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GSM based Underground Cable Fault Detection

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Abstract: ***Underground cable is the replacement of overhead wires providing electrical power or telecommunication using underground cable; they have small voltage drops, low chances of developing faults and have low maintenance cost. In the paper presented arduino has been used to identify location of fault using GSM. Implementation has been done on a small scale using double throw switch to create short circuit fault. Each phase has been given voltage supply through fixed resistors across which fault voltage is measured. LCD used displays the fault location and GSM module sends SMS to the registered mobile number.***

Keywords: Arduino, DC, LCD, GSM, Fault location.

I. INTRODUCTION

In modern cities we need to make our electrical distribution network simple, reliable and efficient. So, underground cable system plays an important role today[1]. Underground cables are traditionally preferred over the overhead lines for economic reasons, risk management and for high power rating[2-5]. Moreover, underground cable systems reduce unnecessary chaos of tangled wiring systems and gives a nice and clean arrangement over a vast area, with no interference with surrounding system[6-7].These cable systems are being accepted worldwide. Even in developing countries underground cable system are being increasingly used[8].

A fault in underground cable due to a number of reasons such as digging, earthquakes, construction work etc. have been a major drawback to the system[9-12]. Due to the unknown location of the fault in the cable, the repairing process becomes very difficult[16]. The detection of these faults can be a major issue in the repairing process due to lack of proper instruments that could detect the faults. The digging of the entire area is done due to a fault which causes wastage of money and manpower. It is also time consuming and also leads to disruption in the supply of power until the fault is corrected[13]. So, in this project we devised a new method to locate the fault in the cables using GSM[14]. There exist several works regarding underground cable fault detection as follows- G. S. Darvhankar et al.[15] derive a new concept to detect fault in underground cable by using a HV surge tester which generate spark at fault position to produces noise and vibrations in fault site. This noise sensed by sensitive ground microphone which is further amplified and exact fault point is located by detecting the fault having maximum noise and vibrations. . M. R. Hans et al.[16] tested murray loop test for fault detection in which they uses wheatstone bridge to find exact location of fault. Gustavo D. Ferreira at al.[17] used load flow analysis to calculate fault distance by impedence matching having local voltage and current as input data. A. D. Filomena et al.[18] proposed a technique in which they used an extended impedance-based fault location formulation for single line-to-ground faults by using only local voltages and currents as input data. An iterative algorithm for cable capacitive current compensation in the fault location formulation is proposed by using systempsilas data, as lines impedance and admittance matrices, and also system loads. Sudesh et al.[19] proposed a system to locate fault location in underground cables by measuring parameters at different points in the cable by using optical fibre cable. Pavan et al.[20] designed a system using 8051 microcontroller to locate the fault and this information of fault detection is also sent to a dedicated website over internet (IOT). R.K.Raghul et al.[21] they studied a system of finding underground cable fault, especially high impedance incipient fault using Raspberry Pi and Arduino. They uses the simple concept of CT (Current Transformer) Theory so fault can be easily detected. V Surya Nagendra et al.[22] prosed a system in which they calculated fault location using ATMEGA microcontroller. Kunal et al.[23] devised a setup using Microcontroller PIC18F4550 for processing changed parameters and calculating fault location. T.Nandhini et al.[24] devised a system in which fault location is obtained by using programmed ARDUINO UNO.

II. PROPOSED SYSTEM

The circuit consists of a power supply, 4 line display, arduino and resistance measurement circuit. To induce faults manually in the kit, double throw fault switches are used to create earth fault. About 18 fault switches are used which are arranged in three rows with each row having 6 switches. The 3 rows represent the 3 phases namely R, Y and B which are represented in their respective colour and earth wire in green colour. The fault switches: have 2 positions-No fault position(NF) and fault position(F).Main component of the underground cable fault detection circuit is low value resistance measurement. It is constructed using a constant supply of 12v, 1Amp. Maximum cable length that can be checked is 30kilometers.

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Four Diodes are used to form bridge rectifier which delivers pulsating dc voltage of 12v and then fed to capacitor filter. The output voltage from rectifier is fed to filter to eliminate any a.c. components present even after rectification. This output is then passed through voltage regulators to get constant 12v DC voltage.

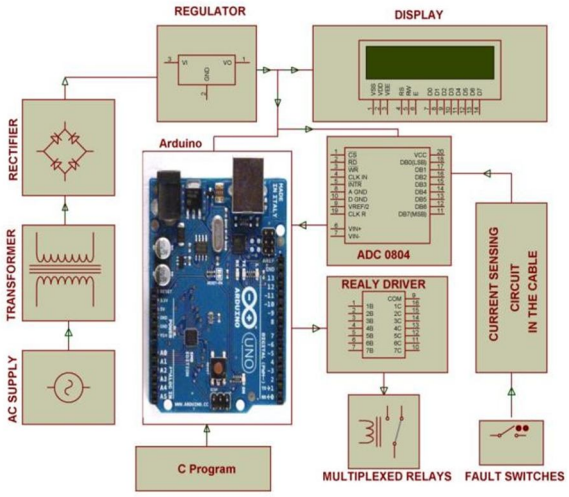


Fig 1: Block Diagram

The voltage output from bridge rectifier can be calculated by the equation

$V^{dc} = 2V^{max}/3.14 = 0.637V^{max} = 0.9V^{RMS}$

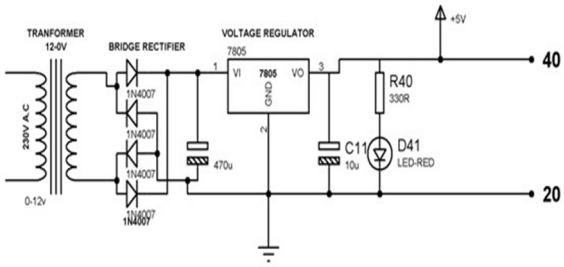


Fig 2:Power Supply

LCD is interfacing to microcontroller 8051. A 16*2 LED is used having supply voltage range of 4.7v-5.3v. 7805 and 7812 voltage regulators are used, wherein 78 represents positive supply and 05, 12 represents the output voltage levels.

