OPTIMIZATION OF MULTI AGENT BASED ENERGY MANAGEMENT SYSTEMS USING REINFORCEMENT LEARNING FOR MICROGRIDS

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Degree of Master of Science

Department of Electrical Engineering

University of Moratuwa

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November 2021

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
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DECLARATION

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Name of the supervisor 1: Prof. K. T. M. U. Hemapala

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Name of the supervisor: Prof. W. D. A. S. Wijayapala

Signature of the supervisor: Date:

ABSTRACT

People's concerns about environmentally friendly power generation have given rise to a new concept known as distributed generation. The integration of renewable-based distributed generation resources into the main power grid, on the other hand, is difficult due to their constant monitoring and control requirements. As a result, microgrids have been identified as appropriate platforms for integrating distributed generation resources and loads. Instead of using traditional centralized control architecture, these microgrids use distributed control systems like multi-agent-based systems as a novel approach. Social, reactive, proactive, and autonomous are the common features of these control agents. These agents can be improved by using machine learning-based technologies to introduce intelligence. As a result, the focus of this research is on using Reinforcement Learning as an experimental machine learning method to optimize the energy generation function of a grid-connected microgrid so that the microgrid's grid dependency is minimized as the agent learns. To determine the best technique for system optimization, the proposed microgrid's performance is tested using single and multi-agent reinforcement learning models in Python. A hardware testbed is developed for the selected high-performance model to demonstrate the practical applicability of reinforcement learning.

Keywords: Distributed Generation, Energy management, Microgrid, Multi-Agent, Neural network, python programming, Q learning, Reinforcement learning

ACKNOWLEDGEMENTS

I would like to convey heartfelt gratitude to Prof. K. T. M. U. Hemapala and Prof. W. D. A. S. Wijayapala who supervised and guided me throughout this research. Without their immense guidance, shared experiences, assistance and motivation it would have been impossible to achieve the targeted objectives successfully. I would be much obliged to Prof. K. T. M. U. Hemapala, Head of the Department of Electrical Engineering, for giving permission to use necessary lab facilities under the guidance of the laboratory staff.

And also, I would like to convey gratitude to my evaluation panel members, Dr. W. D. Prasad and Dr. S. K. Abeygunawardane for their kind guidance from the very beginning to the end of the research by encouraging to achieve the targets. Comments and guidance given during all the progress reviews were highly helpful for the development of the research. I highly appreciate the assistance provided by the academic staff of the Department of Electrical Engineering for their valuable suggestions, comments and assistance. I am thankful to the staff members of Faculty of Graduate Studies and Post Graduate Studies Division, University of Moratuwa for their administrative assistant.

I would gratefully acknowledge the financial assistant provided by the Senate Research Committee (SRC), University of Moratuwa under the grant SRC/LT/2018/22.

I would like to thank all the laboratory staff members of Department of Electrical Engineering University of Moratuwa for giving their support in carrying out our project works. We deeply appreciate the assistance of Mr. Asoka Chandana and Mr. S. J. B. Mahanthe at power systems laboratory.

My special thanks go to the members and colleagues of smart grid research laboratory of the Department of Electrical Engineering for their supportive nature throughout this research. And also, I would like to convey my heartiest gratitude to my family members for being the strength and encouragement in each and every step. Finally, I would like to thank all who helped me in any mean for the successful completion of the research.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AGC	Automatic Generation Control
ANN	Artificial Neural Network
CN	Convolutional Neural
DER	Distributed Energy Resource
DG	Distributed Generation
DoD	Depth of Discharge
DQL	Deep Q Learning
IDLE	Integrated Development Environment
LCD	Liquid Crystal Display
MAE	Mean Absolute Error
MARL	Multi-Agent Reinforcement Learning
MAS	Multi-Agent System
MC	Monte Carlo
MCU	Micro Controller Unit
MDP	Markov Decision Process
MLP	Multi-Layer Perceptron
NCRE	Non-Conventional Renewable Energy
PCC	Point of Common Coupling
PV	Photovoltaic
RER	Renewable Energy Resource
ReLu	Rectified Linear Unit

RL	Reinforcement Learning
RMSE	Root Mean Square Error
RN	Recurrent Neural
RSE	Residual Standard Error
SARL	Single Agent Reinforcement Learning
TD	Temporal Difference
TOU	Time of Use
UCB	Upper Confidence Bound

LIST OF APPENDICES