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Fault detection and production of induction motorusing smart controller

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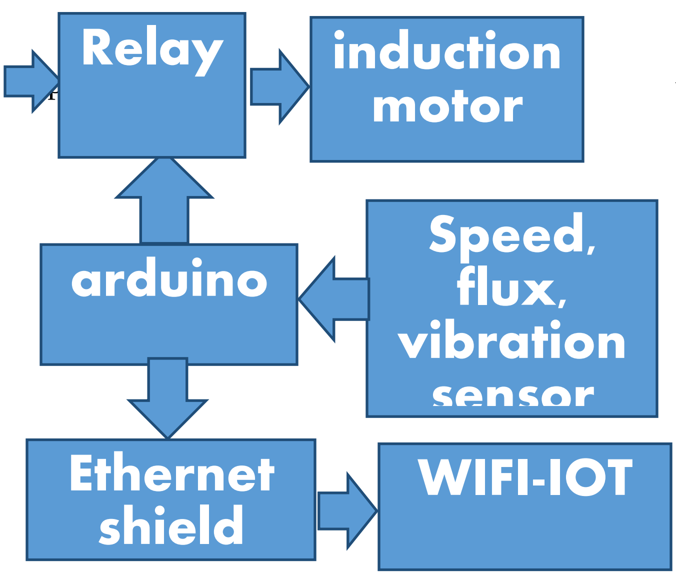
Abstract

This paper focuses on speed,flux and vibration sensor fault detection and control) for induction motor (IM) drives. A new, accurate and high-efficiency approach is proposed so that a system can continue operating with good performance even in the presence of speed sensor faults, current sensor faults or both. The proposed three paralleled adaptive observers are capable of coil flux sensor fault detection and localization. By using observers, the rotor flux and rotor speed can be estimated which allows the system to isolation under the fault condition. In order to detect vibration sensor faults, a threshold-based scheme is proposed. To verify the feasibility and effectiveness of the proposed FDI strategy, experiments are carried out under different conditions based on a embedded IOT platform. We can monitor these parameter through IOT from anywhere

Introduction

During the past decade, the reliability and safety of electric-motor drive systems, especially in high-risk applications, have drawn the attention of many researchers. Fault detection and isolation (FDI) or fault tolerant control (FTC), which aims to detect faults and to keep a system running continuously after faults have occurred, has become a very active research field. There are three main kinds of faults in induction motor drive systems: electrical faults, such as stator faults (open- phase, short-circuit, electrical discharges, etc.) [1], [2], rotor faults (broken bar or cracked end-ring) [3], [4], and inverter faults (short-circuit and open-circuit) [5]; mechanical faults, such as bearing faults [6], [7] and eccentricity faults [8], [9]; and sensor faults. A lot of studies have been published on the diagnostic techniques of electrical and mechanical faults and an overview of these techniques is given in [10]. On the controller side, sensor faults are one of the most common problems in industrial applications [11]. Fig. 1 shows the structure of the most widely used voltage source inverter (VSI) fed induction motor drive system. In this system, it can be seen that a speed sensor, a DC-link voltage sensor and two or three current sensor are utilized. The fault detection and isolation of these sensors are of great importance since their failure can lead to a drive failure. In recent years, a growing number of researchers have dedicated themselves to the study of this topic



Fault detection method

In this section, a novel speed and current sensor fault detection and isolation unit for induction motor drive systems is proposed. An induction motor drive system incorporated with the proposed current and speed sensors FDI unit is shown in Fig.2. It operates in vector controlled mode with speed information feedback in healthy speed and current sensors conditions. In the case of a current sensor fault occurrence, its fault can be detected, localized, and isolated, and system will continue operates in vector controlled mode with the other two healthy current sensors and speed sensor. In case of speed sensor fault occurrence, its fault can also be detected and isolated, and the system will transfer to speed sensorless vector control mode. As a result, the system can obtain speed senor fault tolerance capability. The FDI unit consists of a current sensor FDI unit, a speed sensor FDI unit and three parallel adaptive observers in which the stator currents, rotor fluxes and rotor speed are estimated. The inner structures of the three observers are all the same and will be designed later. Each observer is fed by corresponding stator currents (s,li , l =1,2,3) and stator voltages (us) which are calculated by the current and voltage calculation units. The output variables of the observers (ll , l =1,2,3) are sent to the current sensor FDI unit which identifies the faulty current sensor and reconfigures the system to ensure continuous operation. The estimated rotor speed, measured rotor speed and sdi are sent to the speed sensor FDI unit to detect the speed sensor fault and keep the system running continuously under a faulty speed sensor. In the following sections, the adaptive observers, the current sensor FDI unit and the speed sensor FDI unit will be introduced

