# Research on Design and Development of Intelligent Test System of Induction Motor

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**Abstract:** The continuous development of electronic technology, computer control technology and motor control technology has promoted the development of motor test system. This paper designs an intelligent test system of induction motor based on LabVIEW software and Siemens PLC. The paper elaborates on the designs of programmable logic controller, frequency conversion driving device, communication of PLC and S120, virtual instrument interface upper computer and lower computer to provide some references for relevant researchers.

## 1. Introduction

Motor plays an important role in national life and economy [1]. In order to improve the quality of motor production, after the development and production of new motors, the manufacturer should refer to the standard, carry out factory test and type test to determine its performance. Traditional motor test is usually carried out by separating instrument, which reads, records, processes data and draws curves manually. This method has low automation, high work intensity, and consumes a lot of manpower, material resources and time. The intervention of human factors and the error of test instrument will result in the increase of error in the test process and the decrease of test precision. Therefore, it will affect the judgment of the overall performance of the motor. As an important electrical equipment, asynchronous motor is widely used in various fields of industrial and agricultural production and daily life. Therefore, it is very important to improve the performance of asynchronous motor. The performance testing technology of asynchronous motor has been widely valued and deeply studied at home and abroad for many years. The experimenters can also choose advanced algorithms to design virtual instruments, so as to better process digital signals and achieve functions that traditional instruments do not have. Through software configuration, more functions can be integrated together to improve testing functions. Using virtual instrument technology to test the motor automatically, the test data can be transmitted to the computer through sensors, and combined with the virtual test software designed, the data can be displayed, sent, processed and real-time detection. This can greatly reduce the work intensity of the tester and the error of the test results, and improve the accuracy and speed of the motor test. We feedback the test results to the testers in time, so that the design of the motor can be adjusted accordingly, so that the motor can meet the requirements [2].

## 2. Overall Design of Intelligent Test System of Induction Motor

Virtual Instrument is a test system which uses computer, peripheral control and parameter acquisition equipment to control the equipment under test to realize automatic measurement. This instrument makes use of advanced computer computing ability to write test panels of various functions on the computer to complete the comprehensive measurement of a specific equipment. Peripheral equipment mainly realizes the acquisition and control of the parameter data of the equipment under test. In order to complete the automatic measurement, besides the measurement function, virtual instrument can also analyze the measurement data, draw curves flexibly, store data and curves, and compare different data. The test system of asynchronous motor transmits control

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signal to the controller by the software of the upper computer. The controller controls the power module according to the control information of the upper computer, and then controls the operation of the motor. At the same time, the sensor and other components will transfer the collected data information to the data acquisition card after conversion. The data acquisition card collects the sensor information, and then transmits the digital quantity to the computer. The computer software will display, process and analyze the digital quantity. At the same time, in order to realize the automatic measurement of the upper computer software, the controller can control the operation of the motor. Asynchronous motor has the advantages of high reliability, high efficiency, high power density, easy maintenance and low price. Previously, due to the limitations of electronic devices and microcontrollers, AC drive system could not achieve the speed control effect and dynamic performance of DC drive system. However, with the continuous development of electronic devices and microcontrollers, most of the current asynchronous motor controllers adopt vector control strategy of frequency converters, making the current AC asynchronous motor has higher reliability and wider speed range. When the load of asynchronous motor changes, the speed and slip rate of the rotor will also change, making the electromotive force, current in the rotor conductor and the electromagnetic torque acting on the rotor produce corresponding changes to meet the needs of the load [3].

