

The Control System of the Full-automatic Dryer Based on PLC

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Abstract: With the acceleration of the pace of life and the enhancement of environmental awareness, the demand for intelligent household dryers is becoming increasingly urgent. Traditional dryers mostly rely on mechanical timers or simple temperature control, which have problems such as large temperature fluctuations, high energy consumption and single functions. This paper designs a set of fully automatic dryer control system based on Siemens PLC. Through the interaction of sensors and touch screens, it realizes closed-loop control of temperature and humidity, multi-mode selection and energy consumption optimization, providing a more efficient and intelligent drying solution for families.

Keywords: PLC; Dryer; Intelligent Control; Energy-saving; Touch Screen.

1. Introduction

The demand for intelligent household appliances in Chinese families is growing rapidly, but most dryers on the market still remain in the extensive mode of "timed + high-temperature" [1-2], which consumes a lot of energy and is prone to damaging clothes. Especially in the humid areas of the south, traditional drying is inefficient [3-4], and dryers have gradually become a necessity. However, users have more complaints about the convenience of operation and energy conservation [5-6].

In the European and American markets, high-end dryers that support "clothing texture recognition" and "adaptive temperature control" have been widely adopted. For instance, products from Bosch and Siemens can be remotely controlled via an APP, increasing drying efficiency by over 30%.

Consumers need a dryer with a moderate price, simple operation and the ability to automatically adjust parameters. Precise control achieved through PLC technology can not only reduce energy consumption but also enhance user experience.

2. General Design of System

The design of the fully automatic washing machine control system based on PLC mainly consists of the following parts:

Input devices: This section includes various sensors and switches for detecting the status of the dryer and receiving user instructions. For example, pressure sensors are used to detect whether the cabin door is closed, temperature sensors are used to detect the temperature inside the dryer, and touch screens or buttons are used for users to input instructions.

PLC (Programmable Logic Controller): PLC is the core of the control system, responsible for receiving data from input devices and performing data processing and output control based on preset program logic. A PLC usually contains a microprocessor and a memory for storing and executing programming logic.

Output devices: This section includes actuators such as motors and solenoid valves, which are used to drive and control various actions of the washing machine. For instance, the motor is used to drive the rotation of the dryer, and the

high-temperature heat pump drying unit is used to control the temperature inside the chamber.

Human-machine Interface (HMI): The HMI is used to display the status information of the washing machine and receive user instructions. It can be achieved through touch screens, LED display screens or LCD display screens.

Communication interface: This part is used to achieve communication between the PLC and other devices or systems, such as data exchange with the upper computer software. Common communication interfaces include serial port communication, Ethernet communication, etc.

As shown in the figure below:

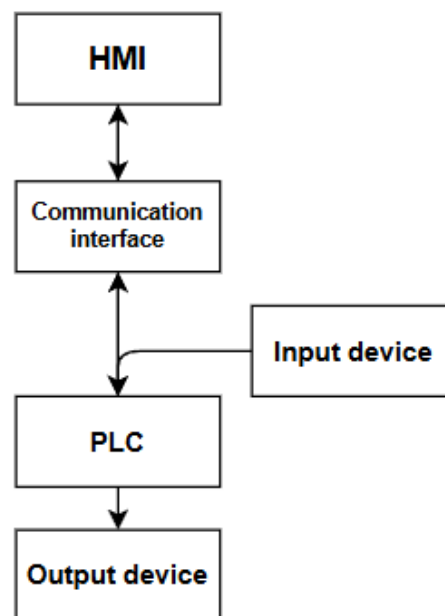


Figure 1. System composition diagram

The main working principle of the dryer:

This dryer is equipped with a variety of practical drying modes to meet the needs of different clothes and scenarios. In standard mode, the temperature is set at 80°C and the drying time is 60 minutes. It is suitable for the rapid drying of most daily clothes, such as cotton T-shirts and linen shirts. It can

quickly remove moisture and restore the clothes to dryness, meeting the daily wearing needs. The energy-saving mode lowers the temperature to 70°C and extends the time to 80 minutes. It is particularly suitable for light and thin clothing, such as silk pajamas and lace underwear. While reducing energy consumption by 20%, it avoids high temperatures from damaging the fabric fibers and protects the texture of the clothing. The fast mode raises the temperature to 90°C and shortens the time to 40 minutes. It is suitable for situations where drying is urgently needed, such as wet sportswear after exercise or towels that need to be used urgently. It can make the clothes dry and wearable in a short time. The user only needs to select the corresponding mode with one click on the operation interface. The dryer will automatically adjust to the matching heating power and time, then start to rotate the cabin to evenly arrange the clothes, and then start heating. After the heating is completed, the power will be automatically cut off. The operation is simple and convenient.

3. Hardware Design of Control System

(1) PLC

The S7-1200 is a small programmable logic controller launched by Siemens. It is suitable for small projects with less complex requirements for the automation system. It can achieve simple logic control, sequential control, motion control, process control and other functions, and supports multi-sensor input and complex logic operations.

According to the practical application of this design, we choose the S7-1200-1215C-DC/DC/DC programmable logic controller.



Figure 2. S7-1215C-DC/DC/DC

(2) Touchscreen

The Siemens S7-1200, when paired with the Siemens Slim Panel series, builds an automated control and monitoring system.

The compatible compact panels come in various size specifications such as KTP400, KTP700, KTP900 and KTP1200. Its features are remarkable, featuring an intuitive graphical operation interface and convenient operation. High-resolution display screen, with clear data presentation; When we choose the KTP700 panel, it can communicate seamlessly with the S7-1200 through standard protocols and has strong compatibility. It has a rich function library and can meet diverse industrial needs. It adopts industrial-grade design and is adaptable to harsh environments.

On the designed touchscreen main interface, three modes can be selected: standard mode, fast mode and energy-saving mode. At the same time, it is equipped with function indicator lights and operation buttons. During operation, the indicator lights will change along with the change of mechanical state. During operation, the touch screen will display the

temperature inside the cabin and the weight of the clothes in real time. During operation, you can press the stop button at any time to stop it. Pressing the start button again will restore it to the state before stopping and continue running.

The touchscreen interface is shown in the following figure:

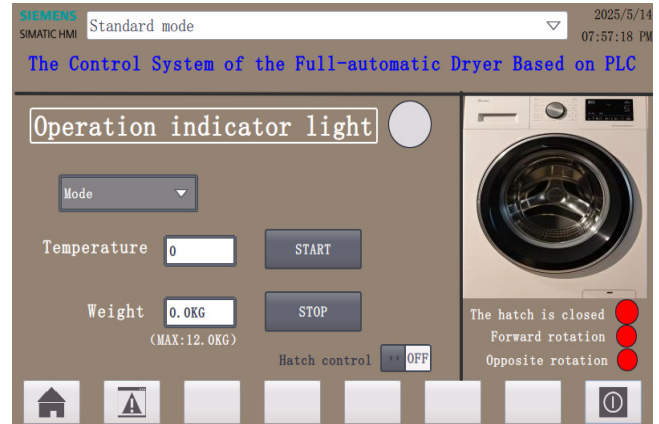


Figure 3. Touch screen interface

Variable assignments are shown in the following table:

Table 1. List of Data Register variables

Input		Output	
Data register	Data object	Data register	Data object
M50.2	Start button	Q60.0	The cabin is turning forward
M50.3	Stop button	Q60.1	The cabin turns in reverse
M20.0	Hatch door pressure sensor	Q60.2	Heat pump heating up
MD22	Cabin weight sensor		

(3) PLC program

First, according to the requirements, the temperature thresholds of the three modes are designed using the mov instruction, which are as follows: 80 degrees for the standard mode; The drying time is 60 minutes. Energy-saving mode: 70 degrees The drying time is 80 minutes. Fast mode 90 degrees The drying time is 40 minutes. Three modes can be selected in the HMI. Before pressing the start button, you need to choose one of them.

Meanwhile, the system is also equipped with an alarm system. When the cabin door is opened during operation or the temperature inside the cabin is too high, the dryer will immediately stop running. After returning to normal, click the start button to resume operation.

