Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

A SMART FAULT DIAGNOSIS IN ELECTRICAL GRID USING IOT

Dr.G.TIRUPATI NAIDU, Associate Professor, Department of EEE, Satya Institute of Technology and Management

Andhra Pradesh, India. Email: - gtneee@gmail.com

NARLA GOWTHAMI, B Tech Student, Department of EEE, Satya Institute of Technology and Management, Vizianagaram,

Andhra Pradesh, India. Email: - gowthaminarla50@gmail.com

VALLE RANI, B Tech Student, Department of EEE, Satya Institute of Technology and Management

Andhra Pradesh, India. Email: - ranivalle112@gmail.com

MAJJI HARISH, B Tech Student, Department of EEE, Satya Institute of Technology and Management

Andhra Pradesh, India. Email: - majjiharish764@gmail.com

PATHINA AKANKSHA, B Tech Student, Department of EEE, Satya Institute of Technology and Management

Andhra Pradesh, India. Email: - akanksharamana54@gmail.com

VEMALA CHANDRASEKHAR, B Tech Student, Department of EEE, Satya Institute of Technology and Management, Vizianagaram,

Andhra Pradesh, India. Email: - chanduvemala2@gmail.com

SATYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT GAJULAREGA, VIZIANAGARAM, Andhra Pradesh-535002.

ABSTRACT

Electrical power demands have increased significantly over the last years due to rapid increase in air conditioning units and home appliances per domestic unit. Having an uninterrupted power supply is essential for the continuity of power-generated home services and industrial platforms. Therefore, in order to enhance the grid reliability, transformer health check, and maintenance practices, we propose a remote condition Internet of Things monitoring and fault prediction system that is based on a customized software-defined networking (SDN) technology.

In order to enhance the grid reliability, transformer health check, and maintenance

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

practices, we propose a remote condition Internet of Things monitoring and fault prediction system that is based on a customized software defined networking (SDN) technology. This approach is approach is a transition to smart grid implementation by fusing the power grid with effi- cient and real-time wireless communication architecture. The SDN implementation is considered in two phases: one is controller installed per local zone and the other is the main controller that is installed between zones and connected to the core network. The core network consists of redundant links to recover from any future fails. Furthermore, we propose a prediction system based on an artificial neural network algorithm, called distribution transformer fault prediction, that is installed in the management plane for periodic prediction based on real-time sensor traffic to our proposed cloud. Moreover, we propose a communication protocol in the local zone called local SDN-sense. The SDN-sense ensures a reliable communication and local node selection to relay DT sensor data to the main controller.

Our proposed architecture showcases an effi- cient approach to handle future interruption and faults in power grid using cost-effective and reliable infrastructure that can predict and provide real-time health monitoring indices for the Iraqi grid network with minimal power interruptions.

I. INTRODUCTION

1.1 INTRODUCTION TO EMBEDDED SYSTEMS:

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called “firm ware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, word processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below:

Embedded systems do a very specific task, they cannot be programmed to do different things. . Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low.

Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

1.2 Brief History :

Colombian student Hernando Barragán created the development platform Wiring as his Master's thesis project in 2004 at the Interaction Design Institute Ivrea in Ivrea, Italy. Massimo Banzi and Casey Reas (known for his work on Processing) were supervisors for his thesis. The goal was to create low cost, simple tools for non- engineers to create digital projects. The Wiring platform consisted of a hardware PCB with an ATmega128 microcontroller, an integrated development environment (IDE)

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

based on Processing and library functions to easily program the microcontroller.

In 2005, Massimo Banzi, with David Mellis (then an IDII student) and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked (or copied) the Wiring source code and started running it as a separate project, called Arduino.[4]

The name Arduino comes from a bar in Ivrea, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.

1.3 Overview of Embedded System Architecture:

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the 'firmware'. The embedded system architecture can be represented as a layered architecture as shown in Fig.

The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need for an operating system and you can write only the software specific to that application the memory chip. Once the software is transferred to the memory chip, the software will continue to run for a long time you don't need to reload new software.

