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OVERHEAD TRANSMISSION LINE FAULT DETECTION ALERT AND LOCATION USING IoT TECHNOLOGY

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Abstract:

The fault location detection has been a main objective of power system engineers, in transmission and distribution systems. Identification of fault source is tedious task; fast fault detection can help to protect the equipment before any significant damage of the equipment. The exact fault location can help service man to remove persistent of the faults and locate the areas where the faults occur regularly, thus reducing the occurrence of fault and minimize the time of power outages. The paper is intended to detect the location of fault in transmission line using an Wi-Fi module and the same is transmitted to control center using IoT device. This proposed model to detect the fault location is quick, reliable and cost effective.

Index Terms **– Node MCU, Faults-open circuit, short circuit, Transmission lines, Relay,16x2LCD, Switches.**

I. INTRODUCTION

Overhead lines are prone to a wide variety of faults due to conditions wear and tear, rodents etc. Diagnosing the fault source is difficult and entire line should be taken out from the ground to check and fix faults. The project work is intended to detect the location of fault in overhead line lines from the base station using a NODE MCU controller. To locate a fault in the line, the line must be tested for faults. This prototype uses the simple concept. In the urban areas, the electrical lines run in overhead instead of overhead lines. [5]Whenever the fault occurs in overhead line it is difficult to detect the exact location of the fault for process of repairing that particular line. The proposed system finds the exact location of the fault. In case of fault, the voltage across series resistors changes accordingly, which is then fed to an controller to develop precise digital data to a programmed that further displays fault location in distance. The fault occurring phase, and time is displayed on a 16X2 LCD interfaced with the microcontroller. IoT is used to display the information over Internet using the Wi-Fi module ESP8266.

II. IOT TECHNOLOGY

[10]The Internet of things describes physical objects that are embedded with sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.

The future of IoT has the potential to be limitless. Advances to the industrial internet will be accelerated through increased network agility, integrated artificial intelligence (AI) and the capacity to deploy, automate, orchestrate and secure diverse use cases at hyperscale.IoT involves **extending internet connectivity** beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally "dumb" or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the internet

III. TYPES OF FAULTS

[9]Electrical fault is the deviation of voltages and currents from nominal values or states. Under normal operating conditions, power system equipment or lines carry normal voltages and currents which results in a safer operation of the system. But when fault occurs, it causes excessively high currents to flow which causes the damage to equipment's and devices. Fault detection and analysis is necessary to select or design suitable switchgear equipment's, electromechanical relays, circuit breakers and other protection devices.

There are mainly two types of faults in the electrical power system. Those are symmetrical and unsymmetrical faults.

Symmetrical faults

These are very severe faults and occur infrequently in the power systems.[9] These are also called as balanced faults and are of two types namely line to line to line to ground (L-L-L-G) and line to line to line (L-L-L).

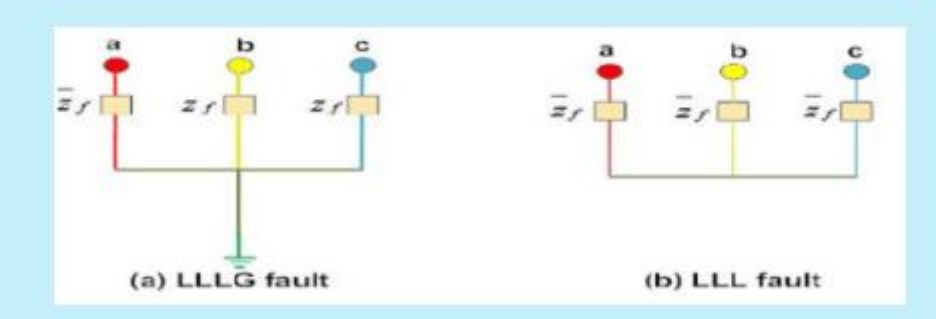

Fig 1: Symmetrical Faults

Only 2-5 percent of system faults are symmetrical faults. If these faults occur, system remains balanced but results in severe damage to the electrical power system equipments. Above figure shows two types of three phase symmetrical faults. Analysis of these faults is easy and usually carried by per phase basis. Three phase fault analysis or information is required for selecting set-phase relays, rupturing capacity of the circuit breakers and rating of the protective switchgear.

