



Intelligent Power Quality Disturbance Classification using Machine Learning

Presented by_

Shrimathi G - 2127220601070

Sanjay Kumar V - 2127220601063



- 1. Project Area** : Smart Grid / Power Systems + AI
- 2. Project Title** : Intelligent Power Quality Disturbance Classification using Machine Learning
- 3. Place of Work** : In-house
- 4. Supervisor Name** : Mr. N. Suresh
- 5. Project Group** : Batch 5

Motivation

- Increased convenience and automation in PQ monitoring
- Enhanced efficiency through AI-driven real-time detection
- Improved energy utilization and sustainable grid operation
- Intelligent edge-based power quality and energy management

Problems Identified and Solutions Suggested

Problems Identified

- Frequent PQ Disturbances: Over **60%** of grid issues stem from voltage sags, swells & harmonics — causing **15–20% energy loss** and **30% shorter equipment life**.
- Outdated Detection: Conventional FFT/RMS systems **miss ~40% of transients** and analyze events **5–10 seconds late**, risking downtime.
- High Computational Demand: Existing AI models need **>2 GB GPU RAM** and cloud connectivity, adding **300–400 ms latency** — impractical for field deployment.

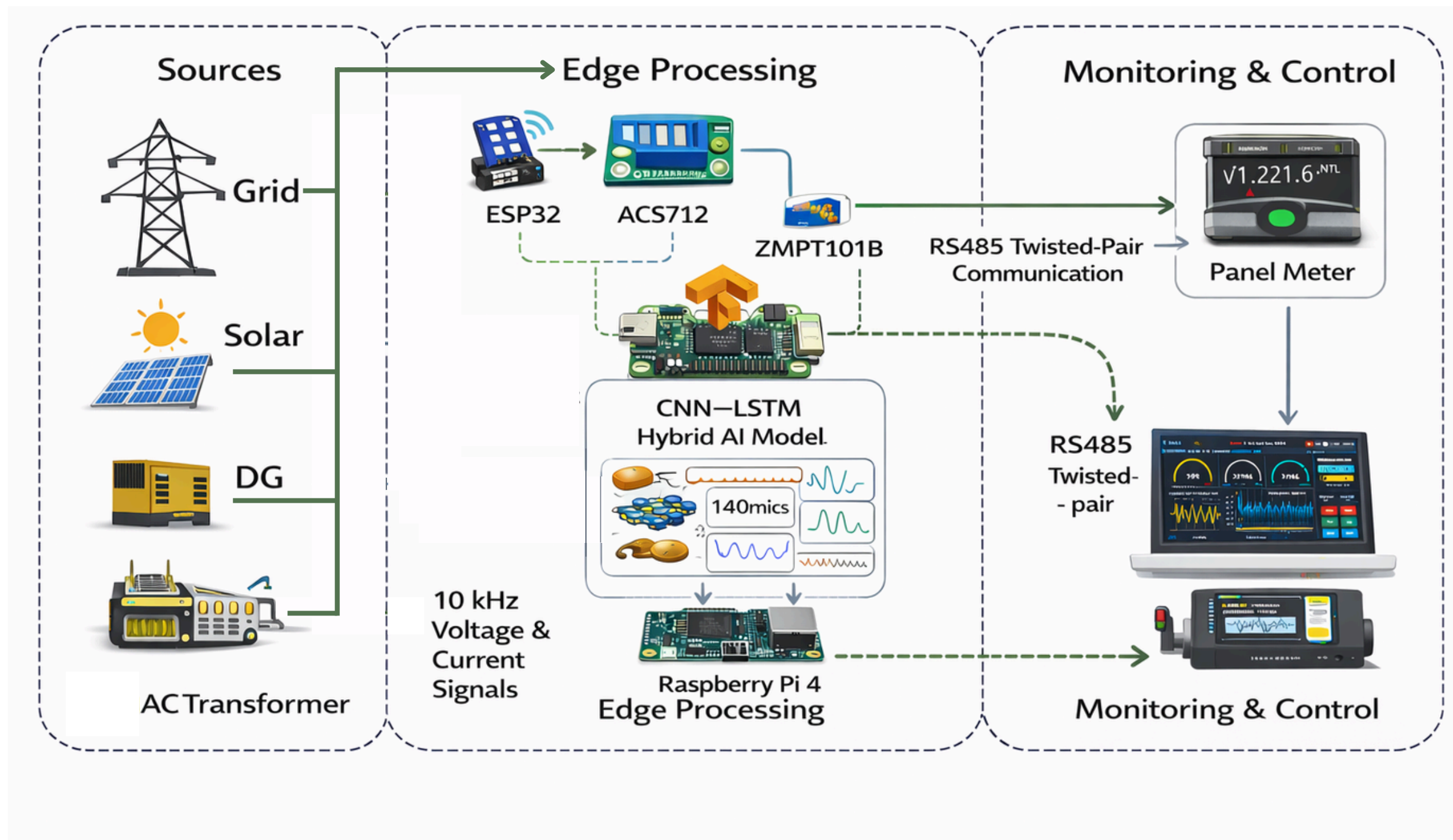
Solutions Suggested

- Hybrid AI: Classifies 6 PQ disturbances with **>98% accuracy** and **<100 ms inference time**.
- Edge AI Implementation: Cutting latency by **80%** and power cost by **40%**.
- IoT-Based Monitoring: Sensors stream **10 kHz data** to a live Node-RED dashboard, improving response **speed by ~70%**.

Literature Survey

PAPER TITLE & AUTHOR	WORK	OUTCOME
Deep Learning Model for PQ Disturbance Classification - M. N. Islam	Used CNN–LSTM with optimization to detect power quality problems.	Got 99% accuracy, but needed powerful computers — not fit for small devices.
Hybrid AI for Power Quality Improvement - R. Chinthaginjala et al.	Used AI with power control hardware to reduce PQ issues.	Worked well (97% accuracy) but only fixed problems, didn't classify them.
PQ Disturbance Detection in Solar Systems - S. Aslam et al.	Created a complex deep learning model for solar power PQ issues.	96% accurate, but too heavy to run in real time on small devices.
