Predicting and Determining Faults Using Deep Learning on the 161kV Transmission Line from Aboadze Thermal Power Station to New Obuasi, Ghana

David Laud Amenyo Fiase[1], Kwadwo Opoku Attah[2], Prince Sackey[3], and Samuel Lartey[4]

david.fiase@regent.edu.gh; opoku.attah@regent.edu.gh; prince.sackey@regent.edu.gh ; samuel.lartey@regent.edu.gh

Regent University College of Science and Technology, P.O. Box DS1636-dansoman, Accra-Ghana

Abstract

This research explores the application of deep learning, specifically artificial neural networks, to predict and determine faults on the 161kV transmission line from Aboadze Thermal Power Station through Takoradi, Tarkwa, and Prestea to New Obuasi in Ghana. This transmission line is critical due to its role in supplying power to New Obuasi, one of the richest gold mining communities in the country. The study aims to use a deep learning approach to detect, classify, and determine the accuracy of fault predictions to ensure uninterrupted power supply. The methodology includes data collection from the transmission line, training an artificial neural network model, and evaluating its performance. Results indicate high accuracy in fault prediction, enabling timely and effective maintenance. The study concludes with recommendations for integrating deep learning models into the power grid's fault detection systems to enhance reliability and efficiency.

Keywords: Long Short-Term Memory (LSTM) networks; Convolutional Neural Networks (CNNs)

Introduction

The 161kV transmission line from Aboadze Thermal Power Station through Takoradi, Tarkwa, and Prestea to New Obuasi is crucial for delivering uninterrupted power to one of Ghana's richest gold mining communities. Ensuring a reliable power supply is essential for the continuous operation of mining activities. However, maintaining the integrity of this transmission line is challenging due to the potential for faults, which can lead to power outages. This research investigates the use of deep learning, particularly artificial neural networks, to predict and determine faults along this critical transmission line.

Problem Statement

The transmission line from Aboadze to New Obuasi is vital for the continuous operation of the gold mining community. Any faults along this line can result in significant disruptions to power supply, impacting mining operations and economic output. Traditional fault detection methods are often reactive and can result in delays in fault identification and rectification. This study aims to develop a predictive model using deep learning to proactively detect and classify faults, ensuring timely maintenance and reducing the risk of power outages.

Study Objectives

The study aims to apply deep learning techniques to enhance fault detection on the 161kV transmission line. The specific objectives are:

1. To develop a deep learning model for predicting faults on the transmission line.
2. To classify different types of faults using artificial neural networks.

3. To determine the accuracy of the model in fault detection.
4. To evaluate the model's performance in real-time fault detection and classification.

Literature Review

Recent advancements in deep learning and artificial neural networks have shown significant potential in various domains, including power systems. Fault detection in power systems is critical for ensuring reliability and minimizing downtime. Traditional fault detection methods rely on manual inspection and simple statistical models, which can be time-consuming and less accurate.

Studies have demonstrated the effectiveness of machine learning techniques, particularly deep learning, in fault detection and classification. For instance, Li et al. (2019) applied convolutional neural networks (CNNs) to detect faults in power grids, achieving high accuracy and real-time performance. Similarly, Zhang et al. (2020) used a deep learning approach to identify faults in transmission lines, highlighting the robustness and efficiency of these models compared to traditional methods.

Deep learning models, such as artificial neural networks, can analyze large datasets, identify patterns, and make accurate predictions. These models are particularly useful in handling the complexity and variability of data from power systems. Furthermore, advancements in sensor technology and data acquisition systems have enabled the collection of high-resolution data, which can be used to train and optimize deep learning models for fault detection.

Theoretical Frameworks

The study is anchored in the theory of deep learning and its application in predictive maintenance. The artificial neural network (ANN) technique is utilized to analyze large datasets, identify patterns, and predict faults. The risk-assessment framework is used to evaluate the potential risks and benefits of integrating deep learning into the fault detection system.

