Multiple Turbine Flow Distribution Control using Intelligent Controller in Mini Hydro Power Plant.

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Degree of Master of Science in Industrial Automation

Department of Electrical Engineering

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma

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Signature: Date:

……..

U L D V Deshapriya

The above candidate has carried out research for the Masters thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of the supervisor: Prof. A.G.B.P Jayasekara

Signature of the supervisor: Date:

……..

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my project supervisor, Prof. A.G.B.P Jayasekara in the Department of Electrical Engineering at the University of Moratuwa, for his continuous support in my M.Sc. studies and research. Their patience, motivation, enthusiasm, and guidance have been the source of inspiration behind my success.

I would also like to thank academic staff members of the Department of Electrical Engineering for their encouragement and insightful comments during progress review sessions.

I would like to express my sincere gratitude to Resus Energy PLC for the support extended to me. In particular, I thank the power plant supervisor and the staff of Moragaha Oya power plant for their dedication.

I would like to convey my sincere gratitude to my wife Buddhini Anushika and family members who helped me in numerous ways to achieve my targets all the time.

Last but not least, I would like to thank my brother Tharindu Sampath for his excellent craftsmanship in the design and fabrication of all hardware components installed in the power plant.

ABSTRACT

Mini hydropower plants have been located at relatively small streams such streams often found upstream of a large river system. With a small catchment and high runoff, those stream parameters such as flow, debris content and water purity are highly dynamic with seasonal intense rainfall.

To generate maximum electricity from river available flow, mini hydropower plants are equipped with multiple turbines. Thus, different flow combinations can be used to harvest maximum energy. The Present flow distribution control technique consists of a PID loop and a pre-tuned flow distribution table which allocates flow to each turbine by changing wicket gate opening depending upon available river flow.

But as a result of variable stream parameters, water density and penstock friction losses will drastically change and therefore a flow distribution combination given by the existing controller may not be the optimum combination for the given moment. with alternating upstream rainfalls, most mini hydropower plants are not able to reach maximum design capacity even with 100% flow until clear water appears in the river.

This research aims to introduce an artificial neuron network based intelligent controller which will measure flow variables and update the flow distribution table frequently ensuring optimum flow distribution and maximum power generation.

"Moragaha Oya" mini hydropower plant located in Kandy district, Sri Lanka is selected as the test site for this research. Required additional hardware has been installed for the water quality and rainfall measurements. Developed intelligent controller with data collection and training software has been installed in power plant control computer enabling the update of flow distribution table. The intelligent controller has been trained and performance validation completed.

A significant improvement of total output power has been obtained during performance validation, especially during the flow conditions where the existing controller could not obtain the optimum flow condition. the maximum output power increment is recorded as 3% of the previous maximum output power. By using energy harvest data of 47 days and rainfall data of the last 4 years, a 2% increment of annual energy harvest was also predicted during performance validation. Required further developments were also identified.

The findings of this research may very important to renewable energy developers to optimize their powerplant yield.

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LIST OF ABBREVIATIONS

Abbreviation	Description
NCRE	- Non-Conventional Renewable Energy
IPP	- Independent Power Producers
IRR	- Internal Rate of Return
HV	- High Voltage
PLC	- Programmable Logic Controller
SCADA	- Supervisory Control and Data Acquisition
HMI	- Human Machine Interface
MV	- Medium Voltage
PID	- Proportional Integral Derivative
3D	-Three Dimensional
PC	- Personal Computer
ANN	- Artificial Neural Network
GUI	- Graphical User Interface
TDS	- Total Dissolved solids
TSS	- Total Suspended solids
RMS	- Root Mean Square
NTU	- Nephelometric Turbidity Units
CPU	- Central Processing Unit
AC	- Alternating Current
DC	- Direct Current
LED	- Light Emitting Diode
TCP	- Transmission Control Protocol
RAM	- Random Access Memory
yr	- Year

hr - Hour

LIST OF APPENDICES

OBJECTIVE

"The specific objective of this research is to identify the relationship between water quality parameters and the power loss and develop an intelligent controller capable of distributing water flow between turbines based on identified inputs that ensure maximum power generation at an available flow."