Review on PQ Detection Using AI - S. Jain et al.	Compared over 150 AI methods for power quality detection.	Found that real-time edge systems are missing — which our project solves.
PQ Classification Using AI - M. Satyanarayana et al.	Used CNN with wavelet features to detect power issues in MATLAB.	98% accurate, but only tested in simulation — no real hardware used.

Objectives of the Project



- Solve inaccurate and delayed PQ detection by developing a hybrid CNN-LSTM model that classifies disturbances with >98% accuracy in real time (<100 ms).

Plan of Action

	DECEMBER 2025	JANUARY 2025	FEBRUARY 2026	MARCH 2026
TASK				
Literature Survey				
Design				
Simulation				
Hardware Implementation				
Report Preparation				

SDG

SDG Goals	Project Contribution
SDG 7 – Affordable and Clean Energy	Improves energy efficiency and grid stability by enabling real-time detection of power quality disturbances, ensuring reliable and sustainable electricity supply.

References

- [1] M. N. Islam, “A Multimodal Deep Learning Model with Differential Evolution-Based Optimized Features for Power Quality Disturbance Classification,” *Journal of Electrical Systems and Information Technology*, vol. 12, no. 2, pp. 98–114, 2025
- [2] R. Chinthaginjala, A. Srinivasulu, A. Agrawal, and T. H. Kim, “Hybrid AI and Semiconductor Approaches for Power Quality Improvement,” *Scientific Reports (Nature)*, vol. 15, pp. 2211–2224, 2025
- [3] S. Aslam, K. V. Kumar, T. A. Babu, and P. Rajesh, “Hamiltonian Deep Neural Network Optimized via Lyrebird Algorithm for PQD Recognition in PV-Integrated Systems,” *Environment, Development and Sustainability*, vol. 27, no. 3, pp. 5450–5463, 2025
- [4] S. Jain, A. Satsangi, R. Kumar, and D. Panwar, “Intelligent Assessment of Power Quality Disturbances: A Review of ML and DL Solutions,” *Computers and Electrical Engineering*, vol. 115, p. 108652, 2025
- [5] M. Satyanarayana, V. Veeramsetty, and D. Rajababu, “Power Quality Classification Approaches Using Artificial Intelligence Techniques,” in *Next-Generation Green Technologies for Smart Energy Systems*, Springer, pp. 289–301, 2025