UNIVERSITI PUTRA MALAYSIA

MOTOR CURRENT SIGNATURE ANALYSIS OF INCIPIENT BROKEN ROTOR BAR OF SQUIRREL CAGE INDUCTION MOTOR

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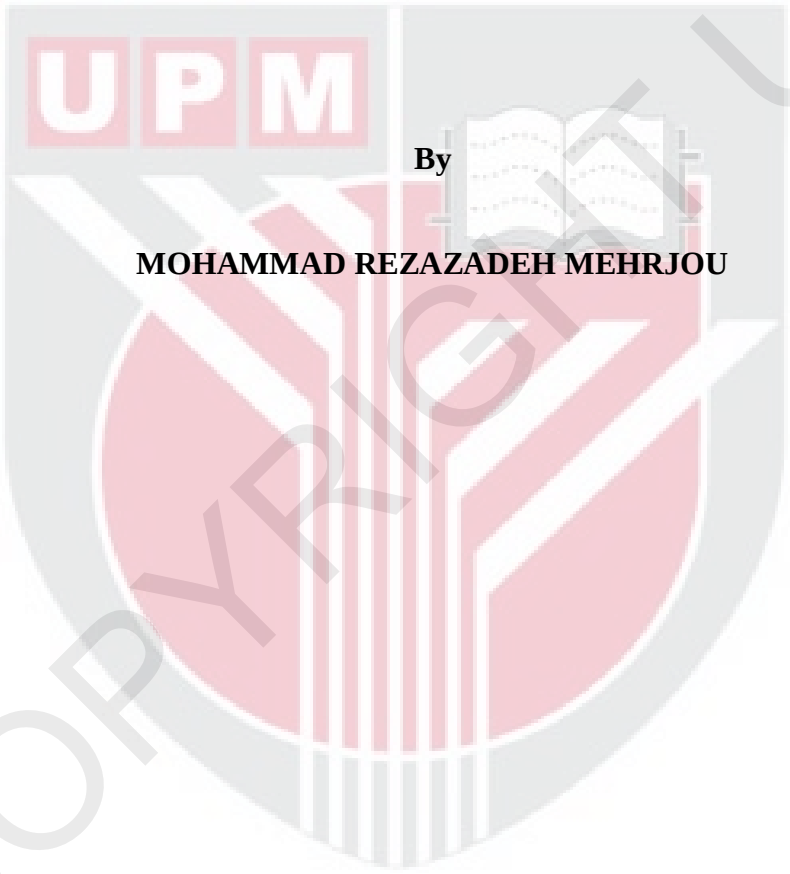

By

MOHAMMAD REZAZADEH MEHRJOU

This thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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Chair: Professor Norman Mariun, PhD, PEng

Faculty: Engineering

Nowadays, manufacturing companies are making great efforts to develop incipient fault detection, as it prevents the unscheduled downtime and hence reduces maintenance costs. The machine problem and irregularity can be detected at an early stage using a suitable condition monitoring. The condition monitoring schemes have concentrated on sensing specific failure modes in different parts of the motor. Rotor faults are of significance importance as they cause secondary failures which lead to serious motor malfunctions. Detection of rotor faults has long been an important but difficult job in the detection area of motor faults.

Motor current signature analysis (MCSA) is considered as an effective condition monitoring in any induction motor. However, a signal processing technique, which enhances the fault signature and suppress the dominant system dynamics and noise must be considered. Previous researches found that when broken bars occur in the

machine rotor, the anomaly of electromagnetic field in the air gap will cause two sideband frequency components presented in the stator current spectrum. Therefore, identification of these sideband frequencies can be used as a convenient and reliable approach to detect the broken rotor bar in induction machines.

