Project Title:

AI/ML-Based IoT Framework for Wide-Area Energy Management System

B25RVP01

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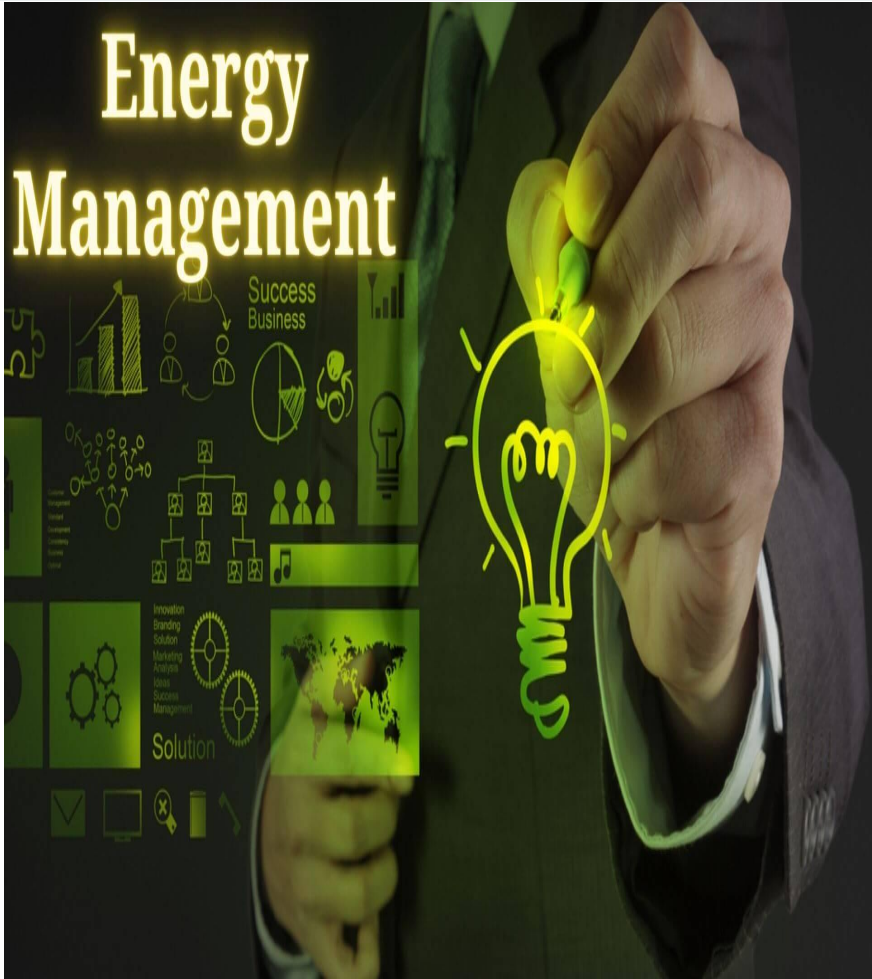
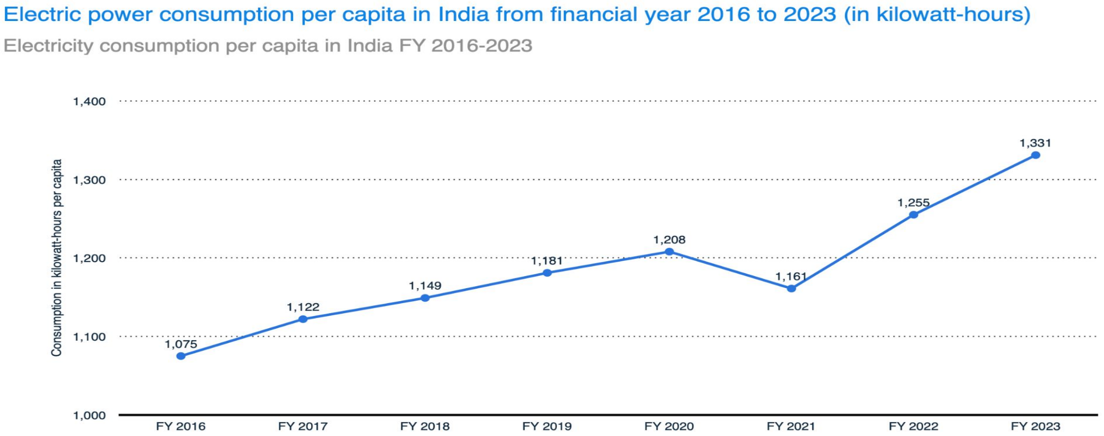


1.Introduction & Motivation



Energy Management is crucial due to rising **demand, inefficiencies,** and **environmental concerns**. Traditional systems lack **real-time monitoring** and **optimization**.

