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Wirelesssystemfor Real Time Dynamic Torque and Efficiency Monitoring using Sigsbee in Industrial Motors

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***Abstract**: Analysis of induction motor is much essential to find out utilization index of a motor for better performance. When we analyse an efficiency of an induction motor we need to acquire many parameters like voltage, current, KW, speed, and torque from motors. All the above said parameters must be acquired at fastest speed to present an instantaneous efficiency indication. When we analyse these parameters we can easily identify whether the motor is suitable for particular operations or not, can be identified. In this paper, we are going to propose a system which can monitor the values at the same time can adjust the speed of the motor to required torque level. With this option we can increase the motor efficiency The PIC microcontroller manufactured by microchip will be used in our project to complete the need of software and hardware. The PIC embedded controller contains ADC, PWM and much more built-in options are there to have a better design. These data are available at the base unit using wireless sensor networks. Local processing is done at the controller part so that the calculation frequency is high and the result is more accurate.Proposed system is having a MOSFET control with driver PWM control circuit to adjust the speed of the motor and uses a ZigBee communication to pass the data from the system to the PC. Proposed system is also a standalone system with computing properties. This will compute the efficiency and torque locally and transmit over the communication network to the PC.*

I. Overview

In industrial environment, mechanical systems driven by electric motors are used commonly in all processes, accounting for more than two-thirds of industrial electricity consumption. Classifying on the basis of motors usually used, about 90% are three-phase ac induction based, mainly due to low cost, mechanical robustness and balancing of current over 3 phases.Torque is the main parameters in production machines. In many industry sectors, torque measurement alone can identify equipment failure, which avoids disasters in critical production processes (e.g., oil and gas, mining).

Traditionally, energy monitoring and fault detection in industrial systems are performed in an offline manner or through wired networks. Besides the high cost this approach offers little flexibility. Since these are monitoring the system in offline manner, which is removed from the machine and attaching to an experimental setup. This type of experiments is difficult to conduct as these will need an extra setup and machine has to be stooped for the particular period of time.

With the help of embedded system and few sensors we can make a system which can be connected to any system and conduct an online monitoring of the parameters and calculate the efficiency of the motor at any point of operation. This doesn't need an external setup also for monitoring. In the proposed system we have to take some values from the motor. When we analyse an efficiency of an induction motor we need to acquire many parameters like voltage, current, KW, speed, torque from motors. All the above said parameters must be acquired at fastest speed to present an instantaneous efficiency indication.

Just monitoring of efficiency won't do anything special in a system, system has to perform action to increase the efficiency of the motor. For this in this system we are adjusting the speed of motor to adjust the motor efficiency. A PIC microcontroller manufactured by microchip will be used in our project to cater the need of software and hardware. The PIC embedded controller contains ADC, DAC, PWM and much more built-in options are there to have a better design. These data are available at the base unit using wireless sensor networks. Local processing is done at the controller part so that the calculation frequency is high and the result is more accurate.

II. System Analysis

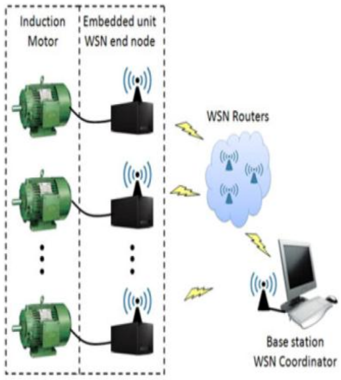


Figure3.1 system overview

An embedded system shown as in figure 3.1 is employed for acquiring electrical signals from the motor in a noninvasive manner, and then performing local processing for torque and efficiency estimation

The values calculated torque and efficiency in induction motors in real time by the embedded system are transmitted to a monitoring unit through an IEEE 802.15.4-based WSN.\

In this system only monitoring of torque and efficiency, no actions done in case of degradation of motor is there.

Has not considering the actual running speed and torque of motor, System only monitors the values from the motor and does nothing to adjust the torque by that increase efficiency of the motor. Acts as a watcher with help of PC they may be able to give alarms of conditions which may harm the motor, but require a human to continuously keep eye on monitoring screen and act accordingly to avoid these conditions

Determine speed by completely not touching the system using air gap method which may cause errors. Has to take actual RPM from the motor shaft to determine the actual output RPM

III. Proposed System

In the proposed system, we propose is which overcomes the draw backs of the existing system. System is a standalone system which can monitor current and voltage values and speed. That is system will acquire all values existing system is reading from the field.

