Cairo University
Faculty of Engineering
Electrical Power and Machines

CONDITION MONITORING AND FAULT DIAGNOSIS OF INDUCTION MOTOR USING NEURO FUZZY LOGIC

BY

Eng. Hussein Adel Taha Hussein

A Thesis Submitted to The
Faculty of Engineering at Cairo University
In Partial Fulfilment of The
Requirements for the Degree of

MASTER OF SCIENCE

In

ELECTRICAL POWER AND MACHINES ENGINEERING

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LIST OF SYMBOLS

$I_{o.l}$	Motor over load current setting
i^{r}_{abc}	Rotor Current in three phase ABC
I_{rated}	Motor rated current
i^{s}_{abc}	Stator Current in three phase ABC
$L_{a1a2)f}$	Mutual inductance between faulty area and healthy area of phase A
$L_{a2a2)f}$	Self inductance for faulty area of phase A
L_{asr}	Mutual inductance between phase A and any rotor phases
L^{sh}_{q}	Representation of self inductance of phase A faulty area in dq frame
L^{shr}_{q}	Representation of mutual inductance between phase A faulty area and any rotor phases in dq frame
L^{s}_{q}	Representation of self Inductance for healthy area of phase A in dq frame
L^{sr}_{q}	Representation of mutual inductance between phase A healthy area and any rotor phases in dq frame
L^{ssh}_{q}	Representation Mutual inductance between faulty area and healthy area of phase A in dq frame
p	Differential operator =d/dt
P	Machine pair poles
r^{r}_{abc}	Rotor resistance in three phase ABC
r^{s}_{abc}	Stator resistance in three phase ABC
V^{s}_{abc}	Stator Voltage in Three Phase ABC
w_m	Motor rotational velocity rad/sec2
X	Fault percentage %
λ^{r}_{abc}	Rotor flux linkage in three phase ABC
λ^{s}_{abc}	Stator flux linkage in three phase ABC
λ^{s}_{qd}	Stator flux linkage in dq frame
λ^{sh}_{q}	Stator flux linkage of faulty area in q phase as represent phase A fault

LIST OF ABBREVIATIONS AND DEFINITIONS

ANN: Artificial neural network.

ANFS: Adaptive Neuro Fuzzy.

Failure*:* An abnormal permanent condition that affects the system performance.

Fault: An abnormal temporary condition that occurs in the system.

Fault detection: Is the determination of fault as kind and time.

Fault diagnosis: The determination of fault as kind, size, location and time.

Fault Monitoring*:* Detection of fault in real time base through recording the physical system data and determining the abnormalities.

FFT: Fast Fourier Transform

FL: Fuzzy logic.

Malfunction*:* An irregular fault that affects the system desired output.

ABSTRACT

The Induction machine is one of mostly common machine. It is almost used for all industrial applications, wind energy generation and recently it has been proposed for applications of hybrid electrical vehicle and electrical air craft. Fault monitoring and control becomes high priority for induction machine.

This thesis discusses the fault diagnosis and monitoring of the induction motor, starting with the machine different faults and the different algorithms to detect these faults (intelligent control, parameter estimation…). The scope of this research is the fault with high occurrence percentage, which is stator turns faults .It is built on objects of:

a) Three phase induction motor modeling in both the symmetric healthy and asymmetric faulty cases using of dq frames instead of ABC.
b) An algorithm of on-line fault detection based on the motor fault response and motor electrical parameters change.
c) The efficient design of an Adaptive Neuro Fuzzy system.

This thesis reviews methods of fault detection and diagnosis of stator inter-turn short circuits for three phase induction machine. It is based on motor stator current and motor modeling in “dq” frame at different loading condition and various percentages of faults using an artificial intelligence technique of Neuro Fuzzy which lead to a high efficiency method for fault detection because of its ability to learn and adapt to the motor environment condition.

CHAPTER ONE

INTRODUCTION AND THESIS STRUCTURE