IDENTIFICATION OF MACHINE PARAMETERS IN INDUCTION MOTOR DRIVE

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"I declare that this thesis entitled 'Identification of Machine Parameters in Induction Motor Drive' is the result of my own research except as cited in the references".

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ABSTRAK

Penggunaan motor aruhan yang meluas dalam industri disebabkan ianya mudah dihasilkan dan ‘rugged’, boleh dipercayai dan mempunyai kebolehan yang baik dalam permulaan pergerakan. Selaras dengan penggunaannya yang meluas dalam industri, adalah amat penting dalam menghasilkan suatu teknik untuk menjangkakan perubahan parameter dalam motor tersebut yang mana tidak boleh ditentukan secara terus atas pelbagai faktor. Selepas beberapa tahun beroperasi, model asli berdasarkan data yang dikeluarkan oleh syarikat pengeluaran tersebut itu sendiri tidak lagi tepat. Dalam situasi berlainan, sifat sistem yang dihasilkan manusia akan mengalami perubahan terhadap umur, tahap penggunaan ataupun perubahan dalam parameter sistem yang dianggap pegun. Perubahan dalam parameter motor aruhan turut dipengaruhi oleh suhu, frekuensi dan saturasi. Projek ini adalah untuk mengenal pasti parameter mesin motor aruhan dengan menggunakan aplikasi perisian Matlab dan pengenalan terhadap kaedah penggunaan Artificial Intelligent (AI). Beberepa bentuk persamaan dihasilkan dan digunakan dalam membentuk sistem tersebut. Dalam menyelesaikan persamaan tersebut, kaedah Newton Raphson telah digunakan. Dengan menjalankan simulasi menggunakan kaedah AI yang telah dihasilkan, parameter mesin motor aruhan boleh ditentukan. Hasil daripada nilai parameter mesin yang telah ditentukan, keadaan motor aruhan itu sendiri boleh dipastikan samada beroperasi secara stabil ataupun bergerak di bawah keupayaan asal.

ABSTRACT

Induction motors (IM) are the most widely used motors in industry because they are simple to build and rugged, reliable and have good self-starting capability. Due to their wide spread in industry, it is of great importance to devise a technique that can estimate different parameters of these motors which cannot be measured directly for different reasons. Planners models based on the original manufacturers' information may not be accurate enough after a few years' operation. In other situations, some simple man-made systems deviate from its designed behavior due to aging, wearing out, or change in a system parameter that was assumed to be static. Induction motor parameters change with temperature, frequency, and saturation. This project basically is based on identifying the machine parameters of induction motor drive by using Matlab software and introducing of Artificial Intelligent(AI) method through it. The set of differential equation was produced and used to model the system. To solve the set of differential equation, the Newton Raphson method have been used. By running the simulation using the Artificial Intelligent(AI) method that have been created, the machine parameters of the induction motor can be determine. As the result of the machine parameters been determined, the condition of the induction motor itself can be observe whether it still on under stable condition or running with lower performance.

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LIST OF ABBREVIATION

IM	-	Induction Motor
AI	-	Artificial Intelligent
AC	-	Alternating Current
NEMA	-	National Electrical Manufacturers Association
EMF	-	Electromagnetic Field
CI	-	Computer Intelligent
EA	-	Evolutionary Algorithm
ANN	-	Artificial Neural Network
CNS	-	Central Nervous System
PSO	-	Particle Swarm Optimization
GUI	-	Graphical User Interface
RLS	-	Recursive Least Squares

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Accurate models of power plant components are essential for realistic simulation and analysis of the dynamic performance of electrical power systems. Generator models have received considerable attentions during last decade, but Induction motors (IM) model are less addressed in the published papers. Induction motors (IM) are the most widely used motors in industry because they are simple to build and rugged, reliable and have good self-starting capability. Due to their wide spread in industry, it is of great importance to devise a technique that can estimate different parameters of these motors which cannot be measured directly for different reasons. This project is being developed the equations by using the Newton Raphson method to be run in Matlab software. By running the equations in Matlab software programming, all the data that have been collected can be put in the equations as actual value of the machine system. Particularly, by doing the simulation using the Artificial Intelligent (AI) method that have been created, the machine parameters of the induction motor can be determine. As the result of the machine parameters been determined, the condition of the induction motor itself can be observe whether it still on under stable condition or running with lower performance.

1.2 Background

This project basically is based on identifying the machine parameters of induction motor drive by using Matlab software and introducing of Artificial Intelligent (AI) method through it. The set of differential equation was produced and used to model the system. To solve the set of differential equation, the Newton Raphson method has been used. After the differential equations of the system are solved, the three-phase currents are evaluated and compared to their counterpart in the real system. The absolute value of the difference between the estimated and measured currents over a certain period of time indicates how well the model resembles the real system, and henceforth, how well the estimated parameters match their real counterparts.