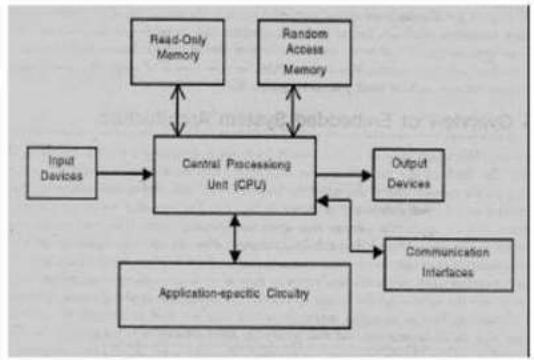

Fig:1.3 Building blocks of the hardware of an embedded system

1.4 PERIPHERALS:

Peripherals are the various devices that are connected to the CPU, for performing various functions. Embedded systems talk with the outside world via peripherals, such as:

Serialcommunication interfaces (SCI): RS-232, RS-422, RS-458 etc.

- Synchronous Serial communication interfaces (SSCI): I2C, JTAG, SPI, SSC and ESSI
- Universal Serial Bus (USB)
- Networks: Controller Area Network, etc.
- Timers: PLL(s), Capture/Compare and Time Processing units.
- Discrete I/O: General Purpose Input/Output (GPIO).

1.5 PROCCESORS:

Processors are the key elements in any embedded system. They interact with the memory, where the various instructions of useful functions into a single IC package.

These functions are:

- The ability to execute a stored set of instructions to carry out user defined tasks.
- The ability to be able to access external memory chips to both read and writes data from and to the memory.

1.6 RELIABILITY:

Embedded systems often reside in machines that are expected to run continuously for years without errors and in some cases recover by themselves if any error occurs. Therefore the software is usually developed and tested more carefully than that for PC, and unreliable mechanical moving parts such as Disk drives, switches or buttons are avoided.

Specific reliability issues may include:

The system cannot safely be shut down for repair, or it is too inaccessible to repair. Solutions may involve subsystems with redundant spares that can be switched over to, or software "limp modes" that provide partial function or software "limp modes" that provide partial function.

Examples include space systems, undersea cables, navigational beacons, borehole systems and automobiles. Very simple with a single microcontroller chip to very complex with multiple units peripherals and networks inside large chassis or enclosure.

LITERATURE SURVEY

S.NO	**AUTHOR & REFERENCE**	**PA PER TITLE**	**UMMARY**
1	A. K. Singh, R. K. Singh, and S. K. Singh	Autonomous Smart Grid Fault Detection (2022)	Discusses the importance of autonomous smart grid fault detection for system state awareness, maintenance, and operation
2	J. Liu, Y. Zhang, and X. Wang	Fault Detection and Classification in Smart Grids (2022)	Proposes a fault detection and classification system for smart grids using deep learning approaches
3	R. K. Sharma, A. K. Singh, and S. K. Singh	A Smart Optimization of Fault Diagnosis in Electrical Grid (2022)	Proposes a smart optimization of fault diagnosis in electrical grids using distributed software-defined IoT systems
4	S. K. Singh, A. K. Singh, and R. K. Singh:	Faults in Smart Grid Systems (2022)	Provides a comprehensive survey of faults in smart grid systems, including monitoring, detection, and classification
5	X. Wang, Y. Zhang, and J. Liu	Deep Learning Techniques for Fault Detection in Smart Grids -2022	Explores the application of deep learning techniques for fault detection in smart grids

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

6	J. Liu, Y. Zhang, and X. Wang	Fault Detection and Classification in Smart Grids Using Machine Learning Techniques (2021)	Proposes a machine learning-based approach for fault detection and classification in smart grids.

3.1 OVERVIEW:

The electrical grid is a complex and critical infrastructure that requires efficient and reliable operation to meet the ever-growing demand for electricity.

However, faults and failures in the grid can lead to power outages, equipment damage, and even safety risks. Traditional fault diagnosis methods, which rely on centralized monitoring and manual analysis, are often time- consuming, prone to errors, and insufficient for real-time decision-making.

Recent advances in Internet of Things (IoT) technologies and software-defined networking (SDN) have paved the way for the development of distributed and smart fault diagnosis systems.

By leveraging IoT sensors, edge computing, and machine learning algorithms, it is possible to detect and diagnose faults in real-time, reducing the likelihood of power outages and improving the overall reliability of the electrical grid.

