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Developing speed control application using ABB inverter (ABB 550-01-08A8-4) for 3 phase induction motor / Laxchumy Saravanamuthu.

DEVELOPING SPEED CONTROL APPLICATION USING ABB INVERTER (ABB 550-01-08A8-4) FOR 3 PHASE INDUCTION MOTOR

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BEKE
MAY 2009

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"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality for the award of Bachelor of Electrical Engineering (Power Electronics & Drive)"

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DEVELOPING SPEED CONTROL APPLICATION USING ABB INVERTER (ABB 550-01-08A8-4) FOR 3 PHASE INDUCTION MOTOR

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This Report Is Submitted In Partial Fulfilment of Requirements for the Bachelor's Degree in Electrical Engineering
(Power Electronics & Drives)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

"I hereby declare that this report is result of my own effort except for works that have been cited clearly in the references."

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For my family, who offered me unconditional love and support
throughout the course of this project.

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ABSTRACT

This project requires developing a speed control application for 3 phase induction motor using ABB inverter (ABB 550-01-08A8-4). It is the aim of this work that the application has to be developed where close loop speed control concept can be applied. The 3 phase induction motor's speed will be controlled via the feedback to the inverter. Based on calculation and comparison of data with the motor's data sheet, the necessary simulation to show the speed control is done. The ABB inverter is also programmed based on the obtained data from the mathematical calculation. The ABB inverter used in this project is programmed via "DriveWindow Light 2" which is the start up and maintenance tool for Inverter ABB ACS 550 drive series. This software enables the monitoring of the actual status of the connected drive, edit and show the drive parameters. Besides that it also allows user to load the drive parameters, control the drive and also graphical monitoring of drive signals such as frequency, speed, torque and current. The tasks is to study the theory of 3 phase induction motor and understand the necessary calculations, design the close loop speed control application for 3 phase induction motor using ABB inverter, do simulation to compare the actual outcome through the drive, and design the electronics part for the suitable application. The application designed is used to control the temperature in a warehouse that stores explosives. The designed involves a temperature controlling circuit which acts as a feedback to the inverter to determine the speed selection of the motor according to the temperature range detected. Therefore the blower's (driven by the 3 phase induction motor) speed should vary according to the temperature changes.

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ABSTRAK

Projek ini memberi fokus untuk membangunkan satu aplikasi untuk kawalan kelajuan motor induksi 3 fasa dengan menggunakan penukar 3 fasa daripada model ABB (ABB 550-01-08A8-4). Keutamaan projek ini diberi untuk membangunkan satu aplikasi dimana pengawalan kelajuan motor gelung tertutup boleh diaplikasikan. Kelajuan motor induksi 3 fasa akan dikawal dengan menggunakan mekanisma suap balik. Berdasarkan pengiraan dan perbandingkan data di antara helaian data motor tersebut, simulasi dan eksperimen dibuat bagi mebuktikan pengawalan kelajuan motor dilakukan. Penukar ABB diprogramkan berdasarkan data yang ditentukan menggunakan pengiraan dengan persamaan matematik. Penukar ABB yang digunakan dalam projek ini diprogramkan dengan menggunakan perisian "DriveWindow Light 2" yang juga merupakan perisian untuk memulakan dan menyelenggarakan pemacu penukar ABB siri ACS 550. Perisian ini membolehkan pemantauan status semasa pemacu, menukar dan menunjukkan parameter pemacu, memasukkan parameter pemacu, mengawal pemacu dan juga membolehkan pemantauan grafikal isyarat pemacu seperti frekuensi, kelajuan , daya kilas dan arus. Dalam projek ini juga teori motor induksi 3 fasa serta pengiraan meggunakan persamaan matematik akan dikaji untuk mengawal kelajuan motor induksi 3 fasa. Simulasi dibuat untuk membandingkan keputusan sebenar yang diperolehi melalui pemacu dan merekabentuk bahagian elektronik yang bersesuaian dengan aplikasi yang dipilih. Aplikasi yang direkabentuk digunakan untuk mengawal suhu gudang yang menyimpan bahan letupan. Ia terdiri daripada litar pengawal suhu yang berfungsi sebagai mekanisma suap balik kepada penukar 3 fasa untuk menentukan pemilihan kelajuan motor berdasarkan had suhu yang dikesan. Ini membolehkan kelajuan penghembus (yang dikawal oleh motor induksi 3 fasa) berubah berdasarkan perubahan suhu.

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LIST OF SHORTFORMS

UTeM	-	Universiti Teknikal Malaysia Melaka
PSM	-	Projek Sarjana Muda
IM	-	Induction motor
NEMA	-	National Electrical Manufacturer's Association
N-T	-	Speed-Torque
rpm	-	rotation per minute
PLC	-	Programmable Logic Control
AC	-	Alternating Current
V	-	Voltage
VFD	-	Variable frequency drive
AFD	-	Adjustable frequency drive
VSD	-	Variable speed drive
VVVF	-	Variable voltage Variable frequency
DC	-	Direct Current
IGBT	-	Insulated-gate bipolar transistor
PWM	-	Pulse width Modulation
I/O	-	input/output
A	-	Ampere
PC	-	Personal computer
NO	-	Normally open
NC	-	Normally close
RTD	-	Resistance temperature detector

