

Determining the Accuracy of Fault Classification Using Deep Learning Models: An Analytical Approach

David Laud Amenyo Fiase¹, Kwadwo Opoku Attah², and Samuel Larrey³

david.fiase@regent.edu.gh; opoku.attah@regent.edu.gh;

samuel.larrey@regent.edu.gh

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

Abstract

This research investigates the accuracy of fault classification using deep learning models, specifically Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNNs). These models are applied to the 161kV transmission line from Aboadze Thermal Power Station through Takoradi, Tarkwa, and Prestea to New Obuasi in Ghana. The study aims to evaluate the performance of these models in accurately detecting and classifying faults to ensure the reliability and efficiency of the power supply. The methodology includes data collection from the transmission line, training LSTM and CNN models, and assessing their accuracy in fault classification. Results demonstrate high accuracy in fault prediction and classification, supporting effective maintenance and reducing power outages. The study concludes with recommendations for improving fault classification systems using deep learning techniques.

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

Introduction

Accurate fault classification in power transmission systems is critical for maintaining reliability and minimizing downtime. The 161kV transmission line from Aboadze Thermal Power Station to New Obuasi is crucial for supplying power to one of Ghana's richest gold mining communities. This study investigates the use of deep learning models, particularly LSTM networks and CNNs, to accurately classify faults on this transmission line.

Problem Statement

Accurate fault classification is essential for the reliable operation of power transmission lines. Incorrect or delayed fault identification can lead to significant disruptions in power supply, affecting industrial operations and economic output. Traditional fault detection methods often lack the accuracy and speed required for effective fault management. This study aims to determine the accuracy of deep learning models in classifying faults on the 161kV transmission line, enhancing the reliability of power supply.

Study Objectives

The study aims to evaluate the accuracy of deep learning models in fault classification. The specific objectives are:

1. To develop LSTM and CNN models for fault classification on the transmission line.
2. To determine the accuracy of these models in fault detection and classification.
3. To compare the performance of LSTM and CNN models in classifying faults.
4. To provide recommendations for improving fault classification accuracy using deep learning techniques.

Literature Review

Recent advancements in deep learning have shown significant potential in improving fault classification in power systems. LSTM networks are effective in handling time-series data, making them suitable for analyzing the sequential data of power systems. CNNs are known for their ability to recognize spatial patterns, which is crucial for fault classification.

In a study by Li et al. (2019), CNNs were applied to detect faults in power grids, achieving high accuracy and real-time performance. Similarly, Zhang et al. (2020) demonstrated the robustness and efficiency of deep learning models in identifying faults in transmission lines. These studies highlight the potential of LSTM and CNN models in improving fault classification accuracy.

Theoretical Frameworks

The study is anchored in the theory of deep learning and its application in fault classification. LSTM and CNN techniques are used to analyze large datasets, identify patterns, and classify faults accurately. The risk-assessment framework is used to evaluate the potential risks and benefits of integrating deep learning into fault classification systems.

Methodology

The methodology involves:

1. **Data Collection:** Gathering historical data on transmission line faults, including voltage, current, and environmental conditions.
2. **Model Development:** Training LSTM and CNN models to classify faults using the collected data.
3. **Model Evaluation:** Using statistical techniques to evaluate the accuracy and performance of the models in classifying faults.
4. **Comparison Analysis:** Comparing the performance of LSTM and CNN models in fault classification.

Results

The study finds that deep learning models, particularly LSTM and CNN networks, significantly enhance the accuracy of fault classification on the 161kV transmission line. The models demonstrate high accuracy in predicting and classifying 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 models, specifically LSTM networks and CNNs, in fault classification on the 161kV transmission line from Aboadze to New Obuasi has demonstrated significant benefits. The models' high accuracy in classifying faults ensures timely maintenance and uninterrupted power supply. However, continuous training and updates to the models are recommended to maintain their effectiveness. Future research should focus on integrating additional data sources and improving model robustness.

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;

[4] 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.