THREE PHASE TRANSMISSION LINE FAULT DETECTION AND ANALYSIS SYSTEM WITH GPS LOCATION

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ABSTRACT: The stability and reliability of power transmission systems are critical for uninterrupted electricity supply. Faults in three-phase transmission lines can lead to equipment damage, power outages, and safety hazards. Early detection and precise location of such faults are essential to minimize downtime and enhance maintenance efficiency. This project presents a hardware-based system for detecting, analyzing, and locating faults in three-phase transmission lines using GPS technology. The system uses voltage and current sensors to continuously monitor each of the three phases. In the event of an anomaly such as a line to-ground, line-to-line, or three-phase short circuit the microcontroller identifies the type and affected phase(s) by comparing real-time values against predefined thresholds. Once a fault is detected, the system categorizes it and initiates a location tracking protocol using a GPS module. The GPS unit provides the exact geographic coordinates of the fault point, enabling field personnel to respond quickly and accurately. To communicate fault data and location, the system incorporates a wireless transmission module, allowing remote monitoring stations to receive real-time alerts. This integration ensures prompt maintenance actions, reduces system downtime, and enhances the reliability of the power network. The modular design also allows scalability for integration into larger smart grid infrastructures. The project combines fault detection with real-time geographic fault mapping, offering a low-cost and efficient alternative to traditional manual inspection methods. The use of embedded hardware, along with GPS and wireless technologies, enables a portable and practical solution for power utilities. This system is particularly suitable for long-distance transmission lines where locating faults manually can be time consuming and resource-intensive. Overall, the proposed system improves safety, operational efficiency, and response time in handling transmission line faults. Efficient and accurate fault detection in three-phase transmission lines is crucial for maintaining the reliability and stability of power systems. This paper presents a novel approach to fault detection and localization in high-voltage three-phase transmission lines using GPS (Global Positioning System) technology. The proposed system leverages synchronized phasor measurements obtained from GPS-enabled devices placed at strategic locations along the transmission line.

KEYWORDS: FAULT, GPS, DATA, LOCATION, VOLTAGE.

I.INTRODUCTION: In developing countries like India, there is always the problem of interrupted power supply as insufficient power is being generated to provide consumers with continuous services and satisfactory quality. This leads to constant power failure which in turn affects both the public and private sectors of the economy. Industries, banks, hospitals and so many other public and private establishment all have major critical loads that needs to be powered at all times in order to carry out various processes efficiently. The introduction of some of these alternative sources of power supply brings forth the challenge of switching smoothly in a timely manner between the mains supply and the alternative sources whenever there is a failure on the mains source. Automatic three phase selector is an integral part of the process of power generation, allowing smooth and instant transfer of electric current between multiple sources and load. The function of the automatic three phase selector is to monitor the incoming public supply voltage and detect when the voltage drops below a certain level that electrical/electronic appliances can function depending on the utility supply. This compares the automatic three phase selector voltage of the other two phases using a comparator circuit and if the voltages are not available, the system changes over from public supply to generator. When the generator is in operation, it prevents any feedback current to the load. It also ensures that the different power sources are synchronized before the load is transferred to them. The transfer switch senses when there is interruption if the mains supply remains absent.

In modern power systems, ensuring the reliability and safety of transmission lines is of paramount importance. Transmission line faults, particularly in three-phase systems, can lead to severe disruptions in power supply, equipment damage, and economic losses. Rapid and accurate fault detection is critical for maintaining system stability and minimizing downtime. Traditional fault detection methods often face challenges such as delayed response times, inaccurate fault location estimation, and dependency on manual inspections. To overcome these limitations, the integration of Global Positioning System (GPS) technology with fault detection systems has emerged as an innovative solution. Three-Phase Transmission Line Fault Detection System that utilizes GPS technology to accurately locate faults in real-time.

II.LITARATURE SURVEY: Power failure is a common problem. It is often noticed that power interruption in distribution system is about 70% for single phase fault while other two phases are in normal condition. Thus, in any commercial or domestic power supply system where 3 phases is available, an auto phase selector system is required for uninterrupted power to critical loads in the event of power failure in any phase. In any commercial or domestic power supply system where 3 phase is available, it is advisable to have an automatic changeover system for uninterrupted power to critical loads in the event of missing phase [1].

In this system auto selection is achieved by using a set of relays interconnected in such a way that if one of the relay feeding to the load remains energized always. Power supply in Nigeria and most developing countries of the world is anything but stable. In this paper, we provide an automatic switching mechanism that transfers the consumer loads to a power source from a generator in the case of power failure in the mains supply. It automatically detects when power has been restored to the mains supply and returns the loads to this source while turning off the power from the generator set [2].

Transmission lines are crucial components of electrical power systems, responsible for delivering electricity from power plants to various distribution points. Ensuring the reliability and safety of these transmission lines is paramount for uninterrupted power supply and the prevention of potential hazards. One of the critical challenges in maintaining the reliability of transmission lines is the timely detection and localization of faults that can disrupt the flow of electricity. Different faults and anomalies commonly occur in transmission lines. Any malfunction that prevents the appropriate passage of electric current in any power system network or circuit is referred to as a fault [3].

