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Transmission Line Fault Detection Using IoT

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***ABSTRACT*: -Due to transmission line conditions, transmission lines are susceptible to a wide range of defects. The defect is difficult to diagnose, and the entire cable should be replaced. Using a microcontroller, this project will detect the location of a fault in transmission cable lines from the base station in kilometers. When a defect occurs, the voltage between series resistors changes, which is then supplied to an ADC, which produces exact digital data for a programmed destination. It also shows the distance between faults. Location may be tracked using GPS. On a 16X2 LCD connected to the microcontroller, the fault distance, phase, and time are displayed. The Wi-Fi module is utilized in IOT to display information over the Internet. The information concerning the occurrence of the defect is shown in a webpage produced with HTML code.**

Key Words: Internet of things, short circuit fault, Open Circuit Fault, Voltage sensor, Current sensor, Arduino, Microcontroller, GPS.

INTRODUCTION:

One of the most important components of the electricity system is the transmission network. When compared to other sections of the power system, transmission and distribution network losses are considered to be extremely high. The electric power grid is extremely vulnerable to a variety of natural and malicious physical events. To detect faulty transmission lines, many electric power transmission companies have relied primarily on circuit indicators. Several of these issues are addressed by wireless sensor-based transmission line monitoring, such as real-time structural awareness, faster fault localization, accurate fault diagnosis by identifying and distinguishing electrical faults from mechanical faults, cost savings due to condition-based maintenance rather than periodic maintenance, and so on. These applications have strict requirements, such as delivering a large amount of highly reliable data quickly. The design of a cost-effective and reliable network architecture with a fast response time is critical to the success of these applications. The network must be capable of transporting sensitive data to and from the transmission grid, such as transmission line status and control data. This paper presents a framework for designing a real-time data transmission network that is cost-effective. Sensors are installed in various components of the power network to monitor the status of the power system in real time.

FAULTS IN TRANSMISSION LINE :

OPEN CIRCUIT FAULTS:

Failure of one or more conductors causes these faults. Joint failures of cables and overhead lines, failure of one or more phases of a circuit breaker, and melting of a fuse or conductor in one or more phases are among the most common causes of these faults. A series fault is the same as an open circuit fault. Except for three-phase open faults, these are unsymmetrical or unbalanced faults.

SHORT CIRCUIT FAULTS:

A short circuit is an abnormally low-impedance connection between two points of different potential, whether intentionally or accidentally made. These are the most common and dangerous types of faults, which cause abnormally high currents to flow through equipment or transmission lines. If these faults are allowed to persist even for a short time, the equipment will be severely damaged. Shunt faults are another name for short circuit faults. Insulation failure between phase conductors, between earth and phase conductors, or both causes these faults. Three phases to earth, phase to phase, single phase to earth, two phase to earth, and phase to phase are all possible short circuit fault conditions. A fault can occur between any of the three lines and the ground in a single line to ground fault. A fault occurs between any two of the three lines and the ground in a double line to ground fault. A fault can occur between any two lines in a line-to-line fault. A sudden change in voltage occurs when a fault occurs. If not corrected immediately, this voltage change could cause serious system damage.

FAULT DETECTION METHODS:

ONLINE METHOD:

This method utilizes and processes the sampled voltages and current to determine the fault points.

OFFLINE METHOD:

In this method special instrument is used to test out service of cable in the field. Existing system used for offline method. This method can be divided into two methods. They are tracer method and terminal method.

EXISTING SYSTEM:

Tracer method:

The tracer method is an exhaustive way to locate a faulted segment by walking through the cable circuits. A faulted segment can be determined from audible or electromagnetic signals and requires dispatching crew members to the outage area.

There have been various techniques largely used in the industries, including the tracing approach through acoustic, electromagnetic or current.

Terminal method:

The terminal method is a technique used to determine a fault location of a distribution cable network from one or both ends without tracing exhaustively. A bridge technique is one of the most popular terminal methods that links with a resistor to determine a fault location. It is a technique used to detect fault location of cable from one or both ends without tracing.

