OPTIMAL CONTROL OF CENTRIFUGAL WATER PUMP DRIVEN BY A HIGH SPEED WIND TURBINE

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Department of Electrical Engineering

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DECLARATION

This work submitted in this dissertation is result of my own investigation, except where otherwise stated

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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Date:

I endorse the declaration by candidate.

Dr.A. M. HarshaS. Abeykoon

Abstract

Agriculture is the main livelihood of the majority of the population of Sri Lanka and as such ours is defined as an agro based or agricultural economy. In this respect contribution of the farmers of the north and the east is immense and continue to receive attention of legislators and planners. As a result the largest ever irrigation scheme Mahaweli became a reality. However even in spite of a development project of that magnitude people of the Dry Zone still continue to face hardships due to lack of adequate supply of water for cultivation during the South – West Monsoon ("Yala" Season). It is high time we focussed our attention on a viable system to supplement existing irrigation systems in the dry zone. In this backdrop a wind based Lift Irrigation system is suggested due to high wind potential in this season.

It is essential to develop a system which requires low maintenance, is less labour intensive and highly productive. The study was focussed on developing a wind based electric water pumping system in order to replace the existing multi bladed wind water pump which has high failure rate. In the new system the water pump and the wind turbine are not required to be located at the same place and wind turbine can be installed in a good wind site.

As a solution, high speed wind turbine driven electric centrifugal pumping system was developed. This system works using Maximum Power Point Tracking (MPPT) base optimal controller to harvest the maximum power from the available wind without using a battery backup. This system was a wind sensor less application method and wind estimator was developed to have wind estimation for the controller by using PMG output voltage (V_e) and PMG output power (P_e) at a given instance. DC motor driven centrifugal pump voltage was controlled to have maximum available power using a Buck Boost controller. PI controller was used to provide the duty ratio for PWM generator that uses for the Buck Boost controlling. Maximum power point base optimum voltage finder provides the MPPT commands to the system to drive in maximum power points relevant to each and every wind speeds.

Centrifugal pump model for the variable speeds were developed in experimental base method and capacity of the pump is 1Hp with maximum flow rate of 2.3 l/s for the system. The NACA 4415 two bladed wind rotor was used with permanent magnet generator.

It was modelled and simulated using MATLAB Simulink 7.9 and simulated the performance of wind turbine generator and electrical centrifugal pump by optimal controlling (Maximum Power Point Tracking). Dynamic simulation was done for 1s wind data for one hour and steady state analysis was done for analyze the maximum performance.

Performance comparisons of the newly developed system as against multi bladed water pump system developed by NERD Centre, at Higurakgoda site, had been carried out and benefits were identified. It is established that the new system is capable of irrigating as much as twice the area than the existing one.

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TABLE OF CONTENTS

DECLARATION i
Abstract ii
Acknowledgment iii
List of Figures vii
List of Tables x
1 INTRODUCTION 1
1.2 Literature review 3
1.2.1 History of windmills 3
1.2.2 Water Pumping by Windmills 5
1.3 Objectives 11
2 CASE STUDY OF HIGURAKGODA MULTI BLADED WIND TURBINE TYPE WINDMILL PUMP 12
2.1 Main Specifications of the Multi Bladed wind turbine and windmill pump 12
2.2 Characteristic of Multi bladed wind rotor 13
2.3 Control system 14
2.4 Characteristics of Reciprocating Pump 15
2.5 Wind data Measurement and irrigation requiremnt in Higurakgoda 16
3 SYSTEM MODELLING AND SIMULATION 18
3.2 Why need of a controller 19
3.3 Maximum power point tracking (MPPT) 21
3.3.2 Maximum Power Point Tracking Methods 21
3.4 Wind Rotor Model 24
3.4.2 Aerodynamic characteristics of the rotor 24
3.4.3 Wind Rotor Mathematical model 26
3.4.4 Parameters of Modeled Wind Turbine 26
3.4.5 Calculation of wind rotor diameter 26
3.4.6 Block diagram and MatLab Simulink model of wind rotor 27
3.5 PMG Model 28
3.5.1 Wind rotor with PMG mathematical model 29

