Research on the design of PLC control system of motor testing system

Wenju Ji[1], Jianwen Wang[2]
Inner Mongolia University of Technology, Hohhot, 010051, (CHINA)

ABSTRACT

Many kinds of motors have been made in the current motor. With the explanation of types and styles as well as the continuous refinement of motor functions, various motors which are used in professional field have been born. Measurement of motor performance parameters has always been the focus of research in the motor domain, and measuring range is getting wider and wider. So it is necessary to update the existing motor measuring system. And the development of digital technology and the IT technology brought the spring day to research and development of motor measuring system. This study makes research on scheme which combines the PLC technology and computer technology, effectively using the technical advantages of both technologies. It can quickly make objective and accurate evaluation on the performance and parameters of the motor system, at same time can test the specific parameters according to customer requirements. Therefore, the research on the PLC control system of motor testing system on such basis is of realistic significance and reference value. The presented research on the PLC control system of the motor testing system are based on the idea of modular design, and make modularization segmentation according to the function of the system, making the complex system appear to be clear. The system adopts the CPU of Siemens as the core of PLC control system and combines with the existing situation of motor measurement to make design and optimization of software and hardware, which include the CPU, I/O interface, and communication module and so on. The paper, from a macro point of view, make the systematic study on overall design motor testing system and the design thought of the soft and hardware in the core PLC control system. At the same time, the system program is compiled using modular method, and the software system reflects the high execution efficiency with good maintainability and readability.

KEYWORDS

Motor testing; PLC control technology; Design of software; System testing.

INTRODUCTION

With the continuous development and perfection of digital integration, computer technology and IT technology and perfect, measuring motor system has already transferred from manual measurement to the automatic measurement and from analog measurement to digital measurement. The existing motor measuring system has already been well developed in application field, with types of testing performance and parameters of the motor being more and more abundant. However, testing range of motor testing system in the current market is relatively narrow, with the range of testing parameters being quite narrow which can only be applied to a specific motor and specific parameters. It will influence the universal development of motor and caused a large waste of the research on the unique system[1]. Therefore, based on the previous research in this field such as integration, IT, PLC, and digital control technology, this study make designs and modification on the basis of the existing testing system, in order to achieve a better generality of electrode measurement system, higher accuracy of the measurement parameters, more testing items, and more type. At the time the application functions such as recording and inquiring in the whole data will be enhanced, making it more intelligent, integrated, networking on the whole. Considering from the system design inputs, the competitiveness of future products in the market, as well as the usage and maintenance, this study uses PLC that is currently used widely in industrial environment as the main IC. And the controller which is based on this IC are characterized by being more reliable, convenient and having wider using rage[2].

THE OVERALL DESIGN OF PLC CONTROL SYSTEM OF MOTOR TESTING SYSTEM

The motor testing technology are used for studying the various parameters, the measurement principle and the measurement method which mainly includes motor mechanical characteristics, working characteristic, parameters of acoustics, heat, and electricity, the error analysis and data processing and so on[3]. Motor testing system is a platform of motor testing technology, and usage of the system can test the performance and parameters of the motor. In recent years, because of the development and maturity of new technology, the development of motor testing system goes towards the direction of miniaturization, integration, networking, and automation. And in the execution of a task, manual operation is possibly minimized, which also reduces the probability of error in[4]. Most of the current system is of specialty. For example, some only are special for the stepper motor or some other motor, without a more mature universal system. Therefore, when facing with large rage of capacity and parameters, the existing system cannot be so effective.

The testing system in this research is mainly divided into two parts: hardware design, and software design. The two parts are not only mutually independent but also closely linked to each other. The present study should consider comprehensively and grasp the matches of these two parts from the macro direction, forming a highly efficient, convenient motor testing system.

Analysis of the function of the testing control system design

(1) Real time controlling function

Testing system can send control instructions to the execution unit at any time, and the instruction can fully control each testing process. At the same time it can collect all kinds of data in the testing trial and generate reports. Users can, through various testing button and control parameters, adjust the equipment to control each processes and links such as setting speed, torque.

(2) Image displaying function

The testing system can display the important setting parameters and real-time parameter in the experimental process in the form of graph, picture and so on and the displaying curve, table can shows the overall state of testing system.

(3) Data management function

The testing system can realize data acquisition, display, and storage, and provides the function of data query, report generation and report printing. The user can find the required data in the system, such as the recording parameters, curve recording etc. At the same time users also can use and print the database of testing system.

(4) Alarm displaying function

When the operation of the equipment fails or beyond the range of setting parameters, the testing system can through photoelectric or various signals, notify the staff, and briefly indicate the possible fault range.