PROPOSED SYSTEM:

An IoT-enabled overhead cable fault detection system is proposed. The voltage varies when a fault occurs in the cable, which is used to calculate the fault distance. Wi-Fi module and Microcontroller make up the system. A step-down transformer, rectifier, and regulator are used to provide power. The microcontroller receives the magnitude of voltage drop across the resistors from the cable's current sensing circuit, and the voltage is used to locate the fault distance.

ADVANTAGES:

- Detects accurate fault sub location
- Reduce human effort
- Time saving and faster maintenance
- Less software requirements
- Cost effective
- Less complexity

DISADVANTAGS:

- In some rural areas, there is no GPS signal.
- High initial cost.

POWER SUPPLY:

Arduino works on 3.3V Power supply, So LM117 a 1A low dropout regulator is designed to provide 3.3V from a 5V supply. It is ideally suited for system which contains both 5V and 3.3V logic.

BLOCK DIAGRAM:

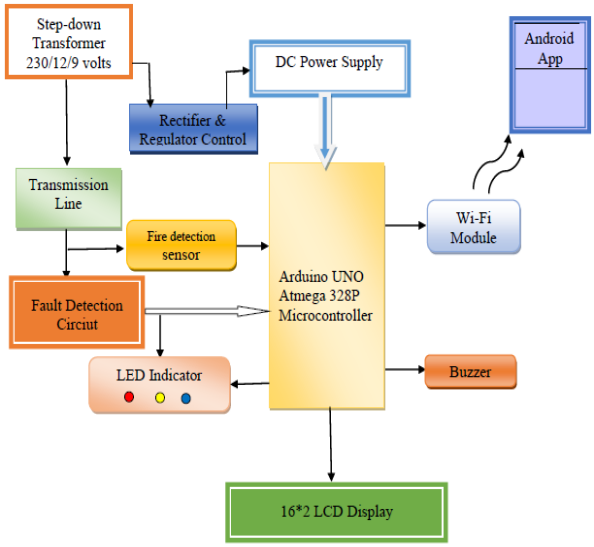
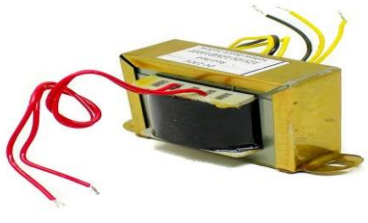


Fig. 1: Block Diagram

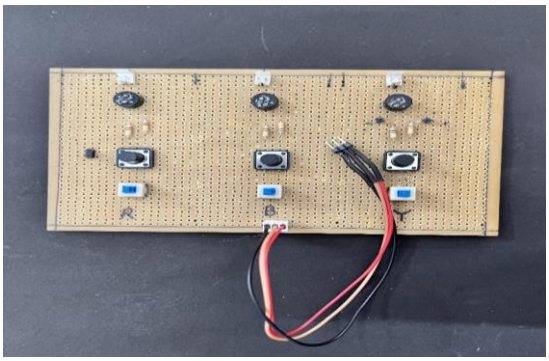
STEP DOWN TRANSFORMER:

A transformer designed to reduce the voltage from primary to secondary is called a step-down transformer. This transformer takes input of 230 volts AC and reduces the voltage to 12 volts/9 volts AC. In total four step down transformers are used in which 3 are used as transmission line components (230V/9V) and one is used to provide DC supply (230V/12V)



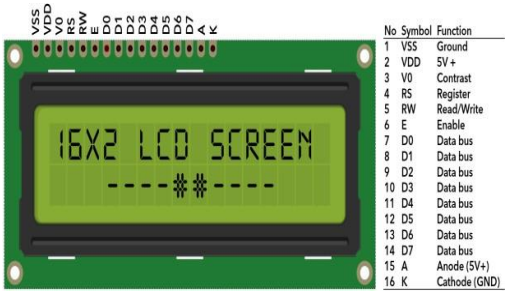
PUSH SWITCHES:

These are the switches which are used to simulate the faults in system. Two types of switches are used i.e., DPDT push button and tactile switches. When these buttons/ switches are pressed, fault is initiated in the system as the connections are done in such way. DBDT switches produce line-line faults and tactile faults produce line-ground faults.



