INDUCTION MOTOR STATOR RESISTANCE ESTIMATION USING PI ESTIMATOR

AIZAT FAHMI BIN A.AZIZ

A report submitted in partial fulfillment of the

requirements for the award of the degree of

Bachelor of Electrical Engineering (Power System)

Faculty of Electrical & Electronic

Universiti Malaysia Pahang

NOVEMBER 2009

"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power System)"

Signature : ______________________________

Name : NORAZILA JAALAM

Date : ______________________________

"All the trademark and copyrights use herein are property of their respective owner. References of information from other sources are quoted accordingly; otherwise the information presented in this report is solely work of the author."

Signature : ______________________________

Author : AIZAT FAHMI BIN A.AZIZ

Date : ______________________________

ACKNOWLEDGEMENT

I am thankful to Allah the Almighty for it is with His blessings and mercy that I may complete this project.

I gratefully thank the lecturers and teaching staff at the Faculty of Electrical and Electronic Engineering of Universiti Malaysia Pahang for their help and support throughout my degree course here.

I am also indebted to all those who made constructive criticisms, as well as those who shared their thoughts and concerns on the project; especially my supervisor, Mrs. Norazila Jaalam and my class peers.

Lastly, I am forever indebted to my parents, Mr. A.Aziz bin Mohd and Ms. Nohapish bte Pandak Ab. Jalil for their never ending encouragement and undying love to me.

May Allah reward His peace and blessings to all of you, and may this work brings benefit to the mankind.

ABSTRACT

During the operational of induction motor, stator resistance changes continuously with the temperature of the machine and this will cause trouble to operate the machine. High temperature or too low temperature will disturb the progress of the machine. When the temperature change due to the operational of the motor, the resistance values will be affected. When the temperature is high, the resistance value will increase. The current will increase and this will damage the machine. When temperature is low, the resistance will drop. Hence, the current will drop and make the machine fail to operate. This project will verify the resistance used when there is a change of the temperature value of the induction motor. This project also will reduce the overshoot stator resistance to protect the motor from damage. PI Estimator will be used in this project using MATLAB. Calculation and block diagram will be used in this project to identify the suitable resistance value due to the temperature of the machine.

ABSTRAK

Semasa operasi induksi motor, rintangan static berubah-ubah mengikut suhu mesin dan ini menyebabkan masalah untuk mengoperasikan mesin tersebut. Suhu yang tinggi atau suhu yang terlalu rendah akan mengganggu perkembangan mesin ini. Bila suhu berubah mengikut operasi atau kendalian motor ini, nilai rintangan akan terjejas. Bila suhu terlalu tinggi, nilai rintangan akan naik. Arus elektrik akan naik dan menyebabkan kemusnahan atau kerosakan kepada mesin tersebut. Bila suhu rendah, nilai rintangan akan menurun. Maka, arus elektrik akan jatuh dan menyebabkan mesin gagal untuk berfungsi. Projek ini akan mengenal pasti rintangan yang digunakan apabila berlaku perubahan suhu pada induksi motor. Projek ini juga akan mengurangkan ‘overshoot’ rintangan static untuk mengawal motor dari rosak. ‘PI Estimator’ akan digunakan di dalam projek ini menggunakan MATLAB. Jalan kira dan blok gambar rajah akan digunakan dalam projek ini untuk mengenal pasti rintangan yang sesuai mengikut suhu pada mesin tersebut.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

A	-	Ampere
Rr	-	Rotor Resistance
Rs	-	Stator Resistance
V	-	Voltage
Ω	-	Ohm

LIST OF ABBREVIATIONS

ANN	-	Artificial Neural Network
NN	-	Neural Network
PI	-	Proportional-Integral

LIST OF APPENDICE

CHAPTER 1

INTRODUCTION

1.1. Background

In high performance drive application, an induction motor become the most frequently used electrical machine due to its rugged construction, high efficiency, and the ability to control the speed of the motor [1]. However, during the operational of induction motor, stator resistance changes continuously with the temperature of the machine and this will cause trouble to operate the machine. The performance of the induction motor is depends on the accuracy of the estimated rotor flux from the measured stator currents. A mismatch between the real rotor flux and the estimated rotor flux, leads to error between the real motor torque and the estimated torque and hence poor dynamic performance.

