FAULT DETECTION AND CLASSIFICATION USING ARTIFFICIAL NEURAL NETWORK (ANN)

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DEDICATION

This thesis is dedicated to my beloved parents, En. Mohd Lutpee bin Salleh and Pn. Faizah binti Ali, my supervisor, Assoc. Prof Ir Dr Saifulnizam bin Abd. Khalid, my family and all my supportive friends.

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ABSTRACT

Various reasons contribute to the occurrence of transmission line faults, which lead to system outages. To prevent power supply failure, a transmission line failure must be detected and isolated as soon as possible. This study aims to establish a system for identifying and classifying the various kinds of faults that might occur in power transmission lines, by using the Artificial Neural Network method. ANN is one of the most effective methods for identifying and diagnosing faults that have occurred. To develop ANN, backpropagation was used as a learning algorithm that could handle large volumes of data. These were the detection and classification training methods used by Levenberg-Marquardt (trainlm) and Scaled-Conjugate Gradient (trainscg). In order to implement this project, the ANN, feed-forward-networks-with-backpropagation algorithms for each phase (voltage and current) are selected. Based on the simulation results, fault voltages and currents are measured and allocated as input data for ANN. The training data set consists of with faults and without faults on three-phase lines and ground. MATLAB Simulink was used in this study to run tests on 14-bus, 30-bus, and 57-bus systems to generate fault parameters. This project examines neural network output for Line-to-Line-faults, Single-Line-to-Ground faults, and Double Line-to-Ground faults. Then, import the data into MATLAB as input for ANN to-detect-and-classify-the fault. Three critical phases are used in ANNs: training, validation, and testing. The mean squared error (MSE), correlation coefficient, and confusion matrix are all used to evaluate the detection and identification network efficiency. The detection in the 14-bus system achieves a satisfactory MSE of 1.8857e-15, correlation of 1, and accuracy of 100%, indicating that the performance of the system is excellent. Meanwhile, the classification achieved a reasonable MSE of 0.48107, a correlation of 0.75643, and an accuracy of 80%, indicating that the system is acceptable.

ABSTRAK

Sistem perlindungan yang berkesan dan boleh dipercayai diperlukan untuk bekalan elektrik berkualiti tinggi kerana ia mesti mampu menangani kerosakan dalam talian penghantaran yang disebabkan oleh sumber rawak yang tidak dapat diramalkan. Untuk mengelakkan kegagalan bekalan kuasa, kegagalan talian penghantaran mesti dikesan dan diasingkan secepat mungkin. Kajian ini bertujuan untuk mewujudkan satu sistem untuk mengenal pasti dan mengklasifikasikan pelbagai jenis kerosakan yang mungkin berlaku dalam talian penghantaran kuasa, dengan menggunakan kaedah Rangkaian Neural Buatan. ANN adalah salah satu kaedah yang paling berkesan untuk mengenal pasti dan mendiagnosis kesalahan yang telah berlaku. Untuk membangunkan ANN, perambatan belakang digunakan sebagai algoritma pembelajaran yang boleh mengendalikan jumlah data yang besar. Ini adalah kaedah latihan pengesanan dan pengelasan yang digunakan oleh Levenberg-Marquardt (trainlm) dan Gradient Scaled-Conjugate (trainscg). Untuk melaksanakan projek ini, algoritma ANN, suapan ke hadapan rangkaian dengan perambatan belakang untuk setiap fasa (voltan dan arus) dipilih. Berdasarkan keputusan simulasi, voltan dan arus kerosakan diukur dan diperuntukkan sebagai data input untuk ANN. Set data latihan terdiri daripada dengan kerosakan dan tanpa kerosakan pada garisan dan tanah tiga fasa. MATLAB Simulink telah digunakan dalam kajian ini untuk menjalankan ujian pada sistem 14-bas, 30-bas, dan 57-bas untuk menjana parameter kerosakan. Projek ini mengkaji keluaran rangkaian saraf untuk ralat Talian ke Baris, ralat Talian Tunggal-ke-Ground, dan ralat Talian-ke-Ground Berganda. Kemudian, import data ke dalam MATLAB sebagai input untuk ANN untuk mengesan dan mengklasifikasikan kesalahan. Tiga fasa kritikal digunakan dalam ANN: latihan, pengesahan dan ujian. Purata ralat kuasa dua (MSE), pekali korelasi, dan matriks kekeliruan semuanya digunakan untuk menilai kecekapan rangkaian pengesanan dan pengenalpastian. Pengesanan dalam sistem 14-bas mencapai MSE yang memuaskan iaitu 1.8857e-15, korelasi 1, dan ketepatan 100%, menunjukkan bahawa prestasi sistem adalah cemerlang. Sementara itu, klasifikasi mencapai MSE munasabah 0.48107, korelasi 0.75643, dan ketepatan 80%, menunjukkan bahawa sistem itu boleh diterima..