3.5.2 PMG equivalent model 30

3.5.3 PMG parameters taken for analysis 31

3.5.4 Wind rotor MATHLAB Simulink simulation model and curves 32

3.6 Optimum power control unit 33

3.6.1 Maximum Power point tracking unit 33

3.6.2 Lookup table base wind estimator 34

3.6.3 Maximum power point controlled optimum voltage finder 36

3.7 PI controlled BUCK BOOST model 37

3.7.1 Buck boost mathematical model 38

3.7.2 Buck boost MATHLAB Simulink simulation model and curves 39

3.7.3 Tuning of PI parameters 39

3.8 Centrifugal pump model 41

3.8.2 DC motor model 42

3.8.3 DC motor model (SIMULINK standard module) 43

3.8.4 DC motor mathematical model 44

3.8.5 DC Motor Parameters 45

4 DEVELOPMENT OF PUMP MODEL 47

4.1 Centrifugal Pump 47

4.2 Experiment to obtain pump curves 49

4.2.1 Objectives 49

4.2.2 Facility used 49

4.2.3 Experiment setup 49

4.2.4 Experiment procedure 50

4.2.5 Experiment Data of pumps 51

4.2.6 Result and Analysis (Output) 51

4.2.7 Selecting pump for the system 53

4.2.8 Lookup table base MatLab Simulink base Pump model 53

5 RESULTS AND ANALYSIS 57

5.1 Flow rate variation with the wind speed 57

5.2 Simulated System Flow Rate with wind speeds 58

5.3 Maximum Power Point Tracking with Wind Speeds 58

5.4 Maximum Electrical Power Point Tracking with PMG Output Voltage 59

5.5 Dynamic Analysis of the System with 1 S wind Data 60

5.5.2 Simulated Flow from 1s Wind Data 61

5.5.3 Power Tracking of the System 62

5.6 Analysis of Higurakgoda site data with wind turbine driven multi bladed system 63

5.7 Comparison of system flow rates of developed system and multi bladed windmill system 67

6 Discussion and conclusion 69

6.1 Benefits, Limitations and Drawbacks 69

6.2 Benefits and future uses of the system 70

6.3 Difficulties and future research 70

6.4 Concluding remarks 71

Reference 72

List of Figures

Figure 1.1 (a) Climatic Zones in Sri Lanka, (b) Rainfall of Sri Lanka 1

Figure 1.2 Wind speed variation at Nikawaratiya wind turbine site during a year 2008 - From NERDC wind data archive 2

Figure 1.3 Sri Lanka Wind Resource Map [NERL wind map.] 3

Figure 1.4 Block diagram of the water pumping system 6

Figure 1.5 Block diagram of the water pumping system 7

Figure 1.6 (a) Direct electrical connection between stator with coupled speed, (b) Connection thought full scale converters with decoupled speeds. 8

Figure 1.7 System scheme with torque and V/f = k control loops 8

Figure 1.8 System scheme with BDFIG control water pump 9

Figure 1.9 System scheme with torque and V/f = k control loops 9

Figure 1.10 Developed system schematics 10

Figure 2.1 (a) Water Pumping wind Pump, installed in North Central part (Higurakgoda) of Sri Lanka, (b) Blade geometry of NERD Multi bladed wind water pump 13

Figure 2.2 Performance curve of the NERDC wind rotor 14

Figure 2.3 Configuration of reciprocating pump 15

Figure 2.4 Characteristics Performance Curves of the Reciprocating Pump 15

Figure 2.5 Characteristics Performance of wind mill pump 16

Figure 2.6 Wind speed variation at Higurakgoda site during year on hourly average 17

Figure 3.1 Main Block Diagram of the System 18

Figure 3.2 Centrifugal pump curve with PMG curve for several wind speeds 20

Figure 3.3 System power curve (without optimum controller) 20

Figure 3.4 Maximum Power Point Tracking of Wind Rotor 21

Figure 3.5 Hill climbing 22

Figure 3.6 NACA 4415 High Speed Wind Blade 24

Figure 3.7 NACA 4415 High Speed Wind Blade C_p& C_T – λ (Tip speed ratio) relationship 26

Figure 3.8 Control block diagram of wind rotor 27

Figure 3.9 (a) MatLab Simulink model of wind rotor and (b) MatLab Simulink model block of wind rotor 27

