DESIGN OF AN ADAPTIVE OVERCURRENT PROTECTION SYSTEM FOR MICROGRIDS

Thiramuni Sisitha Sameera Senarathna

188117D

Degree of Master of Science by Research

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

April 2020

DESIGN OF AN ADAPTIVE OVERCURRENT PROTECTION SYSTEM FOR MICROGRIDS

Thiramuni Sisitha Sameera Senarathna

188117D

Thesis submitted in fulfilment of the requirements for the degree of Master of Science by Research

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

April 2020

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Masters/MPhil/PhD thesis/ Dissertation under my supervision.

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

Signature of the supervisor: Date

ABSTRACT

Microgrids have been popularized in the past decade due to their ability to add distributed generation into the classic distribution systems. Protection problems are among several other problems that need solutions in order to extract the full capability of these novel networks. This research follows the branches of two major solutions, namely Adaptive protection, and Protection Optimization.

Adaptive protection implementation with a novel concept of clustering is studied and protection setting optimization is done using a novel hybrid nature-inspired algorithm. Two test system models are used to test the performance of the proposing method as final outcome being the operating time of relays due to different faults.

The selected algorithm proven to be effective than most other algorithms and the clustering approach for adaptive protection was able to reduce the number of adaptive groups.

Keywords— Adaptive Protection, Microgrid Protection, Protection Optimization, Directional Overcurrent Protection, Nature Inspired Optimization Algorithm, k-means Clustering

ACKNOWLEDGEMENT

Foremost, I would like to express my gratitude to my supervisor Professor Udayanga Hemapala for his guidance and support throughout my research. It's my pleasure to acknowledge all the other academic staff members of the Electrical Engineering Department of the University of Moratuwa for their valuable advice and support which were valuable in achieving project goals.

I am grateful to the National Research Council for the financial support provided through their grant scheme in carrying out the research.

I also want to acknowledge the technical officers and other supporting staff of the Electrical Machines laboratory for their assistance to carry out laboratory trials.

Furthermore, I would like to extend my gratitude to my family for their encouragement, understanding and patience throughout my academic pursuit. Finally, I am grateful to my colleagues and friends for showing interest in my work and giving constructive ideas towards the success of the research.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CT	Current Transformer
CTI	Coordination Time Interval
DER	Distributed Energy Resources
DFIG	Doubly-Fed Induction Generators
DG	Distributed Generation
DOCR	Directional Overcurrent Relays
ECDG	Electronically Coupled Distributed Generation
ESS	Energy Storage Systems
IIDG	Inverter Interfaced Distributed Generation
VSC	Voltage Source Converter
LOG	Loss of Grid
LOM	Loss of Mains
MINLP	Mixed-Integer Non-Linear Programming
NIA	Nature-Inspired Algorithms
PCC	Point of Common Coupling
PS	Pickup Setting
SG	Synchronous Generator
SSC	Symmetrical Short Circuit
TDS	Time Dial Setting
WCMFO	Water Cycle - Moth Flame Optimization