Unsymmetrical faults

These are very common and less severe than symmetrical faults.[9] There are mainly three types namely line to ground (L-G), line to line (L-L) and double line to ground (LL-G) faults.

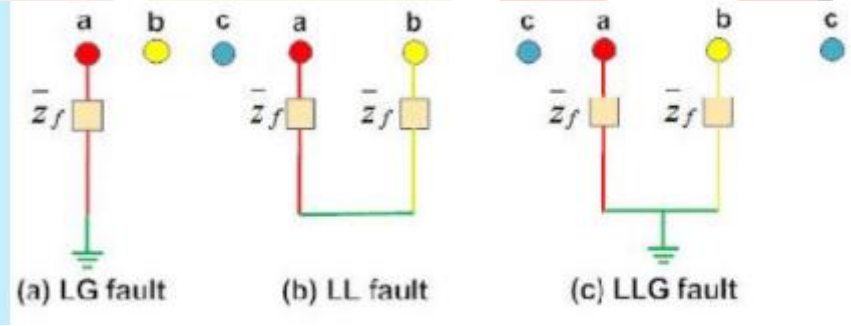

Fig 2: Unsymmetrical Faults

Line to ground fault (L-G) is most common fault and 65-70 percent of faults are of this type.

[9]It causes the conductor to make contact with earth or ground. 15 to 20 percent of faults are double line to ground and causes the two conductors to make contact with ground. Line to line faults occur when two conductors make contact with each other mainly while swinging of lines due to winds and 5- 10 percent of the faults are of this type.

These are also called unbalanced faults since their occurrence causes unbalance in the system. Unbalance of the system means that that impedance values are different in each phase causing unbalance current to flow in the phases. These are more difficult to analyze and are carried by per phase basis similar to three phase balanced faults.

IV.ESP8266 WI-FI MODULE

Espressif's ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry.[8] With the complete and self-contained Wi-Fi networking capabilities,[8]ESP8266EX can perform either as a standalone application or as the slave to a host MCU. When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated highspeed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any microcontroller design as a Wi-Fi adaptor through SPI/SDIO or UART interfaces. ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receives amplifier, filters and power management modules. The compact design minimizes the PCB size and requires minimal external

circuitries. Besides the Wi-Fi functionalities, ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor and on-chip SRAM.[8] It can be interfaced with external sensors and other devices through the GPIOs. Software Development Kit (SDK) provides sample codes for various applications. Espressif Systems' Smart Connectivity Platform (ESCP) enables sophisticated features including:

• Fast switch between sleep and wakeup mode for energy-efficient purpose;

• Adaptive radio biasing for low-power operation

• Advance signal processing

• Spur cancellation and RF co-existence mechanisms for common cellular, Bluetooth, LVDS, LCD interference mitigation

Categories	Items	Parameters
Wi-Fi	Certification	Wi-Fi Alliance
	Protocols	802.11 b/g/n (HT20)
	Frequency Range	2.4 GHz ~ 2.5 GHz (2400 MHz ~ 2483.5 MHz)
	TX Power	802.11 b: +20 dBm
		802.11 g: +17 dBm
		802.11 n: +14 dBm
	Rx Sensitivity	802.11 b: –91 dbm (11 Mbps)
		802.11 g: –75 dbm (54 Mbps)
		802.11 n: –72 dbm (MCS7)
	Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware	CPU	Tensilica L106 32-bit processor
	Peripheral Interface	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/ADC/PWM/LED Light & Button
	Operating Voltage	2.5 V ~ 3.6 V
	Operating Current	Average value: 80 mA
	Operating Temperature Range	–40 °C ~ 125 °C
	Package Size	QFN32-pin (5 mm x 5 mm)
	External Interface	-
Software	Wi-Fi Mode	Station/SoftAP/SoftAP+Station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Software Development	Supports Cloud Server Development / Firmware and SDK for fast on-chip programming
	Network Protocols	IPv4, TCP/UDP/HTTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

