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Study on motor test system based on PLC control technology

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ABSTRACT

Motors have developed by leaps and bounds, which has resulted in an increasingly widening range of motors. As a research emphasis of motors, the measurement of motor performance parameters has developed dramatically in its measurement scope, utilized more complex and bigger test systems as motors are changing rapidly, and adopted digital technology and information technology, all of which could greatly enhance the maintainability and efficiency of the motor system. The combination of computer technology and PLC control technology could effectively and rapidly test the present motor's parameters and performance; meanwhile it could also modify the software to test other parameters at any time according to customer's demands. Thanks to PLC and computer's excellent software and hardware and data processing ability, the test system's efficiency were markedly enhanced. Therefore it was of great significance of practice and research to study the test system based on these core technologies. This study adopted modular design, usually used in system design, to divide the system's functions into modules, thus revealing the design concepts of the complex system. This study adopted Siemens' s CPU as the PLC control system core to design and upgrade software and hardware, which included CPU, I/O pot, and communication module, etc. based on the current situation of motor measurement. Meanwhile, modular design concepts were applied to system programs. The software system showed great operating efficiency and good maintainability and readability.

KEYWORDS

PLC control technology; Motor test; Software design; System debugging.

INTRODUCTION

The present motor test system has made great progress in measuring motor performance parameters and been well accepted in commerce. However, the present motor systems can only measure a limited range of certain parameters and be applied to specific motors, which will affect the universality of motors and lead to enormous waste in developing specific motor. Consequently, based on the previous studies on this field and the present test systems, this study combined digital, information and PLC control technologies and was committed to realizing better universality of motors, more accurate measurement of parameters, a wide scope of measurement and improving the functions of integrated data record and inquiry, allowing the test systems to be more intelligent, integrated and networked. Taking into consideration the future test systems' s design, investment, competitiveness, application, and maintenance, etc., this study adopted the widely used PLC as master IC, which were more reliable, convenient, and applicable to a wide scope.

THE WHOLE DESIGN OF MOTOR TEST SYSTEM

The motor test technology is mainly focused on various parameters, measurement principles and methods, which included machinery specialty, performance, sound, heat, electricity, error of margin analysis, and data processing, etc. The motor test system is the platform for motor test technology, which can be used to measure motor's parameters, performance. In recent years, the development and improvement of new technologies have pushed the motor test systems towards the direction of becoming smaller, integrated, networked, and automatic which largely reduces man power in operation and the chances of errors. There are no universal systems, because most of the present test systems are specific to one or several kinds of motors, such as step-motors or other motors. As a result, the present motor test systems can not be applied to measure a wide range of parameters.

The motor test system in this study was mainly divided into two parts, hardware design and software design which were independent but also closely interconnected. This study took a holistic consideration to match the two parts so as to create a highly efficient and convenient motor test system.

Analysis of test control system

(1) Display function

The measurement system could display all the crucial default parameters and real-time parameters in the forms of graphs, diagrams, etc. Which could show the whole state of the test system.

(2) Function of real-time control

The test system could send control orders to the operating units at any time. The orders could control all the phases of the test and produce a report of the parameters and data in the test. The user could use all the adjustment equipment, such as the buttons, to control all the phases and process of the test, like setting the rotating speed and moment of force, etc.

(3)Alarming function

If something went wrong with the equipment, or the tested parameters were beyond the default parameters, the test system could warn the operators in the forms of light or electrical signals and point out the failure area.

(4) Data management function

The test system could collect, store, display the test data which could be inquired, produce reports with these data and print the reports. The uses could find data they wanted, such as parameter record, curve record, and etc. Meanwhile, the database could also be retrieved and printed.

This system adopted PLC as the IC of parameter collection and process control, and the control system consisted of several equipment and one PLC. (refer to Figure 1) This kind of system is usually used when the component equipment are not far away from each other and closely related. However, if one subjects was changed, the all the subjects must be stopped which was one of the disadvantages of centralized control system. But this system in the study could totally meet the test demands.