Differences in the proposed system are that speed of the motor is acquired through sensor implemented at the motor shaft in a manner which will not disturb the working of the system. Can be connected to any portion which will have proportional RPM of motor.

In the system shown in figure 3.4 we can adjust the speed of the motor using the remote PC given for monitoring. As adjusting speed of motor to the required speed of motor for that application will increase the motor efficiency and torque will get adjusted. As the speed of motor is adjusted there won't be any sudden overshoot of amps from the system.

The proposed system is an application level model, hence considered methods to reduce the cost of the system. At the same time can work with different motor with not much change in the system program and hardware. To reduce the cost, system has considered methodology to sense current; voltage and speed are economical models. These economical models will have some errors compared to the best method for sensing the same parameter.

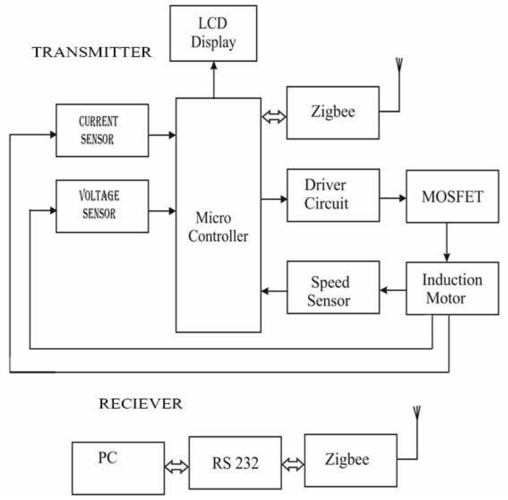


Figure3.4 Proposed block diagram

Proposed system is having a MOSFET control with driver PWM control circuit to adjust the speed of the motor. And uses a ZigBee communication to pass the data from the system to the PC. Proposed system is also a standalone system with computing properties. This will compute the efficiency and torque locally and transmit over the communication network to the PC. This uses a ZigBee communication.

IV. System Description

i. Mosfet And Driver Circuit

Pulse Width Modulation of a power source means modulation of its duty cycleto control the amount of power given to the connected appliance.

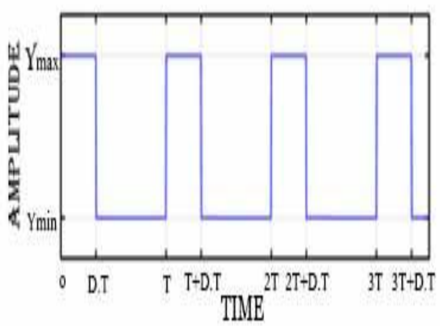


Figure 4.1 PWM signal

With PWM we can limit the power delivered to the loadwithout losses which is involved normally in case resistive methods. This is because through PWM we are adjusting the average power delivered by the adjustment of duty cycle. With a high modulation rate, passive electronic filters can be generating a smooth analog waveform.

High frequency PWM power control systems are easily realizable with semiconductor switches. The discrete ON & OFF pulses are used to control the state of the switch (es) which correspondingly control the voltage across or current through the load. The major advantage seen in these systems are no voltage drop across the switches and not conducting any current. The product of the current and the voltage at any given time defines the power dissipated by the switch, thus (ideally) no power is dissipated by the switch. Realistically, semiconductor switches such as MOSFETs or BJTs are non-ideal switches, but high efficiency controllers can still be built.

ii. Voltage Regulation

Using PWM we can regulate voltage efficiently by switching the supply with app duty cycle. The average voltage will be the required voltage. At the output side by adding a capacitor, noise can be filtered.

One of the methods to measure output voltage. When output is at the lower region than the required switch will turn on. Same vice versa when high switch will be turnedoff.

iii. Mosfet

The **metal-oxide-semiconductor field-effect transistor** (**MOSFET**, **MOS-FET**, or **MOS FET**), is by far the most common field-effect transistor in both digital and analog circuits. The MOSFET is composed of a channel of n-type or p-type

MOSFET circuits are designed mainly to control the speed of the AC and DC motors. This is done by varying the voltage to the motor. MOSFET can switch at very high speed using a PTO output.usuallyPTO generated from a controller.

From a microcontroller we are generating two PWM waves having diff duty cycle. This waves are given to an AND gate. When both the inputs of the AND gate is at high state the AND gate will give a high output this output is taken to a transistor network with BC547 and BC557. When both the transistors are in ON state an output of 12V will be given to the MOSFET.