1.3 Objectives

The main objectives of this study are:

i. To identify the unknown machine parameters in induction motor.
ii. To illustrate the analytical results and to demonstrate the practical capabilities.
iii. An approaching the Artificial Intelligent (AI) method to identify the induction motor parameters.

Through the way to achieve all the three objectives, the understanding on how the actual induction motor behavior should be observed. The technique of running Matlab program also needs to be understood because this project basically to run the set of equation and model the system itself. By approaching an Artificial Intelligent (AI) technique to run the simulation, the data or the machine parameters of induction motor drive can be solved.

1.4 Scopes

Under this project sources, research and methodology that already been planned, there is scope that being the border for this project to look more specific:

i. Three phase machine parameters of induction motor drive.
ii. Using Matlab software as the tool to run the simulation.
iii. Newton Raphson method as an equation solver.
iv. A nonlinear AI approach for identification of the induction motor parameters.

According to industrial condition for nowadays, the needs of identification for the parameters of induction motor drive should be done because of wide spread used of induction motor in industry. As a capable software that can be approach by Artificial Intelligent (AI) technique, Matlab software have been chose as a tools to solve the differential equation and run the simulation. Newton Raphson method being chooses to solve the set of differential equation and particularly model the system.

1.5 Problem Statement

Although some of the systems, such as motor induction system, are a man-made system, its exact behavior cannot be determined given current and past inputs to this system. This uncertainty in such systems is due, in large part, to the complexity of the system in question. Planners models based on the original manufacturers' information may not be accurate enough after a few years' operation.

In other situations, some simple man-made systems deviate from its designed behavior due to aging, wearing out, or change in a system parameter that was assumed to be static. Induction motor parameters change with temperature, frequency, and saturation.

The consequence of any mismatch between the parameter values used in the controller and those in the motor is that the actual rotor flux position does not coincide with the position assumed by the controller. This leads to a loss of decoupling flux and torque control. Performance of the drive therefore deteriorates from that desired. Such models are often derived from the off-line tests and by the estimation of each individual parameter separately and the combination of each part of the system to get an integrated system model. System identification involves creating a model for the system in question that, given the same input as the original system, the model will produce an output that matches the original system output to a certain degree of accuracy. The input or excitation to the system and model, and their corresponding output are used to create and tune that model until a satisfactory degree of model accuracy is reached.

1.6 Thesis Organization

This thesis basically consist of 5 chapter altogether. Chapter 1 is focus on overall overview for the whole project what is all about including objectives, scopes and problem statement.

For the Chapter 2, its description of literature review of the project which has been got from different sources such as internet, journal, thesis and books.

Chapter 3 is consisting of methodology of the project, mostly focus on the project flow and how it's being organized.

Chapter 4 is about the result of the project which comes out from the program that has been created.

The last chapter which is Chapter 5 is the conclusion for the whole project. There are also suggestions that can be used for future implementation or upgrading for this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The understanding on this project basically come from the research that have been done through many type of sources such as internet, journal, thesis, books and supervisor knowledge based on his experience before. The main thing that must be understood is induction motor itself, the part of the induction motor and its function. From this we can know and understand why the machine parameters of induction motor have change. Then, the study on Matlab software as a main program that need to be used to get and check the data acquisition. By using the Newton Raphson method, the equations that we have can be run just by putting the data that have been collected. Artificial Intelligent (AI) technique being used in the program that being create in the Matlab programming to solve and specified the data needs.

2.2 Induction Motor

The Induction motor is a three phase AC motor and is the most widely used machine. Its characteristic features are:

i. Simple and rugged construction.
ii. Low cost and minimum maintenance.
iii. High reliability and sufficiently high efficiency.
iv. Needs no extra starting motor and need not be synchronized.

An Induction motor has basically two parts which are stator and rotor. The stator is made up of a number of stampings with slots to carry three phase windings. It is wound for a definite number of poles. The windings are geometrically spaced 120 degrees apart. Two types of rotors are used in Induction motors are squirrel-cage rotor and wound rotor. Figure 2.1 shows the induction motor parts.

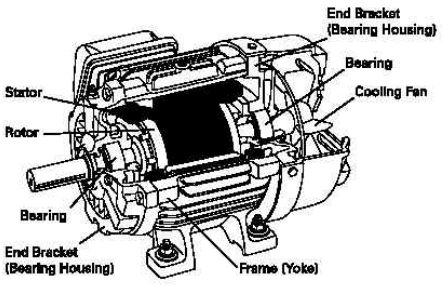


Figure 2.1: Induction Motor Parts

The enclosure consists of a frame (or yoke) and two end brackets (or bearing housings) .The stator is mounted inside the frame. The rotor fits inside the stator with a slight air gap separating it from the stator. There is no direct physical connection between the rotor and the stator. The enclosure also protects the electrical and operating parts of the motor from harmful effects of the environment in which the motor operates. Bearings, mounted on the shaft, support the rotor and

allow it to turn. A fan, also mounted on the shaft, is used on the motor shown below for cooling. All loads moved by electric motors are really moved by magnetism. The purpose of every component in a motor is to help harness, control, and use magnetic force. When applying an AC drive system it helps to remember you are actually applying magnets to move a load. To move a load fast does not require more magnets, you just move the magnets fast. To move a heavier load or to decrease acceleration time (accelerate faster) more magnets (more torque) are needed. This is the basis for all motor applications.

