Design of HMI Monitor System Based on PLC Press Electrical Control

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Abstract: Living in the current era of the 21st century, the international industrial automation science and technology has reached a very advanced level. And with the replacement of industrial equipment, the intelligent HMI monitor system has also been included in the press stamping industry. Aiming at the advanced electrical control method, it has been realized that the design and function of the press monitoring system based on PLC. Combined with the cooperation of various press control systems, by using the data communication mode of Industrial Ethernet, a set of real-time monitor system is designed, which uses PROFACE touch screen as the display interface. Thus, it is easier to control the corresponding operation state and working parameters of large press equipment.

1. Introduction

China became a major automobile production country for 10 consecutive years as of 2019, and the automobile industry has entered a rapid development period there. Reducing labor intensity, improving product quality and production efficiency have become the main research content [1-2]. In order to solve this problem, the reference of the human-machine interface (HMI) provides us with the best project to design the real-time monitor system of press. It avoids the difficult problems caused by the old mechanical electrical control, display components, irregular panel layout, a large number of cumbersome component wiring, and the lack of some functions [3]. This paper describes the design and implementation process of the press electric control display system. The HMI interface of the press electric control system is designed considering the factors of cost economy, simple operation, working environment, reliable communication and technological performance.

2. Overall System Project

Siemens S7-315-2PN/DP main controller is used in the press electrical control system. The HMI display device adopts the touch screen with the PROFACE model GP-4501TW. The design and configuration of the system picture are made by GP-Pro EX 4.07 programming software, so that the overall operation status of the device can be monitored in real time.

2.1 HMI Monitor and Display System

Hardware includes processor, display unit, input unit, communication interface, data storage unit, etc. The relationship between them is shown in the Fig.1, i.e. the system software running the HMI hardware and the screen programming or configuration software running in the window operating system of the PC. The screen configuration software of the HMI is used to make engineering documents, and then the edited engineering documents are downloaded to the processor of the HMI for operation through various communication interfaces of PC and HMI.

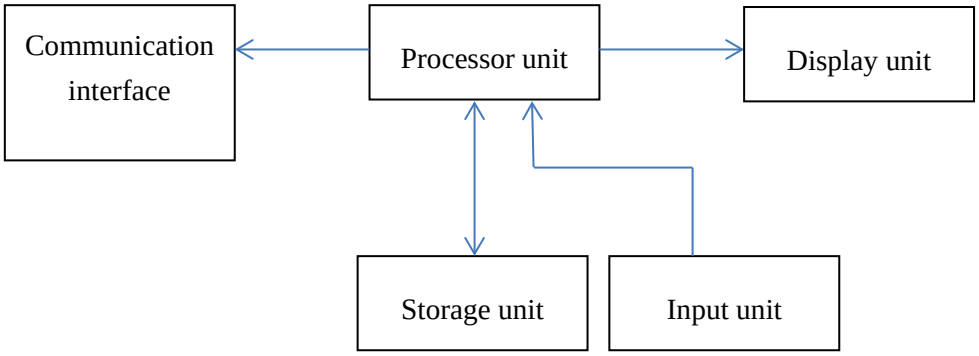

Fig. 1 The composition and relationship of human-machine interface hardware

The performance specification of HMI touch screen is TFT real color LCD with 10.4 inch large display screen, the resolution of 640 * 480 and backlight with white LED. The internal memory is FLASH-EPROM 16MB, and the data backup area is SRAM 128KB. The SD card interface slot is connected with 32G SD/SDHC card at most. The touch screen is equipped with Ethernet interface.

2.2 Design Principle and Key Points

Understand the pre-sequence conditions that the machine tool program is controlled and required to meet when executing each action. And the auxiliary contact addresses and field acquisition signal of each PLC intermediate relay in the program conditions need to be confirmed.

The address setting of BOLL quantity in HMI program shall be completely determined according to each point addresses in PLC program. The address of numerical display is determined according to the address of DM register where the final calculated result in PLC program is located, with the same format [4].

The picture of working state flow chart should be work out. The input, output and some important relay signals are made into text and color change block diagram which are given the form of flow node and flow chart. The relay signal node button is compiled and the sub flow chart of direct monitor is attached, so that the machine tool can directly display the controlled state of the command element and the executive element at any time [5].

3. Communication Design for Monitor System

In this design, Ethernet communication mode is adopted, and the high-speed transmission of information package between equipment reaches 10-100Mbps, and the twisted pair cable is 10BaseT. Ethernet has become the most widely used network technology because of its low cost and high reliability [6].

As shown in the Fig.2, firstly opening the pro-face\GP-Pro EX4.07 software, then clicking the engineering window, and selecting the system settings from it. Then match the HMI model in the HMI settings column, and the upper machine PC first connects with the HMI touch screen device by Ethernet network, matching the network IP address. Click the four corner screen of the touch screen to wait to enter the network OFFLINE, MAIN MENU, INITIALIZE, PLC SET UP, EXTENDED SET UP to set its IP address 192.168.1.118 and gateway address in sequence. Click back and the setting success is displayed.

