AI-Based Smart Power Plant Subsystem Monitoring and Intelligent Control Using IoT

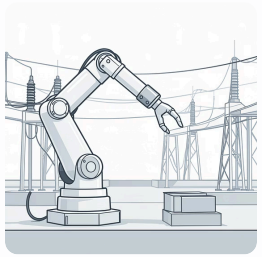
Presented by: Kakarla Mahammad Afrid

Electrical and Electronics Engineering, 3rd Year

Chadalwada Ramanamma Engineering College

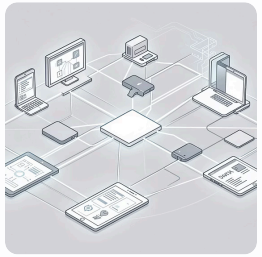
INTRODUCTION

The Dawn of Intelligent Power Systems



Automation's Imperative

Enhancing efficiency and reliability in power systems.



IoT in Electrical Engineering

Connecting infrastructure for real-time data exchange.

AI for Protection

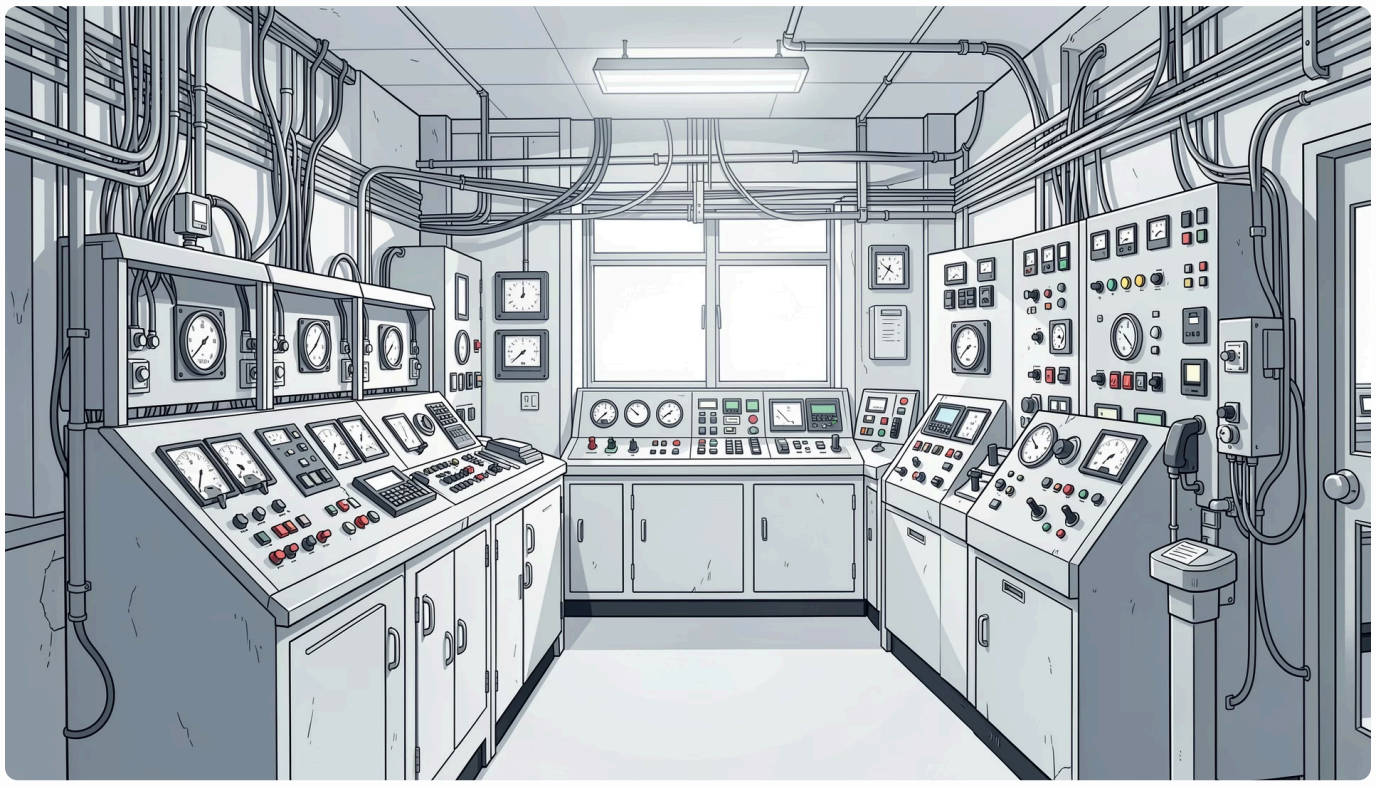
Revolutionising fault detection and system resilience.