Table: Specifications of the ESP8266 module

V.CODE USED IN PROJECT

```
#include<ESP8266WiFi.h>
#include <FirebaseArduino.h>
#include <SoftwareSerial.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#define FIREBASE "jbit-fault-default-rtdb.firebaseio.com"
#define WIFI_SSID "faultiot"
#define WIFI_PASSWORD "faultiot01"
int sen=A0;
int sw1=D6;
int sw2=D5;
int sw3=D3;
int r1=D0;
int r2=D7;
int r3=D8;
String msg;
int acc_v,s_v;
float latitude;
float longitude;
float spd;       //Variable  to store the speed
float sats;      //Variable to store no. of satellites response
String bearing;  //Variable to store orientation or direction of GPS
int x,i,g,m,v,s,k;
long int distance_l;
long int distance,duration;
void setup()
{
Serial.begin(9600);
lcd.begin();
pinMode(sw1,INPUT);
pinMode(sw2,INPUT);
pinMode(sw3,INPUT);
pinMode(r1,OUTPUT);
pinMode(r2,OUTPUT);
pinMode(r3,OUTPUT);
digitalWrite(r1,LOW);
digitalWrite(r2,LOW);
digitalWrite(r3,LOW);
WiFi.begin(WIFI_SSID,WIFI_PASSWORD);
   Serial.print("Connecting.....");
   while(WiFi.status() != WL_CONNECTED)
   {
      Serial.print(".");
      delay(500);
    }
     Serial.println();
     Serial.print("connected: ");
     Serial.println(WiFi.localIP());


lcd.clear();
lcd.print("FAULT DETECTION SYSTEM");
}
void loop()
{
st:
while((digitalRead(sw1)) && (digitalRead(sw2)) && (digitalRead(sw3)))
{
  digitalWrite(r1,LOW);
digitalWrite(r2,LOW);
digitalWrite(r3,LOW);
Serial.println("welcome");
lcd.setCursor(0,1);
lcd.print("                ");
delay(1000);
}
```

```
delay(3000);
Serial.println("ACTIVATED-FAULT");
while(1)
{
if((!digitalRead(sw1)) && (!digitalRead(sw2)) && (!digitalRead(sw3)))
{
Serial.println("LLL-FAULT");
lcd.setCursor(0,1);
lcd.print("RYB-FAULT");
  digitalWrite(r1,HIGH);
digitalWrite(r2,HIGH);
digitalWrite(r3,HIGH);
}
if((!digitalRead(sw1)) && (!digitalRead(sw2)) && (digitalRead(sw3)))
{
Serial.println("1-2 FALUT");
lcd.setCursor(0,1);
lcd.print("R-Y FAULT    ");
  digitalWrite(r1,HIGH);
digitalWrite(r2,HIGH);
digitalWrite(r3,LOW);
}
if((!digitalRead(sw1)) && (digitalRead(sw2)) && (!digitalRead(sw3)))
{
Serial.println("1-3 FAULT");
lcd.setCursor(0,1);
lcd.print("R-B FAULT    ");
  digitalWrite(r1,HIGH);
digitalWrite(r2,LOW);
digitalWrite(r3,HIGH);
}
if((digitalRead(sw1)) && (!digitalRead(sw2)) && (!digitalRead(sw3)))
{
Serial.println("2-3 FAULT");
lcd.setCursor(0,1);
lcd.print("Y-B FAULT    ");
  digitalWrite(r1,LOW);
digitalWrite(r2,HIGH);
digitalWrite(r3,HIGH);
}
if((!digitalRead(sw1)) && (digitalRead(sw2)) && (digitalRead(sw3)))
{
 Serial.println("1 - FAULT");
lcd.setCursor(0,1);
lcd.print("R FAULT    ");
  digitalWrite(r1,HIGH);
digitalWrite(r2,LOW);
digitalWrite(r3,LOW);
}
if((digitalRead(sw1)) && (!digitalRead(sw2)) && (digitalRead(sw3)))
{
 Serial.println("2 - FAULT");
lcd.setCursor(0,1);
lcd.print("Y FAULT    ");
  digitalWrite(r1,LOW);
digitalWrite(r2,HIGH);
digitalWrite(r3,LOW);
}
if((digitalRead(sw1)) && (digitalRead(sw2)) && (!digitalRead(sw3)))
{
 Serial.println("3 - FAULT");
lcd.setCursor(0,1);
lcd.print("B FAULT     ");
  digitalWrite(r1,LOW);
digitalWrite(r2,LOW);
digitalWrite(r3,HIGH);
}
delay(1000);
```

```
//Serial.print("SEN:");
//Serial.println(analogRead(A0));
//Serial.println();
//delay(500);
}
}
```

