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Parameter Estimation of Single-Phase Induction Motor

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ABSTRACT

This paper presents a methodology to estimate the parameters of a single-phase induction motor (SPIM) equivalent circuit using a dc test, a locked-rotor test, and a no-load test. By neglecting the core-loss resistance, the SPIM parameters can be first directly calculated using a simplified equivalent circuit. However, an equivalent circuit using the resultant parameter values fail to match the power input measured at the motor terminals, especially for the active power under the no-load test. We include the core-loss resistance into the parameter estimation framework and use the Newton-Raphson (N-R) algorithm to improve the estimates obtained by the direct calculation method. Experimental results on a laboratory SPIM demonstrate the effectiveness of our proposed N-R based parameter estimation scheme, in terms of excellent match with the active and reactive power measurement data from the aforementioned tests, and mismatch reduction at other operating conditions.

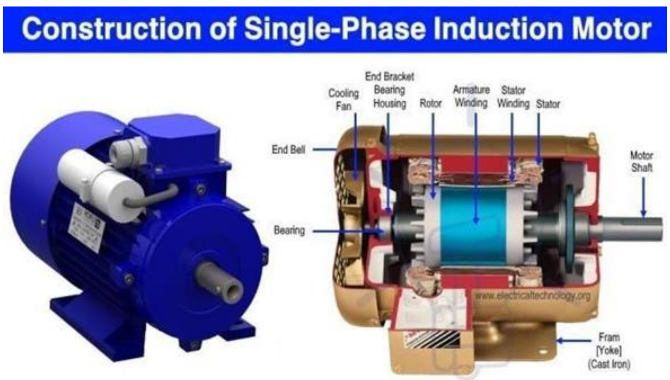
Keywords : Induction Motor Faults, Motor Current Signature Analysis, Identification, Diagnosing Techniques, Arduino Uno, Embedded system, Tests, Voltage, current, speed, power, torque, efficiency.

I. INTRODUCTION

Industries of this modern era are mainly concerned with quality and quantity of production over a period of time. More than 300 million industrial electric motors are installed worldwide. AC motors are chosen prior to DC motors as it requires a single power source whereas DC machines require separate power sources to the rotor and stator of the motor. Apart from this, there are other factors which make induction motors well suited to industrial usage, like robust in construction, low maintenance cost, high starting torque, efficiency and reliability makes difference from other motors.

Furthermore, motors are an essential machine and it also has a tendency to fail at some point in time. Taking industrial motors as an example, factors such as amount of lubrication, electrical considerations, motor ventilation, alignments and motor load are some possibilities that can be reason for motor failure. These factors result into motor vibrations or rise in motor temperature to critical levels or any other failure.

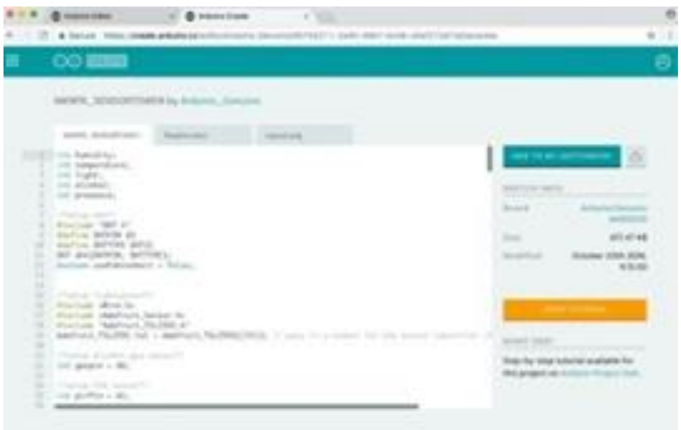
The health of an induction motor can be easily estimated by condition monitoring which overcomes the difficulties caused by the other method of maintaining motors condition on time basis. Maintenance of motors on time basis may cause shutdowns that are unexpected. On the other hand condition monitoring will provide information not only on motor status and performance but also the type of maintenance required. Condition monitoring has got a great significance these days since it helps to predict equipment health, to optimize equipment performance and reduces maintenance cost.



