TinyML in Power Systems:

Trends, Possibilities, Prospects and Challenges

by

JOHN OLUWASEUN BABALOLA

Workshop on Machine Learning on Low-Power Devices: Applications and Advanced Topics

Introduction

- Nigerian
- Teach at Electrical/Electronic Engineering Department, Bowen University, Iwo, Nigeria.
- Member of Computing and Analytics Research Group (CARG)
- Research interests include Electricity Markets, Smart Grids, TinyML, AI and ML applications in Power Systems.
- Other interests/hobbies are Basketball, Movies (a good Sci-Fi), Psychology and Philosophy.

Power System

- Generation, Transmission and Distribution of electrical energy
- Power systems are evolving, becoming more sophisticated and dynamic.
- Integration of renewable energy, smart grids, DERs, and EVs requires efficiency and robustness.
- ML is used to enhance reliability and efficiency.
- IoT devices are used to collect complex data for accurate forecasting, fault detection, and protection.

ML/TinyML Trends in Power Systems

01
Forecasting

- Renewable Energy Generation
- Load Demand

02
Electricity Markets

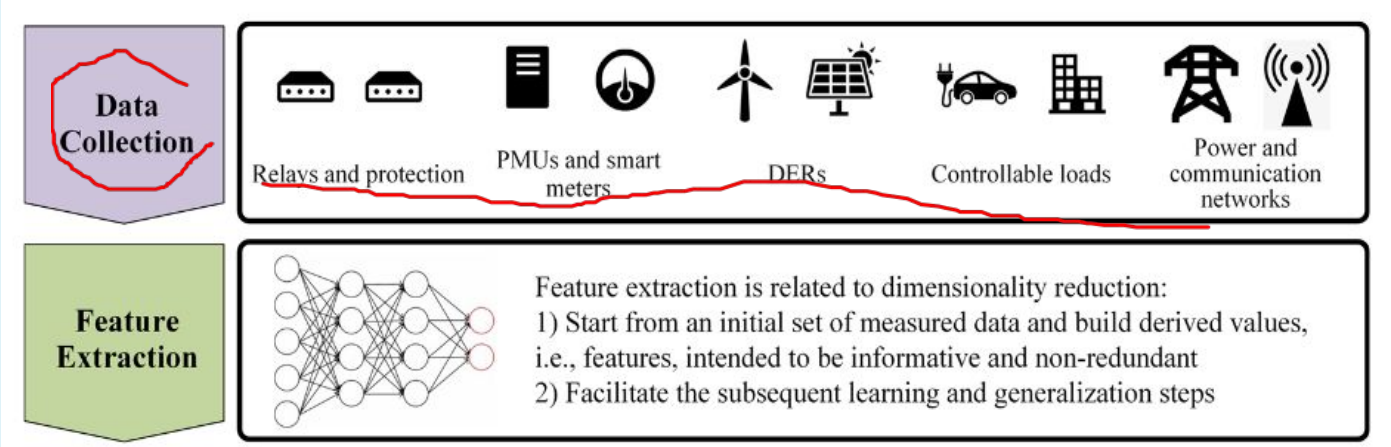
- Price volatility
- Cost Optimization

03
Fault Analysis and Detection

- Large grid size
- Fast fault detection is needed

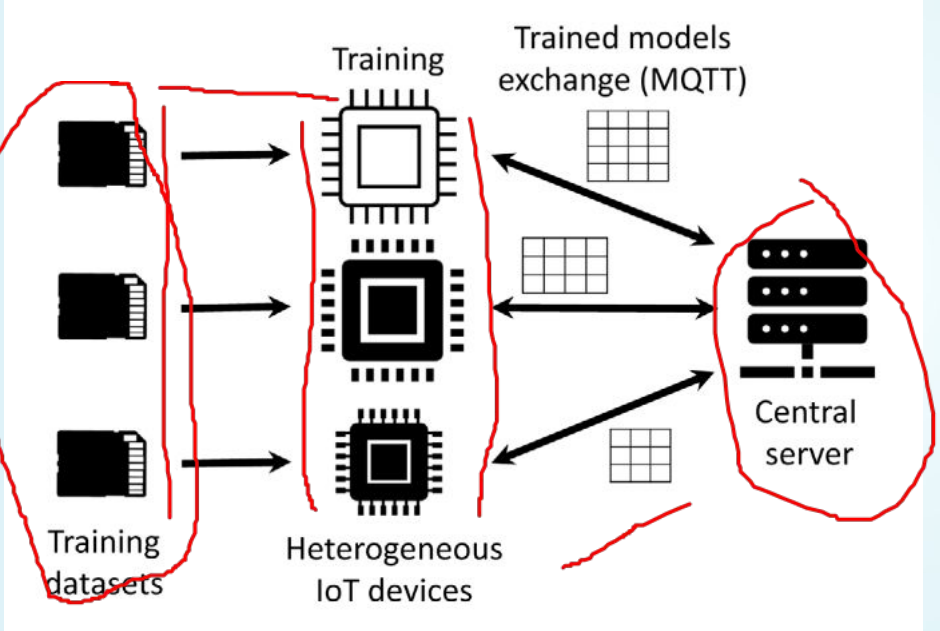
Possibilities for TinyML in Power Systems

- Feature Extraction
- Anomaly Detection
- Simple Forecasting



M. Farhoumandi, Q. Zhou, and M. Shahidehpour, 'A review of machine learning applications in IoT-integrated modern power systems', Electr. J., vol. 34, no. 1, p. 106879, Jan. 2021, doi: 10.1016/j.tej.2020.106879.

Prospects of TinyML in Power Systems



Federated Learning

- Edge devices train the model
- Weights are transferred to a central server
- Central server aggregates the weights and sends updated weights back to edge devices

M. Ficco, A. Guerriero, E. Milite, F. Palmieri, R. Pietrantuono, and S. Russo, 'Federated learning for IoT devices: Enhancing TinyML with on-board training', Inf. Fusion, vol. 104, p. 102189, Apr. 2024, doi: 10.1016/j.inffus.2023.102189.

Prospects of TinyML in Power Systems

USE CASES

Electricity Markets

- Pourdaryaei et al. (2019) proposed a feature selection approach and optimized adaptive neuro-fuzzy inference system (ANFIS) technique

Fault Detection

- Abdelgayed et al. (2018) proposed applying PSO to optimally determine suitable wavelet functions and decomposition levels for achieving accurate and fast fault classification of transmission lines.

Challenges of TinyML in Power Systems

- Limited Memory
- Periodic Model Updates
- Low-power devices in High Powered systems

Thanks!