Detection and Analysis of Transient Behaviour In Squirrel Cage Induction Machine using Signal based Method

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***ABSTRACT*: The design and the implementation of a system for detecting and preventing faults of motor using LabVIEW based analysis, in order to prevent faults in various pattern and reduce the complexity of data processing. The various inputs are composed of voltage and current signals for the various parts. These inputs will be calculated and fed to the monitoring unit via controller. These values are comparable to which of the normal condition of the motor, in order to identify the faults in different conditions of Winding continuity, High torque, Flux variation and current. The software is designed by embedded c program connecting with the LabVIEW for controlling the signal inputs receiving. After the experiment under the various loading conditions was conducted, the system can detect and prevent the faults in different conditions satisfactorily.**

Keywords—LabView, Signal Based, Trasient Behaviour, Embedded C, Monitoring unit via controller

I. INTRODUCTION

The presence of electrical and mechanical faults in the induction motors can be detected by analysis of stator current. However, when a motor is fed by a source, the analysis of stator current signal becomes difficult. For this reason, the monitoring must depend on multiple signatures in order to reduce the effect of harmonic disturbance on the motor current. The aim of this paper is the description of new approach for fault detection and analysis of motor using signal based method. The proposed approach is tested on LabVIEW in order to detect motor flux continuity, high torque, fluctuation in current, winding discontinuity at different levels. The experimental results prove that the efficiency of the proposed signal based method is more compared to existing detection methods.

There are various faults that occur in induction motors. The faults we have considered in this paper are:

- Motor flux continuity
- Current fluctuation
- High torque
- Winding discontinuity

Insulation breakdown, leading to burnt windings, imply short circuit either within the motor or within the power supply circuit for the motor, and may be caused by overheating, overloads and over voltages. Around 80% of the electrical motors fail due to winding damage in stator and bearing faults.

II. BLOCK DIAGRAM

In this paper we have considered four parameters, they are continuity in flux, current variation, winding continuity detection and torque. An induction motor of rating 12V, 2A and ¼ HP is been used.

All the reference values are given to LabVIEW and reference graph is setup.

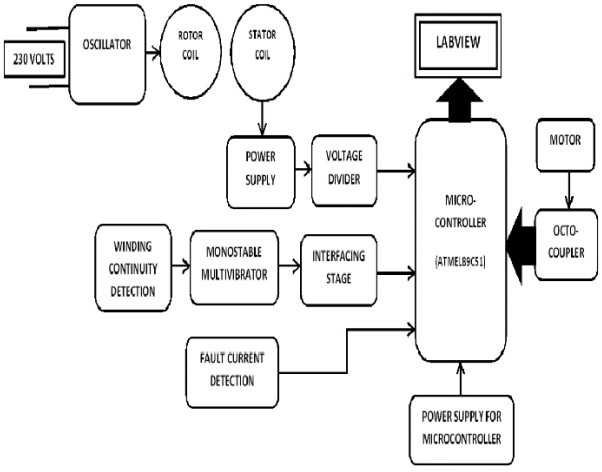

FIG 1: Block Diagram

First parameter is Flux continuity. 230v supply is given to a ocsillator(ferrite core transformer) which produces a frequency which excites the rotor windings which consists of 25 turns. Due to mutual induction EMF of 1.2Wb/m^2 is produced in stator winding which has 35 turns. This setup is interfaced to microcontroller through voltage divider.
Second parameter is Winding continuity. Here monostable multivibrator is conneted to both the ends of the winding and this detup is interfaced with microcontroller. When there is any fault occurred in winding or if there is discontinuity in winding, monostable multivibrator sends signals to microcontroller and graph is displayed in LabVIEW.
Third parameter taken is fault current. Here a current sensor is placed and whenever there is any fault in current, sensor senses it and gives signals to microcontroller and graph is displayed in LabVIEW.
Foruth parameter considered is High torque. High torque is one with great acceration and comparitively having less top speed. An eccentricity is created by making the shaft of the motor bent. Here octocoupler is mounted on the shaft of the motor. Octocoupler senses the number of revolutions and sends signals to microcontroller and graph is displayed.
All the graphs of the fault parameters are displayed in LabVIEW and results are analysed with respect to reference graph.