DC input is given to the middle terminal and other terminals connected to the MOSFET. Source is connected to the negative terminal. During the next duty cycle portion another MOSFET will be ON.

With high switching frequency of the PWM given to the MOSFET DC input will be converted to pulsating DC output. As the switching frequency increases the output resemblance to DC will be reduces and seems to be AC waves.

iv. Currrent Sensing Methodology

Current sensing is done via a non-invasive manner, uses a split core current transformer for current sensing. This sensor is clamped to the line supply wire of an electrical load of which we want to sense the current.

The theory in this is a current carrying conductor will generate a magnetic field across the conductor according to the amount of current drawn by the load. With this you can calculate how much current is passing through the conductor.

The particular sensor used in this project can detect up to 30amps. These sensors won't be having any load resistor fitted; an external resistance has to be given for converting the inducted current to voltage.

Another method which can be used is by employing a transformer and a shunt resistor. In this the transformer will give step down the voltage. The resistor connected in parallel will have correspondence with the amount of current drawn by the load.

v. Voltagesensing Methedology

There are so many method of voltage sensing. With voltage sensing circuit we are sensing the supply voltage by using a step down potential transformer. Normally we use 0-6v potential transformer for this purpose. The step down voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier.

The full wave rectifier consists of summing amplifier and rectifier.as long as the input voltage remain –ve, diode will have a negative voltage. This time the diode will act as an open circuit and will give zero output. When input moves to positive region the output is amplified by an operational amplifier. These time the diode will be in ON state.

In this case, when the input is greater than zero, D2 is ON and D1 is OFF, so the output is zero. When the input is less than zero, D2 is OFF and D1 is ON, and the output is like the input with an amplification of R2 / R_1. The full-wave rectifier depends on the fact that both the half-wave rectifier and the summing amplifier are precision circuits. It operates by producing an inverted half-wave-rectified signal and then adding that signalat double amplitude to the original signal in the summing amplifier. The result is a reversal of the selected polarity of the input signal.

Then the output of the rectified voltage is adjusted to 0-5v with the help of variable resistor VR1. Then given to ripples are filtered by the C1 capacitor. After the filtration the corresponding DC voltage is given to ADC or other related circuit.

V. Advantages Of Proposed System

Can increase or reduce torque to adjust efficiency

Apart from the existing system proposed system can vary the speed of the system and hence vary the torque of the motor. This results in the change of efficiency of the motor.

Partially non-invasive manner

A completely non-invasive manner will not be free of error chance of error will be there. Hence a proposed system is having sensors to measure the actual speed of motor.

System is stand alone.

System proposed can do the calculations and display the values locally. Values obtained after calculations are transmitted to the remote station for display. Hence if loss of communication happens, system will work without interrupt.

Actual motor speed estimation.

Application level model.

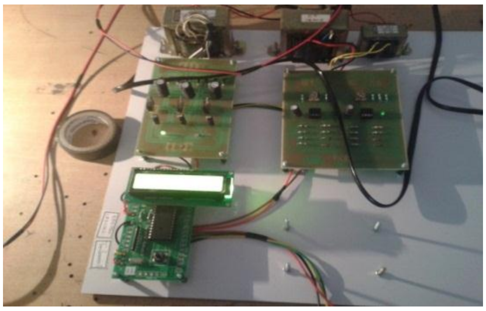
The model can be installed in real time in any motor. Also embedded system can work in motors in-service has to vary the sensor according to the motor KW/HP to adopt the in online current.

Can give alarms

System is able to give error alarms according to the system conditions. If any alarm occurs due to under efficiency, under torque, motor Shaft stuck case andMotor over current system will stop without any human interaction.

VI. Result

With an experimental setup the system is tested with connecting motor and found that system can detect the faults and more than that significantly can improve the efficiency of the motor



VII. Conclusion

Motor efficiency is main factor we are all think further as the cost of power is increasing day by day, and shrinkage of the non-renewable resources. Through this project we can implement a system which can help us to improve motor efficiency to a good extend. By adjusting the motor speed we can reduce the initial cost of the higher gearbox also.

Wireless system employed can easily log the data for monitoring the motor has degraded or not. Even through this we can turn ON/OFF the motor remotely through wireless protocols (currently we have used ZigBee protocol for this communication.

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