1. Introduction & Motivation

1.1 Importance of Energy Management

1. Reduces **costs, carbon footprint, and grid load**
2. Traditional systems **lack real-time monitoring & analytics**
3. **AI/ML enables** load forecasting & anomaly detection

1.2 Facts & Statistics

1. **India** → 3rd largest energy consumer (after China & USA)
2. **Global demand ↑ 25% by 2040**
3. **30% energy wasted** in buildings due to inefficiencies
4. **AI-based management** cuts energy costs by **10-30%**

2. Problem Statement

2.1 Challenges in Current Energy Management Systems

1. No Real-Time Monitoring

2.No Predictive Analytics

3.Manual & Inefficient

4.Limited Connectivity & Scalability

2. Problem Statement

2.2 Need for an AI/ML-Based IoT Solution

1. Smart Monitoring
2. LoRa Communication
3. Cloud Database
4. AI/ML Optimization
5. Automated Decisions

3. Objective

Develop an **AI/ML-based IoT framework** for **real-time energy monitoring** and **optimization** using **Modbus meters and LoRa communication**. Utilize **cloud storage**, **AI/ML analytics**, and a **real-time dashboard** for **load forecasting**, **anomaly detection**, and **efficiency improvement**. Optimize **energy consumption** to **reduce costs** and **support sustainability goals**.

4. System Architecture

4.1 Hardware Perspective

1. **Multifunction Meters** → Measure voltage, current, power, and energy (Modbus)

2.**LoRa Nodes** → Wirelessly transmit real-time data over long distances

3. **LoRa Gateway** → Connects LoRa nodes to the cloud for reliable data transfer

Low-power, long-range, cost-effective setup for seamless energy monitoring

MULTIFUNCTION METER

LoRa OUTDOOR GATEWAY

LoRa NODE

4. System Architecture

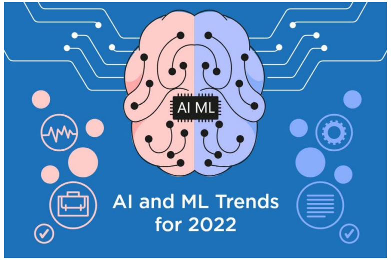
4.2 AI/ML Perspective

1. **Energy Consumption Patterns** → AI/ML analyzes usage trends for better planning

2.**Predicting** → ML forecasts energy demand using real-time and historical data

3. **Anomaly Detection** → AI/ML identifies faults, inefficiencies, and unusual consumption

4. **Insights** → Provides data-driven recommendations for optimization and cost reduction