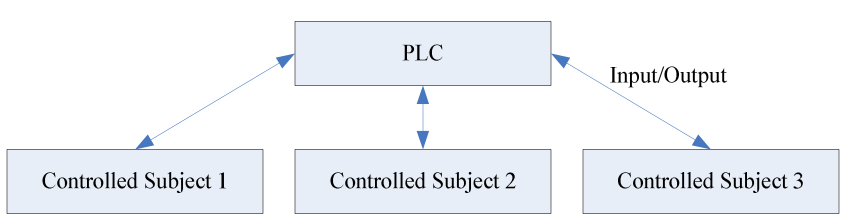

Figure 1 : Centralized control system

Because the man-machine interface resources of PLC controller were limited, therefore, extra equipment should be added in the design to offset this problem. In this study, a industrial computer was utilized which was applicable in industrial environment characterized with intense dust, strong noises, and strong electric-magnetic field, etc. Meanwhile, this industrial computer had sufficient software resources, strong man-machine interface, whose system functions and resources could be updated to meet different demands and its windows operating system could be sued to control the test.

In this system design, the master controller and PLC were its host computer and core of control respectively, which were connected by data link equipment. The host computer had the real-time functions, including display, sending orders, parameter setting, and controlling the display; while the functions of PLC were collecting data, controlling test equipment, and shifting, etc. The test system could control all the test processes smoothly and control several test parameters at the same time. The system could also effectively and rapidly collect, converse and store, display the data. Besides, the system could check itself when it was working, and man could check the system as well. The function of PLC is clear, and its structure is shown in the following Figure2.

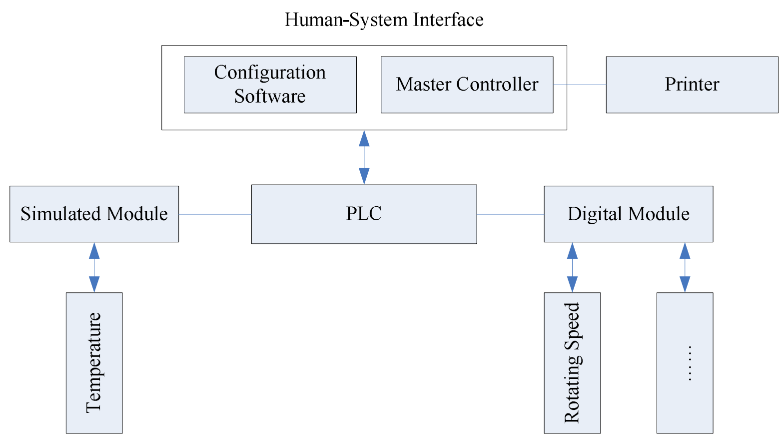

Figure 2 : Control system structure

This study clearly took a scheme that was characterized by PLC as the core of master control and the combination of master controller with PLC. In this motor test design, PLC sent order signals to the driver to start the motor, then the program-control power was started to control-hysteresis brake so as to simulate the load size, and the sensor collected the signals from the rotating axis and sent them back to PLC for processing. Finally, the resulted data were displayed, processed and managed by the master controller. The structure of the PLC control system was shown as Figure 3.

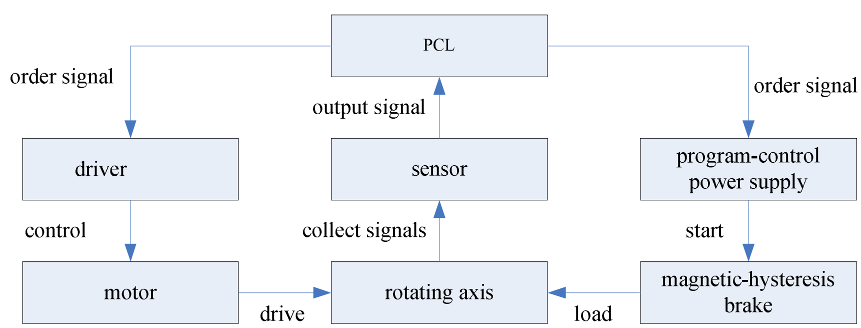

Figure 3 : The structure of the PLC control system

SOFTWARE AND HARDWARE DESIGN BASED ON PLC CONTROL SYSTEM

The software and hardware of motor test system controlled by PLC were design independently, whose compatibility should be ensured. The steps of PLC controlled were as follows: analyzing control demands, distributing I/O ports, hardware design, software design, debugging on the scene. Apart from meeting the design tasks and demands and conforming to the present production process, the system design should serve the purposes of safety, reliability, easy operation, convenient maintenance, and being economical and practical.

