DIAGNOSING THE CONDITION MONITORING SYSTEM USING FPGA- BASED ALTIUM NANOBOARD

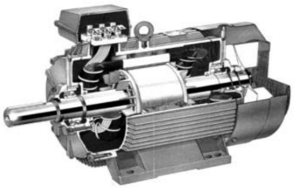
Jenny.M[1], Dr.X.Susan Christina[2]
[1]M.E-VLSI, [2]Ph.D.,ME, Assistant Professor, MIET Engineering College, Trichy

Abstract: Condition monitoring is applied to improve operational consistency, decrease failure rate and improve the consumer service of electrical machines. Fault diagnosis in induction motors have been implemented in recent because of its potential to detect faults at an early stage. The on-line and non-invasive options of fault detection are growing rapidly now days, because of its capability to detect faults while the machine is operational and to work sensor less. The proposal of the project is motor condition monitoring with FPGA-BASED ALTIUM NANO BOARD on various machine failures along with the principles and criteria of the diagnosis process. It aims to review the main choices in finding different fault diagnosis techniques but NANOBOARD, as the low-level engineers are still in need of easy, user friendly, automated devices.
Keywords: ECG, Bayes Algorithm, Ventricular Arrhythmia

I. INTRODUCTION

The induction motors are most widely used electrical machines for industrial, domestic and commercial applications. These motors have advantages such as ruggedness, simplicity of its construction and high reliability. Although the induction motors are undoubtedly reliable but the possibility of failure cannot be avoided. Different faults of induction motors are mainly categorized as either electrical or mechanical faults.

Different types of faults include stator winding faults, broken rotor bar, misalignment, static and/ or dynamic air-gap irregularities



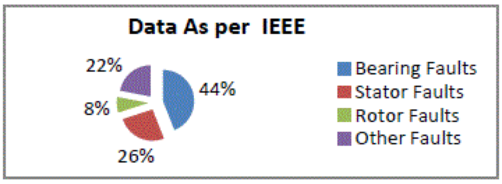
Induction Motor

There is a wide acceptance of Condition Monitoring, but there are several limiting factors, most coming from a historical context of the application being the answer to all of maintenance's needs:

- CM is often used as a 'stand-alone' maintenance concept
- Frequently CM is simply used for Failure Prediction, little else is asked for or expected
- Too often CM has been driven from the bottom upward
- CM alone does not provide for reliability
- CM does not prevent failure – it detects and predicts it.

The most commonly used techniques of condition monitoring are:

- Vibration Measurement and Analysis
- Oil Condition and Wear Debris Analysis
- Thermography
- NDT, especially thickness testing
- Performance trending, e.g. flow rate measurement



Percentile Failure Component of Induction Motor

1.4.1 ELECTRICAL-RELATED FAULTS

Faults under this classification are unbalance supply voltage or current, single phasing, under or over voltage of current, reverse phase sequence, earth fault, overload, inter-turn short-circuit fault, and crawling.

MECHANICAL-RELATED FAULTS

Faults under this classification are broken rotor bar, mass unbalance, air gap eccentricity, bearing damage, rotor winding failure, and stator winding failure.

ENVIRONMENTAL-RELATED FAULTS

Ambient temperature as well as external moisture will affect the performance of induction motor. Vibrations of machine, due to any reason such as installation defect, foundation defect, etc., also will affect the performance.

BROKEN ROTOR BAR FAULTS

The squirrel cage of an induction motor consists of rotor bars and end rings. If one or more of the bars is partially cracked or completely broken, then the motor is said to have broken bar fault.