Methodology

The methodology involves:

1. Data Collection: Gathering historical data on transmission line faults, including voltage, current, and environmental conditions.
2. Model Development: Training an artificial neural network model to predict and classify faults using the collected data.
3. Model Evaluation: Using statistical techniques to evaluate the model's accuracy and performance in detecting faults.
4. Real-time Implementation: Testing the model in a real-time environment to assess its effectiveness in predicting and classifying faults.

Results

The study finds that the deep learning model significantly enhances fault detection on the 161kV transmission line. The model accurately predicts and classifies faults, reducing the time required for fault identification and rectification. This leads to improved reliability of the power supply to New Obuasi, minimizing disruptions to mining operations.

Conclusion

The application of deep learning, specifically artificial neural networks, in fault detection on the 161kV transmission line from Aboadze to New Obuasi has demonstrated significant benefits. The model's high accuracy in predicting and classifying faults ensures timely maintenance and uninterrupted power supply. However, careful management of data security and integration challenges is essential. A balanced approach, involving continuous training and updates to the model, is recommended to maximize its effectiveness.

References

Frank Otchere, Fredrick Okang and Co, “2020 Electricity Supply Plan for the Ghana Power System”, 2020, published by Electricity Supply Grid Committee;

PSEC,” Ghana Power Reliability Report 2010”, March 2010, published by Power System Energy consulting

Volta River Authority,” Power Network Ghana 2014”, 2014, published by VRA;

Baskar. D, Dr. Selvam. P, “Machine Learning Framework For Power System Fault Detection And Classification” Vol 9, 2020;

Majid Jamil, Sanjeev Kumar Sharma* and Rajveer Singh, “Fault detection and classification in electrical power transmission system using artificial neural network”, Spring open journal, 2015;

D. Nguyen, R. Barella, S. A. Wallace, X. Zhao, and X. Liang, "Smart grid line event classification using supervised learning over pmu data streams," in 2015 Sixth International Green and Sustainable Computing Conference (IGSC), Dec 2015, pp. 1–8.

F. Gao, J. S. Thorp, S. Gao, A. Pal, and K. A. Vance, "A voltage phasor based fault-classification method for phasor measurement unit only state estimator output," Electric Power Components and Systems, vol. 43, no. 1, pp. 22–31, 2015.

D. Nguyen, S. Wallace, and X. Zhao, "Finding needles in a haystack: Line event detection on smart grid pmu data streams," in 2016 Sixth International Conference on Smart Grids, Green Communications and IT Energy aware Technologies, 2016, pp. 42–47.

N.Stalin, P.Selvam." Power Transfer efficiency Analysis of Double Intermediate-Resonator for Wireless Power Transfer". International -Journal of Advances in Engineering and Emerging Technology, 9(3), pp.130-141, 2018.

D.Madeshwaran P Selvam." Back To Back Converter Based Real and Reactive Power Control with Constant Speed Operation of Dfig in Wind Mill", 8(2), pp.1855- 1860, 2019.

K. S. Swarup, H. S. Chandra Sekharaiah. "Fault detection and diagnosis of power systems using artificial neural networks." Proceedings of the First International Forum on Applications of Neural Networks to Power Systems, pp. 102-106, Jul 1991.

N. S. Coleman, C. Schegan, and K. N. Miu, "A study of power distribution system fault classification with machine learning techniques," 2015 North American Power Symposium (NAPS), Charlotte, NC, 2015, pp. 1-6.

Singh, N. Thakur, and A. Sharma, "A review of supervised machine learning algorithms," 2016 3rd International Conference on Computing for Sustainable Global-Development (INDIACom), New Delhi, 2016, pp. 1310-1315.

Ravikumar, D. Thukaram, and H. P. Khincha, "Application of support vector machines for fault diagnosis in power transmission system," in IET Generation, Transmission & Distribution, vol. 2, no. 1, pp. 119-130, January 2008.

Andersson, J. E. Solem, and B. Eliasson. "Classification of power system stability using support vector machines," IEEE Power Engineering Society_General-Meeting, 2005, San_Francisco, CA, 2005, pp. 650-655 Vol. 1.