The program is shown in the figure 4:

After pressing the start button, the dryer begins to operate according to the mode selected by the user, and the main program starts to call different program blocks.

The running programs of the three modes are respectively shown in the figure 5:

4. Experimental Results and Analysis

After the PLC program and the touch screen program are designed, in the TIA V18 software, in the tool menu at the top, the compiled PLC program is written into the virtual PLC for PLC virtual simulation. In the software, click on the

touchscreen simulation startup to start the touchscreen simulation. The program can be debugged after startup

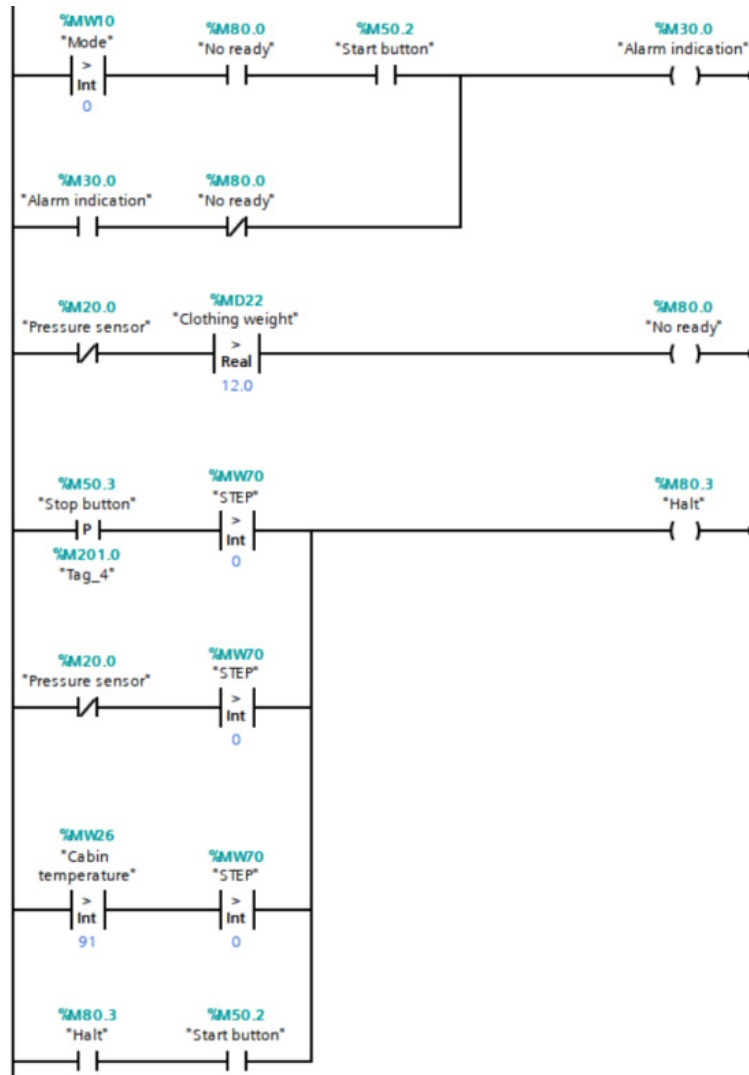


Figure 4. Program 1

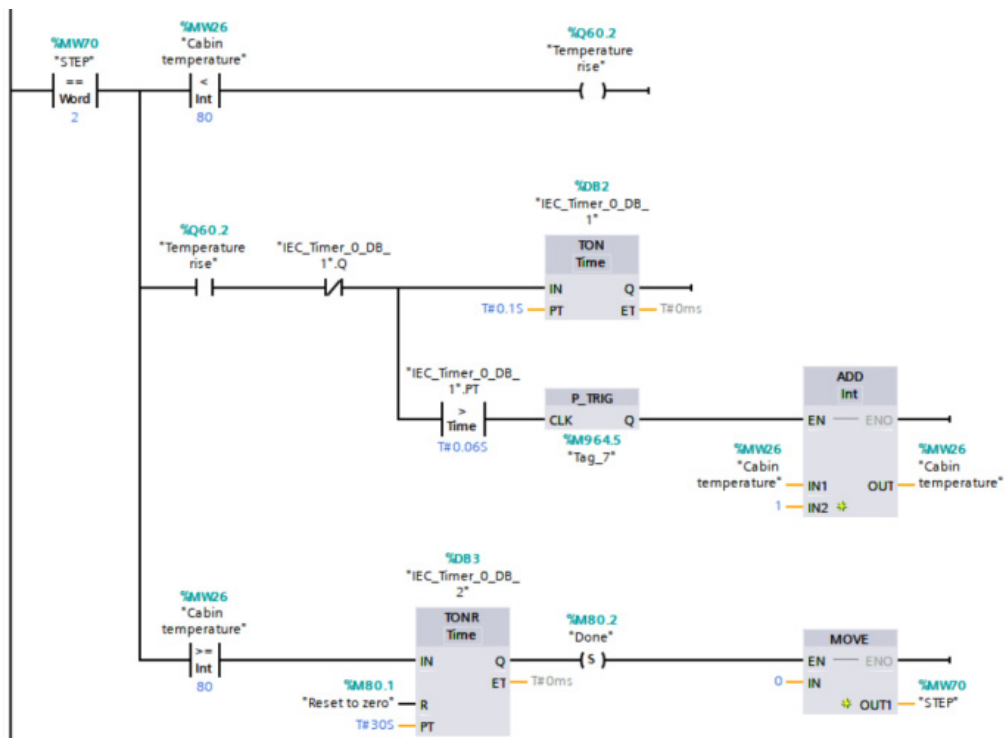


Figure 5. Standard mode program diagram