A. POWER SUPPLY

The circuit needs two different voltages, +5V & +12V, to work. These dual voltages are supplied by this specially designed power supply. This section needs two voltages viz., +12V & +5V, as working voltages. Hence specially designed power supply is constructed to get regulated power supplies of every electronic circuit.
The transformer rating is 230V AC at Primary and 12-0-12V, 1 Amperes across secondary winding. This transformer has a capability to deliver a current of 1 Ampere, which is more than enough to drive any electronic circuit or varying load.

B. MOTOR USED

An electric motor is an electrical machine that converts electrical energy into mechanical energy. In an electric motor, the moving part is the rotor, which turns the shaft to deliver the mechanical power. The stator is the stationary part of the motor's electromagnetic circuit and usually consists of either windings or permanent magnets. There are two types of motors. DC motors and AC motors. The two main types of AC motors are induction motors and synchronous motors.
Induction motor (asynchronous motor) is an AC electric motor. There are two types of Induction motors, one is 'Single Phase Induction Motor' and other is 'Three Phase Induction Motor'. According to type of rotor an Induction Motor is classified into two types: 'Squirrel Cage Induction Motors' and 'Slip Ring Induction Motor'. The working of an Induction Motor can be summarized as "The stator winding produces magnetic field and due to electromagnetic induction a current is induced in rotor which produces torque."

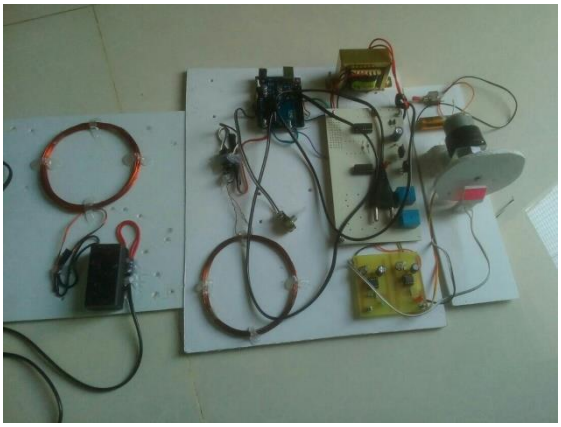

FIG 2: Hardware Built

In this paper we are considering Squirrel Cage Induction Motor as 70% of the industries use this motor and it has many applications.
A squirrel cage rotor is the rotating part of the common squirrel cage induction motor. It consists of a cylinder of steel laminations, with aluminum or copper conductors embedded in its surface. In operation, the stator winding is connected to an alternating current source, the alternating current in the stator produces a rotating magnetic field. The rotor winding has current induced in it by the stator field, and produces its own magnetic field. The interaction of these two sources of magnetic field produces torque on the rotor.
Squirrel cage induction motors are largely used in industry, in sizes from below one kilowatt. They are simple, rugged, self-starting and maintain a constant speed from light load to full load, set by the frequency of the power supply and number of poles of the stator winding.

C. BUFFER AND DRIVER

When the user programs the schedule for the automation using [Graphical User Interface software, it actually sends 5-bit control signals to the circuit. The present circuit provides interfacing with the Microcontroller and the controlling circuitry. Buffers does not affect the logical state of a digital signal (i.e., logic 1 input results into logic 1 output whereas logic 0 input results into logic 0 output). Buffers are normally used to provide extra current drive at the output, but can also be used to regularize the logic present at an interface, and Inverters are used to complement the logical state (i.e., logic 1 input results into logic 0 output and vice versa). Also inverters are used to provide extra current drive and, like buffers, are used in interfacing applications.
Diodes here are used for transferring the signal. ULN2003 is the driver IC used. Diode output will be bit less than the original. This output is given as input and the output will be inverted. Because ULN2003 IC has two darlington transistor for each RL which acts as an inverter.

D. OCTOCOUPLER

Octocoupler consists of LDR, LDR is nothing but light dependent resistor led senses the light glowing led sends the signal to the constable multivibrator. It is relatively easy to understand the basics of an led working. LDR is a

photoresistor controlled variable resistor can sense the led light intensity this is fed to the monostable multivibrator single stable state, and is being able to produce the trigger the buffer circuit.