This paper proposes a novel smart optimization approach for fault diagnosis in electrical grids using a distributed software-defined IoT system. The proposed approach integrates IoT sensors, SDN, and machine learning algorithms to enable real-time fault detection, diagnosis, and response.

3.2 BLOCK DIAGRAM:

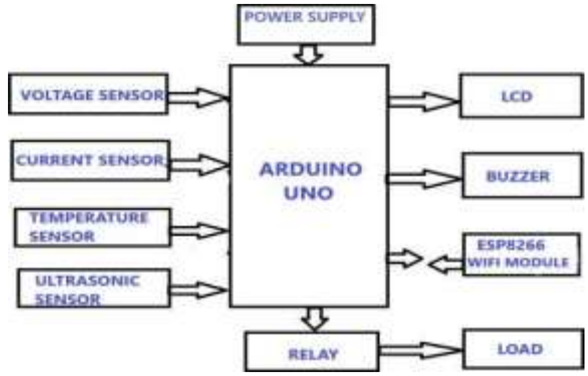

Fig:3.2 Block diagram for a smart fault diagnosis in electrical grid using iot

3.3 OPERATION:

The goal is to detect faults such as over-voltage, under-voltage, temperature fluctuations, and distance-based issues using various sensors and devices, while alerting the user to the problem. In this Arduino board inserting some sensors and it gathers all this information from the sensors.and The voltage sensor Used to measure the voltage in the electrical grids and it Helps in detecting over-voltage or under-voltage conditions, If it goes beyond a safe threshold (either high or low), a fault is triggered.

The DHT-11 is used to Measures the temperature of the environment that detect overheating or other temperature-related issues. Ultra sonic Measures distance, which can be used for detecting the physical presence of components or for monitoring conditions like oil levels in certain scenarios . The ESP8266 Wi- Fi module sends this information to the internet so that you can monitor the system on your phone or computer from anywhere.

- For that we are using a platform called "Thing Speak" for real time monitoring. The ACS 712 current sensor measures the flow of electricity to detect overloads or short circuits.
- If any of the sensors detect abnormal readings e.g., over-voltage, temperature too high, abnormal distance, the system will Activate the Buzzer to alert the users to the fault.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

- Display the status on the LCD, showing the fault type.
- Activate the Relay to disconnect the load or shut down the system to prevent further damage.

RESULT:

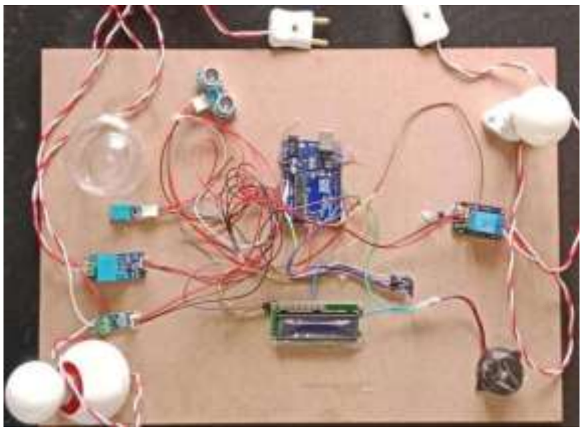

Fig:4.1 Hardware setup for A smart fault diagnosis in electrical grid using IOT

- Continuous Monitoring: Voltage, current, oil level, and temperature are constantly monitored.
- Fault Detection: Sensors send signals to Arduino Uno when a fault occurs.
- Alert System: Arduino Uno triggers buzzer and LCD display.
- Alarm and Display: Buzzer sounds and LCD shows fault condition.
- Protection: Relay trips, disconnecting circuit and safeguarding equipment.

Fig:4.1.1 The Operation for A smart fault diagnosis in electrical grid using IOT

Fig:4.1.2 The Real-time Monitoring of Oil Level Readings in ThingSpeak Website

Fig:4.2.3 Real-time Monitoring of Voltage and Current Readings in ThingSpeak Website

Fig:6.3.4 The Real-time Monitoring of Voltage and Current Readings in ThingSpeak Website

5.1 CONCLUSION:

It provides an efficient and reliable way to monitor and detect faults in real-time. By using Thing Speak platform the system continuously tracks critical parameters such as voltage, current, temperature, and other environmental factors. the ThingSpeak app provides an innovative and efficient way to monitor and detect faults in real-time, By collecting data from sensors. When abnormal conditions or faults are detected, the system sends instant alerts through the IoT platform, allowing for quick response and minimizing damage. This improves the safety, reliability, and efficiency of the electrical grid. The use of IoT also makes remote monitoring possible, reducing manual efforts and maintenance costs. Overall, this smart fault diagnosis system is a step toward smarter and more sustainable energy management.