This system adopts PLC as process parameters acquisition and process control IC. And control system of the research use control scheme of centrally connecting multiple devices with one PLC as shown in Figure 1. The scheme of controlling system is mostly applied under the circumstances that the equipments are not far from each other and they have certain relationships.
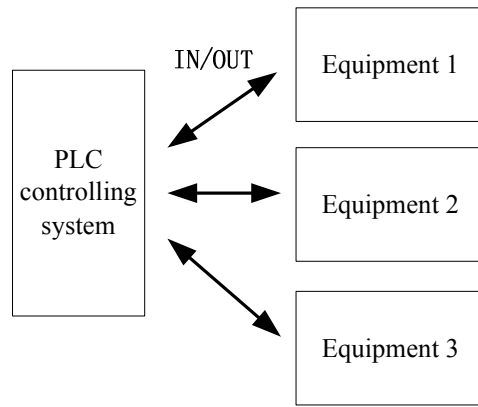
Figuire 1 : Centralized controlling system

This controlling scheme uses a PLC controlling design scheme, so it needs no additional communication link. However the change of testing a certain object needs to stop the whole PLC controlling object. This is also the disadvantage of centralized controlling system. But the application of centralized control can completely meet the requirements in the design of this system.

Because there are little man-machine interface of the PLC controller, it needs to add additional equipment to balance the disadvantages in the system design. This study use industrial computer program which can be applied in industrial environment where has the strong dust, strong noise, strong electromagnetic. At the same time, the computer software is rich in resources and has powerful man-machine interface. Users can, according to their needs, conveniently expand the function and resource of the system, being conveniently using windows operating system to control the whole test[5].

In designing the system, IPC is used as the host computer, PLC as the control core, and IPC and PLC is connected by a data link. The host computer plays the functions of displaying, setting instruction, setting parameter, controlling the synchronization of pictures and so on. And PLC plays the functions of data collection, collection, controlling the testing equipment, conversion and so on. Testing system can not only realize the stable control of each testing process, but also can simultaneously carry out centralized control of multiple testing parameters, making the system can effectively and quickly complete data collection, conversion, storage display and output. In addition, the system is able to carry out self-checking once being started, manual checking, automatic control and other functions. The function of PLC is clear, and the diagram of its controlling structure is shown in the Figure 2.
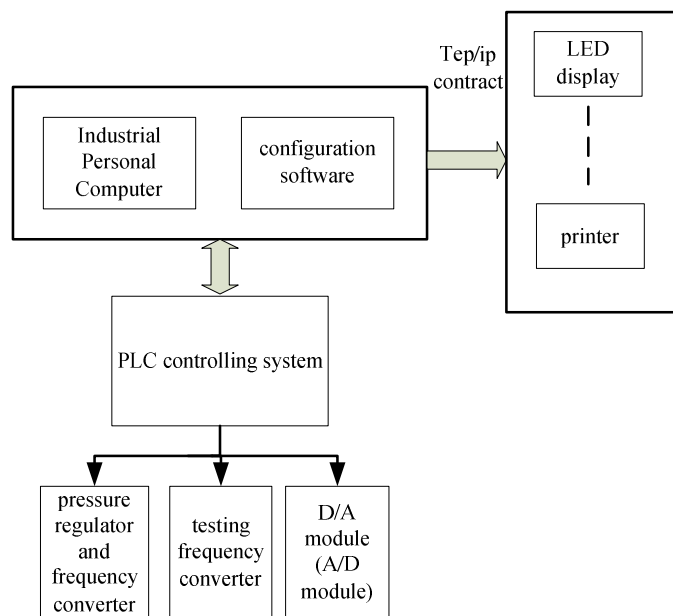
Figure 2 : The structure of controlling system

This study uses the controlling scheme which adopts PLC as the main control center, and combines the engineering machine and PLC system. In the design of testing the motor, PLC sends out a signal to drive to drive the motor to run. The signal is sent to program-controlled current source to control the magnetic remanence brake, thereby simulating the size of the loading load. And the sensor collects signal of the rotating axis and return it to the PLC, for the PLC to make signal

sampling and processing. At last the data is to be displayed processed and managed on the industrial personal compute in the way of suitable for industrial control computer. Figure 3 is the block diagram of the PLC controlling system.
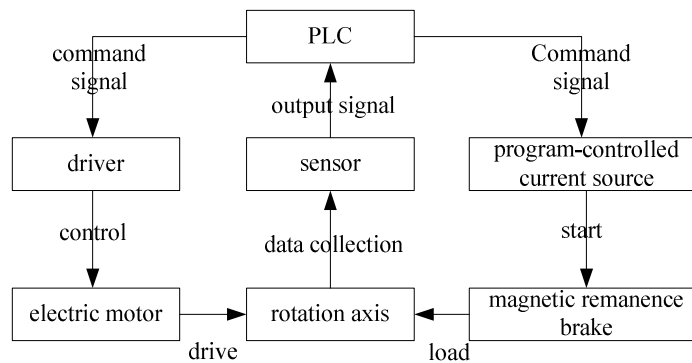

Figure 3 : The block diagram of the PLC controlling system

THE DESIGN OF SOFTWARE AND HARDWARE BASED ON PLC CONTROLLING SYSTEM

The software and hardware of the used motor testing system controlled by PLC can be independently designed, as long as the compatibility and matching attribute of them can be guaranteed. The general steps of the PLC control are as follows: analyze the controlling requirements, assign the I/O interface, design the hardware, design the software and debugging. While meet the requirements of design task and the current production processing conditions, the system designing should be possibly safe, able to adapt to the development, easy to operate, convenient to be maintained and economic and practical.