III.PROPOSED SYSTEM:

Fig 1 block diagram

Transformer: It steps down the high voltage and current levels from the transmission line to safer, measurable levels that can be handled by the monitoring equipment. This allows the system to accurately detect abnormalities such as faults, short circuits, or imbalances.

Rectifier: It is used to convert the AC signals from the transformers into DC signals. This conversion is necessary because many fault detection circuits, microcontrollers, and signal processing units require DC input for stable operation and accurate analysis.

GPS: It is used to provide accurate time synchronization and precise location data. It enables the system to time-stamp electrical events, such as faults or disturbances, with high precision. This is crucial for fault analysis, especially when multiple monitoring units are placed along the transmission line.

Arduino UNO: It acts as the central processing unit that controls the entire operation. It receives analog signals from voltage and current sensors (after being stepped down and possibly rectified), processes these signals to detect abnormalities such as over current, short circuits, or phase imbalances, and determines whether a fault has occurred.

LCD: LCD stands for Liquid Crystal Display. It is a flat-panel display technology that uses liquid crystals to produce images or text.

Current Sensor: It is used to continuously monitor the current flowing through each phase of the transmission line. It detects abnormal changes in current, such as sudden increases caused by short circuits or faults. These current readings are sent to the processing unit, like an Arduino Uno, for analysis.

Operation This block diagram outlines is Three-Phase Transmission Line Fault Detection and Analysis System with GPS Location is a smart monitoring solution designed to detect and analyze faults in power transmission lines, particularly in three-phase systems. This system is essential in ensuring the reliability, safety, and efficiency of power delivery, especially over long distances. The core idea is to identify abnormalities in voltage and current levels in real time and pinpoint the exact location of any fault using GPS technology. The system begins by using step-down transformers connected to each phase (R, Y, B) of the high-voltage transmission line. These transformers reduce the high voltage to safer, measurable levels suitable for monitoring. The outputs of the transformers are then passed through rectifier circuits, which convert the AC signals to DC, making them readable by the microcontroller—typically an Arduino. Alongside voltage monitoring, current sensors are also installed on each phase to detect any unusual fluctuations in the current flow, such as spikes or drops, which may indicate a fault like a short circuit, line break, or overload.

The Arduino microcontroller acts as the brain of the system. It continuously reads the voltage and current values from each phase and compares them with predefined safe limits. If a fault is detected—such as a sudden voltage drop or current spike in any of the phases— the system immediately identifies which phase is affected. At the same time, a GPS module integrated into the system captures the geographical location where the fault has occurred. This location data is crucial for utility companies to quickly locate and address the issue, especially in remote or inaccessible areas.

Personnel to monitor the system locally. Additionally, the data can be stored or transmitted remotely if needed, enabling automated alert systems. Overall, this system enhances the capability of power utilities to monitor their networks, reduces the time required to locate and fix faults, and contributes to minimizing downtime and service disruptions.

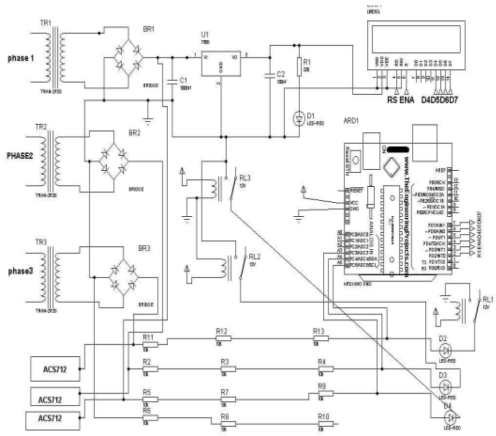

Fig 2 proposed schematic diagram

IV.HARDWARE RESULTS: The Hardware Module of Three Phase Transmission Line Fault Detection and Analysis System with GPS Location is shown in Fig 3

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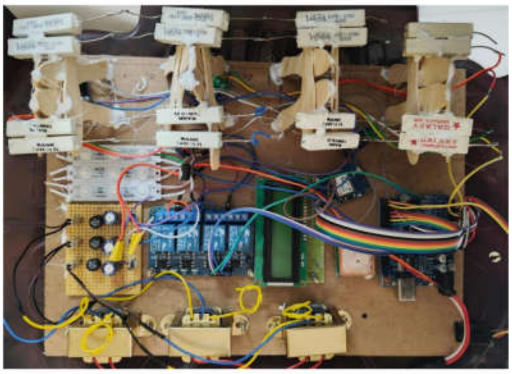

Fig 3 hardware setup

The Three-Phase Transmission Line Fault Detection and Analysis System with GPS Location, as shown in the image, is an system designed to monitor and detect faults in three-phase power transmission lines and identify the exact geographical location of the fault using a GPS module. The system uses an Arduino microcontroller as the central controller that receives data from voltage monitoring circuits and a GPS module. Each of the three transmission lines — R (Red), Y (Yellow), and B (Blue) — is monitored through separate voltage sensing circuits built using power resistors, which simulate or measure voltage levels from each line. If any line experiences a voltage abnormality such as over-voltage, under-voltage, or a complete disconnection, the system detects it as a fault. Once a fault is identified, the Arduino immediately determines which specific phase is affected. It then triggers the corresponding relay (via the blue relay module in the center of the image) to isolate that line, thereby preventing further damage to the system or connected equipment. Simultaneously, the system fetches real-time GPS coordinates from the GPS module (the small board with a ceramic antenna) attached near the ribbon cables. These coordinates indicate the exact location of the fault, which is crucial for transmission line maintenance teams to quickly locate and repair the issue, especially over long rural distances. The LCD display module in the setup shows live status updates. Under normal operation, it shows “Line Healthy, while during a fault, it shows messages such as “R Phase Fault Detected” along with the GPS coordinates.

