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A Laboratory Platform for The Induction Drive System Using LabVIEW

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ABSTRACT

Significant technological advances in software and industrial electronics, contributed to the development of industrial automation systems dramatically, particularly in the area of drive induction motors with squirrel cage induction motor and used in practical applications that require variable speed systems which were used DC motors, for these purposes using (Variable Frequency Drive (vector drive)) which enabled the vector control without sensor (sensorless vector control) with squirrel cage induction motor . In this work we presented a review of the methods of driving the induction motors used by these vector drive to control the motors of both traditional (scalar) and vector control and discussed the specifications of the vector drives that used in driving the motors, including features and schemes of delivery We used labview to control the vector drive that drives the induction motor directly without programmable logic control, aurdino. etc, in order to reduce the cost, and use the same vector drive as a controller for communication between the computer and the vector drives.
Keywords : Industrial Automation, Induction Motors, Labview, Vector Drive.

I. INTRODUCTION

With the great technological development, the relationship between induction motor and industrial control processes has increased. These motors are now the mainstay of the current industry, especially after the development of the methods of driving these motors through the use of VFD, which provided solutions to the problems of driving these motors at variable speed thanks to the techniques of v/f control ,vector control and sensorless vector control are used for motor control [1].

At present, NI has introduced a powerful virtual program architecture, used to control complex tools and processes that collects, processes and analyzes data quickly and simulates hardware with its advanced software [2]. Through this work, we introduced an induction motor platform driven by vector drive, and we designed a control and monitoring interface for the motor using the LABVIEW program, via a vector drive that receives commands from the program via the USB / RS485 adapter and analyzes these commands and uses them to drive the motor. The objective was to provide a miniature model of the induction motor drive at the lowest possible cost and with the simple equipment available to us, using effective and flexible control programs [3].

II. METHODS AND MATERIAL

INDUCTION MOTORS

Induction motors are the nucleus of engineering systems, used in all types of industries and are also known as asynchronous machines. It is called induction motors because the effort is incited in the rotor and therefore there is no need for brushes. The rotor can have a squirrel cage or a wound rotor. In this way, the induction motors are classified as induction motors with a wound rotor or a squirrel cage [4] the squirrel cage induction motor is simpler, more economical and more durable. The squirrel induction motors are of constant speed if they are connected to a constant voltage and frequency source of power. This is appropriate for fixed-speed driving systems, On the other hand, many industrial applications require variable speeds or require regulation on a specific range of speeds. DC motors are usually used in these driving systems but are expensive and require compressors, so we prefer squirrel cage motors because they are cheap and robustness and do not require The presence of filters and suitable for high speed applications, as the modern control techniques provided the possibility of using these motors in the changing speed systems. [5] Induction motors have the following advantages that make them play an important role in most industrial applications

1. The ability to produce high torque at low speeds, including zero speed.
2 - High efficiency in the field of speeds and greatness.
3. High robustness for various operating conditions.
4. A quick speed torque response.
5- The operation of the motor and the driving circuits on the entire field of speed efficiently and reliability, and less failures.

Speed control in induction motors is much more difficult than speed control in DC motors because the relationship between the motor current and the torque is nonlinear, and requires strong and controlled control algorithms to achieve control purposes in the wide operational area. There are two basic approaches to controlling the induction motor: analog: It depends on the direct measurements of the machine parameters (rotor speed) which are compared with the reference via the closed loop. Digital: It is based on estimating the parameters of the machine in a method called sensor less control without relying on speed sensors.

DRIVING METHODS OF INDUCTION MOTORS

The scalar control method was the most common motor control method. If the specified frequency is to be reduced at a particular feeding voltage, the airgap flux will tend to saturate, causing an excessive increase in the stator current and distortion of the flux wave. Therefore, the reduction in frequency should be accompanied by constant voltage reduction in order to keep the airgap flux constant. If the voltage to frequency ratio is constant, the flux will remain constant, but by changing voltage and frequency the torque and speed will change[6].

The purpose of the v / f technique is to keep the air gap flux constant for the induction motor to achieve higher operating time efficiency, as the constant flow demand is proportional to the constant voltage to frequency ratio. If this ratio is constant, it is stable and the motor's torque will depend only on the sliding of the frequency. In this technique of the driving system, the sliding characteristics are usually low, i.e., the resistance of the circuit is low and therefore gives high efficiency. The absence of the sudden surge current reduces the tension and thus increases the effective life of the motor[].. Variable speed driving operates with a control mode (Low variable voltages) at low frequencies and therefore low voltage curves show a significant reduction in peak torque, at low frequencies (and therefore low voltages), the low impedance prevents adequate voltage availability. In order to maintain sufficient torque at low frequencies, Relative voltage at low speeds. Using this technique, it is possible to obtain good good starting torque and good stable condition. In short, this method is to supply the motor with the required voltage in proportion to the equivalent frequency of the required speed, regardless of the mechanical motor load and the actual speed of the motor. But in reality the actual speed is less than that and the (VFD) does not receive a feedback signal from the actual speed of the motor. Therefore, it cannot be used in applications with high sensitivity to speed, but under dynamic conditions this type of control is inadequate and we need more sophisticated techniques.