According to the above analysis, and combining with functional requirements for motor testing system, this system uses PLC chip S7-200 of Siemens Company which suitable for small and medium controlling occasions as the CPU, for this PLC is currently widely used, and has stable performance. Siemens is a word leading company of semiconductor integrated electronics, as well as one of the largest providers of electronic equipment which has the leading automatic controlling technology and experience, and a large share in the PLC market[6]. The PLC-S7-200 which is one of medium-sized products in Siemens S7 series can meet the needs such as A/D, D/A conversion, I/O interface, communication interface and so on in the whole system design, and at the same time, in the aspects such as reliability, price stability, it is superior to similar products.

In this system, although CPU has RS485, DP and MPI (Multiple Point Interface) interface, it is far from enough for modern testing system. So in order to achieve the I/O function effectively and enhance the advantages of system configuration, SM321 (digital input modules), SM322 (digital output module), and SM332 (analog output module) are selected in this study. And in order to effectively deal with signal interference, anti-interference measures are set up in the design around circuit in I/O module, such as increasing the photoelectric isolation device at the input port, adopting RC filter technology to filter jamming, reducing the effect of the delay caused by the signal[5]. For the voltage and current of digital quantity output module is relatively small, additional relay is requires to enable it to drive large electrical equipment, such as the calibration of I/O module parameters on different voltage value and the maximum current under sense /resistive load. The composition of hardware of the PLC controlling system is shown in Figure 4.
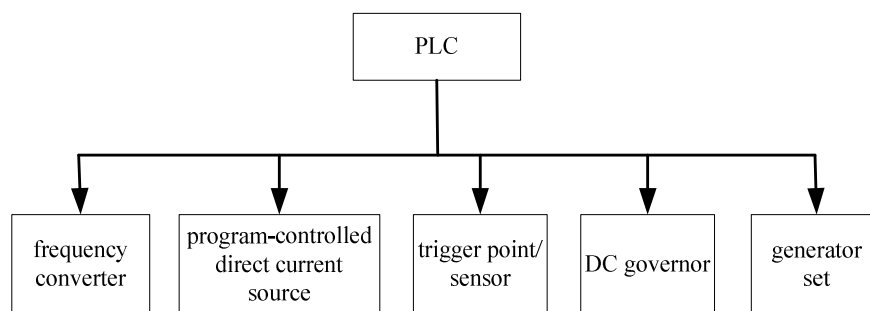
Figure 4 : The composition of hardware of PLC controlling system

As PLC development tool which is specifically customized for the S7-200CN series by Siemens Company, STEP 7-Micro/WIN V4.0 is developed based on windows system, main realizing system programming and resource allocation. The software has friendly interface and powerful function, and it can not only achieve a variety of programming operations, but also can real-time monitor the executing program of the client[8]. The PLC programming language of S7-200 series is very

rich. There are functional module, the statement table, ladder diagram and many other ways. Users can use one kind of language to make the instruction, or adopt the mixed mode, using various languages to write function instruction through the specialized host computer or programmer.

During writing programs, in order to make the programming easy to understand, modify and query, the memory location, the function module using and all the other notes should be made clearly. The hardware in this study are all selected from Siemens equipments, therefore they have better compatibility in the programming. Choose the appropriate programming language style according to the actual situation, such code repertory, structured text, ladder diagram and so on. The essence of the testing system is to process digital quantity on each I/O interface. And this study adopts the programming scheme of combining ladder diagram and code repertory. Overall, the PLC program is modular, and composed of different modules.

PLC programming is similar to computer programming. Both programming are finished in this way: after the designer complete a structured framework, write instruction set of the corresponding functions in the corresponding module[9]. The system in this study can complete the work of testing various motors. So the motors models in each test are different, in writing programs FC is used instead of FB which has a storage area. The system will direct release the interim data, effectively saving system resources. Here take the frequency conversion motor for example, design the program-controlled motor testing. Firstly, test the various parts of the power. The power test should be placed in front of all tests for it is a base of the tests. in the PLC program, the first step is to test all the power to finish the preparing task. Secondly, judge the working state of the inverter. Start the delay timer, and at the rising edge, start the timer to time. Meanwhile set the SD as "1"; Stop at the falling edge. And reset the timer, and wait until the next rising edge. If no failures of the power occur, remain the opening state, and revoke the switching signal to ensure the normal power supply of the inverter. Check the inverter output signal and make records. When the experiment is finished, disconnect the output circuit. After completing the operation, send instructions through a network line to modify internal parameters of transducer, and reset the factory settings. In case of an emergency situation in the testing process, press the emergency stop button and PLC will send an emergency stop command, stopping the inverter in the shortest time.