## 3. Special Design and Development of Intelligent Test System of Induction Motor

### 3.1 Design of Programmable Logic Controller

The system takes PC as its main computer, 8031 single chip computer and its peripheral circuit as its extension, the main computer is located in the central control room, and the extension is located in the test site. All the test hardware of the system adopts modular design, and each test module completes a test task. The main circuit module is mainly composed of relay switch array. Under the control of computer, the circuit between each test module and the motor under test is connected sequentially to make the corresponding test module work. The system mainly completes the type test and factory test of small and medium-sized asynchronous motors. A guideway can install up to eight modules. When configuring, the system will automatically assign the address of the module. The power module is always installed in the No. 1 slot of the guide rail, the CPU module is installed in the No. 2 slot on the right side of the power supply, and the interface module should be installed in the No. 3 slot on the right side of the CPU. The three slots are fixed and occupied. There is no slot limit for the signal module and it can be installed in any other slot. Because the module of PLC in this system is connected by bus connector, which is different from other PLCs installed by bus socket welded on the backplane, the slot number is relative and there is no physical slot on the guide rail. The test system does not need to expand the guide rail, so there is no interface module installed on the guide rail. CPU module and SM module are close together, but slot is still occupied by the interface module which does not exist in practice. No. 1 slot (power module): This test system uses AC input PS_307 power module, order number is "6ES7307-1KAOO-OAAO". The power module converts AC220V voltage to DC24V voltage to supply S7-300 sensor and frequency converter. The power module of S7-300 is connected with CPU module through power connector, providing DC 24V power supply for CPU module and other modules [4].

### 3.2 Design of Frequency Conversion Driving Device

The drive device used in this system is the DC/AC inverter with common DC bus, namely Sinamics S120 multi-axis driver. The hardware structure is that the power module and the motor module are separated. A power module can rectify three-phase AC to DC and connect multiple motor modules to DC bus. It is especially suitable for multi-axis control. Energy sharing can be realized between the motor axes. The modular multi-axis driver used in the test system consists of control unit CU320, input interface module AIM, active power supply module ALM and Book motor module. Modular system components can accomplish the rigorous driving tasks in the industrial field. The

functions and components are coordinated, and can be freely combined according to the system requirements, so as to get the best scheme. The rich motor models make the function of Sinamics S120 very powerful. No matter what kind of motor can be supported by Sinamics S120. On Sinamics S120, the closed-loop control and intelligent control of the driver are realized in the control unit. It is not only responsible for vector control, but also for V/f control. In addition, the control unit is also responsible for the speed control, torque control and other functions of the drive shaft. The interconnection of the axes can be realized in one control unit, which only needs to be configurated in START software. Sinamics S120 has basic speed and torque control. It can restart automatically after power interruption. Driver I/O signals are interconnected and drive system can be adjusted according to equipment conditions. Controllable rectifier and feedback unit can avoid noise on the input side and regenerative feedback energy generated by controlling motor braking, and improve the applicability of voltage fluctuation on the input line. Interface connects the main components of Sinamics_S120, including motors and coders. Unified cable and connector specifications can reduce the diversity of parts and storage costs.

### 3.3 Communication Design of PLC and S120

Industrial Ethernet supports wide area open network model. It is applied between controllers in management and workshop level and between controllers and PCs. Generally, it has large data volume, long transmission distance, fast transmission rate, and can adapt to harsh environment and high anti-jamming requirements. As-I is an actuator-sensor interface, which can connect binary sensors and actuators to network. Two-way data communication of field automation equipment, as-I is especially suitable for connecting sensors and actuators that need to transmit switching signals. As-I can also transmit analog data. Only specific messages can be used the message of power module in this system chooses siemens_TELEGRAM_370, pzd-1/1. The 370 message contains the sending of one word and the receiving of one word. It can control the starting and stopping of power module and return some state values of power module Vector message of motor module chooses, pzd-2/2_The standard message 1 contains two words. Send and receive two words, can control the start and stop of the motor and set the speed value, and return some state value of the motor module and the speed value of the motor running. The existing message structure of S120 sometimes cannot meet the actual requirements, so it needs to be expanded on the basis of existing messages to transmit the required information. In this system, the standard message 1 of motor module vector needs to add several words to the existing message to transmit the voltage, current, torque, frequency and power of two motors, and the output torque value of a given load motor.