II. METHODOLOGY

The block diagram shows the entire picture of the work. The objective of condition monitoring of induction motor is achieved by continuously recording the considered parameters using various sensors. Accelerometer is used to record vibrations; LM 135 temperature sensors are used to record winding and bearing temperature, ACS712 current sensor for current, and a Voltage sensing circuit to measure voltage. All the sensors are connected to Arduino microcontroller board which is to be installed at the motor site.

The sensors will sense the parameters and are analyzed by the micro controller board to the instruction coded. The data sensed by different sensors can be seen on the serial monitor of Arduino IDE. The power supply is turn ON the Arduino and all the interface components get the required supply. Sensor unit senses the corresponding motor parameters and feed to the Arduino . Arduino reads the data from various sensors and analyses according to the given instructions, Then sends the sensor information to LCD.

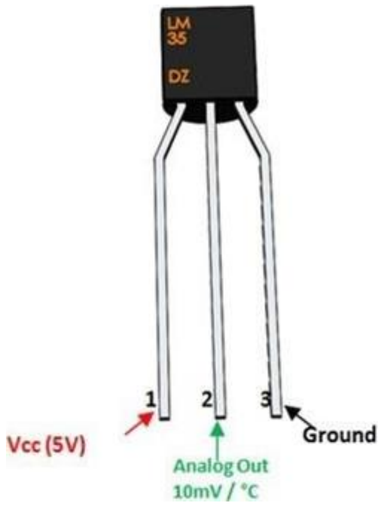


COMPONENTS

LM35 TEMPERATURE SENSOR

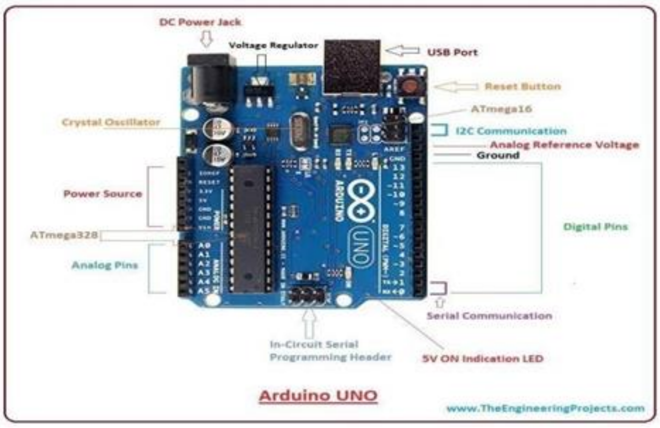
- LM35 is a temperature measuring device having an analog output voltage proportional to the temperature.
- It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry.
- The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, output voltage also increases. E.g. 250 mV means 25°C.

- It is a 3-terminal sensor used to measure surrounding temperature ranging from - 55 °C to 150 °C.
- LM35 gives temperature output which is more precise than thermistor output.



ARDUINO UNO

The Arduino Uno R3 is a opesource microcontroller board based on the ATmega328 chip. This Board has 14 digital input/output pins, 6 analog input pins, Onboard 16 MHz ceramic resonator, Port for USB connection, Onboard DC power jack, An ICSP header and a microcontroller reset button. It contains everything needed to support the microcontroller. Using the board is also very easy, simply connect it to a computer with a USB cable or power it with DC adapter or battery to get started.



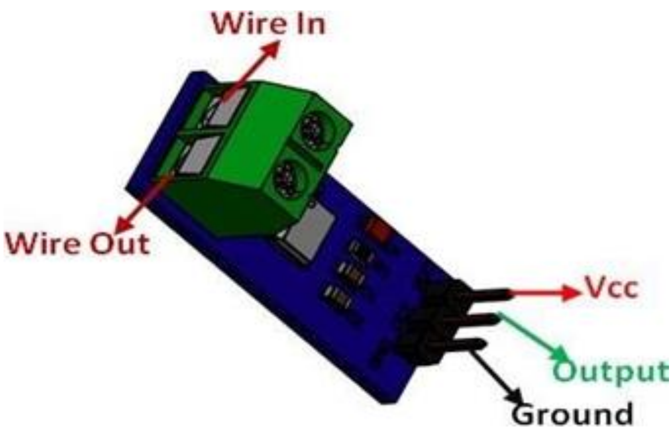
Features:-

- Microcontroller: ATmega328P.
- Operating Voltage: 5V.
- Input Voltage: 7-12V.
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current: 40mA.
- Flash Memory: 32 KB.
- EEPROM: 1 KB. ;Clock Speed: 16 MHz.