High temperature or too low temperature will disturb the progress of the machine. The resistance values will be affected when the temperature changes due to the operational of the motor [4]. When the temperature is high, the resistance value will increase. The current will increase too and this will damage the machine. When temperature is low, the resistance will drop. Hence, the current will drop and make the machine fail to operate.

This project will verify the resistance used when there is a change of the temperature value of the induction motor. This project also will reduce the overshoot stator resistance to protect the motor from damage. Proportion-Integral (PI) Estimator will be used in this project using MATLAB. Calculation and block diagram will be used in this project to identify the suitable resistance value due to the temperature of the machine.

1.2. Objective of Project

The main objectives for this project are to identify and observe the error of calculated current and measured current by the induction motor. It also will identify the variation of stator resistance by using PI Estimator and develop PI with anti-windup when there is an overshoot.

1.3. Scope of Project

In order to achieve the objective of the project, several scopes have been outlined. This project will cover on how resistance reacts with the induction motor process due to the variation of temperature values. The error of the calculated and measured value of the current from the induction motor will be shown in this project. The variation of stator resistance value due to the changes of temperature will be identified in this project.

1.4. Thesis Outline

For the thesis outline, it has five chapters. All the progress elements are divided into chapters and the details of each chapter are as follows:

Chapter 1 will explain detail about the general information of this thesis. The problem statement is stated here along with the relevant solution. It’s to support the main objectives and the relevant of the proposed title. The objectives of this project as the goal of the project are stated in here. It’s consists of the aim that must be achieved at the end of the project. Scope of work which are the flow of work that will be implemented in this project. This step by step flow work is to keep the project’s progress on track and to meet the objective. And lastly the thesis outline, the overall elements needed in the thesis.

Chapter 2 will cover the literature review, which is the study on the others papers, journal, website citation and other dependable sources that related to the project. Literature review is crucial for every thesis not only to support the proposed title but also for guidelines and references on the conducted thesis.

Chapter 3 will cover on the methodology. It will describe in details about the scope of project. In this part, every step on how to approach the solutions to overcome the stated problems is described in details. Its shows how the work will be done. The details such as flow chart, schematic diagram are shown in here.

Chapter 4 will cover on the result gained. The result section will state the results that will be achieved at the end of the project.

Chapter 5 will cover on conclusion and suggestion part. It will conclude the project's objectives and result achieved. The project success or failure is stated in here. The suggestion for the future of this project also will be stated here.

CHAPTER 2

THEORY AND LITERATURE REVIEW

2.1 Introduction

Currently induction motor has become widely used in industry and many more. Induction motor resistance need to be determined in order to get the best dynamic performance.

In this project, PI Estimator has been used in order to identify the variation of the resistance value based on the changes of the temperature value of the stator condition. The current produce from the calculated and measured will be identified in order to avoid any mismatch between these two currents. These two currents produced from 2 sources which are from the Newcastle Drive Simulation Library and from the equation and block diagram built from MATLAB software. A mismatch between the real rotor flux and the estimated rotor flux, leads to error between the real motor torque and the estimated torque and hence poor dynamic performance.

The experiment on the other method in finding the stator resistance led to the findings new way in order to measure the stator resistance. Quassi-Fuzzy Logic describes an on-line method of induction-motor stator-resistance estimation, where fuzzy and non-fuzzy approaches have been mixed [5]. The fuzzy algorithm estimates the stator-winding temperature rise at steady state as a function of stator current and frequency, and then the signal is processed through a low-pass filter with an approximate thermal time constant to determine the transient temperature information. It is then added with the ambient temperature, and the stator resistance is calculated in precision as a function of stator temperature. Calibration with a thermistor network data indicates the excellent performance of the estimator. The principle of the estimator can be extended to rotor-resistance estimation. The stator-resistance estimation exemplifies possibly one of the best applications of fuzzy logic.