LCD (Liquid Crystal Display):

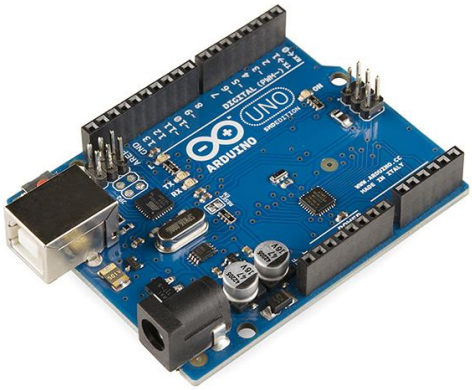
An Interface IC is used to handle the difficult task that the MCU can't handle. The IC's job is to take commands and data from the MCU and process them so that meaningful information can be displayed on the LCD screen.



No	Symbol	Function
1	VSS	Ground
2	VDD	5V+
3	V0	Contrast
4	RS	Register
5	RW	Read/Write
6	E	Enable
7	D0	Data bus
8	D1	Data bus
9	D2	Data bus
10	D3	Data bus
11	D4	Data bus
12	D5	Data bus
13	D6	Data bus
14	D7	Data bus
15	A	Anode (5V+)
16	K	Cathode (GND)

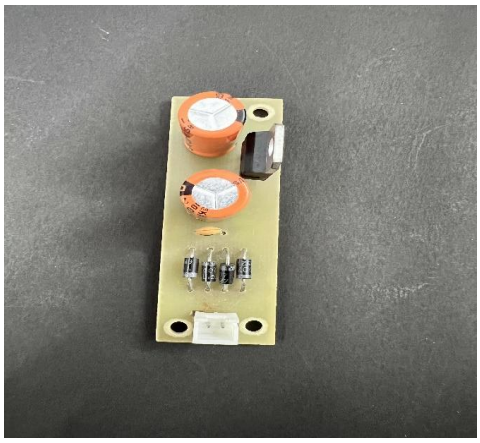
ARDUINO UNO :

The Arduino Uno is an open-source microcontroller based on the Microchip ATmega328P Microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shield) and other circuits. The board has 14 digital I/O pins (six capable of PMW output), 6 analog I/O pins, and is programmable with the Arduino IDE, via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is available on the Arduino website and is licensed under the Creative Commons Attribution Share-Alike 2.5 license. Some versions of the hardware have layout and production files available as well. [4]
Arduino is made up of a programmable circuit board and pre-installed software called Arduino IDE (Integrated Development Environment), which is used to write and upload computer code to the physical device.



AC-DC POWER MODULATOR:

Power modulator converts AC supply to fixed DC. It consists of bridge rectifier circuit, voltage regulator (7809) circuit. It takes 12 volts AC input from transformer and converts it into 9 volts fixed ripple free DC supply.



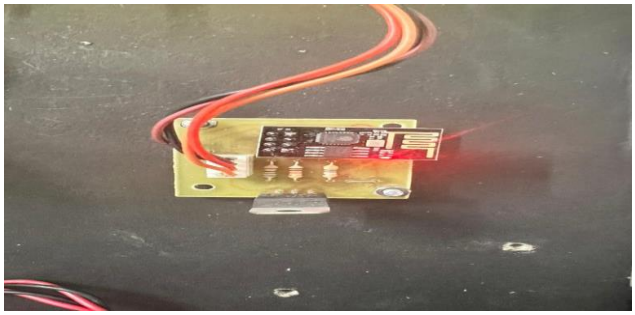
INTERNET OF THINGS (IOT):

The Internet of Things (IOT) allows users to send and receive data in real time in a simple and secure manner.

This platform allows developers to extend the platform for private customization by allowing interactive, real-time data visualization. Its purpose is to empower data from devices.