CURRENT SENSOR

Current sensors, also commonly referred as current transformers or CTs, are devices that measure the current running through a wire by using the magnetic field to detect the current and generate a proportional output.They are used with both AC and DC current.

- Can measure AC/DC current upto 30A
- Uses the popular ACS712 IC
- Easy to read analog output corresponding to the sensed current
- Requires 5.0 VDC for operation
- 66 mV/A output sensitivity



VOLTAGE SENSOR

Single-phase ac active output voltage transformer module and voltage sensor module. ZMPT101B voltage sensor module is a voltage sensor made from the ZMPT101B voltage transformer. It has high accuracy, good consistency for voltage and power measurement and it can measure up to 250V AC. It is simple to use and comes with a multi turn trim potentiometer for adjusting the ADC output.

Features

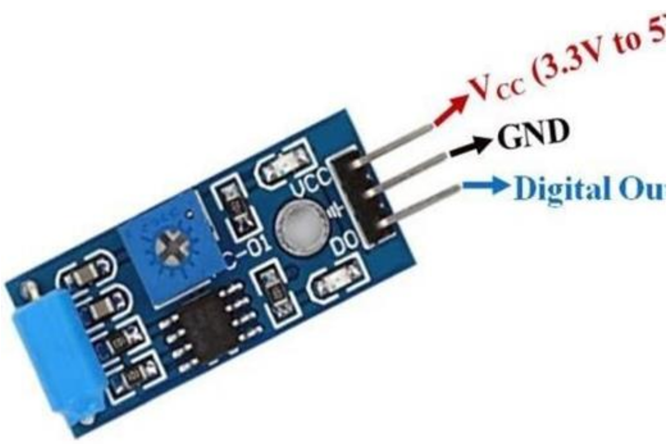
- within 250 V AC voltage can be measured.
- onboard micro-precision voltage transformer
- Installation : PCB mounting (Pin Length> 3mm)
- Operating temperature : 40ºC ~ + 70ºc

VIBERATOR SENSOR

The vibration sensor is also called a piezoelectric sensor. These sensors are flexible devices which are used for measuring various processes. This sensor uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge.

Specification:-

- Voltage supply: 3.3V to 5.0V
- Type of sensor: ball rolling type
- The sensor used: SW-460D or SE-250D
- Comparator IC used: LM393
- Output type: Digital



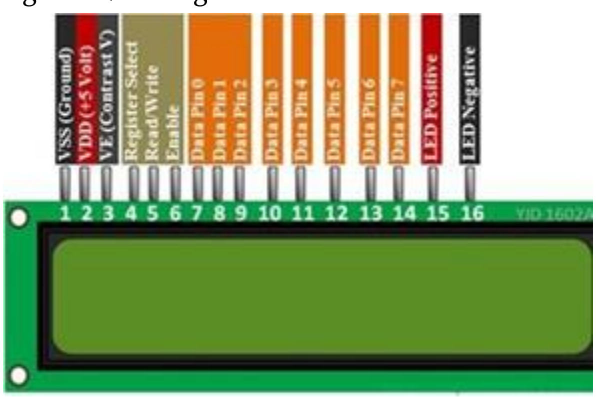
IR SENSOR

IR sensor is an electronic device that emits the light in order to sensesome object of the surroundings.An IR sensor can measure the heat of an object as well as detects the motion.Usually, in the infrared spectrum.

- The sensor module output port OUT can be directly connected with the microcontroller IO port can also be driven directly to a 5V relay; Connection: VCC-VCC; GND- GND; OUTIO.
- The comparator using LM393, stable.
- 3-5V DC power supply module can be used. When the power is turned on, the red power LED is lit.
- Each module in the delivery has threshold comparator voltage adjustable via potentiometer, special circumstances, please do not adjust the potentiometer.

