Improving the Stability of Smart Power Grids Using Evolutionary Neural Networks

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Abstract

The research evaluates various computational methods to improve the efficiency of power grid operations. The objective is to design an algorithm that improves the efficiency of power grids by controlling the operation of the voltage regulators and power converters. Using a real-time communication with distributed sensors and evolutionary artificial neural networks, the method could reveal the presence of disturbances and provide configurational changes that improve the system stability.

Introduction

Various disturbance levels are given weights and thresholds that relate to their impact on the normal functioning of the power grid.

Moreover, the neural networks are operated alongside an evolutionary algorithm to evaluate how the control system could change its responses over time.

The project was implemented both in software and in hardware. MATLAB-Simulink was used to implement the software, and a hardware emulator are used to experiment the implementation of the project.

Methodology

- Explore previous work on topic
- Read pertinent MATLAB examples
- Design Neural Network
- Train the network with data
- Compare training results with predicted results

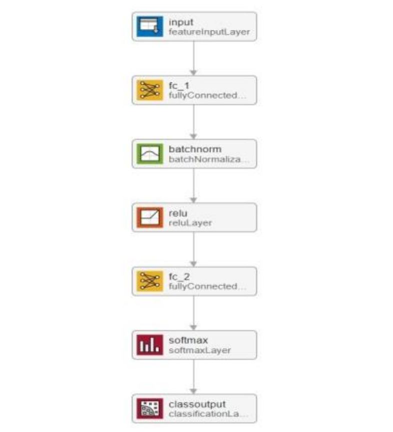

Figure I: Neural Network Layers

Sensor 1	Sensor 4
-152.59	-72.748
-152.59	-72.748
-152.59	-72.748
-73.235	-49.898
-73.235	-49.898
-73.235	-49.898
-152.59	-72.748
-152.59	-72.748
-152.59	-72.748

Fig. II: Data From Node I

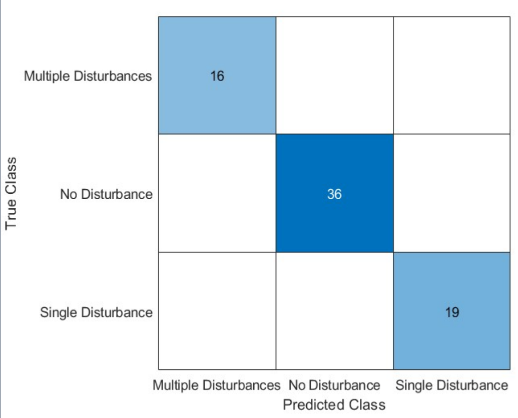

Figure III: Decision Chart

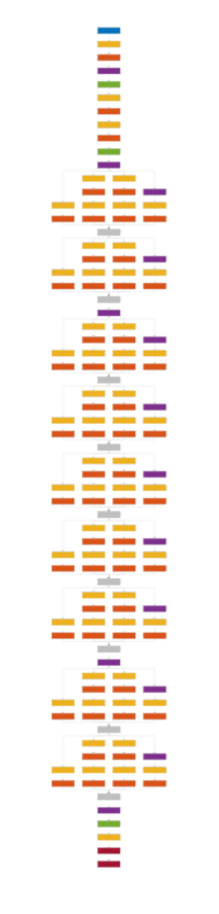

Figure IV:GoogleNet Network

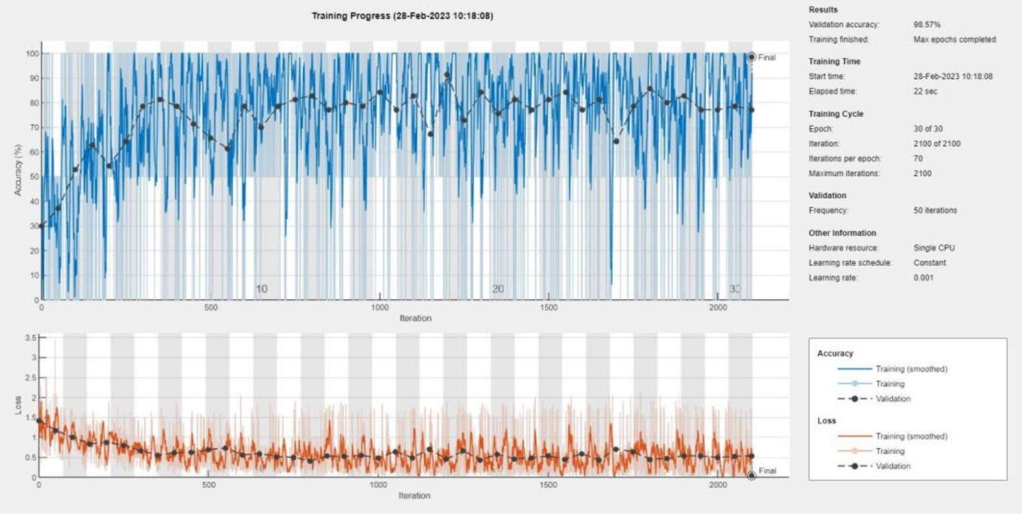

Figure V: Training Progress Plot

Results

- Obtained a neural network from a MATLAB example [2] and made slight alterations to fit the purpose of this research and the data.
- Used this neural network to train the data and obtain the training plot shown in Figure V.
- Compared selected samples of trained data and compared it to selected samples of validation data to measure the accuracy of the network
  - This comparison proved to be accurate, giving us the confusion chart in Figure III.

Conclusion

This project was centered on the development of an evolutionary neural network for the optimization of the stability smart power grids.

Taking voltage flow data between nodes of a power grid, the neural network that was designed was able to train the data, processing it based on a random sample of the input data, and categorizing the data into categories based on whether the grid experienced a disturbance or not.

Resources

[1] B. Abegaz and J. Kueber, "Smart Control of Automatic Voltage Regulators using K-means Clustering," in *IEEE Conference System of Systems Engineering (SoSE)*, Anchorage, AK, May 2019
[2] "Train Network with Numeric Features," *MathWorks*. [Online].
[3] "googlenet," *MathWorks*. [Online].
[4] T. Guillod, P. Papamanolis and J. W. Kolar, "Artificial Neural Network (ANN) Based Fast and Accurate Inductor Modeling and Design," in *IEEE Open Journal of Power Electronics, vol. 1*, pp. 284-299, 2020, doi: 10.1109/OJPEL.2020.3012777.

Acknowledgements

We would like to thank the LUROP fellowship program for the opportunity to conduct research.