WI-FI MODULE:

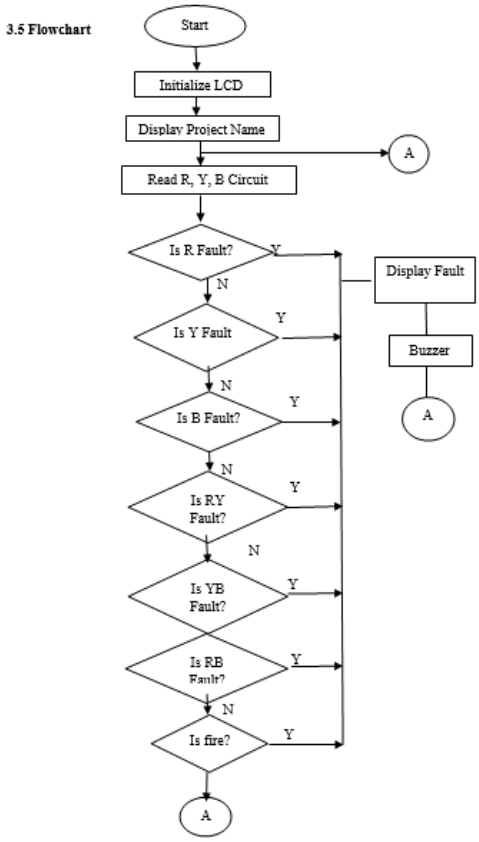
The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community



BUZZER:

An audio signaling device like a beeper or buzzer may be electromechanical piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren

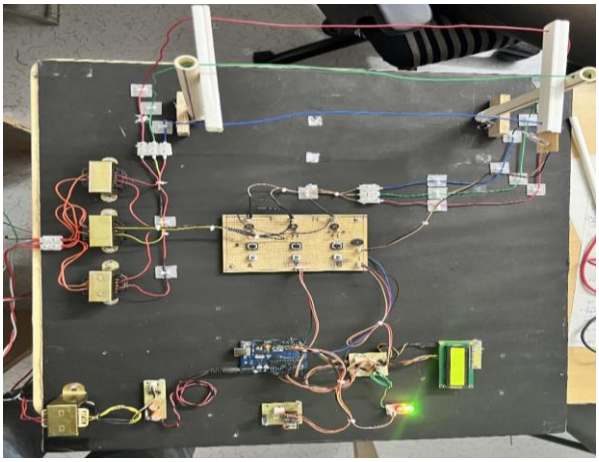
FLOWCHART:



IMPLEMENTATION OF WORK:

- This prototype is used to detect the fault, which has occurred in transmission line.
- By using ATMEG328p microcontroller, Push Switches, Indicating LEDs, LCD; this prototype is assembled with a set of resistors, cables, by using set of switches made to creation of fault in prototype.
- A 230V AC supply is fed through a Step-down transformer which gives 12 V AC output which is to AC-DC Power Modulator, where it converts AC voltage into DC voltage using a Full Wave Rectifier circuit. 7809 voltage regulator is used to regulate voltage output voltage to 9V as micro controller needs 9V power supply.
- Through micro controller, there is only one 5V power output pin and single ground. The main challenge is that the prototype needs to power various components i.e., LCD, Wi-Fi module, buzzer, and fire sensor. To solve this issue, a Power Extension PCB has been introduced in module. It provides multiple power pins which can be used for many components. In short Power extension PCB works as Power extension

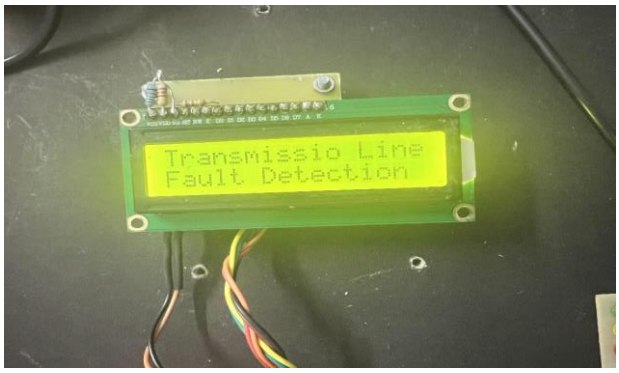
board which provides multiple outputs using single supply.