ADVANTAGE

- over speed and over load fault control is possible
- We can protect inner coil damage from flux control, we can also find coil insulation fault
- We can save motor damage from vibration due to physical damage
- We can monitor all motor datas through IOT using smart phone or PC

POWER SUPPLY

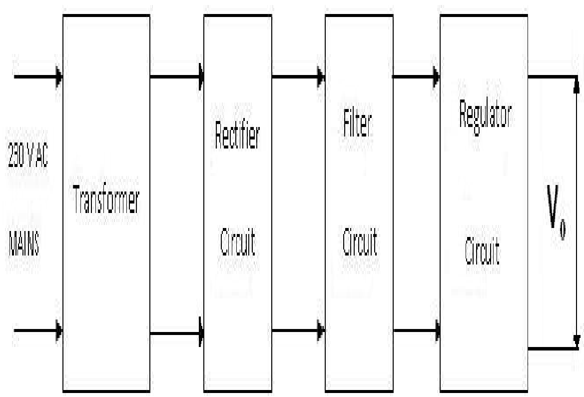


Fig 3.2: Block diagram of power supply

The given block diagram includes following:

Transformer: A transformer is an electro-magnetic static device, which transfers electrical energy from one circuit to another, either at the same voltage or at different voltage but at the same frequency.

Rectifier: The function of the rectifier is to convert AC to DC current or voltage. Usually in the rectifier circuit full wave bridge rectifier is used.

Filter: The Filter is used to remove the pulsated AC. A filter circuit uses capacitor and inductor. The function of the capacitor is to block the DC voltage and bypass the AC voltage. The function of the inductor is to block the AC voltage and bypass the DC voltage.

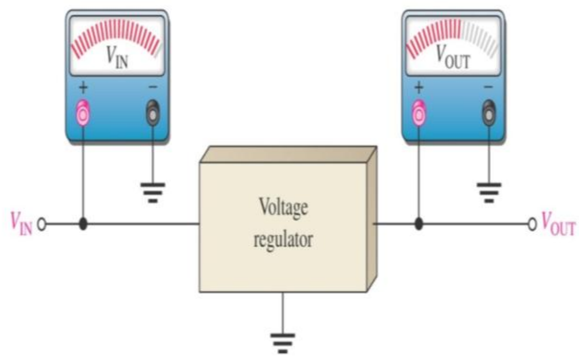
Voltage Regulator: Voltage regulator constitutes an indispensable part of the power supply section of any electronic systems. The main advantage of the regulator ICs is that it regulates or maintains the output constant, in spite of the variation in the input supply.

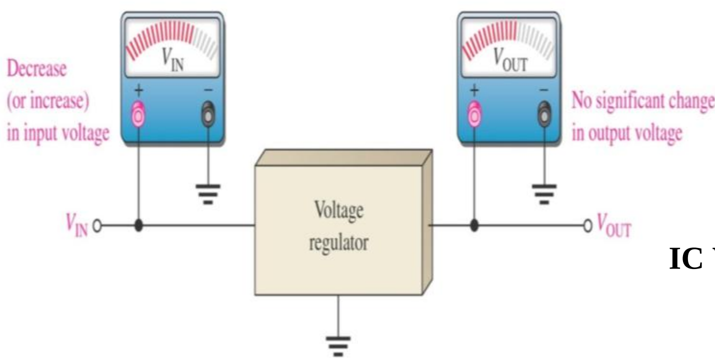
Voltage Regulation

- **Two basic categories of voltage regulation are:**
  - **line regulation**
  - **load regulation**
- **The purpose of line regulation is to maintain a nearly constant output voltage when the input voltage varies.**