To prove that the induction motor stator and rotor temperature can be gain and measured, signal injection method had been used in an experiment [6]. Two signals with proper frequencies that yield the high sensitivities of the terminal measurements to Rs and Rr at a given rotor speed are injected to the induction machine to estimate Rs and Rr. The estimated Rs and Rr are then used to estimate Ts and Tr, respectively, according to the relationships between the winding resistances and winding temperatures. Experiment was carried out to verify the proposed method.

The injected signals cause the torque ripple and the speed ripple. However, since only small amplitude signals are injected, the torque ripple and the speed ripple are negligible. The proposed method can only estimate the average winding temperature, not the peak one, which is a common drawback of all resistance-based temperature-estimation methods. However, since the average winding temperature is usually close to the peak winding temperature, the method is still useful for indicating the thermal stress in the motor.

One of the ways in improving efficiency is by using copper die-cast. In [10], there are problems associated with this copper die-casting which is if the injection time is longer than solidification time, then the copper will solidify and casting will not be complete or uniform before the injection is completed. But this way is not too effective as copper is more expensive compare to the aluminum that already used in the rotor. The best way is by using PI Estimator to verify the resistance value and yet, to overcome it to be more efficient.

In [12], Neural Network (NN) based stator current MRAS is used for speed estimation in sensorless induction motor drives. Rotor flux estimation is required for the speed observer. Using a voltage model for rotor flux estimation causes problems at low speed due to stator resistance sensitivity and the pure integration for flux which may cause DC drift and initial condition problems. A current model can be used instead to estimate the rotor flux from the measured stator currents and the estimated speed, which shows less sensitivity to stator resistance variation. However, the MRAS scheme using the current model flux observer shows instability in the regenerating mode of operation. A multilayer feed forward NN is proposed to overcome this problem for rotor flux estimation from present and past samples of the stator voltage and current. Using the NN flux observer gives less sensitivity to stator resistance variation compared to the voltage model and since the flux estimation is independent of the rotor speed, stable operation has been obtained for regeneration. This experiment give the idea on using the neural network in determine the stator resistance. The neural network with various of input give the idea in using it with MATLAB programming.

2.2 Artificial Neural Network (ANN)

An artificial neural network (ANN), usually called "neural network" (NN), is a mathematical model or computational model that tries to simulate the structure and/or functional aspects of biological neural networks. It consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase [3]. NN are non-linear statistical data modeling tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data.