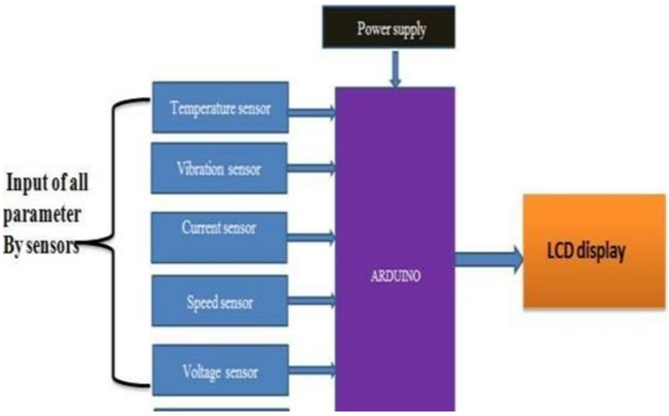
LCD

This is LCD 1602 Parallel LCD Display that provides a simple and cost-effective solution for adding a 16×2 White on Liquid Crystal Display into your project. The display is 16 character by 2 line display has a very clear and high contrast white text upon a blue background/backlight.



Specifications & Features :-

- Arduino IIC/I2C interface was developed to reduce the IO port usage on Arduino board
- I2C Reduces the overall wirings.
- 16 characters wide, 2 rows
- White text on the Blue background
- Single LED backlight included can be dimmed easily with a resistor or PWM.
- Supply voltage: 5V



BLOCK DIAGRAM

OBJECTIVE OF THESIS

- Real time data monitoring of induction motor
- Time reduction in data collection
- Time reduction in parameter calculation like power factor , torque etc.
- Easy testing

III. LITERATURE REVIEW

Shyamala.D "Platform for condition monitoring of industrial motors" Numbers of things are efficiently interconnected, which leads to condition and controlled monitoring to increase productivity. Continuous monitoring of the equipment, receiving alerts and data availability for predictive maintenance. Motor is effectively and continuously monitored by using arduino. Kunthong, Jakkrit, et al. "IoT-based motor condition monitoring in electric machines: Part 1." Power Electronics and Drive Systems (PEDS), 2017 IEEE 12th International conference. In electric motor drive condition for traction was supervised by applying the implementation of a motor health monitoring system. The design and testing of the prototype using an Atmega microcontroller module to acquire motor condition is presented. Prakash, Chetna, and Sanjeev Thakur. "Smart Shut-Down and Recovery Mechanism for Industrial Machines Using Internet of Things." 2018 8th International Conference on Cloud Computing, Data Science & Engineering (Confluence). IEEE, For predictive maintenance of motors in the industries, monitoring needs to be performed continuously so as to determine any degradation in performance or failure of the motors. The recovery mechanism provides a back-up machine which is started when the main motor is shut down. This helps in decreasing the loss that would occur during the downtime. This increases the reliability. Şen, Mehmet, and Basri Kul. "Controller based induction motor monitoring. " Scientific Conference Electronics (ET), 2017 XXVI International. IEEE, 2017. In this way, the production process is not impeded and the required maintenance or replacement can be performed with the least possible disruption. This study has provided statistics not only for creating mathematical models but also for enabling the CMS operator to establish a motor maintenance schedule. Xue.Xin ,V. Sundararajan and Wallace P. Brithinee. "The condition monitoring in three-phase induction motors." Electrical Insulation Conference and Electrical Manufacturing Expo, 2007. The most commonly used technique for the detection of faults in large three-phase induction motors is to measure the supply current fed into the motor and analyze the signal spectrum. This aspect allows companies to reduce downtime when repairing machinery and ensures that productivity does not suffer.

IV. PROPOSED WORK

It is understood from that the parameters of induction motor may vary due to several factors such as: machine internal temperature, machine aging, magnetic saturation, the coupling effect between the internal system and external systems

PROGRESS

Firstly we decide a concept we start working on it we done all related concept and note it down after that we finalized the block diagram and components required for the project . Now we are start working on circuit diagram and the circuit fixing

V. CONCLUSION:

Thus the speed was sensed by the proximity sensor, voltage was measured by potential transformer and current was

measured by current sensor. Input and output power of induction motor was calculated by sensed motor parameters and efficiency was calculated by input and output power of induction motor. All the parameters were displayed and whole process was controlled by arduino uno controller. In future, power factor of motor and temperature of motor are may measure.

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