- **<u>The purpose of load regulation is to maintain a nearly constant output voltage when the load varies</u>**

<u>Line Regulation</u>





<u>Load regulation: A change in load current (due to a varying R_L) has practically no effect on the output voltage of a regulator (within certain limits)</u>

- **<u>Load regulation can be defined as the percentage change in the output voltage from no-load (NL) to full-load (FL).</u>**

$$\text{Load regulation} = \left(\frac{V_{NL} - V_{FL}}{V_{FL}}\right) \times 100\%$$

- Where:

V_{NL} = the no-load output voltage

V_{FL} = the full-load output voltage

Types of Regulator

- Fundamental classes of voltage regulators are **linear regulators** and **switching regulators**.
- Two basic types of linear regulator are the **series regulator** and the **shunt regulator** .
- The series regulator is connected in **series** with the load and the shunt regulator is connected in **parallel** with the load.

IC Voltage Regulators

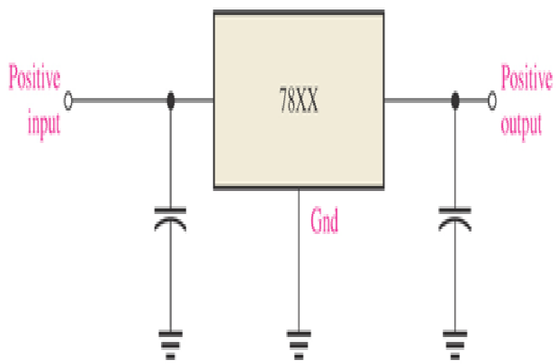
- Regulation circuits in integrated circuit form are widely used.
- Their operation is no different but they are treated as a single device with associated components.
- These are generally three terminal devices that provide a positive or negative output.
- Some types have variable voltage outputs.

Fixed Voltage Regulator

- The fixed voltage regulator has an unregulated dc input voltage V_i

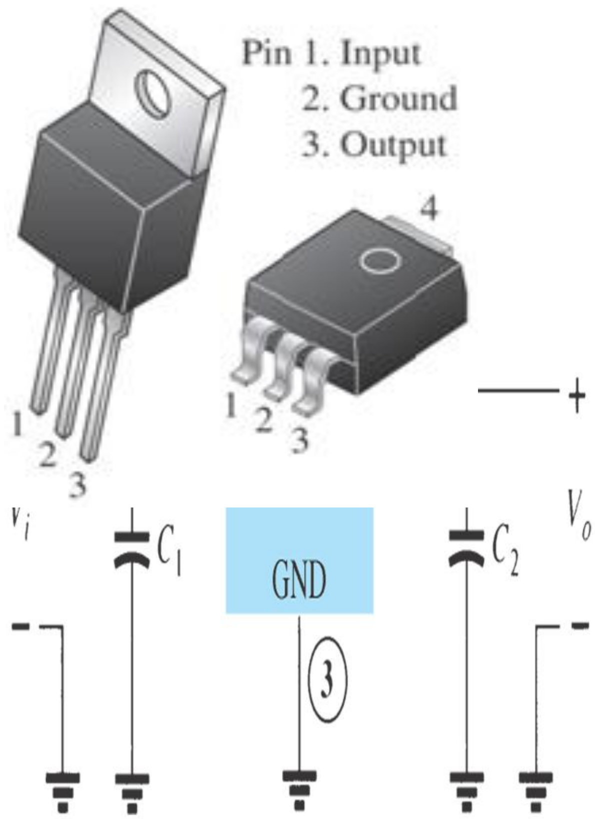
applied to one input terminal, a regulated output dc voltage V_o from a second terminal, and the third terminal connected to ground.

- The series 78XX regulators are the three-terminal devices that provide a fixed positive output voltage.