Figure 3.10 Wind rotor shaft power curve 28

Figure 3.11 Wind rotor with PMG mathematical model 29

Figure 3.12 Equivalent DC Circuit of PMG 30

Figure 3.13 Block diagram of wind turbine + PMG model 31

Figure 3.14 PMG model block 31

Figure 3.15 PMG control block diagram 32

Figure 3.16	MatLab Simulink PMG block diagram	32
Figure 3.17	PMG output power curve	32
Figure 3.18	PMG model block	34
Figure 3.19	PMG output power curve for wind estimator	34
Figure 3.20	MatLab Simulink Programme for calculating the lookup table base wind speed estimator data	35
Figure 3.21	Lookup table of lookup table base wind estimator	36
Figure 3.22	(a) PMG output curve for several wind speeds and (b) Maximum power curve obtain for different wind speeds	36
Figure 3.23	Maximum PMG output voltage for different wind speeds	37
Figure 3.24	Equivalent Buck-Boost circuit	38
Figure 3.25	Buck boost control block diagram	39
Figure 3.26	Buck boost MatLab Simulink block diagram	39
Figure 3.27	Pump motor input voltage with change of the P & I changes	40
Figure 3.28	pump output water flow with change of the P & I changes	40
Figure 3.29	MatLab Simulink model of Centrifugal water pump	41
Figure 3.30	Input power vs. rotational speed 1Hp pump	41
Figure 3.31	Flow rate vs. rotational speed 1Hp pump	42
Figure 3.32	Shunt Wound - DC Operation, Typical Speed - Torque Curve	43
Figure 3.33	DC motor MatLab Simulink model block	43
Figure 3.34	DC motor parameters	45
Figure 3.35	System efficiencies	46
Figure 4.1	Cross section of a centrifugal pump	47
Figure 4.2	Pump characteristic curve	48
Figure 4.3	Experiment setup used to obtain the pump curves	50
Figure 4.4	(a) - Testing of 2Hp pump, (b) - Testing of 1Hp pump	50
Figure 4.5	Centrifugal pump model of Input torque variation	53
Figure 4.6	Input power vs. rotational speed 1Hp pump	54
Figure 4.7	Centrifugal pump model of Input flow variation	54
Figure 4.8	Flow rate vs. rotational speed 1Hp pump	55
Figure 4.9	Efficiency vs. rotational speed 1Hp pump	56
Figure 5.1	Flow rate variations with the wind speed	57
Figure 5.2	Simulated wind flow rate with wind speeds	58
Figure 5.3	Simulated maximum power point tacking curve with wind speeds	58
Figure 5.4	Simulated maximum power point tacking curve for wind speeds with PMG output voltage	59
Figure 5.5	Simulated maximum power point tacking curve for wind speeds with rated PMG output voltage	60

Figure 5.6	1sec wind data for 1 hour	60
Figure 5.7	Water pumping simulation done for 1 hour	61
Figure 5.8	Water pumping simulation done for 1 hour (zoomed view)	61
Figure 5.9	System PMG power simulation done for 1 hour	62
Figure 5.10	System PMG power simulation done for 1 hour (zoomed view)	62
Figure 5.11	Wind speed variation at Higurakgoda site during a year (1 hour data)	63
Figure 5.12	Simulated pump flow at Higurakgoda site during a year	63
Figure 5.13	Simulated pump flow at Higurakgoda site during each month	64
Figure 5.14	Irrigation requirement and simulated pump output at Higurakgoda site during each month	66
Figure 5.15	comparison of system flow rates of developed system and multi bladed windmill system	67
Figure 5.16	comparison of system efficiencies of developed system and multi bladed windmill system	68

List of Tables

Table 1.1	NERDC develop multi bladed wind water pumps present condition	4
Table 2.1	Geometrical Parameters of wind rotor	14
Table 2.2	Irrigation requirement in Higurakgoda, dry zone for each month	16
Table 3.1	Geometrical parameter of NACA 4415 blade	24
Table 4.1	Measured data for 1Hp pump and 2Hp pump	51
Table 4.2	Analyzed data for 1Hp pump	52
Table 4.3	Analyzed data for 2Hp pump	52
Table 4.4	Input power changes for 1Hp pump	54
Table 4.5	Flow rate changes for 1Hp pump	55
Table 4.6	Efficiency changes for 1Hp pump	56
Table 5.1	Simulated pump flow at Higurakgoda site during each month	64
Table 5.2	Typical Irrigation requirement in Higurakgoda site (dry zone - 2001)	65
Table 5.3	System simulated pump volume for month and average pump volume per day for each month	65
Table 5.4	Comparison of irrigation requirement for one hectare taken at Higurakgoda site and system pump output	67