AI/ML OPTIMIZATION

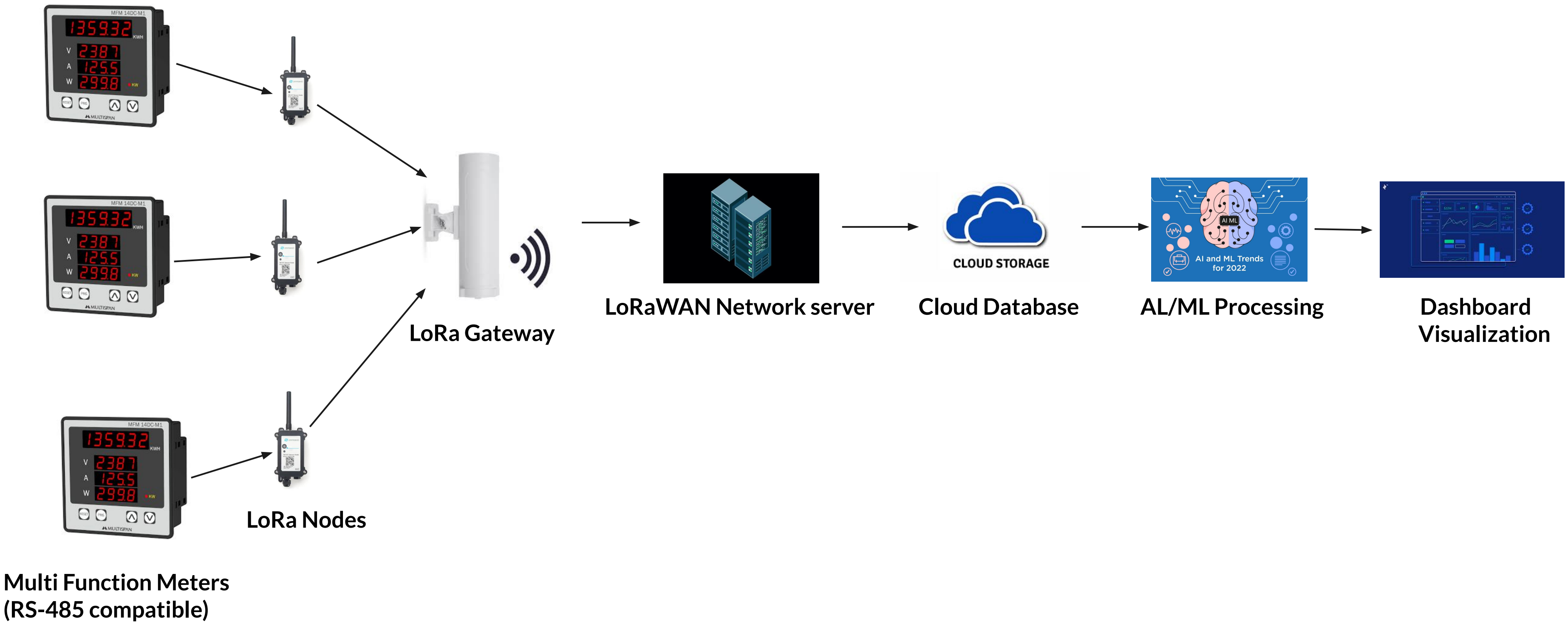
DASHBOARD VISUALISATION

CLOUD STORAGE

5. Literature Survey/Review

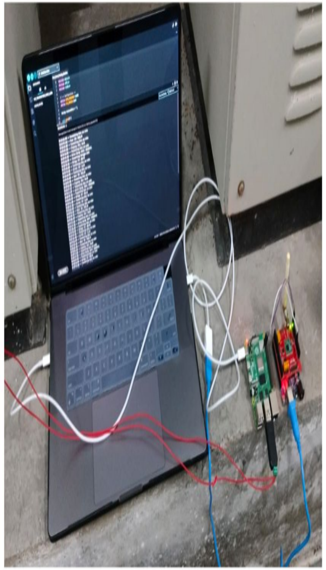
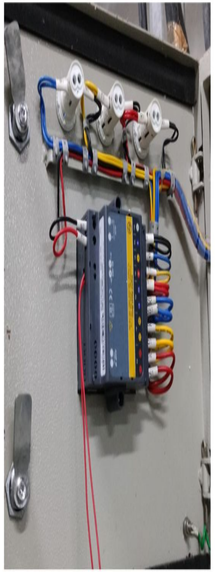
YEAR	TITLE OF THE PAPER	AUTHOR	CONTRIBUTIONS	OBSERVATIONS
2023	A **Unified Metering System Deployed for Water and Energy Monitoring in Smart City**	N Sushma H N Suresh	1.Integration of Wireless Technology for Real-Time Monitoring((LPWAN) 2.Scalable Smart Metering for Efficient Resource Management	1.Limited AI/ML-Based Energy Optimization 2.No Custom Hardware Implementation
2021	**Smart Energy Metering For Cost And Power Reduction In Household Applications**	C Komathi S Durgadevi	1.Integration of Modbus-Compatible Smart Meters 2.Automated Energy Monitoring & Consumer Awareness	1.Lack of LoRa-Based Communication 2.No AI/ML-Based Energy Optimization
2023	**Design of IoT-Based Electrical Energy Meter**	Heri Andrianto Yohana Susanthi	1.IoT-based energy monitoring using ESP32 and Modbus-compatible meters 2.Automated Energy Data Acquisition	1.Limited Communication Range 2.Lack of AI/ML-Based Optimization

