%).

5. Conclusions

This research takes automatic detection and dimming as the research direction, and develops an automated system that can achieve data detection, logic analysis, waveform storage, control lamps, and RS-232 packet transmission according to the detection requirements. Use NI LabVIEW software to develop and design a system with oscilloscope and dimming function. Use FTDI to transmit the commands issued by LabVIEW to the MCU by RS-232, and then complete the dimming function by the internal algorithm of the microcontroller. In addition, this paper used the GentryUSB oscilloscope module to return the detected signal to the central processing unit, and achieves analysis and processing through the internal algorithm of the NI LabVIEW program control interface, and displays the voltage, frequency, period, waveform and other data in real time. After

setting the baud rate, the signal can also be logically analyzed and decoded. In addition, the central processing unit will also record signal-triggered waveforms, logic analysis and decoded values, voltage, frequency, period and other data to create a data set.

This paper independently develops an automated inspection system from software and firmware, which can not only customize functions and user interfaces, but also have higher design flexibility and expandability. The use of automated detection systems can save labor costs, improve accuracy, reduce occupational injuries, and bring higher benefits and convenience to research rooms or factories.

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