Sri Venkateswara College of Engineering

Intelligent Power Quality Disturbance Classification using Hybrid Deep Learning and IoT

Presented by_

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1. **Project Area** : EV/Embedded Systems/Power Electronics
2. **Project Title** : Intelligent Power Quality Disturbance Classification using Hybrid Deep Learning and IoT
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- Outdated Detection: Conventional FFT/RMS systems **miss ~40% of transients** and analyze events **5–10 seconds late**, risking downtime.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.

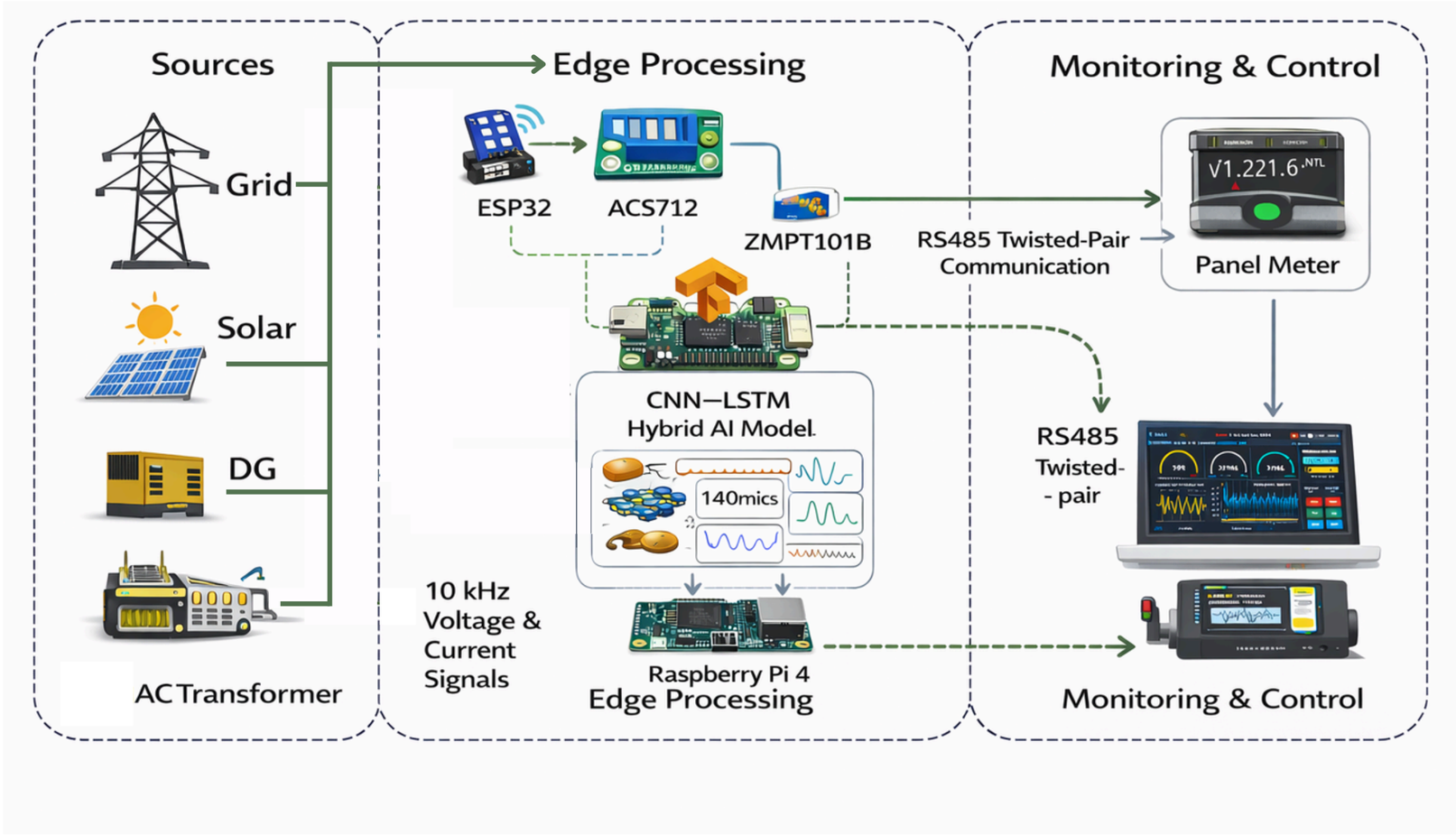
Solutions Suggested

- 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

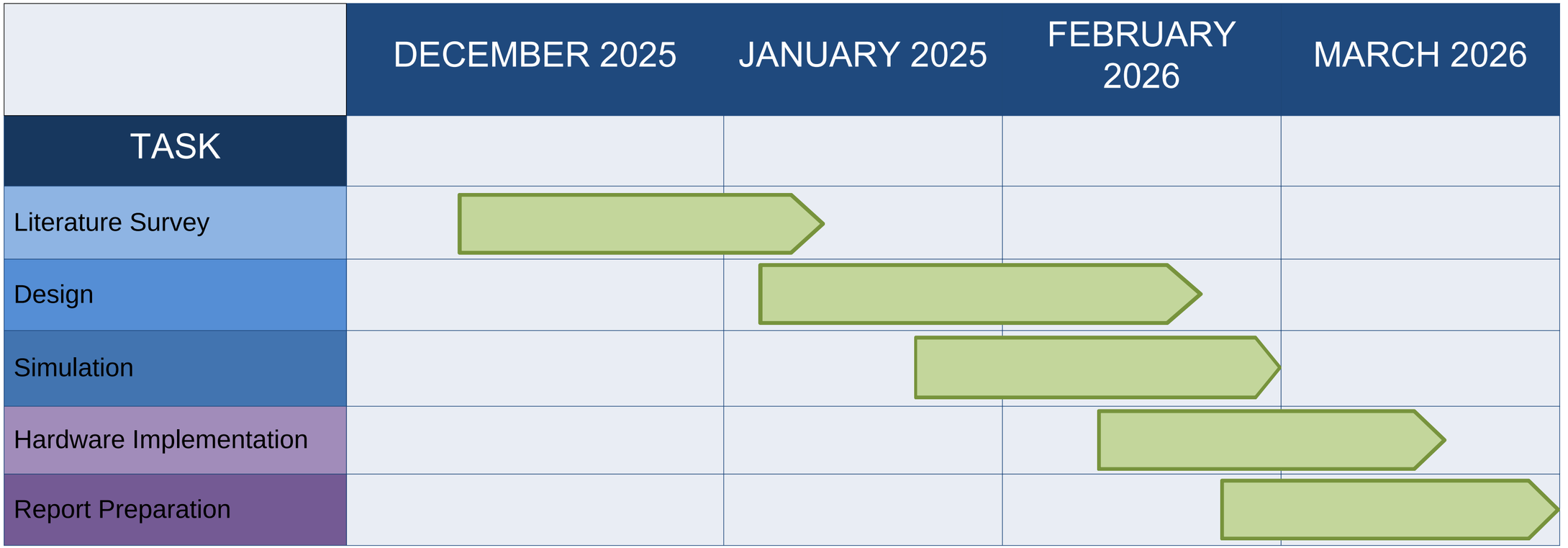
PAPER TITLE & AUTHOR	WORK	OUTCOME
M. N. Islam – Deep Learning Model for PQ Disturbance Classification	Used CNN–LSTM with optimization to detect power quality problems.	Got 99% accuracy, but needed powerful computers — not fit for small devices.
R. Chinthaginjala et al. – Hybrid AI for Power Quality Improvement	Used AI with power control hardware to reduce PQ issues.	Worked well (97% accuracy) but only fixed problems, didn't classify them.
S. Aslam et al. – PQ Disturbance Detection in Solar Systems	Created a complex deep learning model for solar power PQ issues.	96% accurate, but too heavy to run in real time on small devices.
S. Jain et al. – Review on PQ Detection Using AI	Compared over 150 AI methods for power quality detection.	Found that real-time edge systems are missing — which our project solves.
M. Satyanarayana et al. – PQ Classification Using AI	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



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, doi: 10.1186/s43067-025-00194-0.

[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, doi: 10.1038/s41598-025-11116-5.

[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, doi: 10.1007/s10668-024-05514-4.

[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, doi: 10.1016/j.compeleceng.2025.108652.

[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, doi: 10.1007/978-981-95-0441-1_21.