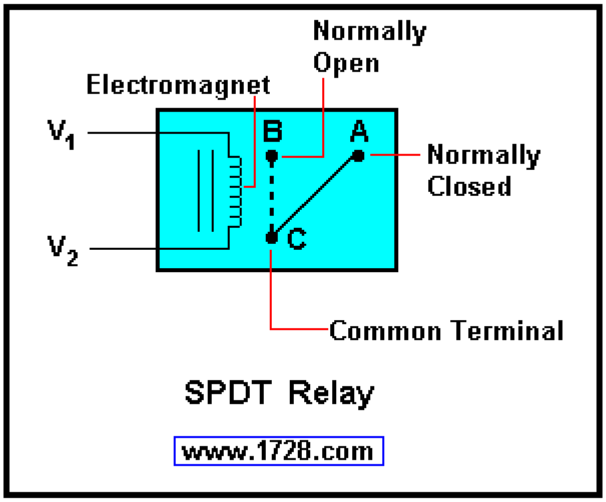
- An unregulated input voltage V_i is filtered by a capacitor C_1 and connected to the IC's IN terminal.
- The IC's OUT terminal provides a regulated +12 V, which is filtered by capacitor C_2.

The third IC terminal is connected to ground (GND



- Voltage regulators keep a constant dc output despite input voltage or load changes.
- The two basic categories of voltage regulators are linear and switching.
- The two types of linear voltage regulators are series and shunt.

- The three types of switching are step-up, step-down, and inverting.
- Switching regulators are more efficient than linear making them ideal for low voltage high current applications.
- IC regulators are available with fixed positive or negative output voltages or variable negative or positive output voltages.
- Both linear and switching type regulators are available in IC form.
- Current capacity of a voltage regulator can be increased with an external pass transistor.
- **RELAY**



A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another.

A relay will switch one or more *poles*, each of whose contacts can be *thrown* by energizing the coil in one of three ways:

- Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a **Form A** contact or "make" contact. **NO** contacts can also be distinguished as "early-make" or **NOEM**, which means that the contacts will close before the button or switch is fully engaged.
- Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also

called a **Form B** contact or "break" contact. **NC** contacts can also be distinguished as "late-break" or **NCLB**, which means that the contacts will stay closed until the button or switch is fully disengaged.

- Change-over (**CO**), or double-throw (**DT**), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a **Form C** contact or "transfer" contact ("break before make"). If this type of contact utilizes”make before break" functionality, then it is called a **Form D** contact.

SPDT – Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

Arduino

Overview

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Conclusion

A FDI scheme based on three adaptive observers has been proposed for the detection and isolation of speed and current sensor faults in induction motor drives. Using the proposed adaptive observers, the phase currents, rotor flux and motor speed can be estimated. The convergence of the proposed observer is proved theoretically. Extensive simulation and dSPACE based experiments are implemented to verify the effectiveness of the FDI scheme. The experimental results show that the detection result is not affected by changes of the load torque, and that sensor faults that occur during the dynamic process of the motor can also be detected. The most important thing is the fact that the failure of one sensor will not influence the detection and isolation of the other kind of sensor fault

Literature survey

Multilevel inverters: A survey of topologies, controls, and applications

Multilevel inverter technology has emerged recently as a very important alternative in the area of high-power medium-voltage energy control. This paper presents the most important topologies like diode-clamped inverter (neutral-point clamped), capacitor-clamped (flying capacitor), and cascaded multi cell with separate DC sources. Emerging topologies like asymmetric hybrid cells and soft-switched multilevel inverters are also discussed. This paper also presents the most relevant control and modulation methods developed for this family of converters: multilevel sinusoidal pulse width modulation, multilevel selective harmonic elimination, and space-vector modulation. Special attention is dedicated to the latest and more relevant applications of these converters such as laminators, conveyor belts, and unified power-flow controllers. The need of an active front end at the input side for those inverters supplying regenerative loads is also discussed, and the circuit topology options are also presented. Finally, the peripherally developing areas such as high-voltage high-power devices and optical sensors and other opportunities for future development are addressed

Recent advances and industrial applications of multilevel converters

Fault management of multicellconvertersq

Component counts and oversimplified reliability rules may lead to the conclusion that multilevel converters are less safe than two-levelconverters, just because they use more components. A better approach might be to consider that they use a different arrangement of components and also that the consequence of faults may be very different. This paper is focused on the study of the consequences offaults in hard-switching and soft-switching multicell converters. Solutions to minimize the consequences of major faults are described.

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