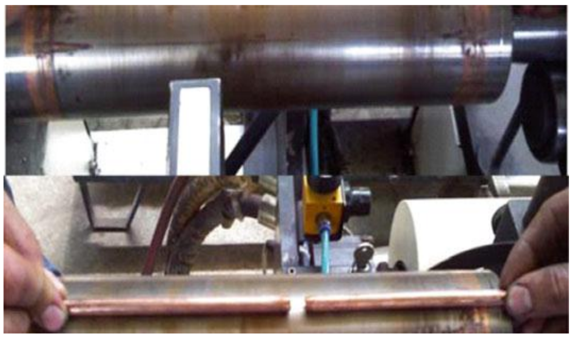


Figure1.5 Broken Rotor Bar Fault

The main causes of rotor broken bar of an induction motor can be mentioned, point wise, as follows

- manufacturing defects
- Thermal stresses
- Mechanical stress caused by bearing faults

- Frequent starts of the motor at rated voltage
- Due to fatigue of metal of the rotor bar.

ROTOR MASS UNBALANCE

This rotor mass unbalance occurs mainly due to manufacturing defect, if not may occur even after an extended period of operation, for nonsymmetrical addition or Subtraction of mass around the center of rotation of rotor or due to internal is alignment or shaft bending due to which the center of gravity of the rotor does not coincide with the center of rotation.

ALTIUM DESIGNER

The FFT computation is done by using the C coding, and it is implemented in the ALTIUM NANOBOARD. The input current signal values are digitized and given as input to the program, then FFT computation is done in the program. This output values can be used for implementation in the hardware.

The programming is done in steps as given below,

- Array of digital inputs is given
- FFT function is generated
- Debugging is done and the output is obtained.

The ALTIUM NANOBOARD 3000 can be programmed by using the ALTIUM designer software. ALTIUM designer summer 09 is used in this project to program the NANOBOARD; this designer tool is a multipurpose tool that can be used for,

- PCB designing and
- Programming the FPGA NANOBOARD.

The ALTIUM designer summer 09 is the latest version of the tool, and by using this programming of NANOBOARD can be made easy. This FPGA NANOBOARD can be programmed in several ways like,

- VHDL and VERILOG programming
- C programming
- Schematic and open bus design.

This is the software specifically designed to program the NANOBOARD devices, hence it is easy to program the hardware. This hierarchical type of programming, here the schematic, open bus and C programming are to be done in the hierarchical order.

The ALTIUM designer devices there is soft chain devices and hard devices chain. Once the ALTIUM NANOBOARD is connected to the system using USB interface, then the device will come into the hard devices chain.

The functions available are,

- Compile
- Synthesize
- Build
- Program FPGA

COMPILE

The developed program is compiled and if there are any errors it will be indicated. The red color will appear in that box if there are errors and by clicking that the errors can be identified, if there are no errors it will become green hence next process can be done.

SYNTHESIZE

Synthesis is the process of translating the schematic and behavioral VHDL descriptions of the design into a low-level form suitable for the vendor place and route tools. The synthesis engine first creates an intermediate VHDL description of the design, and then synthesizes this into EDIF.

BUILD

Placement and routing is done in this part for implementing the design into the NANOBOARD. The task of implementing the design in the actual FPGA is carried out by specialized tools, referred to as place and route tools. These software tools are provided by the FPGA vendors, who with their intimate knowledge of the features available within each FPGA, can write software that can take a low-level description of the design and work out how to arrange, or place, the required logic inside the FPGA, then create the interconnections (or route it).

PROGRAM FPGA

After routing is done the developed program is downloaded into the flash memory of the FPGA. The output can be obtained by displaying it in the soft chain rack or it can be displayed in the LCD display interface of the NANOBOARD.

SOFT DESIGN

'Soft design' is a term that perfectly encapsulates the 'soft' nature of a design, whose intelligence is 'embedded' into a high-capacity programmable device. By moving functionality out of the physical domain and into the soft, you can create the device intelligence needed to generate sustainable differentiation of your product in the market place.

ALTIUM Designer brings together hardware, software and programmable hardware design within a single, unified environment. This integrated environment proves all the tools necessary to create the embedded intelligence for your product – the hardware design itself and the embedded software which is destined to run on any 'soft' processors defined within that design.