E. MONOSTABLE MULTIVIBRATOR

Monostable mulitivibrator has only one stable state and produce a single output pulse when it is triggered externally. The 555 timer which gets its name from the three five kilo ohm resistor it uses to generate the two comparator references voltages, is a very cheap popular and useful precision timing device that can act has simple timer to generate the single pulses. When a sensor senses a signal at its sensing point, after sensing it will send signal to the monostable multivibrator thus timing period is initiated by falling edge high to low transition applied to the trigger input when such an edge is received and the trigger input voltage falls below one third of vice. The output of the lower comparator goes to high the positive non inverting input to comparator are at one third of vice the output from both the comparators are connected to the two inputs of the flip flop which in turn produces either low or high level output based on the status of the input. Monostable multivibrator has only one stable state and produce a single output pulse when it is triggered externally. The 555 timer which get its name from the three five kilo resistor is used to generate the two comparator reference voltages.

F. LABVIEW

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a system-design platform and development environment for a visual programming language from National Instruments. The graphical language is named "G", not to be confused with G-code. Originally released for the Apple Macintosh in 1986, LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of operating systems (OSs), including Microsoft Windows, various versions of Unix, Linux, and macOS.

LabVIEW programs-subroutines are termed virtual instruments (VIs). Each VI has three components: a block diagram, a front panel, and a connector panel. The back panel, which is a block diagram, contains the graphical source code. All of the objects placed on the front panel will appear on the back panel as terminals.

One of the advantage of LabVIEW is that the output obtained is in graphical form and the mathematical calculations is not done. Hence this is more effective.

III. RESULT ANALYSIS

There are many methods to detect the faults in Induction motors. All the previous methods that are present are less efficient due to more mathematical calculations and other constraints. In this paper we detect the faults in the motor using signal based method through LabVIEW which gives us the graphical representation of the faults and the faults can be exactly identified and analyzed.

The four fault parameters which were considered that are motor fault continuity, high torque due to eccentricity, current fluctuation and winding discontinuity are been experimented and the results are more efficient than the previous fault detection methods.

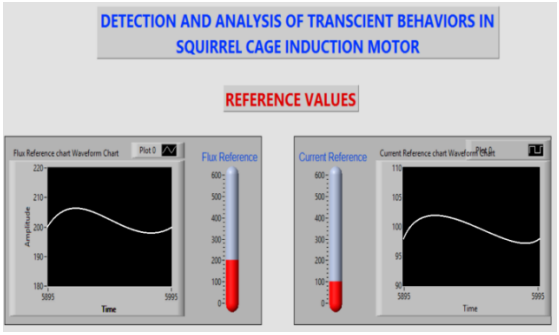

FIG 3: Reference graphs

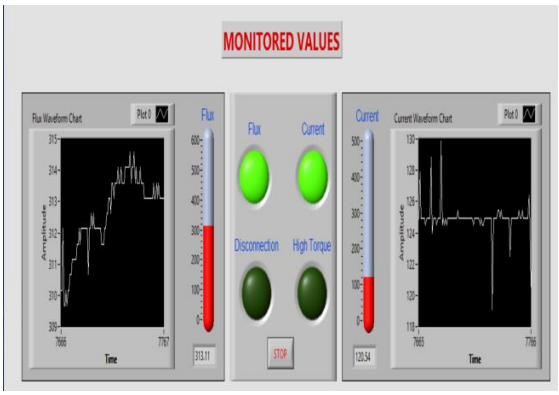

FIG 4: Monitored Graphs

As we observe in FIG 3 and FIG 4, the reference values and the corresponding graphs are set before. Later the motor is checked for its faults, these faults are detected and analyzed with respect to the reference.

IV. CONCLUSION

No machine is 100% efficient, in fact 100% efficient machine cannot be constructed due to the design constraints. We have used a method just to detect and reduce the errors and increase the efficiency better than the other detection methods.

V. FUTURE SCOPE

Though this one of the more efficient detection method as we are using signal based method, faults can only be detected. So in future it can be implemented for control also. Control in the sense, when the motor fault is detected, it can be simultaneously controlled for switching on and off.

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