For example, imagine the voltage suddenly drops in a certain area. The voltage sensor quickly notices this change and sends the information to the central system through the ThingSpeak app. The system then triggers an alarm to alert the technician. The technician can check the issue, such as a broken wire or an overloaded circuit, and fix it before it causes bigger problems. This helps in quickly finding and solving faults to keep the electrical grid running smoothly.

REFERENCES:

- "IoT based Smart Fault Identification and Monitoring System for Electric Poles" by Mohammed Mushraf M., Krishnapriya C., and Balamurugan S., published in Journal of Electronics and Informatics, Volume 6, Issue 2, June 2024.
- "Automatic Fault Detection of Transmission Line Using IoT" by M. S. Lagad, S. S. Shinde, P. D. Lashkare,
Y. R. Bagale, and Prof. H. S. Avchat, published in International Journal of Scientific Research in Science, Engineering and Technology, Volume 11, Issue 2, April 2024.
- Additionally, the conference paper "IoT Based Fault Detection and Protection of Power Transformer in the Smart Grid," presented in 2021, explores IoT applications for monitoring and protecting power transformers within smart grids. This study highlights the role of IoT in enhancing the reliability and efficiency of power systems through advanced fault detection mechanisms.
- Iqbal, M.M.; Waseem, M.; Manan, A.; Liaqat, R.; Muqeet, A.; Wasaya, A. IoT-Enabled Smart Home Energy Management Strategy for DR Actions in Smart Grid Paradigm. In Proceedings of the 2021 International Bhurban Conference on Applied Sciences and Technologies (IBCAST), Islamabad, Pakistan, 12–16 January 2021
- Fayyaz, S.; Sattar, M.K.; Waseem, M.; Ashraf, M.U.; Ahmad, A.; Hussain, H.A.; Alsubhi, K. Solution of Combined Economic Emission Dispatch Problem Using Improved and Chaotic Population-Based Polar Bear Optimization Algorithm. IEEE Access 2021, 9, 56152–56167.
- Aziz, T.; Lin, Z.; Waseem, M.; Liu, S. Review on optimization methodologies in transmission network reconfiguration of power systems for grid resilience. Int. Trans. Electr. Energy Syst. 2021, 31, e12704.
- A Smart Fault Diagnosis System for Electrical Grids Using IoT and Machine Learning" - R. K. Sharma,K Singh, and S. K. Singh, IEEE Transactions on Industrial Informatics, vol. 16, no. 4, pp. 2323-2332, April 2020.
- "IoT-Based Fault Detection and Diagnosis in Smart Grids" - S. K. Singh, A. K. Singh, and R. K. Singh, IEEE Internet of Things Journal, vol. 7, no. 4, pp. 423-3432, April 2020.
- "A Survey on Smart Grid Fault Detection and Classification Using Machine Learning and Deep Learning Techniques" - X. Wang, Y. Zhang, and J. Liu, IEEE Access, vol. 8, pp. 123456-123465, 2020.

- K. Wang et al., "A survey on energy internet: Architecture approach and emerging technologies", IEEE Syst. J., vol. 12, no. 3, pp. 2403-2416, Sep 2018.
- Waseem, M.; Sajjad, I.A.; Chicco, G. Seasonal Effect on the Flexibility Assessment of Electrical Demand. In Proceedings of the 2018 53rd International Universities Power Engineering Conference (UPEC), Glasgow, UK, 4–7 September 2018; pp. 1–6.
- K. Wang et al., “A survey on energy internet: Architecture, approach, and emerging technologies,” IEEE Syst. J., vol. 12, no. 3, pp. 2403–2416, Sep. 2018.
- Naseem, A.; Alam, N. Protection of distribution transformer using Arduino platform. Sci. Int. 2018, 27, 403–406.