

Induction Machine Broken Rotor Bar Diagnostics Using Prony Analysis

by

Shuo Chen

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Abstract

On-line induction machine condition monitoring techniques have been used widely in the detection of motor broken rotor bars for decades. Research has 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 presenting in the stator current spectrum. Therefore, identification of these sideband frequencies can be used as a convenient and reliable approach to broken rotor bar fault diagnosis.

Discrete Fourier Transform (DFT) is a conventional spectral analysis method used in this application. However, the use of DFT has several limitations. The most important one among them is the restriction of frequency resolution by window length. Due to this limitation, the accuracy of broken rotor bar detection can be highly affected in cases such as light machine load and limited data records. However, Prony's method for spectral analysis has the ability of overcoming the restriction of data window length on the frequency resolution, from which the DFT suffers. Such feature makes Prony's method a promising choice for broken rotor bar diagnosis when the machine is operating under light or varying load, or when only restricted data is available. In this thesis, I have demonstrated the implementation of this technique in the induction motor broken rotor bar detection, revealed its better performance than DFT in terms of maintaining high resolution in frequency domain whilst using a much shorter window, and analyzed the influential factors to the method of Prony Analysis (PA).

In this thesis, an induction machine model that includes broken rotor bars is developed using Matlab/Simulink and verified by comparing the experimental and the simulated results. The Prony Analysis method for broken bar diagnosis is implemented and tested using both simulated and measured stator current data. Comparisons between PA and DFT results are presented, clearly indicating improvements of broken bar diagnostics using PA.

Statement of Originality

I hereby declare that this is an original thesis and is entirely my own work under the guidance and advice of my supervisor Dr. Rastko Zivanovic. This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the Adelaide University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

Shuo Chen

April 2008

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I was just trying to have a short break to take breath from writing and rewriting a same piece of work for several months by thanking people. However, what I had not realized was that this would never be a task any easier than writing a thesis. It is not because I have not learned enough affecting English words to express my appreciation, but the fact that I believe, for a man indebted, even the most exquisite word in any language is not competent to deliver this gratefulness. Though clumsy, I still insist on writing down the following words, with the best I am able to put in.

Memory has carried my thought reviewing through the time from day one when my parents saw me off in the international airport. Their images and voices keep on emerging in my mind like that they just happened yesterday. Thank you and forever love to my mother, Yunfeng Lei, and father Jianguo Chen. You could not have given any more than you have done to me. Your love, support and trust is the invaluable wealth that I have. It has carried me for the years I lived through, and will continue to be the inexhaustible source of my encouragement and strength for my whole life.

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Nomenclature

A/D	Analogue/Digital
CT	Current Transformer
DFT	Discrete Fourier Transform
DSP	digital signal processing
FFT	Fast Fourier Transform
FIR	finite-duration impulse response
GUI	Graphical User Interface
IRLS	Iteratively Reweighted Least Squares
LS	Least Squares
MAE	Mean Absolute Error
mmf	magnetic motive force
PA	Prony Analysis
SVD	Singular Value Decomposition