SCADA Evolution

Integrating intelligence into supervisory control.

CHALLENGE

Addressing Critical Gaps in Power System Monitoring



High Costs & Manual Effort

Expensive traditional monitoring demands constant supervision.

Limited Predictive Insights

Reactive maintenance due to lack of foresight.

Delayed Fault Detection

Increased downtime and potential for cascading failures.

Automation Gap

Small-scale plants lack essential smart automation.

> Need for a low-cost, intelligent remote monitoring and protection system.

OUR SOLUTION

Intelligent Monitoring & Control for Power Subsystems

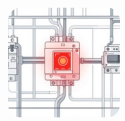
Our proposed system leverages IoT and AI to deliver real-time data, predictive insights, and automated protection, simulating a modern SCADA-like environment for academic demonstration.

IoT-Based Monitoring

Real-time voltage, current, and temperature tracking.

AI-Based Fault Prediction

Proactive identification of potential system anomalies.



Automatic Relay Protection

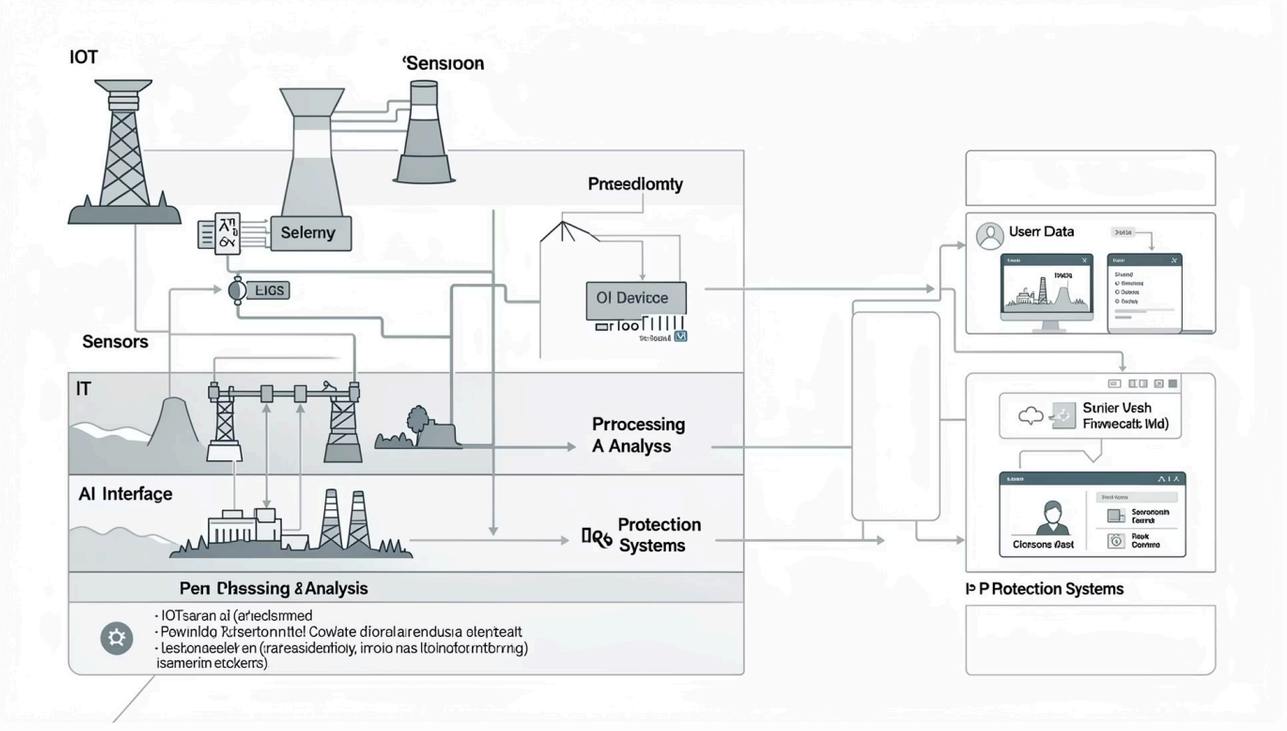
Instantaneous response to safeguard the power system.

