OVERCURRENT RELAY COORDINATION WITH DIFFERENTPENETRATION IN DISTRIBUTED GENERATION

LINA MAJID MOHAMMED

UNIVERSITI TEKNOLOGI MALAYSIA

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LINA MAJID MOHAMMED

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Power distribution network is suspected to performance degrading factors alike load fluctuation which trigger the power losses. In order to substitute the losses in distribution network; known amount of power is being injected directly into load through using of distributed generators (DGs). This alternative can be used to substitute power in range of 25 to 40 percent of the respective busbar load. The integrating of DG into power system influences the protection relays stability which leads to relays miscoordination. Prolonged fault clearance time is one of the negative correspondence of relays miscoordination. The more time required to clear faults is biggest threat to distribution network safety which allows more damages of power equipments. Traditionally, heuristic algorithm such as genetic algorithm are used to optimize the relay parameters d such as dialling time TSD. In this project, we modifiedthe standard fitness function of the genetic algorithm by integrating a new parameterinto it for best optimization. The proposed algorithm is outperformed while it is appliedon 6 bus distribution system.

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ABSTRAK

Rangkaian pengagihan kuasa disyaki mempunyai faktor penurunan prestasi sama seperti turun naik beban yang mencetuskan kehilangan kuasa. Untuk menggantikan kerugian dalam rangkaian pengedaran; jumlah kuasa yang diketahui sedang disuntik terus ke dalam beban melalui penggunaan penjana teragih (DGs). Alternatif ini boleh digunakan untuk menggantikan kuasa dalam julat 25 hingga 40 peratus daripada beban bar bas masing-masing. Penyepaduan DG ke dalam sistem kuasa mempengaruhi kestabilan geganti perlindungan yang membawa kepada salah koordinasi geganti. Masa pembersihan kerosakan yang berpanjangan adalah salah satu koresponden negatif salah koordinasi geganti. Lebih banyak masa yang diperlukan untuk membersihkan kerosakan adalah ancaman terbesar kepada keselamatan rangkaian pengedaran yang membolehkan lebih banyak kerosakan peralatan kuasa. Secara tradisinya, algoritma heuristik seperti algoritma genetik digunakan untuk mengoptimumkan parameter geganti d seperti masa mendail TSD. Dalam projek ini, kami mengubah suai fungsi kecergasan standard algoritma genetik dengan menyepadukan parameter baharu ke dalamnya untuk pengoptimuman terbaik. Algoritma yang dicadangkan adalah mengatasi prestasi semasa ia digunakan pada sistem pengedaran 6 bas.

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LIST OF ABBREVIATIONS

ANN	-	Artificial Neural Network
TDS	-	Time Dialing Settings
NLP	-	Non-Linear Programming
MILP	-	Mixed-Integer Linear Programming
PTS	-	Pickup Tap Setting
IBDERs	-	Inverter-Based Distributed Energy Resources
FCL	-	Fault Current Limiters
SVM	-	Support Vector Machines
OCR	-	OverCurrent Relays
TMS	-	Time Multiplier Setting
CTI	-	Coordination Time of Interval
IDMT	-	Inverse Definite Minimum Time
GWO	-	Grey Wolf Optimization
DOC	-	Directional Over Current
PSO	-	Particle Swarm Optimization
ED	-	Empirical Decomposition
DT	-	Decision Trees
DG	-	Distributed Generation
TLBO	-	Teaching Learning Based Optimization
DOCR	-	Directional Over Current Relays
IWO	-	Invasive Weed Optimization
OF	-	Objective Function
TCCs	-	Time-Current Characteristics
SI	-	Standard Inverse
VI	-	Very Inverse
Ti	-	Operating Time
MDE	-	Modified Differential Evolution
OCDE	-	Opposition Based Chaotic Differential Evolution
OCDE	-	Opposition Based Chaotic Differential Evolution
GA	-	Genetic Algorithm

AC	-	Alternating Current
BRT	-	Bus Rapid Transit
DSM	-	Demand-side management
FIT	-	Feed-in tariff
kW/kWh	-	Kilowatt/kilowatt-hour
DESCO	-	Distributed Energy Service Company
DRE	-	Distributed renewable energy for energy access

LIST OF SYMBOLS

Δ	-	Minimal error
Zs	-	Impedance of the grid and primary transformer
Zg	-	Impedance of the generator
ZL	-	the impedance of the feeder
$l1$	-	Current from the grid
$l2$	-	Current from the generator
P	-	penetration level
N_{Bus}	-	Number of busbars
S_L	-	Load Power (p. u.)
S_G	-	Generated Power (p. u.)
R_{Bus}	-	Busbar type indicator (0, 1, 1…)
$L_{Matrix'}$	-	Upgraded busbar wise DG power to inserted into the system
$PG_{Matrix'}$	-	Final busbar generated power after insertion of DG
IP	-	Pick-up current
Isc	-	the short circuit current

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Since the power distribution system propagates over large scales of geographical locations holding the electrical power for a large number of end-users; several kinds of power losses are likely to be raised. Faults might exist in various locations of power systems including generation stations, transmission lines, and even in protection components. Upon its existence, current in large amounts is passed to the fault point which brings the undesired losses into practice [1].