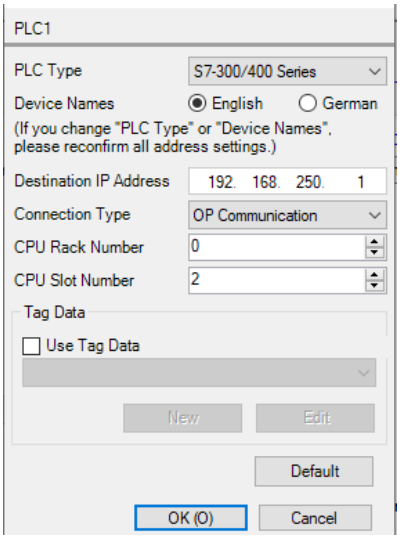

Fig. 2 Ethernet communication settings of human-machine interface

4. Main HMI Design

Using Proface HMI programming software, we can develop some application functions such as status prompt, numerical setting display, real-time pop-up display of fault alarm, information archiving, information logging, etc., so as to design clear and orderly operation process, numerical setting display, real-time centralized monitor of parameters, and timely display of fault alarm and archive [7-8]. When compiling interface, it is necessary to fully understand the principles and functions of some functional elements involved, and create a series of screens with display and switching functional elements for switching between these screens, as shown in the Fig. 3.

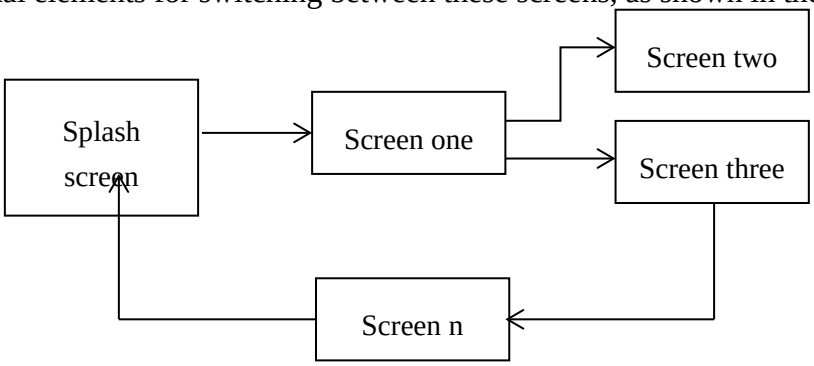

Fig. 3 The relationship between the pictures in the human-machine interface

4.1 Design Principle of Action Flow Chart

For the design of press action flow chart, the spot sampling signal points are included in the flow chart, and the form of series and parallel connection is consistent with it [9]. After analyzing the PLC lubrication condition control program, when the conditions such as high oil pressure of oil tank, air open contact of lubricating motor, lubricating stop button and low oil level of oil tank are all satisfied, the Q5.0 address of PLC can have continuous output signal and the lubricating oil pump can operate normally. In the branch procedure, the indicator light of normal lubrication will be on after meeting the conditions of normal lubrication times and normal lubrication pressure for one minute. The lubrication flow chart is shown in the Fig.4.

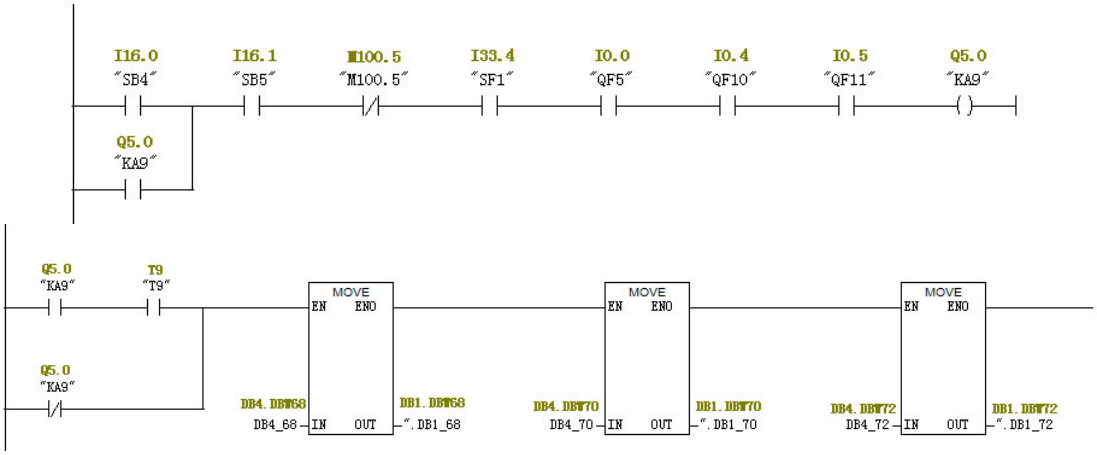

Fig. 4 Lubrication system control procedure

Whether the original state of the signal is normal (green) or abnormal (red) is determined by the hardwired state of field signal sampling components. The contact of the air switch of the lubricating motor, the input point connected to the PLC in the original state is in the normally open state, indicating that the air switch is open, abnormal red state. Press the switch, the input signal connected to PLC will change from normally open to normally closed, and the status display will change from red to green.

