On-Line Monitoring and Diagnosis Broken Rotor Bars in Squirrel-Cage Induction Motor By Using Labview

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Abstract: The condition monitoring of the electrical machines can significantly reduce the costs of maintenance by allowing the early detection of faults, which could be expensive to repair. In this paper some results on non-invasive detection of broken rotor bars in squirrel-cage induction motors are presented. The applied method is the so-called motor current signature analysis (MCSA) which utilizes the results of spectral analysis of the stator current. The diagnosis procedure was performed by using virtual instruments (VIs). The theoretical basis of this method was proved by laboratory tests.

Key words: Broken Rotor Bars; Faults Diagnosis; Squirrel-Cage Induction Motors; Current Signatures; Virtual Instrument (VI).

NI USB-6008 Data Acquisition Device:
LabVIEW is a graphical programming language that is suitable for developing DAQ systems using the PC plug in DAQ boards. It is an effective application for engineering in DAQ, analysis, and presentation (Beitao Guo, J. Z. and Xin Nie, 2009). To prepare the software for measuring systems to be used for the measurements in real and virtual circuits. LabVIEW environment is a complex program enabling the designing and modeling of simple circuits as well as monitoring of complex manufacturing processes by means of graphical programming languages (Developer, 2009). The designing and building of virtual devices used in computer aided measuring systems is also possible in LabVIEW environment (Bruce, 2001). Thanks to special equipment (e.g. data acquisition device), the construction of the instrument panel required for testing of the real system under test is also possible.

Manufactured by national instruments was used in order to record real diagnostic signals originating from the instrument panel installed in the laboratory test stand (Developer, 2006). The data acquisition device is provided with 8 single analogue inputs or with 4 differential programmable analogue inputs, 2 analogue outputs and 12 programmable digital I/O systems. The information received from the inputs or outputs control signals is sent to the control unit (PC) by means of USB line. The signal transmitted between the data acquisition device and PC conforms to full-speed USB standard (Benton, 1995). The layout of NI USB-6008 data acquisition device was illustrated in Figure.1 and the block diagram of a test stand was illustrated in Figure.2.

Analysis Stator Current Waveform And Frequency Spectrum By Labview Programming:
This project involves the development of LabVIEW modules for DAQ and analysis for AC motor test bench. The block diagram of the created virtual instrument panel analogue to the instrument panel installed with three phase squirrel cage induction motor parameters Table1 was illustrated. In order to improve the circuit diagram transparency, some of its elements were combined into a form of subprograms containing a part of input or output elements. Configuration of the data acquisition device ports and performing the conversions required to adapt the input signal parameters to the ranges of indicators and warning lamps (Jen-Hao et al., 2000). The individual subprograms used in the main simulation program are characterized by precisely specified functions enabling quick connection between individual elements without any necessity to analyses their inner block diagrams (Kostic, 2009).

For the motor test, it is to apply the proposed LabVIEW interfaced module to motor to ensure its performances in real life motor at healthy and faulty condition (Muhammad, H.R., 1993). The line current, of the motor is measured by the proposed LabVIEW interfaced module, the results already are compared.

Moduling And Test Result When Motor In Healthy And Faulty Condition With 4 Broken Bars:
In order to make several measurements with healthy and faulty squirrel-cage induction motors a modern laboratory test bench was set up (Omata et al., 1992). It consists of two coupled electrical motors; the motor to be tested and a DC motor fed by a controlled rectifier used for loading are given in Figure7. Several virtual instruments (VIs) were built up in LabVIEW (Prommee et al., 2006). These VIs were used both for controlling the test measurements and data acquisition, and for the data processing (Qiu et al., 2008). The VI created for processing and analyzing the acquired data from the test bench is given in Figure2.The rated data of the tested
three-phase squirrel cage induction machine was illustrated. Table 1. Tests were carried out for different loads with the healthy motor, and with similar motors having up to 4 broken rotor bars.

**Fig. 1:** NI USB-6008 data acquisition device.

**Fig. 2:** Block Diagram Of The Created Virtual Instrument Panel Analogical.

A it can be seen from the figures 3, 4, 5, 6 respectively showed the amplitude and waveform graph of the stator current and current spectrum frequency at no-load (and also at loads). The most eloquent results were obtained at great loads, especially near the rated load.

<table>
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<th>Table 1: Squirrel-cage induction motor parameter</th>
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<tbody>
<tr>
<td>Number of poles</td>
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<td>Number of phases</td>
</tr>
<tr>
<td>Outer diameter of stator</td>
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<tr>
<td>Inner diameter of stator</td>
</tr>
<tr>
<td>Air gap length</td>
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<tr>
<td>Axial length</td>
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<tr>
<td>Number of stator slots</td>
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<tr>
<td>Number of rotor bars</td>
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<td>Rated voltage (V) rms</td>
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<td>Rated frequency (Hz)</td>
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Fig. 3: Stator current waveform and current spectrum in healthy state motor without load under speed 1480rpm.

Fig. 4: Stator current waveform and current spectrum in healthy state motor with load under speed 1395rpm.

Fig. 5: Stator current waveform and current spectrum in faulty state motor without load under speed 1325rpm.

Fig. 6: Stator current waveform and current spectrum in faulty state motor with load under speed 1225rpm.
Conclusion:

Because of its overall versatility as an engineering tool, the software package LabVIEW is chosen in most of the engineering problems. It is a graphical programming language that allows engineers and scientists to develop their own virtual instrument, which is flexible, modular and economical. Furthermore, the software meets most of the software selection criteria, and it not only does the data manipulation, analysis, and control, but also has some multimedia authoring capabilities with the help of the add-on tools.

The LabVIEW software allows for the creating of application-specific templates (sub-virtual instruments) to reduce the production time for the identical subjects. Many useful functions can be incorporated with the LabVIEW programs to perform very useful tasks in a laboratory virtual instrumentation system design.

REFERENCE