VI.Result

In this prototype, we have achieved fault detection and location sharing using IoT technology. [1]The three type of faults able to detect is line fault on any one phase-R,Y,B , line to line fault between any two phases i.e., R-Y,Y-B,R-B, and the three lines fault on all the phases i.e., RYB and used pre-defined locations for each type of fault,We used a 16x2 LCD screen on the board which is used to display the various faults occurring.The location of the fault is shared to concerned persons using an mobile application and also displays the fault in the application.

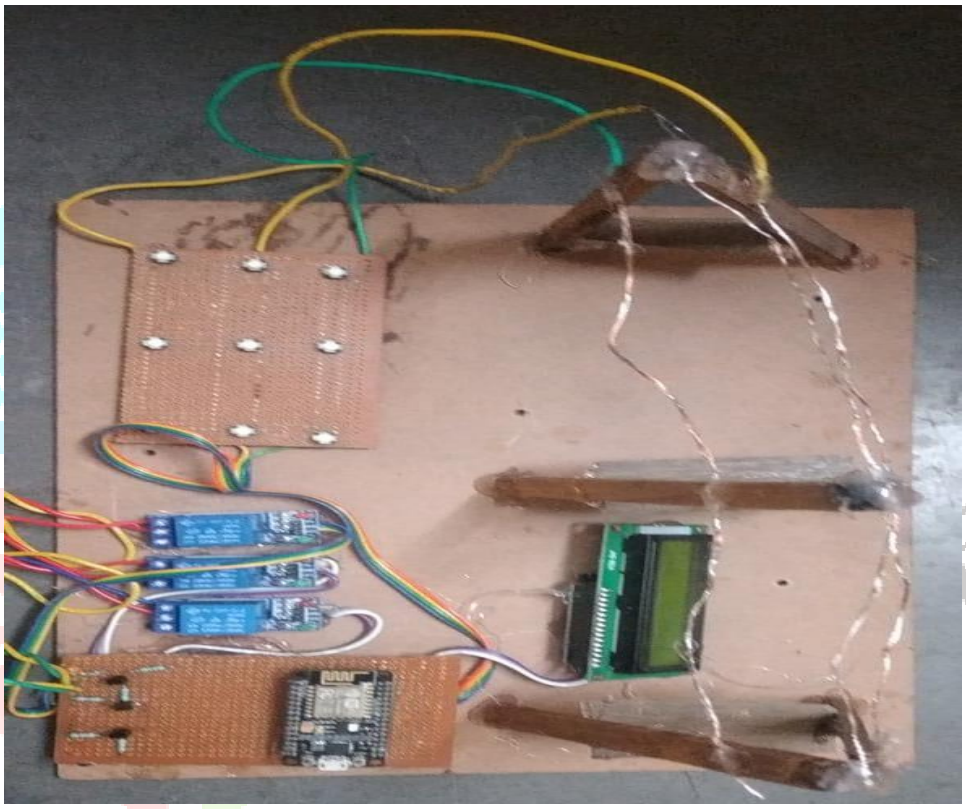

Fig 3 :Top view of kit

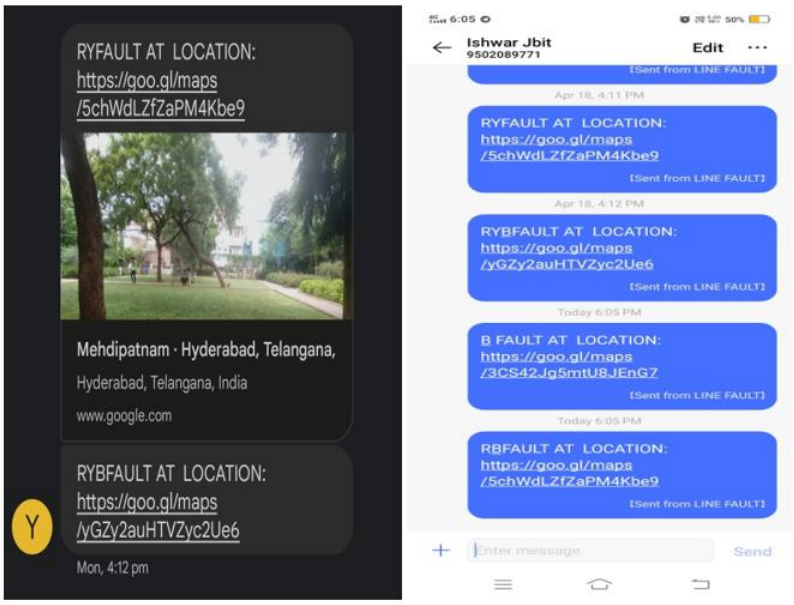

Fig 4: Messages sent and received from mobile application

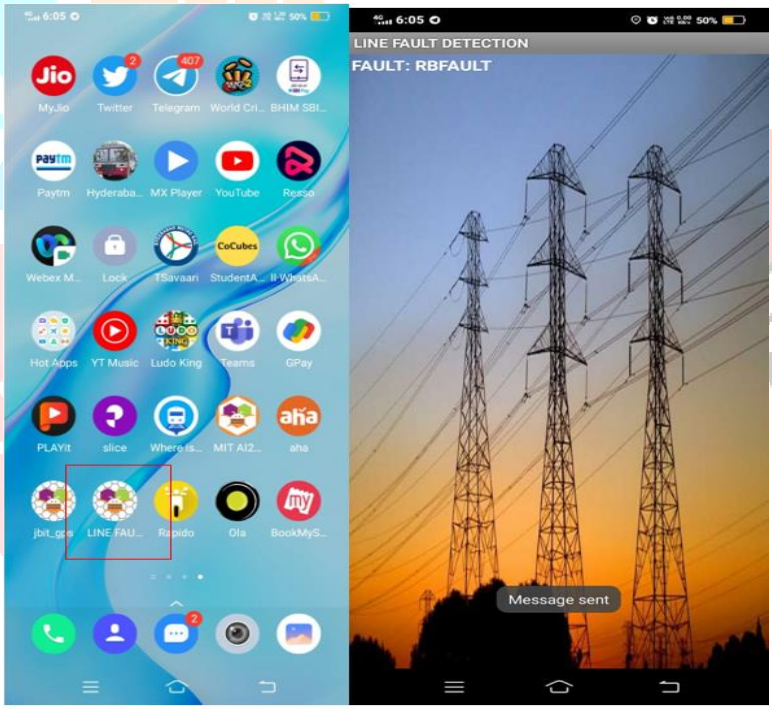

Fig :Application Logo and screen

VII.CONCLUSION

The short circuit fault at a particular distance is located to rectify the fault efficiently using simple concepts of Ohms law. The work automatically displays the phase, distance and time of occurrence of fault with the help of ESP8266 Wi - Fi module in a webpage. The benefits of accurate location of fault are fast repair to revive back the power system, it improves the system performance, it reduce the operating expense and the time to locate the faults in the field

VIII.FUTURE SCOPE

In the project we detect the exact fault location of short or open circuit fault in the Transmission lines from feeder by using NODE MCU controller. Therefore, different types of fault analysis and fault location can be done with ease. Simulation results and prototype's results are matching with the distance at which fault is created. Development for a wide range of line length will be made in the further work in terms of safety and compact size for field measurements.

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