A protection mechanism is a crucial component that can have a substantial impact on system performance. An inappropriate tripping sequence could arise from a scheme failure, causing the system to fail and causing harm to customers. Small configuration problems might prolong the fault-clearing process and cause system feeding to the problem to take longer than expected. Because of its capacity to detect problems in a specific area, unit protection, such as pilot wire and current differential relays, is typically utilized as the primary protection [2].

Non-unit devices, such as distance and overcurrent relays, provide backup protection by detecting in-zone and out-zone failures that are characterized by time coordination. To identify problems, a transmission line's current differential relay relies on communication between substations, and if contact is lost, both substations' protection is deactivated. A distance relay, on the other hand, has one advantage over a standard differential relay: the protection on the opposite side of the distance relay does not fail if one side of the distance relay fails. Engineers may use the distance relay to create more secure and dependable protection schemes since it gives them the tools and flexibility they need. To maintain the power system reliability, faults should be cleared in a fast and reliable manner where further damages to the system can be prevented. In this work, an enhanced protection scheme is proposed for reliable and fast clearance of faults [3].

1.2 Problem statement

Over-current relay (OCR) is a vital component of its power network which takes the responsibility of isolating the faulty lines. That is essential to minimize the loss and safeguard the power equipment. The existence of variable capacity distributed generators (DG) in power networks hurts the coordination of protection relays. Relay reconfiguration is required to maintain the coordination between main and backup protection.

Several approaches are in use for optimizing the configurations of relays in such a way it the relay tolerance to the network fluctuation is increased without violating the main and backup relays coordination. The approaches used for optimizing the relays coordination can be categorized into two groups: traditional analytical approaches and computational (automatic/computational) approaches.

The first category is meant for the deployment of mathematical calculations which solve the highly constrained formulas of coordination. Such a method is complex and can be used for solving coordination problems at the time. On the other hand, the automatic method exists as well which solves the coordination problem using artificial intelligence. Those methods are more adaptable than the previous approach since flexible and quick coordination can be achieved.

A set of issues were reported after the deployment of automatic approaches including miscoordination of relays. That is recognized by monitoring the difference between the main and backup relay times. It is realized that in most cases negative time difference between relays is produced which means that the back backup relay is switching before the main relay making other healthy sectors of the power network to be isolated.

1.3 Research Goal

This research aims to evaluate the influence of distribution generators on the electrical system.

1. To Study the impact of varied penetration sizes on over-current relay coordination and implement an algorithm approach to reduce system uptime for each penetration scenario.

2. To optimize the relays coordination using GA optimization solution.

3. To adopt enhanced protection relay coordination mechanism in presence of DG.

1.4 Research scope

To reduce the overall TDS of relays, past studies have focused on the synchronization of protective system components. There are major consequences for power systems' stability when distributed generators are introduced. Even while prior techniques have managed to reduce overall TDS by improving the timings of each relay this study involves proposing an efficient relay says setting to mitigate the negative impact of distributed generators at different levels of penetration. Optimization of relays dialing settings using a genetic algorithm to create strong coordination invarious DG penetrations is the main focus of this research.

1.5 Proposed work

This dissertation report is consisting of five chapters that prescribe the proposed methodology and technologies of distribution generator coordination with the power grid. On the other hand, the impact of loads and other performance degradation on the power system is to be discussed. Therefore, the structure of this dissertation report can be as herein (Table 1.1):

Table 1.1 Thesis structure and contains a summary.

Chapter	Chapter Title	Brief Introduction
1	Introduction	Includes a summarized introduction of the distributed generator coordination problem and illustrates the problemstatement and the objectives of the project.
2	Literature Review	Demonstrates the previous attempts made in the interest of power system performance enhancement by optimizing protection system coordination.
3	Methodology	Illustrates the infrastructure of thedistribution system as well as the methods adopted for coordinating the protection components.
4	Results and Discussions	Reviews with the required discussions the results obtained after involving the coordination optimization procedure.
5	Conclusion	Enlists the references and books usedwhile constructing this thesis.

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