Frequency analysis as well as time-frequency analysis is the most common signal processing methods applied for fault detection of induction motor. In this research, the effectiveness of these two analysis techniques were investigated for incipient broken rotor bar detection in squirrel-cage induction motor under different levels of load. The result showed that frequency analysis of current signal cannot provide accurate information for incipient fault detection. Therefore, time-frequency analysis was examined for incipient broken rotor bar detection. Wavelet transform of the raw signal depends on the type of wavelet function used for decomposition is different. In view of that, it is desirable to select the appropriate wavelet function, which produces the best results for the signal being analyzed according to the purpose of the research. Therefore, this research investigated the analysis of current signal using different wavelet functions for effective and incipient detection of broken rotor bar in squirrel-cage induction motor. Different functions, namely, Biorthogonal, Coiflet, Daubechies, were compared in screening the features corresponding to the fault present in motor. Among those wavelet functions studied, Daubechies1 provided much more reliable information for incipient detection of broken rotor bar.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

MOTOR TANDATANGAN ARUS ANALISA KEMUNGKINAN KEROSAKAN BAR ROTOR MOTOR ARUHAN SANGKAR TUPAI

Oleh

MOHAMMAD REZAZADEH MEHRJOU

April 2011

Pengerusi: Profesor Norman Mariun, PhD, PEng

Fakulti: Kejuruteraan

Pada masa sekarang, syarikat pengilang berusaha secara besar besaran untuk membangunkan pengesanan kerosakan awal dengan program penyelenggaraan mesin. Masalah mesin dan penyelewengan boleh dikesan pada peringkat awal dengan menggunakan pemantauan keadaan yang sesuai. Keadaan skim pemantauan telah menumpukan pada penderiaan mod kegagalan khusus di berbagai bahagian motor. Kerosakan rotor adalah amat penting kerana ia menyebabkan kegagalan sekunder yang menyebabkan kerosakan motor serius. Pengesanan kerosakan rotor adalah usaha yang penting dan telah lama dijalankan tetapi sulit dalam bidang mengesan kerosakan motor.

Analisa pengenalan arus motor (MCSA) dianggap sebagai kaedah pengesanan kerosakan berkesan dalam setiap motor aruhan. Namun, teknik pemprosesan isyarat, yang meningkatkan pengenalan kerosakan dan menekan dinamik sistem yang dominan dan hingar harus dipertimbangkan. Penyelidikan sebelum ini mendapati

bahawa ketika bar rosak terjadi pada mesin rotor, anomali medan elektromagnet di ruang udara akan menyebabkan dua komponen frekuensi jalur sisi diwujudkan dalam spektrum stator. Oleh kerana itu, pengenalan frekuensi jalur sisi boleh digunakan sebagai pendekatan yang mudah dan boleh dipercayai untuk mengesan bar rotor rosak di mesin aruhan.

Analisis Frekuensi serta analisis frekuensi masa yang paling umum adalah kaedah pemprosesan isyarat yang dilaksanakan untuk mengesan kerosakan motor aruhan. Dalam kajian ini, keberkesanan dari kedua-dua teknik analisis yang diselidiki untuk pengesanan bar rosak rotor pada motor induksi sangkar tupai-berdasarkan tahap beban yang berbeza. Keputusan kajian menunjukkan bahawa analisis frekuensi isyarat arus tidak dapat memberikan maklumat yang tepat untuk mengesan kerosakan awal. Oleh kerana itu, analisis frekuensi masa yang dikaji untuk pengesanan bar kerosakan awal rotor. Transformasi wavelet dari isyarat mentah bergantung pada jenis fungsi wavelet digunakan untuk dekomposisi yang berbeza. Dalam pandangan itu, sangat dianjurkan untuk memilih fungsi wavelet bersesuaian, yang menghasilkan keputusan yang terbaik bagi isyarat yang dianalisa bersesuaian dengan tujuan kajian. Oleh kerana itu, kajian ini juga meneliti analisis isyarat arus menggunakan fungsi wavelet yang berbeza untuk pengesanan yang berkesan dan mengesan awal kerosakan bar rotor di motor aruhan sangkar tupai. Fungsi tersebut iaitu Biorthogonal, Coiflet, Daubechies, dibanding dalam penapisan ciri yang sesuai dengan kerosakan yang terdapat pada motor. Di antara fungsi-fungsi wavelet yang dikaji, Daubechies1 memberikan maklumat yang boleh dipercayai untuk pengesanan awal kerosakan bar rotor.

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I certify that a Thesis Examination Committee has met on 22 April 2011 to conduct the final examination of Mohammad Rezazadeh Mehrjou on his Master of science thesis entitled "Motor current signature analysis of incipient broken rotor bar of squirrel cage induction motor" in accordance with the Universities and University College Act 1971 and Constitution of the Universiti Putra Malaysia [P.U.(A)106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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MOHAMMAD REZAZADEH MEHRJOU

Date: 22 April 2011

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