PERFORMANCE ANALYSIS OF INDIRECT VECTOR CONTROL OF INDUCTION MOTOR USING INTELLIGENT CONTROLLERS

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE
OF

MASTER OF TECHNOLOGY
IN
CONTROL & INSTRUMENTATION
(Electrical Engineering)

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CERTIFICATE

I, Abhishek Choudhary, Roll No. 2K12/C&I/01 student of M. Tech. (Control & Instrumentation), hereby declare that the dissertation titled "Performance analysis of indirect vector control of induction motor using intelligent controllers" is a bonafied record of the work carried out by me under the supervision of Prof. Madhusudan Singh of Electrical Engineering Department, Delhi Technological University in partial fulfillment of the requirement for the award of the degree of Master of Technology has not been submitted elsewhere for the award of any Degree.

Place: Delhi
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ACKNOWLEDGEMENT

First and foremost, I express my sense of gratitude to my supervisor Prof. Madhusudan Singh, Head of Department of Electrical Engineering for his guidance, support, motivation and encouragement throughout the period this work was carried out. His readiness for consultation at all times, his educative comments, his concern and assistance has been invaluable.

I also thank all the non-teaching staff of the Electrical Engineering Department for their fullest cooperation.

I would like to thank all those who have directly or indirectly helped me in completion of the thesis well in time.

Finally, I wish to thanks my parents for their moral support and confidence showed in me to pursue M.Tech at an advanced stage of my academic career.

Delhi, 2014 ABHISHEK CHOUDHARY

ABSTRACT

This dissertation deals with performance analysis of Vector control of IM using intelligent control schemes. Drives today have become an indispensable part of the industrial applications requiring high performance. Electric motors have their impact on almost every sphere of modern life. Electric motors convert electrical energy into useful mechanical energy. The induction motor drives are superior to the dc drives in many aspects such as performance, power to weight ratio, maximum speed capability, efficiency, low initial cost and robustness. The DC motor like performance of drive is achievable using Vector control of induction motor. The induction machine has a very non-linear multivariable structure which makes it very difficult to control. The temperature dependence on motor parameters affects the response of the drive.

The 3 phase squirrel cage induction motor is generally used for the variable speed application because they are rugged, reliable, and economical and require less maintenance. These are least expensive motors. Induction motor is a complex higher-order, nonlinear, strongly coupled, and multi-variable system. When operated directly from the line voltages, an induction motor operates at a almost constant speed.

In the present work, the indirect vector control of Induction motor has been studied, simulated and hardware prototype of the same is developed. The three phase induction motor is fed from a Voltage source IGBT inverter which is controlled using a Hysteresis PWM controller. The load currents i_a, i_b and i_c are compared with the reference currents i_a^*, i_b^* and i_c^* and error signals are passed through hysteresis band to generate the firing pulses, which are operated to produce output voltage in manner to reduce the current error. Various intelligent control schemes like fuzzy logic control and ANFIS control have been developed for speed control of IVCIM and performance of these intelligent control schemes are compared with the conventional PI controller. The comparison between the three techniques shows that the FLC has a robust performance. The transient response is smoother in case of FLC. During sudden load changes, the response obtained from the ANFIS is better. The ANFIS eliminates the transients during sudden change in load as compared to that of PI and fuzzy logic controller. On the other hand, the PI controller shows significant variations to change in load conditions. The response of FLC is faster than PI and ANFIS controller.

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LIST OF SYMBOLS

IM	Induction Motor
R_s	Stator Resistance
R_r	Rotor Resistance
R_r'	Rotor Resistance Referred to Stator side
X_s	Stator Reactance
X_r	Rotor Reactance
X_r'	Rotor Reactance Referred to Stator side
X_m	Leakage Inductance
I_1	Stator Current
I_2	Rotor Current
I_2'	Rotor Current Referred to Stator side
I_m	Magnetizing Current
V_0	Stator Voltage
s	Slip
ω_s	Synchronous Speed
ω_m	Rotor Speed (Machine Speed)
Ω_s	Average Synchronous Speed (in RPM)
f	Supply Frequency
p	No. of Poles
P_g	Air-gap Power
P_{cu}	Copper loss in the machine
P_m	Mechanical Power output of the machine
T	Torque Developed by the motor
s_m	Slip at maximum torque
T_{max}	Maximum Torque
V_d	DC Link Voltage
ω_{ref}	Reference Speed
ω_{sl}	Slip Speed

ω_f	Rotor Speed at Frequency f
Y_d	Space Vector in d-axis
Y_q	Space Vector in q-axis
Y_a	Space Vector of a-phase
Y_b	Space Vector of b-phase
Y_c	Space Vector of c-phase
V_{qs}	q-axis Stator Voltage with stationary frame
V_{ds}	d-axis Stator Voltage with stationary frame
I_{qs}	q-axis Stator Current with stationary frame
I_{ds}	d-axis Stator Current with stationary frame
I_{qr}	q-axis Rotor Current with stationary frame
I_{dr}	d-axis Rotor Current with stationary frame
λ_{ds}	d-axis Stator flux with stationary frame
λ_{qs}	q-axis Stator flux with stationary frame
λ_{dr}	d-axis Rotor flux with stationary frame
λ_{qr}	q-axis Rotor flux with stationary frame
λ_s	q-axis Rotor flux with stationary frame
L_s	Stator Self-Inductance
L_r	Rotor Self-Inductance
L_m	Stator Mutual-Inductance
I_s'	Complex Conjugate of Stator Current
P_i	Instantaneous Active Power
Q_i	Instantaneous Reactive Power