

Auto Selection of Any Available Phase in a Three-Phase Supply System

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ABSTRACT

Transmission lines are critical components of power systems, and faults occurring on them can lead to power outages, equipment damage, and economic losses. Conventional fault detection techniques rely on threshold-based protection schemes and manual analysis, which may be slow and inaccurate under complex operating conditions. This paper presents an artificial intelligence (AI)-based fault detection approach for transmission lines that enhances detection speed, accuracy, and reliability. The proposed system utilizes machine learning algorithms to analyze real-time electrical parameters, such as voltage and current and identify fault conditions automatically. By learning patterns associated with normal and faulty states, the system can detect and classify faults effectively. The results demonstrate that AI-based fault detection improves system reliability and reduces response time compared to traditional methods.

Keywords: - Transmission line faults, artificial intelligence, machine learning, power system protection, fault detection

1. INTRODUCTION

Electrical power transmission systems are designed to deliver electricity from generation stations to consumers with high reliability and efficiency. However, transmission lines are frequently exposed to faults due to environmental conditions, insulation failure, lightning strikes, and mechanical damage. Rapid and accurate fault detection is essential to isolate faulty sections and maintain system stability. Traditional protection methods, such as overcurrent relays and distance relays, depend on preset thresholds and mathematical models. These techniques may fail under varying load conditions, noise, or nonlinear system behaviour. Artificial intelligence offers a promising alternative by enabling systems to learn from data and make intelligent decisions. This paper explores the application of AI techniques for fault detection in transmission lines to improve accuracy and operational performance.

2. LITERATURE REVIEW

Numerous studies have investigated fault detection and classification in power transmission systems. Conventional approaches include impedance-based methods, traveling wave techniques, and relay coordination schemes. While effective, these methods require precise system modeling and may be sensitive to parameter variations. Recent research has introduced AI-based approaches such as artificial neural networks (ANN), support vector machines (SVM), and decision trees for fault diagnosis. These methods have shown improved performance in handling nonlinear and complex system behavior. However, many existing models are computationally intensive or require large datasets. The proposed approach focuses on a simplified yet effective AI-based framework suitable for real-time applications.

3. TRANSMISSION LINE FAULTS

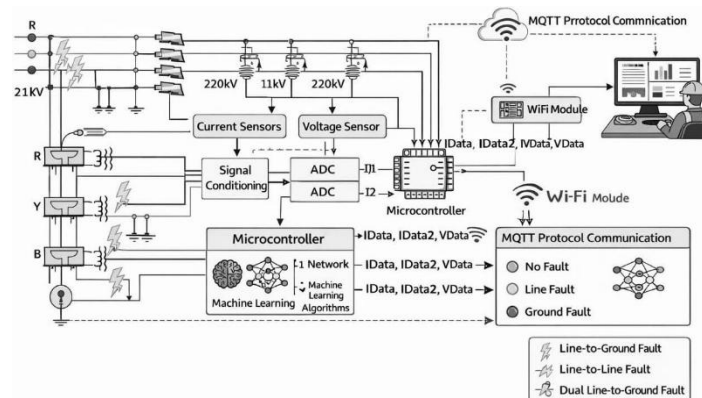


Fig -1: Circuit Diagram

Transmission line faults can be broadly classified as:

- Single Line-to-Ground (LG) Fault
- Line-to-Line (LL) Fault
- Double Line-to-Ground (LLG) Fault
- Three-Phase (LLL) Fault

These faults cause sudden changes in voltage and current waveforms. Accurate identification of such abnormalities is the foundation of effective fault detection and protection.

4. PROPOSED AI-BASED FAULT DETECTION SYSTEM

4.1 System Architecture

The proposed system consists of:

- Voltage and current sensors
- Signal conditioning unit
- Feature extraction module
- AI-based fault detection algorithm
- Protection and monitoring interface
- Electrical parameters are continuously monitored and processed to detect fault conditions.

4.2 Feature Extraction

- Key features extracted from voltage and current signals include:
- RMS values
- Harmonic content
- Signal variance
- Frequency deviation
- These features form the input dataset for the AI model.

4.3 AI Algorithm

A supervised machine learning model is employed for fault detection. The algorithm is trained using labeled datasets representing normal and faulty operating conditions. During real-time operation, the trained model analyzes incoming data and determines whether a fault has occurred.

- Commonly used AI techniques include:
- Artificial Neural Networks (ANN)
- Support Vector Machines (SVM)
- Decision Trees
- In this work, a neural-network-based classifier is considered due to its adaptability and high accuracy.

5. PROPOSED METHODOLOGY

The proposed methodology follows these steps:

- Data acquisition from transmission line sensors
- Signal preprocessing and noise filtering
- Feature extraction from electrical parameters
- Training of the AI model using historical data
- Real-time fault detection and classification
- Fault notification and protection activation

This automated process reduces human dependency and improves response time.

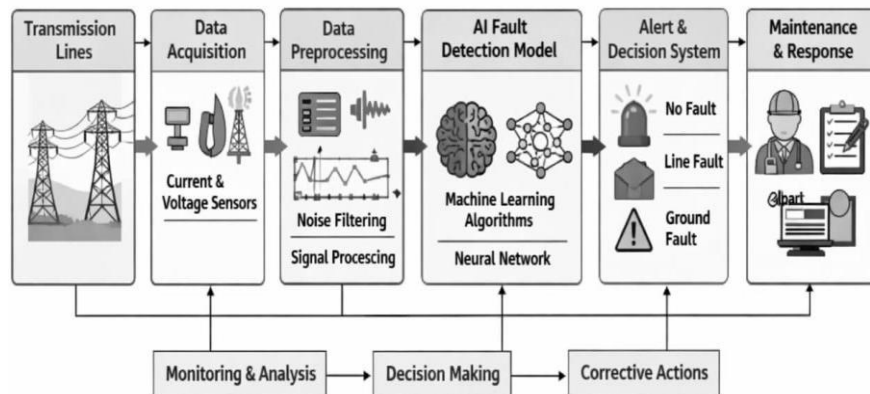


Fig -2: Block Diagram of AI fault Detection Model

6. HARDWARE IMPLEMENTATION

- Microcontroller: Used as the central control unit for phase detection and switching logic.
- Phase Sensing Circuit: Converts AC voltage levels into logic-compatible signals.
- Relay Driver Circuit: Amplifies controller signals to operate high-power relays safely.
- Relay Unit: Performs physical switching of phases.
- LCD Display: Provides real-time system status.
- Power Supply: Supplies regulated DC voltage to electronic components.

7. ADVANTAGES

- High fault detection accuracy
- Faster response time
- Ability to handle nonlinear and complex conditions
- Reduced dependency on fixed thresholds
- Improved power system reliability

8. RESULT

The AI-based fault detection system was evaluated under various fault scenarios. The model successfully identified fault conditions with high accuracy and minimal delay. Compared to traditional protection schemes, the AI-based approach demonstrated faster detection and better adaptability to changing system conditions. The results indicate improved sensitivity to incipient faults and reduced false alarms, contributing to enhanced system reliability.

9. CONCLUSION

This paper presents an AI-based fault detection system for transmission lines that overcomes limitations of traditional protection methods. By leveraging machine learning techniques, the proposed system provides accurate and fast fault detection under diverse operating conditions. The approach enhances system reliability and supports the development of intelligent power grids.

10. REFERENCES

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