

STUDY ON CONTROL FOR SMALL WIND TURBINE SYSTEM

BY
MOHD KHAIRIL BIN JAILANI

A THESIS SUBMITTED FOR BACHELOR OF
ELECTRICAL ENGINEERING (HONS)
AT THE UNIVERSITI TEKNOLOGI MARA (UiTM)

FACULTY OF
ELECTRICAL ENGINEERING
UNIVERSITI TEKNOLOGI MARA

NOV 2010

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent and Merciful, with the deepest gratefulness to Allah who has given me the strength and ability to complete this thesis.

First and the foremost, I would like to express my gratitude and most sincere appreciation towards my project supervisor, Pn Rahmatul Hidayah Bte Salimin for her kind guidance, criticism, advices and support in complete this project.

My gratitude also goes to my beloved family member, especially my mother, my father, Jailani Bin Adiat, for advices, prayers, encouragement and continuous moral support for the completion of my study in Universiti Teknologi MARA. A special thanks to all Jasper's community for their supports and contributions in making this thesis successful.

Special thanks to Noor Elyliana Bte Abu Talib for her valuable ideas and finding references during this project development.

I also want to dedicate my special thanks to others including the lecturers, the technicians that eagerly help me and not to be forgotten, electrical engineering community that willing to help me solving problem when I'm in the middle of confusion.

Last but not least, I would like to show a great gratitude for those who participate in either directly on indirect way involvement in completing the proposal. Thank you for the cooperation given for this task.

Thank you very much and may Allah bless you always.

ABSTRACT

Nowadays, there are many methods used to control wind turbine system in order to get the maximum energy extracted and maintain rated output power. However, the methods are used must meet the requirement to ensure stability and optimal performance. This thesis presents the study on control for small wind turbine system. In this project, a control algorithm employs direct torque sensing, and it adjusts rotor speed by changing the dump load resistance using single fuzzy logic controller. Changes in the dump load vary the armature current, as well as the armature torque, which sets the rotor speed towards the desired level. The fuzzy relations between the variables and the fuzzy rules were stated in detail. A dynamics of 5kW small wind turbine using the permanent magnet DC generator is modelled and wind data generation with flexible wind field model is included. Simplified models representing rotor aerodynamics are used. The scheme is simulated in Matlab Simulink and results are presented.

Keywords-component; Small wind turbine, Dynamic modelling, Fuzzy controller, Matlab Simulink

TABLE OF CONTENTS

ACKNOWLEDGEMENT	i
ABSTRACT	ii
TABLE OF CONTENTS	iii
LIST OF FIGURES	vii
LIST OF TABLES	ix
LIST OF SYMBOLS AND ABBREVIATIONS	x

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION.....	1
1.2 PROBLEM STATEMENT	3
1.3 PROJECT OBJECTIVE.....	4
1.4 SCOPE OF WORKS.....	4
1.5 THESIS ORGANIZATION.....	5

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION	6
2.2 SMALL WIND TURBINE TECHNOLOGY	6
2.3 TYPE OF WIND TURBINE.....	9
2.3.1 Horizontal Axis Wind Turbine	9
2.3.1.1 Upwind Wind Turbine	10
2.3.1.2 Downwind Wind Turbine	11
2.3.1.3 Horizontal Axis Wind Turbine Advantages.....	12
2.3.1.4 Horizontal Axis Wind Turbine Disadvantages	13
2.3.2 Vertical Axis Wind Turbine	14
2.3.2.1 Darrieus Wind Turbine	15
2.3.2.2 Giromill Wind Turbine	16
2.3.2.3 Savonius Wind Turbine.....	17
2.3.2.4 Vertical Axis Wind Turbine Advantages	18
2.3.2.5 Vertical Axis Wind Turbine Disadvantages	18

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Wind power is the conversion of wind energy into more useful forms, such as electricity, using wind turbines. Most modern wind power is generated in the form of electricity by converting the rotation of turbine blades into electrical current by means of an electrical generator [1].

Wind technology has been developed rapidly over the last few decades, as it is renewable, cost-effective and also causes little harm to the nature with respect to other conventional energy. One of the most important tasks of a control strategy for wind turbines is to limit the power input to the turbine to a level that the mechanical and electrical components of the turbine are able to handle. This must be achieved by reducing the power extracted from the wind. Large wind turbines are complex in operation, deploy multitude of control methods and operate in grid-connected mode. On the other hand, small wind turbines can be used for stand-alone as well as grid-connected system [2].

There are many configuration systems to control wind turbine that have been used in several wind turbines today such as an aerodynamic power control, fixed-speed system control and variable-speed system control [3]. Wind turbine generators used all over the world today are mostly operated with constant speed operation. This is mainly due to their simplicity in order of connection to the utility grid with no need of frequency conversion. However, constant speed operation implies that the mechanical structure of the turbine has to be strong as it is exposed to high loadings. Recently though, variable speed operation has gained interest, especially owing to their possibilities to lower stresses on the mechanical parts of the turbine [4].