- Indicating LEDs are provided in the circuit which shows the status of transmission lines when fault occurs. When any fault in any particular line occurs, that led representing that line turns off.
- ESP8266 Wi-Fi Module is connected to microcontroller through its serial communication ports i.e., RXD and TXD pins.
- Three Step down transformers are given in the prototype to feed the transmission line. These transformers convert 230V AC to 9V AC which is further fed to the Push buttons PCB where three bridge rectifiers converts this 9V ac to 9V DC. these Push buttons are connected to analog input pins of microcontroller
- The push buttons shows/ simulates the faults in the system. Various buttons are allotted for various purposes and each button is responsible for different fault. There are total 6 push buttons from which three are DPDT buttons and three of them are Tactile switches. DPDT buttons are used to show phase to phase faults and Tactile switches for phase to ground fault.
  Assuming these names for push buttons and their faults shown: -
  1. DPDT switch 1 – D1 for R-Y fault
  2. DPDT switch 2 – D2 for Y-B fault
  3. DPDT switch 3 – D3 for R-B fault
  4. Tactile switch 1 – T1 for R phase fault
  5. Tactile switch 2 – T2 for Y phase fault
  6. Tactile switch 3 – T3 for B phase fault
     (It means when a certain key is pressed, it creates its respective fault in system)

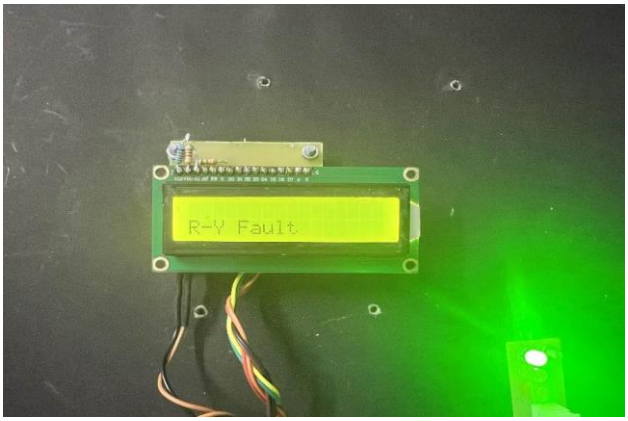
RESULT:

When the circuit is powered ON, the display shows the project name as shown in figure

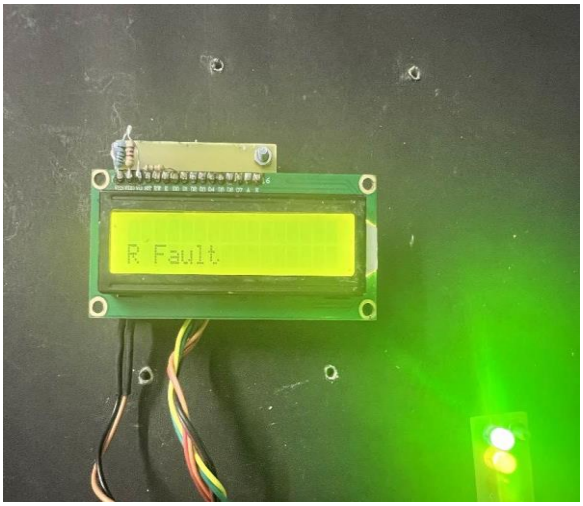


When no key is pressed, i.e., no fault is present in system, display shows “R-Y-B ok” as shown in figure. It means system is not faulty.

when D1 button is pressed, transmission line goes under R-Y phase to phase fault which is shown in LCD display as Now follows:



Now when Tactile switch T1 is pressed, transmission line goes under R to ground fault which is shown in LCD display as follows:



CONCLUSION:

The short circuit fault is located at a specific distance in the transmission line in order to efficiently rectify the fault. With the help of Arduino, the work automatically displays the phase, distance, and time of the fault occurrence. Faster repair of the power system, improved system performance, lower operating costs, and shorter time to locate faults in the field are all advantages of accurate fault location.

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