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LIST OF ABBREVIATIONS

ANN	-	Artificial Neural Network
AI	-	Artificial Intelligence
BPNN	-	Backpropagation Neural Network
MSE	-	Mean Squared Error
SLG	-	Single Line-to-Ground
DLG	-	Double Line-to-Ground
LL	-	Line-to-Line
V	-	Voltage
I	-	Current

CHAPTER 1

INTRODUCTION

1.1 Research Background

The electrical power system is split up into three subsystems: generation, transmission, and distribution. Transmission lines are the main components of electrical power systems that provide a pathway for electricity to be transferred from generation to distribution. Since transmission lines are constantly exposed to the environment, they are prone to various forms of damage. Fault to the power transmission line can cause power outages[1]. Faults are abnormal conditions that occur between two phases or between one phase and the ground, especially in transmission lines[2]. In order to avoid disruption, a failure on the transmission line must be identified and immediately isolated. To avoid unstable problems which can impact the system, it is necessary to detect, identify and clear defects with high speed, selectivity and accuracy.

An excellent fault detection system allows for an effective, dependable, fast, and safe relaying operation[3]. There are two categories of faults. Transmission lines can experience either symmetrical faults or unsymmetrical faults. Unsymmetrical faults can be broken down into three categories: Line-to-Line faults (LL), Single Line-to-Ground faults (SLG), and Double Line-to-Ground faults (DLG) three types of electrical interference[4]. The SLG fault is the most common, followed in frequency of occurrence by the LL fault, DLG fault, and three-phase fault[5].

There are several approaches for detecting and classifying faults, including artificial neural networks (ANN), Fast Fourier Transform (FFT) and Discrete Wavelet Transform (DWT), and others. When it comes to fault detection, each technique has benefits and drawbacks. ANN has excellent characteristics such as generalization,

noise immunity, robustness, and fault resistance[6]. ANN also are extremely effective at recognizing and classifying patterns using pattern recognition[7].

1.2 Problem Statement

Damage to the power system transmission line accounts for most of the voltage and current signal interference[8]. Interruption of the power supply might result in power transmission line failures and customer loss of power supply. However, simply detecting faults is insufficient. It is preferable to have a system that can identify different types of faults in order to take fast and effective corrective action [7].

Hence, the purpose of this research proposal is to identify the fault in the transmission line using the ANN. As a result of the accurate information about the fault provided by the automated system, the amount of time required to detect the fault can be reduced. [9][10]. It is also necessary to distinguish types of faults in the transmission line so that action speed up the process to fix these faults and hence manage to avoid damage the equipment [11].

1.3 Research Objective

The objectives of this project are to solve of all the problems that happened prior to the study. The research objective of the study is:

(a) To diagnose the unsymmetrical fault in the transmission line by using an Artificial Neural Network (ANN).

(b) To identify and classify the fault in the transmission line by using electrical parameter such as Voltage (V) and Current (I).

(c) To compare the output performance of three test cases (14 bus, 30 bus and 57 bus) by using MATLAB Simulink 2021b.

1.4 Scope of Work

The scope of this study is to use an Artificial Neural Network (ANN) to classify and diagnose transmission line faults. In this project, Backpropagation Neural Network (BPNN) will be used since it has more advantages such as fast, simple and easy to program[12].

The limiting works are based on Single Line-to-Ground, Line-to-Line, and Double Line-to-Ground power transmission faults since the transmission line usually has these kinds of faults, the analysis will focus on the performance plot, regression fit plot, and confusion matrices are used to calculate the results[13]. To simulate a power transmission line failure, MATLAB R2021b software will be used.

1.5 Structure of Thesis

This work comprises five main chapters. The following contents were discussed in each chapter:

Chapter 1 discusses the background of the study, the statement of the problem to be solved, the objectives of the project, the scope of the study, and the organization of the thesis. Chapter 2 discusses the literature review on faults and Artificial Neural Network (ANN) which are used in this research.

Chapter 3 describes the overall steps and process, starting with the input and ending with the output. This chapter provides an overview of the research approach conducted to detect the fault using ANN. Chapter 4 presents the results and discussion obtained from doing simulation in MATLAB 2021b.

Lastly, chapter 5 summarises the project's development results and recommendations for future work.

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