6. Proposed System Architecture

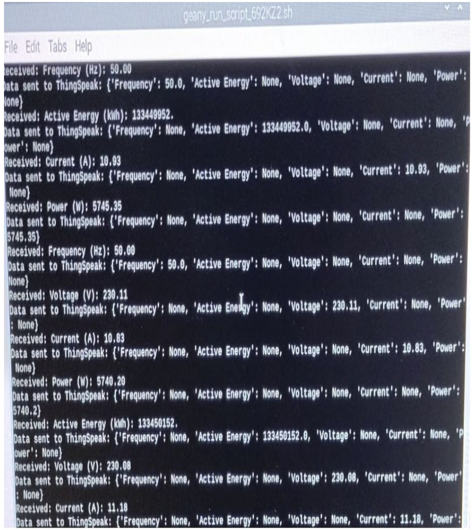


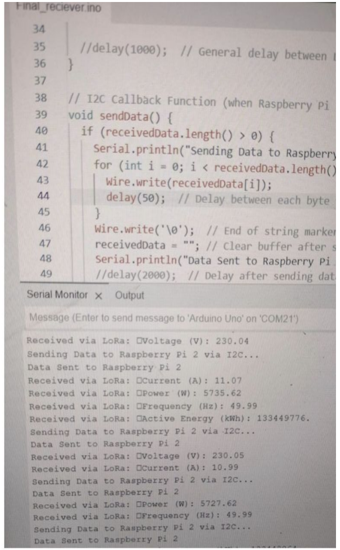
7. Current Status and Achievements

7.1 Hardware Implementation

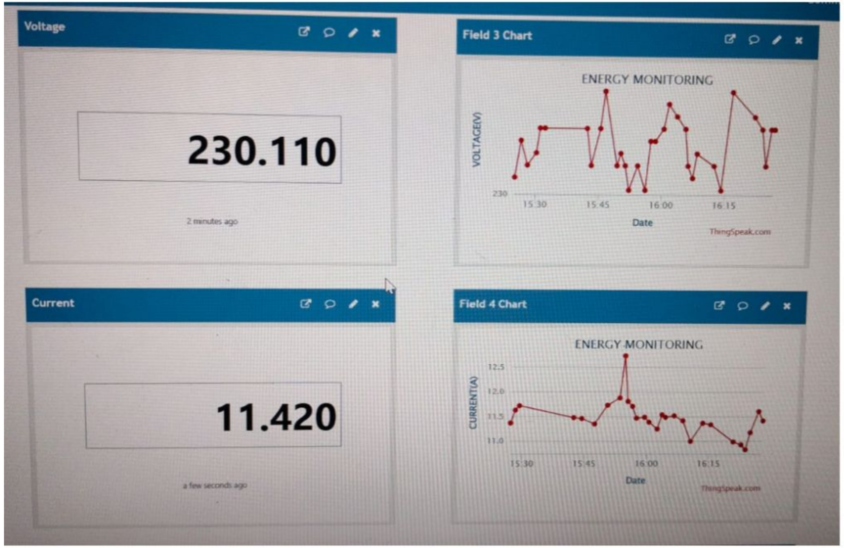

Tested with our campus multifunction meter

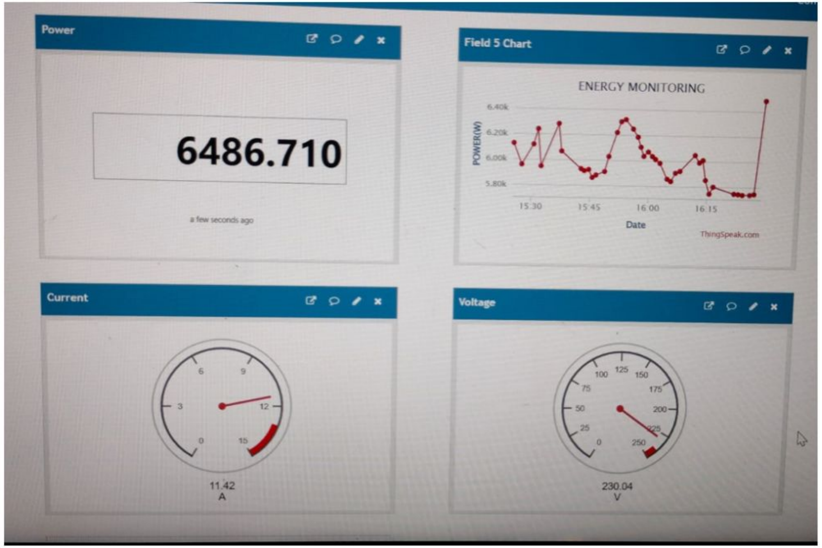




Data receiving on serial monitor

7. Current Status and Achievements

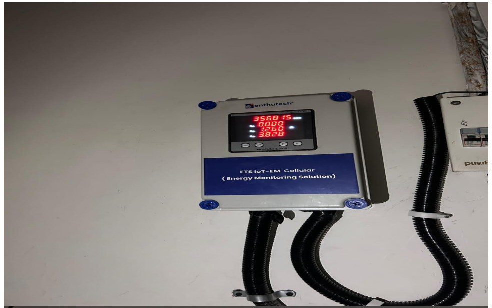


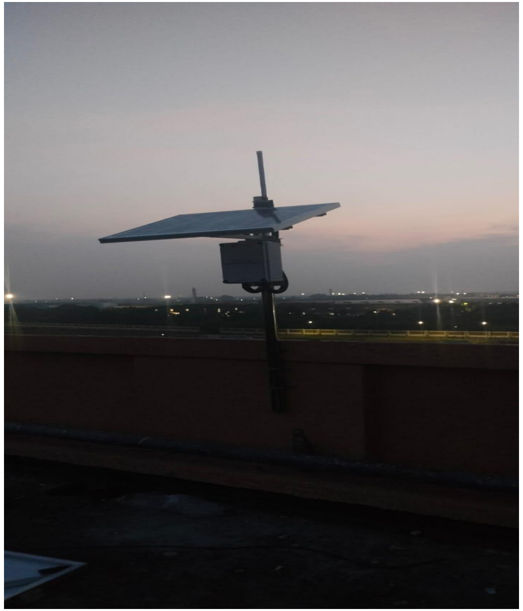


Data visualization on Things speak

7. Current Status and Achievements

7.1 Hardware Implementation





LoRa and Cellular Energy Meters Monitoring G08 and Faculty Wing

LoRa gateway

8. Future works

1. Creating an **AI/ML-based** for predictive energy analytics and optimization.
2. Develop a **custom hardware solution** for improved efficiency, scalability, and cost-effectiveness.
3. Deploy a **complete IoT framework** with real-time analytics and an advanced dashboard for energy management.

9.References

1.H. Andrianto, Y. Susanthi, V. Jonathan and N. Ismail, "Design of IoT-Based Electrical Energy Meter," *2023 IEEE 9th International Conference on Computing, Engineering and Design (ICCED)*, Kuala Lumpur, Malaysia, 2023, pp. 1-4, doi: 10.1109/ICCED60214.2023.10425406.

2.C. Komathi, S. Durgadevi, K. Thirupura Sundari, T. R. Sree Sahithya and S. Vignesh, "Smart Energy Metering For Cost And Power Reduction In Household Applications," *2021 7th International Conference on Electrical Energy Systems (ICEES)*, Chennai, India, 2021, pp. 428-432, doi: 10.1109/ICEES51510.2021.9383725

3.N. Sushma, H. N. Suresh, J. M. Lakshmi, P. N. Srinivasu, A. K. Bhoi and P. Barsocchi, "A Unified Metering System Deployed for Water and Energy Monitoring in Smart City," in *IEEE Access*, vol. 11, pp. 80429-80447, 2023, doi: 10.1109/ACCESS.2023.3299825. keywords: {Meters;Water resources;Real-time systems;Water

THANK YOU