### 3.4 Virtual Instrument Interface Design

SCI communication can be used in the case of small amount of data and low real-time requirement for the virtual instrument of induction motor with simple design function. Most of the applications are to transmit data through the bus of computer interface. Generally, when using this method, we need to equip an interface circuit board, which is mainly used for connecting and processing data format. For the data interface to be frequently plugged in and out, USB interface devices are generally used. Compared with other acquisition devices, the price is slightly higher. The parameters of the measuring equipment need to be transformed into electricity by sensors. The data acquisition card keeps the electric signal, carries out A/D conversion, and then transmits it to the upper computer. General data acquisition equipment has the function of multi-channel acquisition at the same time, and can also be single-channel and time-division acquisition. For the acquisition of multiple correlated parameters, if the final results are shown in real time, these correlated parameters can be collected simultaneously in multiple channels. If there are many parameters to be collected, but the real-time requirement is not high, and the number of channels is insufficient, we can use single channel and time-division acquisition. Using single channel, the lower computer needs to transmit parameter information in different time periods, and the upper computer and the lower computer need to shake hands when transmitting. There is an amplifier circuit inside the acquisition card. If the electric quantity is small, it can be amplified to a certain reasonable acquisition value. When some

sensors are used for a long time, the measured power will be offset, and the data collected by the data acquisition card will not be consistent with the actual value of the measured equipment. At this time, the upper computer programming can be used to correct the results, so that when the offset is large, the sensor needs to be corrected or replaced. Reasonable selection of data acquisition equipment can complete the measurement task at a lower cost. The reliability of the acquisition task should be considered first in the selection. The number of acquisition channels should be reserved for other functions of the system in the future.

### 3.5 Design of Upper Computer and Lower Computer

Only data acquisition equipment can not complete all measurements of a system. In order to make the data acquisition card perform the task well, a lower computer needs to be designed. The functions of the lower computer are mainly to coordinate the various acquisition quantities, manage the hardware circuit, send control signals, collect hardware circuit parameters for protection, etc. The hardware circuit can be directly connected with the data acquisition device, or can transmit the data to the sending hardware circuit module, and then send the hardware circuit according to the handshake signal of the host computer. If multiple hardware devices occupy the same data channel, logic circuits are needed to control their transmission order. When designing, devices should be selected according to the requirements of the parameters to be collected. Generally, the basis of selection is its real-time and accuracy. The lower computer chooses the appropriate microprocessor according to the amount of data calculation it completes. The software part of the instrument can be accomplished by many programming environments, such as MATLAB, VC and so on. Nowadays, the host computer programming environment is mainly divided into two categories: one is to use object-oriented visual high-level programming language, such as VC + + VB, to write virtual instrument software. This method has high system flexibility and is the most widely used at present. The other is graphical programming language, which has good readability. In order to reduce the development cycle, LabVIEW development environment is chosen. LabVIEW was chosen mainly because it has more resources available and less development time than other software. LabVIEW is a virtual instrument development platform developed by the National Instrument Company of the United States. It has a graphical development environment. It is different from traditional programming languages, such as Visual, Basic, Java and C. These languages are programmed in text form. LabVIEW uses graphical programming language to write programs. Programs appear in the form of block diagrams. When using LabVIEW to write programs, icons and wires constitute a flow chart to replace the traditional program code. As far as LabVIEW software itself is concerned, module operation is easy to learn and suitable for most developers.

## 4. Conclusion

The upper computer software part of the asynchronous motor test system developed in this paper is based on LabVIEW programming environment. In the development process, many functional modules are used, which saves a lot of development time because virtual instruments can accomplish more functions. The test system has been able to complete the basic test of induction motor. The actual test shows that the motor test system designed in this paper is easy to operate and has the advantages of flexibility and convenience of virtual instrument. It has high practical value and popularization value in the field of test.

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