Considering the functional demands of motor test system, this test system adopted Siemens’ s PLC chip, S7-200, as its CPU, which has been widely used and has a stable performance track record. Siemens Co. Ltd. is the world’s leading electrics company with semiconductor as its core competitiveness and is one of the biggest electrics equipment providers, who has advanced automatic control technology and experience and a relatively big share of the PLC market. The S7-200

PLC could satisfy the whole system design's needs of A/D and D/A conversions, I/O ports, communication ports. Besides, its cost performance, reliability, and stability, among other things were superior than its fellow products.

The PLC adopted in this system design had MPI (Multiple Point Interface) and DP ports, among other ports, which could still not satisfy the demands of the modernized motor test system. Therefore, this system should add extra I/O ports to enhance the system design' s advantages. As a result, SM332, SM322, SM321 were added to the system in this study. Meanwhile, in order to improve the system' s anti-interference ability around the I/O module, RC filter circuit was added to the system, which had no impact on the system. When the digital signal drove the electrics equipment, with a small volt and current, a relay should be added to control the strong-volt equipment.

As a specifically designed development tool by Siemens for S7-200CN, STEP-Micro/WIN V4.0 was developed based on windows which had a friendly interface, strong functions to allow system programming and resources distribution. It not only allowed all kinds of programmings, but also monitored the real-time operating programs of the users. The PLC of S7-200 series had rich programming languages, which at present included function module, sentences forms, T-shape graphs, and etc. It could use some kind of language order, and also use several languages. The host computer and programmer could use it to program function order.

When programming, in order to make the programming easy and capable of inquiry and modification, the position in memory was marked, and the uses of function modules were noted. The hardware of this study were Siemens equipment, therefore, the compatibility of programs was pretty good. The programming languages were based on the real needs, such as order diagrams, framework texts, T-shape graphs. The essence of this test was to test the I/O ports 's digital signals. In general, PLC programs were modular which were made up pf different modules. The module types and functions are shown in TABLE 1.

TABLE 1 : Module types and functions

Module Types	Module Names	Module Functions
	OB	Operating system and user programs' ports & decide users' program structure
	FC	Programmed by users & no sub-function and memory
Logical Modules	FB	Programmed by users & memory, sub-function
	SFB	Stored in CPU operating system & system function module
	SFC	Stored in CPU operating system & system function module
Data Modules	DB	Store data & shared by all modules

PLC programming and computer programs had similarities so that after the designers drew out the framework, they just need to program the corresponding function orders in the modules. First of all, the test of power supplies was the basic of the whole test which must be done at the beginning of the whole test. Secondly, the inverter must be checked. Started the delay-timer, when the rising edge was approaching, the delay-time began to time, and the position of SD was "1"; the falling edge was blocked, and the delay-timer was stopped to wait for the next rising edge. At this time, if nothing was wrong with the power supply, then the switch was kept open, ensuring normal power supply to inverter. Check and record the inverter' s output signal and cut the circuit when the test was over. Then sending orders to change the internal parameters to its default settings. When something urgent happened in the test, press the related button, then the PLC would stop the orders in the shortest time to top the inverter.

When PLC framework of program module was confirmed, its programming was the same with computer programming, inputting correspondent codes in fixed modules to realize PLC framework programming. As shown in Figure 4, these were the components of the test system.

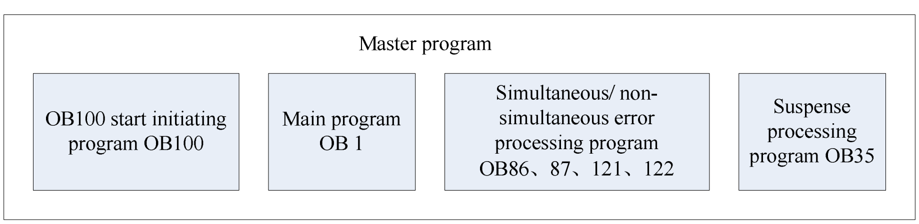

Figure 4 : The components of the test system

OPERATION TEST

When the system design was over, the system functions must be tested which showed that although the program was not big, it took not a little RAM. Nevertheless, the overall scanning response of the test system was rapid and one scanning cycle was 19ms, which laid a solid foundation for the program's rapid implementation of orders.