VECTOR CONTROL

In the scalar control we deal with amplititude of the amounts and the current or voltage are control variables , In the case of voltage control, for example, the flux and torque are dependent on voltage and frequency. This connection impedes the acquisition of good dynamic performance of the machine. A technique called vector control is used to change the speed of the induction motor on a wide range. In the vector control diagram, the complex current is assembled from two quadrilateral components. The first is responsible for the production of the flux and the second is responsible for producing torque in the motor. Precise speed, high dynamic response [7].

Vector control depends on two basic ideas: First, the flow and torque produce currents; the induction motor can be more simply modeled and thus easier to control using square currents than using the three phase currents applied to the motor. These currents are called the direct current I_d and I_q, which are responsible for producing flux and torque in order. Of course, the actual voltage applied to the motor and the current currents are in the three-phase familiar system. The transition between the fixed reference frame and the reference frame which rotates Synchronously with rotor flux is the problem. This leads to the second basic idea of the vector control: The second idea is about the reference frames and the idea is how to convert the sinus quantities in one frame to a constant value in the reference frame that is rotates at the same frequency.

The sinus quantity is converted to a fixed value by a precise selection of the reference sentence, then this quantity can be controlled in a conventional way by the PI controllers.

When the induction motor is presented as a mathematical system with inputs and outputs, it can be analyzed and described in various ways, taking into account different reference coordinates and state space variables [8]. vector control is usually performed by speed measurement or position recognition, but speed and position sensors require increased costs and areas and reduced reliability. sensorless vector control means that no encoder, tachometer or reverse feeding signal is used, which is an improved V / F method that uses field-oriented technology to achieve high performance. This method is based on estimating the speed from the voltages and the currents of the on the motor terminals, and the field estimation is also done using open loop or closed adaptive systems (MARS) techniques. The adaptive reference system model, Different from the controls and guesses that rely on artificial intelligence techniques, and this gives us great benefits such as dynamic performance and increased accuracy in addition to the feature of regulation of the torque [9].

VECTOR DRIVE

The vector drive was known as variable frequency drive(VFD) and also called the variable speed drive, this device consisting of active/passive power electronic components, a high speed central processing unit and sensors. The main function of the drive is to generate variable frequency to change the motor speed, especially used to control of the three phase induction motor. The variable frequency drive is a system that is capable of controlling the rotational speed of the AC motor by controlling the frequency and the voltage of the electric power that feeds the motor. Modern technologies have enabled the development of variable frequency drive to models called vector drive, which have allowed the use of AC motors in applications requiring high torque and low speeds that were previously exclusive to expensive DC motors. Vector control technology is a technique that mimics those used in DC motors. It has a design similar to that used in conventional variable frequency drives, but uses an advanced closed control loop to handle the control algorithms. This type of switch provides excellent control of the speed, torque and energy of the motor and its ability to provide full torque at zero speed and rapid response to load changes, but the initial cost is high compared to conventional switches.

III. RESULTS AND DISCUSSION

LABVIEW

LabVIEW is a programming language that uses icons and symbols instead of linear programming (Virtual Instrumentation Engineering Workbench (LabVIEW)) is a software environment and an integrated development tool produced by National Instruments, a leading manufacturer of microelectronics and embedded systems, It relies on visual programming, where it uses the language G, known as its graphical capabilities, which is called Data Programming Language, which specifies the implementation of the instructions in the structure of a box diagram rather than in line orders similar to other languages, and takes the executable in this Language: (LV-Source Code) The contract is implemented by the contract as long as it has current income data for implementation. As this performance creates the possibility of multiple income situations at the same time this software language has the ability to process and execute parallel data and peripherals, and is used academically and industrially in data collection, automation and industrial control. [10].

It consists of a control and monitoring program designed using the LabVIEW program that sends commands via the USB / RS485 converter, which is used to convert the USB interface signals to the RS485 interface signals, and then the commands reach the variable frequency drive that we analyze and send to control of the motor or read from the registers and resend the information to The program that is displayed on the front panel of LABVIEW. [11].We design the interface through the following steps:

1- Configure serial port according to communications address in VFD.
2- Using visa write to send command to the serial port that we configure
3- Write ASCII (American Standard Code for Information Interchange) characters to the port , Communication Data frame For ASCII character consists of : first Start character (:) , Communication address for VFD , Command code (write or read from registers), Contents of data, Longitudinal Redundancy Check(LRC) check sum, finally End characters.
4- When we want to read from registers we have to use property node and configure it with serial bytes to port then we use VISA read to receive information from VFD.

IV. CONCLUSIONS

The LabVIEW program was successfully used to control the vector drive directly by using the USB / rs485 converter and monitoring motor parameters (actuator current and real frequency at the output terminals connected to the motor, estimated torque ratio, DC bus voltage ,motor speed, frequency command and Output voltage). Programs implemented by simple Vis and visa read / write. This research is based on the study of the protocol of the variable frequency drive used and how it is programmed to deal with incoming commands via the RS485 cable and how to use LABVIEW tools to achieve the required programs. Later, the motor can be loaded and programmed to operate in the traditional control mode, then in the vector control mode and compare the results to observe the characteristics of the vector control.

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