Remote Dashboard Control

Intuitive interface for system oversight and management.

ARCHITECTURE

Modular Design for Robust Subsystem Monitoring



Our system architecture is designed with distinct, interconnected layers to ensure efficient data flow, intelligent processing, and reliable protection, simulating real-world SCADA functionalities.

- **Sensor Layer:** Data acquisition from critical points.
- **Controller Layer (ESP32):** Edge processing and data transmission.
- **Cloud Layer:** Secure data storage and accessibility.
- **AI Processing Layer:** Anomaly detection and prediction.
- **User Interface Layer:** Dashboard for monitoring and control.
- **Protection & Relay System:** Automated fault isolation.

> SCADA-like simulation for academic demonstration.

TECHNOLOGIES

Tools and Technologies Driving Innovation

Hardware Essentials

- ESP32 Microcontroller
- Voltage & Current Sensors (ACS712)
- Temperature Sensor (DHT11)
- Relay Module

Software & Platforms

- Firebase (Cloud)
- Python (AI Model)
- Scikit-learn (Decision Tree)
- Web-based IoT Dashboard

Core Concepts

- IoT Communication
- Relay Protection Principles
- Smart Grid Integration
- AI Fault Detection Algorithms

MECHANISM

Step-by-Step Intelligent Protection

01

Data Acquisition

Sensors continuously measure electrical parameters (voltage, current, temperature, frequency).

02

Data Transmission

ESP32 transmits real-time data to the cloud via WiFi.

03

Cloud Storage & Analysis

Cloud stores data; AI model analyses for abnormal patterns.

04

Fault Detection & Action

If fault detected (overvoltage, overcurrent, overtemperature, frequency deviation), relay trips.

05

System Status Display

Dashboard visually displays real-time system status and alerts.

IMPACT

Broadening Horizons: Market Scope & Applications

Key Applications

- → Smart Power Plants
- → Industrial Load Monitoring
- → Smart Substations
- → Renewable Energy Plants
- → Microgrids

Market Trends

- Growing demand for smart grids.
- Industry 4.0 automation drive.
- Rise of predictive maintenance systems.
- AI-driven energy management solutions.
- IoT-based remote supervision surge.

Significant global investments are driving smart grid expansion.

OUTLOOK

Advantages Today, Innovations Tomorrow

Current Advantages

- Low implementation cost
- Real-time operational monitoring
- Intelligent, automated protection
- Remote accessibility and control
- Automatic fault isolation

Future Scope

- Seamless integration with real SCADA systems.
- Enhanced renewable energy compatibility.
- GSM/SMS alert system for critical events.
- Advanced AI for deeper predictive analytics.
- Scalable industrial-grade deployment.

Conclusion: Powering the Future with IoT and AI

IoT + AI Integration

Successfully merges smart technologies for power systems.

Demonstrated Protection

Reliable relay protection logic confirmed.

Intelligent Load Control

Efficient and responsive power management.

Smart Grid Ready

Ideal for modern smart grid applications.

Scalable for Industry

Potential for widespread industrial deployment.