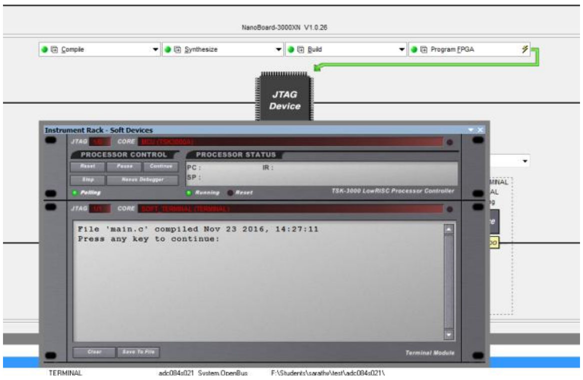
IMPLEMENTATION IN MATLAB

The simulated current signals and the power spectrum outputs are simulated using the MATLAB. The simulated signal with MATLAB

The program developed using the C code is implemented in the NANOBOARD using the ALTIUM designer software. The program is downloaded into NANOBOARD after compile, synthesis and build of the project, the download is done using the USB interface. Steps carried out in programming the NANOBOARD is given below,

- Opening a FPGA project
- Schematic design
- Open bus configuration
- Creating embedded project
- Programming with C code
- Compile, Synthesize and Build.
- Programming target FPGA

These steps are done one after the other and the program is implemented into the NANOBOARD. Figure 4.2 shows the output displayed in instrument rack of the soft devices.



Output Obtained Through the Soft Rack Devices of the ALTIUM NANOBOARD

REFERENCES

[1] Li. B. Chow, M. Y. Tipsuwan and Y. Hung J. C. (2000), “Neural-Network-Based Motor Rolling Bearing Fault Diagnosis”, IEEE Transactions on Industrial Electronics, Volume. 47, No. 5, October, pp. 1060-1069.

[2] Jack, L. B., and Nandi, A. K. (2000), “Genetic algorithm for feature selection in machine condition monitoring with vibration signals”, IEE Proceedings Vision, Image and Signal Processing, Volume. 147, June, pp. 205-212.

[3] Le. Roux, R. G. Harley, and T. G. Habetler. (2002), “Rotor fault analysis of a permanent magnet synchronous machine,” International Conference on Electric Machines, Bruges, Belgium.

[4] Lorand S, Barna D, Agoston. (2004), “Rotor faults detection in squirrel cage induction motors by current signature analysis, International Conference on Automation, Quality and Testing, Robotics, May 13 – 15, Cluj-Napoca, Romania.

[5] Wu. S, and Chow. T. W.S. (2004), “Induction machine fault detection using SOM-based RBF neural networks”, IEEE Transactions on Industrial Electronics, Volume. 51, No. 1, February, pp. 183-194.

[6] Lyubomir, Dimitrov V, and Chobanov V.J. (2004), “Diagnosis of rotor faults of induction motors, operated in non-rated condition, 27th international spring seminar on Electronics Technology, 2004 IEEE, No. 0-7803-8422-9/04, pp.110-113.

[7] Douglas H., Pillay P, and Barendse P. (2005), “The detection of in turn stator faults in Doubly fed induction generators” 2005IEEE, No. 0-7803-9208-6/05.

[8] Cusido, J, Garcia. A, Navarro. L.M, Delgado, M, Romeral. L, Ortega. A. (2009), “On-line measurement device to detect bearing faults on electric motors” IEEE Instrumentation and Measurement Technology Conference, I2MTC '09. pp. 749 - 752.

[9] Riera-Guasp, M, Cabanas, M.F, Antonino-Daviu, J, Pineda-Sanchez, M. Garcia, C.H.R. (2010), “Influence of nonconsecutive bar breakages in motor current signature analysis for the diagnosis of rotor faults in induction motors, IEEE Transactions on Energy Conversion, Volume. 25, No.1, pp. 80 – 89.

[10] Frederick C. Trutt Fellow, IEEE,JosephSottile, Senior Member, IEEE, and Jeffery L. Kohler, Senior Member, IEEE, 2002.