After determining the framework, of the PLC programming module, the implementation of the program is consistent to the computer program writing: filling the corresponding code in a fixed module can realize the PLC structured programming. The composition of software of PLC controlling system is shown in Figure 5.
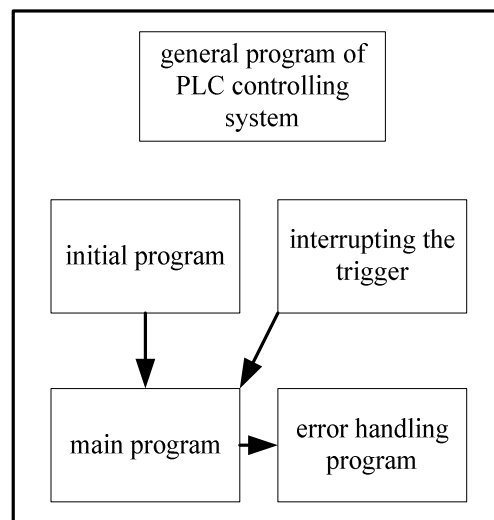
Figure 5 : The composition of the system program

OPERATING THE EXPERIMENT

After the completing the design of the system, experimental verification is carried out aiming at the function of the system. The experimental results show that the program itself is not large but use a lot of memory space, but the total scanning speed of the testing system is very fast. The testing system monitors that one scanning cycle is 19ms, and the short scanning time lays a solid foundation for fast executing the instructions of the program.

There are generally the following four steps for preparing experiment of testing inverter motor of 50kW:

(1)   Choosing the type of the test—frequency conversion test;
(2)   Input corresponding motor parameters in the parameter setting form on the operation interface;
(3)   The instruction is sent to PLC (including the necessary motor parameters);
(4)   PLC executes the instruction of the program and return the results to the operating interface to be display.

In the system experiment of testing frequency conversion motor, the original testing system need to spend about 12 minutes to set all parameters of the frequency converter before testing. And most of them need to be manually set, making

high error rate. The parameter time of the frequency converter is set in general in 1.5 minutes, and most are set automatically, which is not easy to make a mistake. Just from the spending time, the system is excellent in terms of improving efficiency performance.

CONCLUSION

PLC controlling system of the testing motor in this study shows good performance. The design idea of PLC modular work makes great contribution, and the logic is very clear, which is of great help for the expansion of the follow-up system. The reasonable program design and fast data and program processing ability of PLC enables the system to be timely respond to parameters setting and various instructions of the operating system, Overall, the design of the system meets the designing requirements.

In testing phase of the experiment, the system performance is stable and fast, which fully demonstrates that the design strategy based on PLC technology is correct and successful. Therefore the designing method of the system is of higher reference value for the designing motor testing system in the future.

REFERENCES

[1] Shen Kaiming, Wang Yufen, Chang Xing; PLC Control for Motor Testing System [J], Light Industry Machinery, **(04)**, 45-48 (2010).
[2] Han Junfeng, Si Lei etc; Design of PLC control system in NC type angle iron production line [J], Equipment Manufacturing Technology, **(7)**, 74-76 **(2009)**.
[3] Chen Xiangling; Hardware system of tests of platform based on PLC control electrical machinery [J], Industrial Control Computer, **(9)**, **(2006)**.
[4] Zhang Jian; Design of PLC control in motor testing platform [J], Mechanical and Electrical Information, **(12)**, **(2013)**.
[5] Ouyang Santai, Zhou Qin, Ouyang Xi; Design of data acquisition system of motor test station based on the labv platform and PLC [J], Electric Machines & Control Application, **34(1)**, 45-48 **(2007)**.
[6] Liu Lu; The design and debugging of motor test platform control system based on PLC [J], Design and Research, **9**, 3-4 **(2014)**.
[7] Wang Kangping; Research and application of the testing platform of AC asynchronous motor [M], Master Thesis of HeFei Technology University, **(2013)**.
[8] Xu Huale, Xie Jianyun; Study on DC speed control system based on PLC control technology [J], Modern Manufacturing Technology and Equipment, **(02)**, **(2013)**.
[9] Zhao Ran, Wang Ying; The study of motor automatic testing system based on the virtual instrument [J], Instrumentation Customer, **(3)**, **(2011)**.