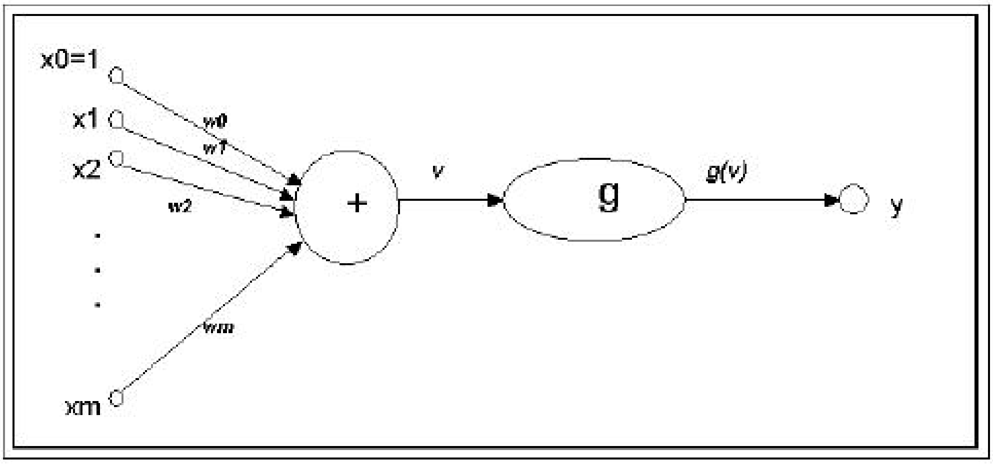

Figure 2.1: General Diagram of Artificial Neural Network

There are numerous different ANN architectures that have been studied by researchers, the most successful applications in data mining of NN have been multilayer feed forward networks. These are networks in which there is an input layer consisting of nodes that simply accept the input values and successive layers of nodes that are neurons [2] as depicted in Figure 2.1. The outputs of neurons in a layer are inputs to neurons in the next layer. The last layer is called the output layer. Figure 2.2 shows the architecture diagram of the ANN application.

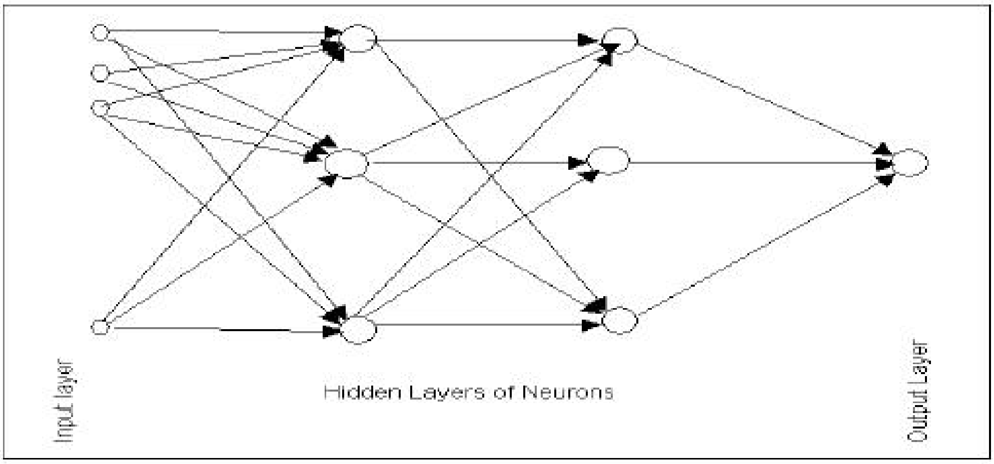

Figure 2.2: Architecture Diagram

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter includes the study of the material used in order to gain and estimate the rotor resistance produce by the induction motor. Three parts will be covered as to design an actual induction motor using The Newcastle Drive Simulation Library, induction motor based on equations and the PI Estimator with anti-wind up using the MATLAB. 2 motor input will be used as one for the actual motor and the other one is for estimated motor. PI Estimator then will be used to verify and identify the error of the measured current and calculated current based on the 2 motor used.

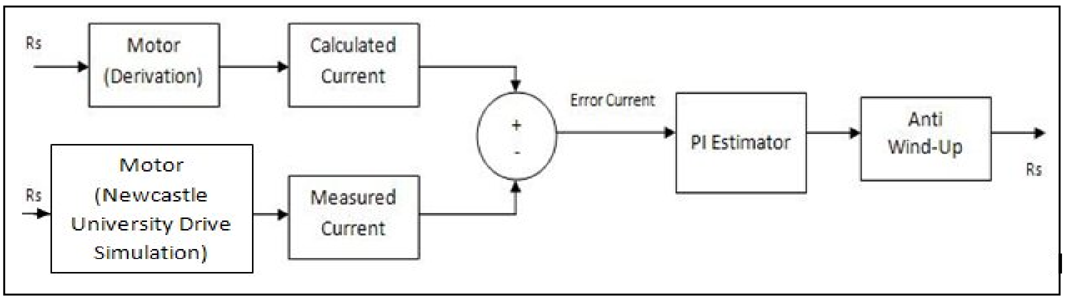

Figure 3.1: Block Diagram of the whole system.

There are two motors that need to be considered; motor from the derivation of PI equation and motor from the MATLAB programming which is Newcastle University Drive Simulation Library. As there is no real motor involve, Newcastle University