The 50KW inverter-fed motor's test preparation work had four steps:

(1) choosing test type-variable frequency test
(2) inputting the motor's parameters in the interface's parameter setting diagram
(3) sending orders to PLC (including necessary motor's parameters)
(4) PLC carrying out orders and displaying the results on the interface

50 KW inverter-fed motor test preparation work is shown in Figure 5.

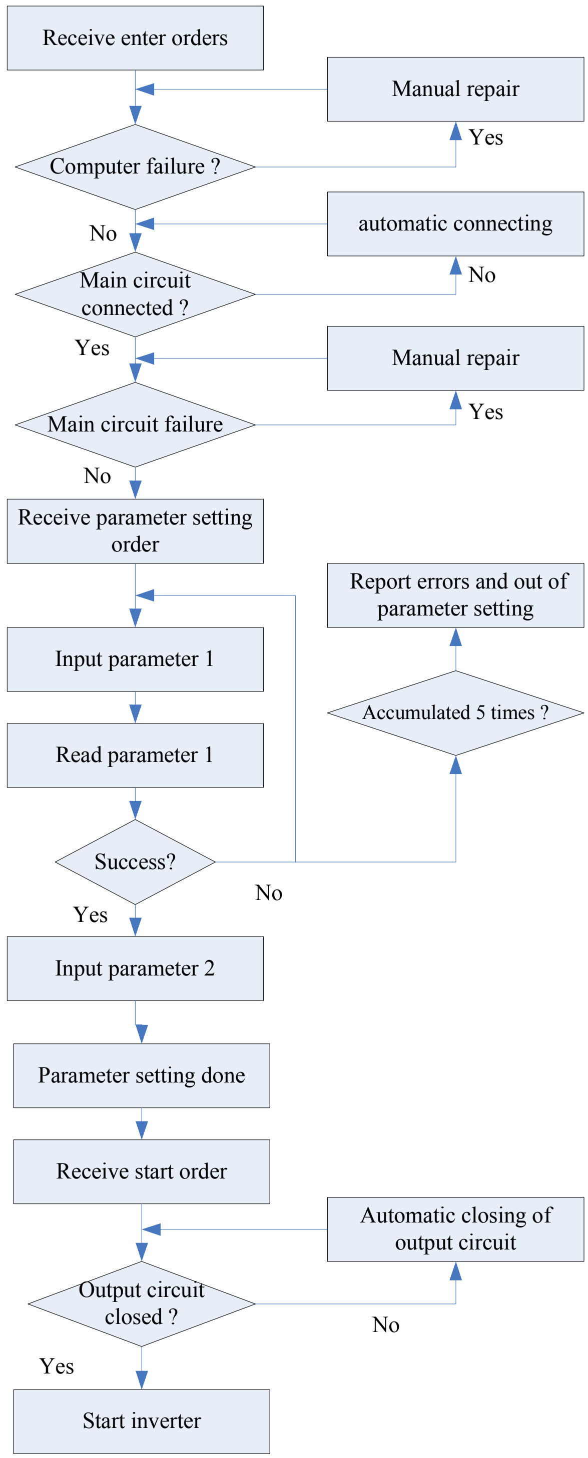

Figure 5 : 50KW motor test preparation confirmation process

In previous system tests, it would take 12 minutes to set the parameters of inverter-fed motor, most of which were set by man and likely to be wrong. But in this test, the parameters of the inverter-fed motor took only 1.5minutes and were set automatically thus had a low chance of errors. In terms of the time spent, the efficiency of this system was excellent.

CONCLUSION

The motor test system showed a great performance which could be attributed to the clear modular design concept of PCL. It would had a positive impact on the following development of motor test systems. The combination of reasonable program design and PLC' s rapid data processing ability enabled the system to respond to the parameters and orders quickly. In general, the system design had met the design demands. In the phase of operation test, this system was running smoothly and its performance was impressive which fully showed the design concept based on PLC control technology was right and successful. Therefore, this system' s design concept had a relatively higher reference value for future motor test system designs.

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