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LIST OF SYMBOLS

N_S	-	Synchronous speed
F	-	Frequency
P	-	Number of poles
N_r	-	Rotor speed
s	-	slip
ω_s	-	angular mechanical speed
ω_m	-	angular rotor speed
R_1	-	Stator resistance
X_1	-	Stator reactance
R_2'	-	Rotor resistance referred to stator
X_1'	-	Rotor reactance referred to stator
R_c	-	Core losses resistance
X_m	-	Magnetizing reactance
P_g	-	Power input to rotor
P_{rc}	-	Rotor copper loss
P_m	-	Mechanical Power
V_{th}	-	Thevenin's equivalent voltage
R_{th}	-	Thevenin's equivalent resistance
X_{th}	-	Thevenin's equivalent reactance
T_{max}	-	Maximum torque
s_{maxT}	-	Slip at maximum torque
V_Φ	-	Phase voltage
I_Φ	-	Phase current

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T_{start}	-	Starting torque
T_L	-	Load torque
J	-	Moment of inertia
V/Hz	-	Voltage to frequency ratio
HP	-	Horsepower
%s	-	percentage of slip
Nm	-	Newton meter
τ	-	torque
P_{out}	-	Output power
η	-	Efficiency

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CHAPTER 1

INTRODUCTION

In this chapter, the background of the project has been discussed briefly. It includes the objectives, scope, and problem statement that had been defined at the initial stage of the project development. The planned methodology and the work breakdown structure of the project are also discussed here.

1.1 Project Overview

Three–phase induction motors plays an extremely important part of the modern day electric drive system and their usage is continuously on a rise due to their inherent properties of ruggedness, minimum maintenance requirements and continually increasing efficiencies.

A great deal of work is being done to improve control through simulation of the electric drives used for various high-power purposes. The accuracy of the simulated results is based on the precise modeling of the various parts of the electric drive system. Usually the three-phase induction motor model used in various research works in UTeM does not incorporate the closed loop speed control application. The present paper aims at

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developing a three-phase induction motor's speed control application where closed loop concept can be applied.

The biggest advantage is that the model is user-programmable in MATLAB environment and can be used for 3 phase induction motor parameter studies. The simulation results of the developed model, with various parameter variations taken into account and subjected to sudden changes in load, will not be a problem as the motor's speed will change accordingly through the feedback obtained via the inverter. The torque and speed performances of the motor both in steady state and dynamic conditions can be monitored using software.

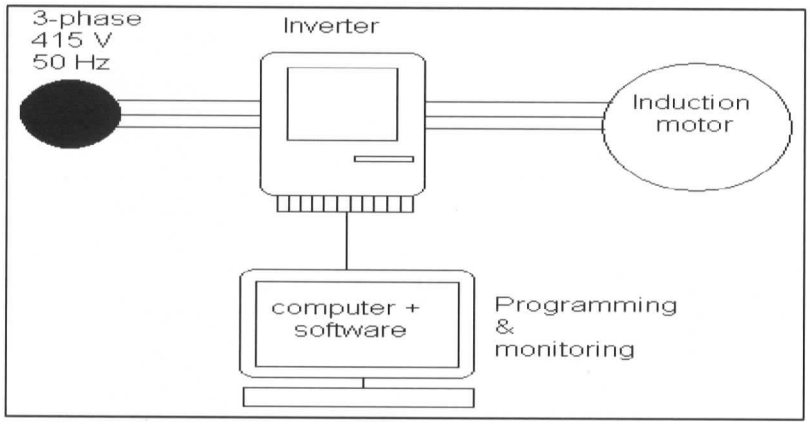

Figure 1.0: Closed loop speed control application overview

Figure 1.0 shows the basic concept of the project. The inverter is fed by a three phase supply to control the three phase induction motor by interfacing the system to computer which enables the programming of the inverter and monitoring of the motor's parameters.

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1.2 Project Objectives

There are few objectives that will be fulfilled in order to complete this project.

a. Simulation of speed control characteristics for the Lorenzo's 3 phase induction motor using MATLAB software.
b. Investigate the performance of 3 phase induction motor speed control using ABB inverter.
c. To develop or modify the appropriate application based on closed loop speed control concept.

1.3 Problem Statement

This project is being carried out due to the lack of close loop speed control application for 3 phase induction motor in the Faculty of Electrical Engineering laboratories which enables the user to monitor the parameters to avoid mishaps by choosing the wrong motor sizing for the maximum required load. This project is expected to be a guide line for students to study the characteristics of 3 phase induction motor in the future. This application will also be crucial in market for fields that require constant monitoring for the motor's parameters such as speed, proportional to the applied load.

1.4 Scope of Works

The project limitations that are considered in performing this project are:

a. This project only considers 3 phase induction motor (DE LORENZO DL1021) and a Low Voltage AC Drive which is 3 phase ABB Inverter (ACS 550-01-08A8-4).

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b. Test to be carried out on the 3 phase induction motor to obtain the per-phase equivalent circuit.
c. Simulation is done using MATLAB software to study the characteristics of three-phase induction motor.
d. The ABB inverter manual is studied in terms of operation and data setting for a closed loop speed control application for the 3 phase induction motor.

The scopes of works in this project can further be divided into 2 categories which are software development and hardware development and design.

1.4.1 Software Development

Software Development includes simulation using MATLAB software to observe the characteristics of the 3 phase induction motor in terms of speed, torque, frequency and current.

The 3 phase ABB inverter will be pre-programmed for a closed loop application and the result of the motor's characteristics with the change of load viewed through the software DriveWindows Light 2.

The characteristics obtained by simulation and by inverter will be compared to check the application's creditability.

1.4.2 Hardware Development and Design

The hardware development includes the connection of motor, inverter and integrating using the software. Upon completion of the hardware and software development, a suitable application such as blower is designed for this system.

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