2.2.1 Stator Construction

The stator and the rotor are electrical circuits that perform as electromagnets. The stator is the stationary electrical part of the motor. The stator core of a NEMA motor is made up of several hundred thin laminations. Figure 2.2 shows the stator construction.

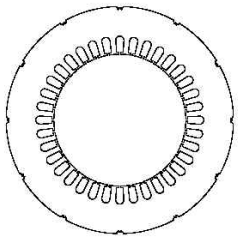


Figure 2.2: Stator Construction

2.2.2 Stator Windings

Stator laminations are stacked together forming a hollow cylinder. Coils of insulated wire are inserted into slots of the stator core.

Each grouping of coils, together with the steel core it surrounds, form an electromagnet. Electromagnetism is the principle behind motor operation. The stator windings are connected directly to the power source. Figure 2.3 shows the windings of stator.

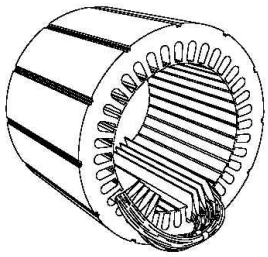


Figure 2.3: Stator Windings

2.2.3 Stator Coil Arrangement

The following schematic illustrates the relationship of the coils. In this figure six coils are used, two coils for each of the three phases. The coils operate in pairs. The coils are wrapped around the soft iron core material of the stator. These coils are referred to as motor windings. Each motor winding becomes a separate electromagnet. The coils are wound in such a way that when current flows in them one coil is a north pole and its pair is a south pole. For example, if A1 were a north pole then A2 would be a south pole. When current reverses direction the polarity of the poles would also reverse.

Figure 2.4 shows the arrangement of stator coil. The stator is connected to a 3-phase AC power supply. In the following illustration phase A is connected to phase A of the power supply. Phase B and C would also be connected to phases B and C of the power supply respectively.

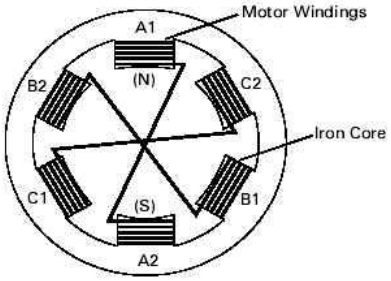


Figure 2.4: Stator Coil Arrangement

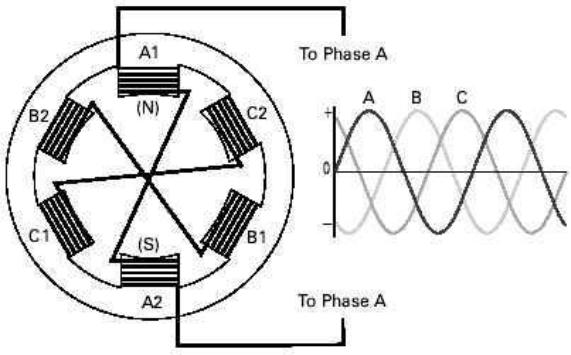
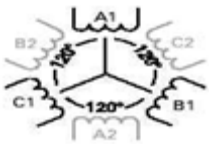


Figure 2.5: Phase Of Stator Coil Arrangement

Phase windings (A, B, and C) are placed 120° apart. Figure 2.5 shows the phase of stator coil arrangement. In this diagram, a second set of three-phase windings is installed. The number of poles is determined by how many times a phase winding appears. In this figure, each phase winding appears two times. This is a two-pole stator. If each phase winding appeared four times it would be a four-pole stator. When AC voltage is applied to the stator, current flows through the windings. The magnetic field developed in a phase winding depends on the direction of current flow through that winding. Figure 2.6 shows the pole of stator winding.



2-Pole Stator Winding

Figure 2.6: Pole Of Stator Winding

2.2.4 Rotor Construction

The rotor is the rotating part of the electromagnetic circuit. The most common type of rotor is the "squirrel cage" rotor. Other types of rotor construction will be mentioned later in the course. The construction of the squirrel cage rotor is reminiscent of rotating exercise wheels found in cages of pet rodents. Figure 2.7 shows construction of rotor.

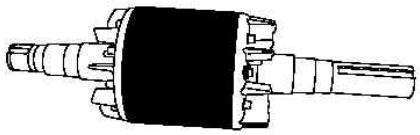


Figure 2.7: Rotor Construction 1

The rotor consists of a stack of steel laminations with evenly spaced conductor bars around the circumference. Figure 2.8 shows the rotor construction 2.