LED indicators (visible at the bottom middle) may also be used to provide visual alerts for each phase, turning on when a corresponding fault is detected. The system is powered by a custom power supply circuit (bottom right), which includes transformers and capacitors to convert AC mains to suitable DC voltage levels required by the microcontroller and other components. This offers a reliable way to continuously monitor three-phase transmission lines, detect faults instantly, and accurately report the fault location using GPS. This allows for faster fault management, minimizes downtime, and enhances the efficiency and safety of power distribution systems.

Case-1: NO FAULT CONDITION

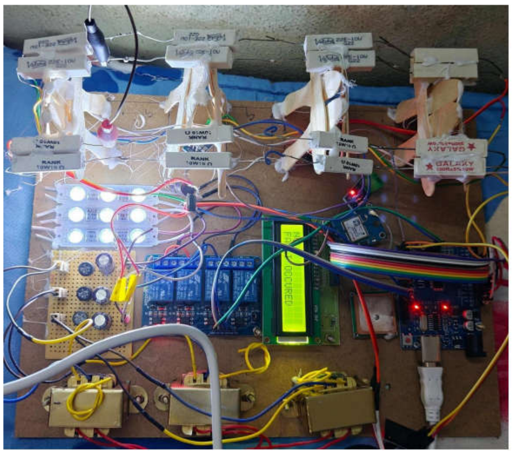

Fig.4 Testing at No Fault Condition

Whenever there is no fault occurred in the system there will be continuous glow of LEDS and there is displaying of no fault occurred in the LCD display. Three-phase transmission line fault detection using GPS location is a modern, advanced technique used in power systems to accurately detect and locate faults in long-distance high-voltage transmission lines. Faults such as line-to-line, line-to-ground, double line-to-ground or three-phase short circuits can occur due to lightning, weather, insulation failure, or mechanical damage. Immediate fault detection and localization are crucial for maintaining system reliability and preventing damage to equipment or blackouts.

Case-2: FAULT CONDITION

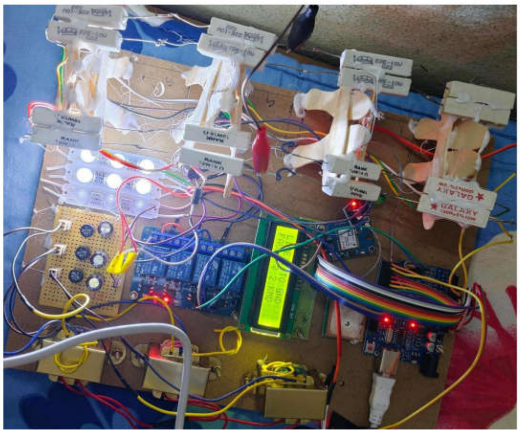

Fig. 5 Testing at Fault Condition

When the fault occurs in the system then there will no glow of LEDs and there will be displaying of fault occurred and which type of fault is occurred and at how much distance the fault is occurred in the LCD display. The current sensor in the affected phase detects a sudden spike or drop in current. Similarly, voltage sensors may detect a voltage dip or complete failure. These deviations from normal values are immediately picked up by the microcontroller. The GPS modules at both end timestamp the moment they detect a fault. Since GPS satellites provide highly accurate universal time (UTC), the system can calculate the difference in arrival time of the fault signal at both ends.

For Example: Suppose if a R line to Ground fault occurs at a distance of 2km then the R-line LEDs will turn off and there will be displaying of line to ground fault at 2km in the LCD display.

V.CONCLUSION: The implementation of a three-phase transmission line fault detection and analysis system with GPS location significantly enhances the reliability, efficiency, and safety of power transmission networks. By continuously monitoring the transmission line parameters and identifying abnormal conditions such as short circuits, line-to-ground faults, and line-to-line faults, the system enables prompt detection and classification of faults. The integration of GPS technology provides accurate geolocation of the fault point, which drastically reduces the time required for maintenance crews to locate and address the issue, thereby minimizing power outages and service disruptions. Furthermore, the system's ability to analyze fault data in real-time contributes to better decision-making for grid operators and supports preventive maintenance strategies. It allows utility companies to maintain operational efficiency, reduce financial losses, and enhance customer satisfaction by ensuring a quicker response to faults. The combination of fault detection with precise location tracking also supports future advancements in smart grid technology and automated grid management. Overall, this system is a crucial step toward modernizing power infrastructure and ensuring a more resilient and intelligent energy distribution network.

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