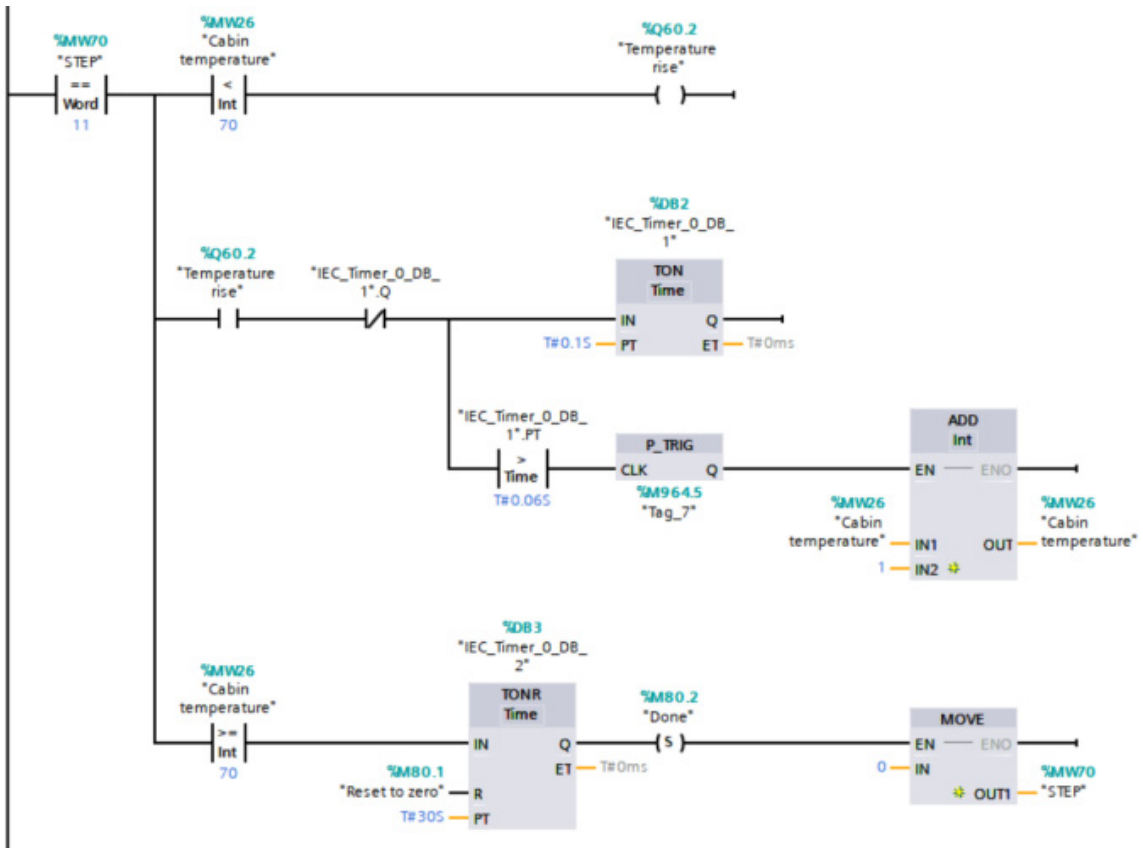


Figure 6. Energy-saving mode program diagram

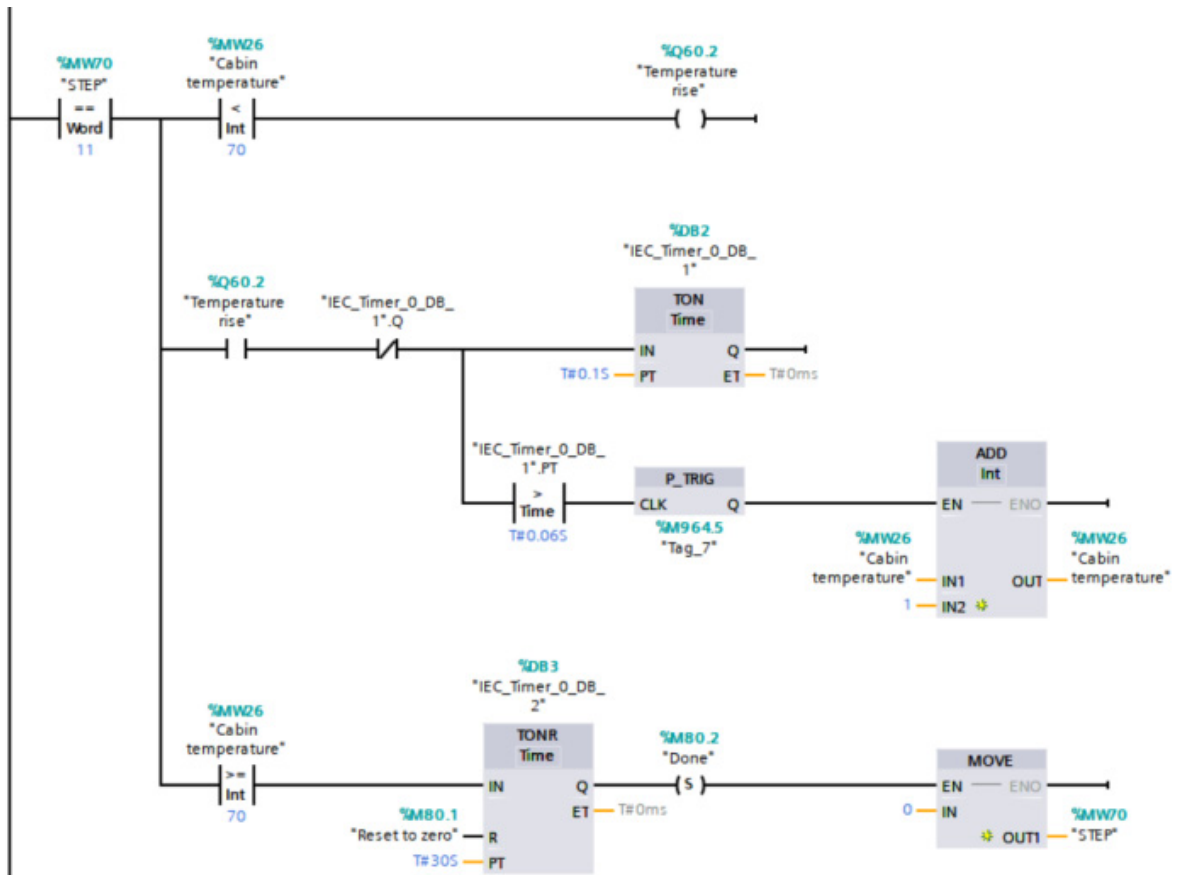


Figure 7. Quick mode program diagram

On the touchscreen screen, you can select the appropriate drying mode through the drop-down box. Meanwhile, the indicator light on the right shows the real-time operating status, as shown in the following figure:

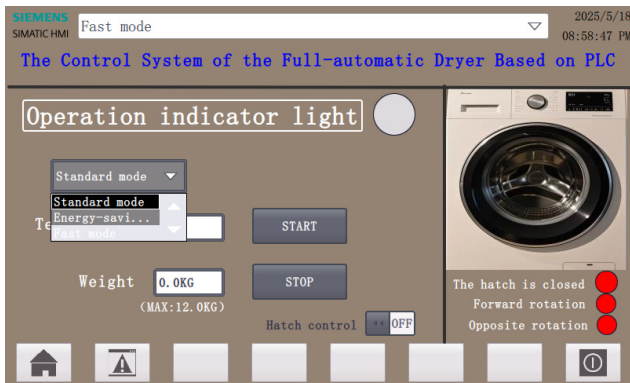


Figure 8. Select the mode

Select the standard mode. After putting in the clothes, the touch screen will display the weight of the clothes in the cabin in real time (up to 12 kilograms). If the cabin door is not closed tightly, the dryer will not run after pressing the start button, and the indicator light on the right will prompt to close the cabin door. The picture is as shown in the following figure:

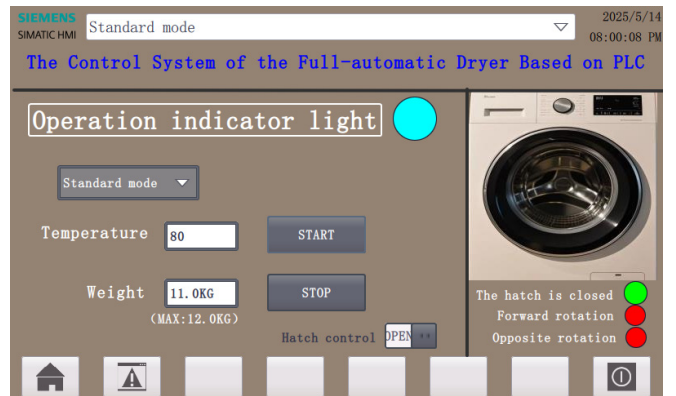


Figure 11. Standard mode

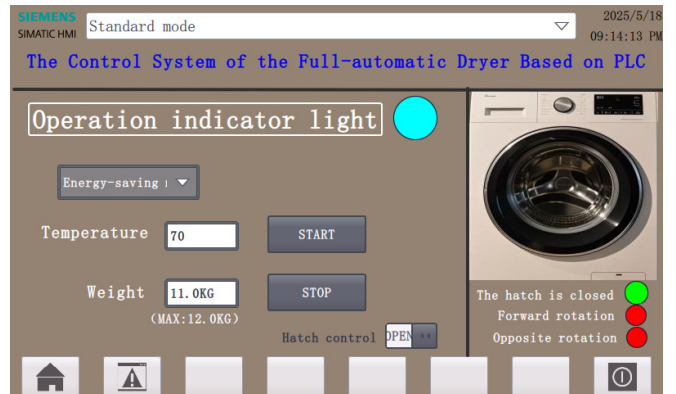


Figure 12. Energy-saving mode

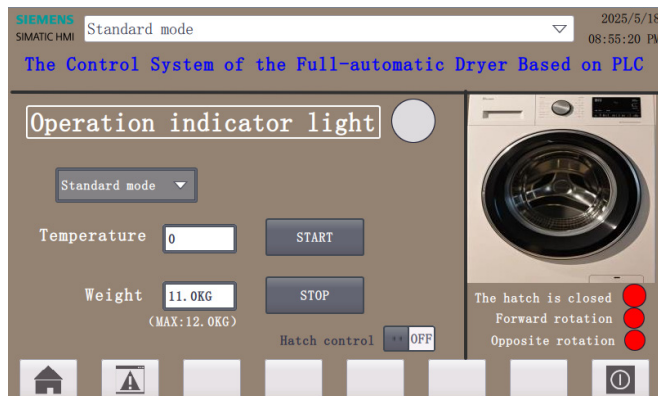


Figure 9. Put in the clothes

After closing the cabin door, click the start button again to start the operation. The dryer begins to work, and the forward rotation, reverse rotation and operation indicator lights all light up at once as set. Part of the picture is shown as follows:

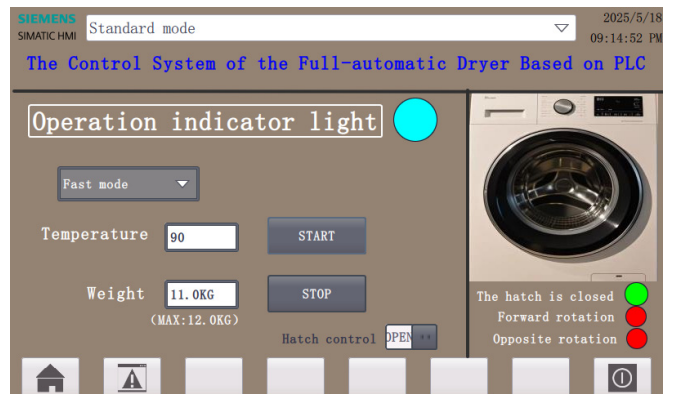


Figure 13. Fast mode

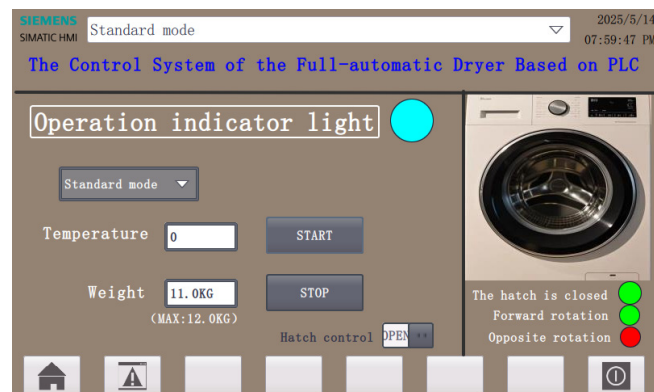


Figure 10. System is running

After the forward and reverse rotation is completed, the clothes are dispersed. Then the heat pump starts to heat up, and the temperature reaches 80 degrees set in the standard mode. The energy-saving mode and the fast mode are 70 degrees and 90 degrees respectively. Their respective pictures are shown in the following figure:

When a mode is completed, the cabin automatically starts to cool down, and the operation indicator light goes off, reminding the user to take away their clothes. The scene is shown in the following picture

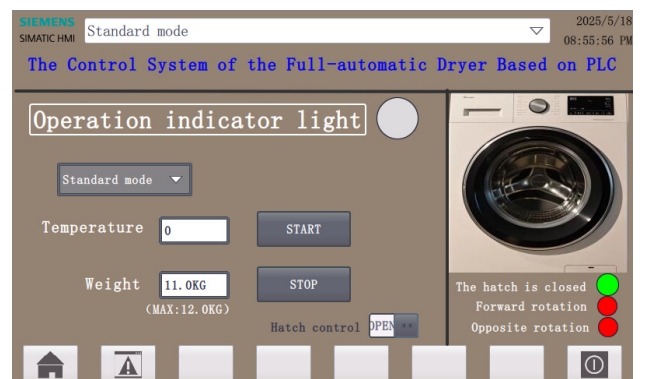


Figure 14. Operation completed

5. Conclusion

From "usable" to "user-friendly", the upgrade of fully automatic dryers is not only a technological iteration but also an inevitable choice that closely meets the needs of users. Precise control is achieved through PLC, which not only reduces energy consumption but also makes operation simpler. In the future, with the addition of remote control and AI learning, dryers will provide great convenience for people's lives.

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