In the component menu, the indicator light component is selected into the corresponding position of basic screen, double-click to set the property, select red in the original off state, select green in the flipped on state, and the storage bit address is similar to the address setting of the PLC input point. The bit states of other BOLL address are also set similarly.

4.2 Writing and Reading of System Parameters and States

According to the electrical control principle, the press cannot operate when the lubrication parameters are wrong. The lubricating oil pump pumps the oil in the oil tank to the top crossbeam through high pressure, and then delivers the oil to each lubricating point through the progressive oil separator, and finally returns to the oil tank. When the lubrication is insufficient, the service life of the equipment may be greatly reduced. Therefore, sensitive proximity switch is used for lubrication detection of main parts of the press. The set value of lubrication times detection of main oil separator is 70 and 72 times respectively, and the detection value of lubrication times of secondary oil separator is 82 and 84 times respectively. When oil passes through the monitoring point of the oil separator, the oil pressure will push the detection pointer to pop up, trigger the proximity switch signal, and add one times.

By the analysis of PLC program, lubrication takes one minute as the cycle, the program automatically transmits the updated new data to the internal register with address DM13, and then whether it meets the standard is judged, while the real-time change value of lubrication times is stored in the internal register with address DM21 [10]. The same register address DM0021 as in the PLC program is wrote in the address column, and 16 digit decimal display and 3 digit number are selected in the display format. The indicator light of lubrication detection point is set at the screen counting position, and the color will turn green when the lubrication is detected. Insert two numeric display components, and set the properties and edit the text of the corresponding words. When the lubrication times of key points per minute is greater than or equal to the set times, it is determined that the lubrication is normal. Thus, the monitor screen is more intuitive and concise. The lubrication status display screen is shown in Fig.5.

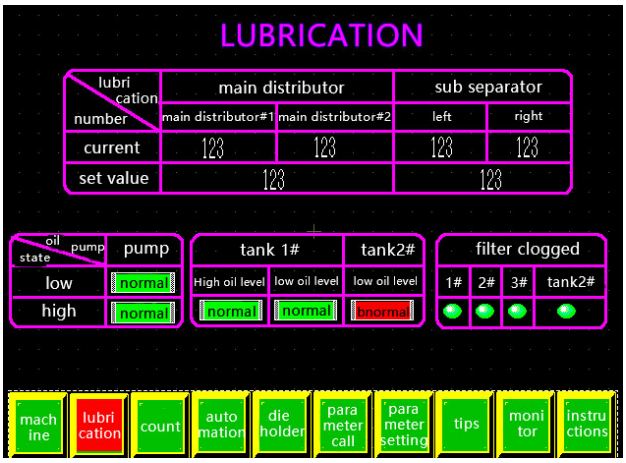

Fig. 5 Lubrication status display screen

4.3 Function Design of Fault Alarm Record Archiving and Viewing.

A fault archive resume screen is designed on the menu page, and the normal alarm faults are archived in the HMI touch screen internal memory. The fault out button is designed on the right side of the screen. And then click up / down to turn over different fault messages. If it needs to be deleted, you will click delete and delete all to delete the fault messages. In the setting page of block 1 in the alarm setting window, you can set the most detailed storage matching address, trigger condition, message and so on for the real-time alarm.

5. The Screen Test of Monitor System

The correctness of the screen program is verified by using the simulation function and field debugging of the software. First of all, the signal action of PLC is simulated on the computer. In the simulation screen, changing the on/off state of the position switch or the value in the specified word address, it can help us to check whether each action of the switch in the HMI program is correct [11]. After that, the screen data is transmitted to the HMI, which is connected with the PLC through Ethernet communication, the lubrication system is tested, and the data operation is normal.

6. Conclusion

Due to the application of HMI monitor in the press electrical control system, the advanced press control system with independent property rights has been developed, which makes the industrial process closer to the direction of more intelligent and humanized. Using fast Ethernet communication to replace the previous tedious hardwiring can eliminate the possible failure of control system. The read-out and write functions of main flow chart and equipment parameter realize that all kinds of buttons can be operated quickly and intensively, and the parameters can be monitored at all times to ensure the stable and continuous operation of the equipment. The application of the man-machine monitoring system strengthens the friendly contact and interaction between people and equipment, improves the system reliability.

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