Arduino UNO 328 is used having rated input supply of 7-12v and DC current per input output pin is 40mamp.Single Pole Double Throw Relay (SPDT) shifts to normally closed side when a fault occurs in the respective phase. The relays periodically scan the three phases and send the signal to the arduino controller. The rating of each of the relays is about 12V. ULN2003 serves as the relay driver circuit. It is an integrated circuit which boosts up the supply going to the relay. The GSM Module have the power ratings as supply voltage range 3.22v-4.2v and current in idle mode less than 1.8, speech mode is 200mamp.

230V ac supply is stepped-down to 12V with the help of step-down transformer (230/12V). This supply is then converted into dc by passing through a bridge rectifier.

But this dc is pulsating in nature so a voltage regulator & capacitor is implemented to get constant 12V dc supply. This 12V dc is then supplied to the cables through relay and a fixed resistance to the cable.

When a fault occurs, the voltage across starting resistor and cable changes. These changed parameters is then send to the analog pin of aurdino helps to calculate the fault location by using Ohms Law.

$$V = IR$$

$$\& \quad R = \frac{PL}{A}$$

Where P= resistivity of the cable.

I = current in the circuit

V = 12v dc supplied to circuit

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V1 = voltage across fixed starting resistor(after fault)
V2 = voltage across cable (after fault)
Then we can calculate v2 as
V2 = V – V1
By Ohms law
V =IR
R = V2/I
*P*L/A = V2/I
L = (A×V2)/I×*P*
Thus fault length is calculated in arduino and stored in programme.

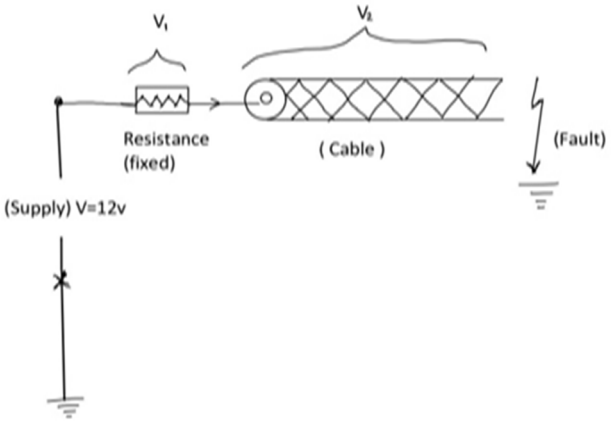


Fig 3: Circuit Diagram

This processed data from arduino is displayed on LCD and the location of fault is sent to the concerned authority via GSM module.

III. OBSERVATIONS

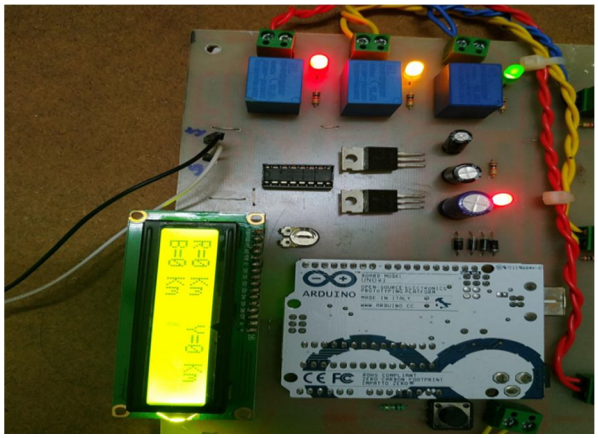
Based on the above working following results were deducted from the test which is depicted in the form of table.

Table 1:Observations after fault

Phases			Distance	Displayed message
R	Y	B	D	M
R1	Y1	B1	5km	R;Y;B=5
R2	Y2	B2	10km	R;Y;B=10
R3	Y3	B3	15km	R;Y;B=15
R4	Y4	B4	20km	R;Y;B=20
R5	Y5	B5	25km	R;Y;B=25
R6	Y6	B6	30km	R;Y;B=30

R1, Y1, B1 shows the fault switch which have been used to create fault in the system manually. It is also observed that fault which is closest is detected first. After one detection, the system requires to be reset as the relay trips when fault occurs.

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R=25Km

B=5Km

B=15Km

R=20Km

Y=5Km

Y=30Km

B=30Km

Y=25Km

Fig 4: LCD and GSM messages

IV. CONCLUSION

The paper gives a very simple yet efficient and reliable technique of fault detection. The technique is economical and saves both time and manpower in maintaining continuity of supply to the end users. It can easily be implemented on a large scale and requires less maintenance with slight advancements; the same technique can be used to detect open circuit and short circuit faults for single and 3-phase systems.

As our civilization is paying more attention towards smart city where underground cables is playing a major role. So this new technique has good scope in near future. There is a scope of advancement in this project for detecting short circuit faults and open circuit faults for single and three phase circuit.

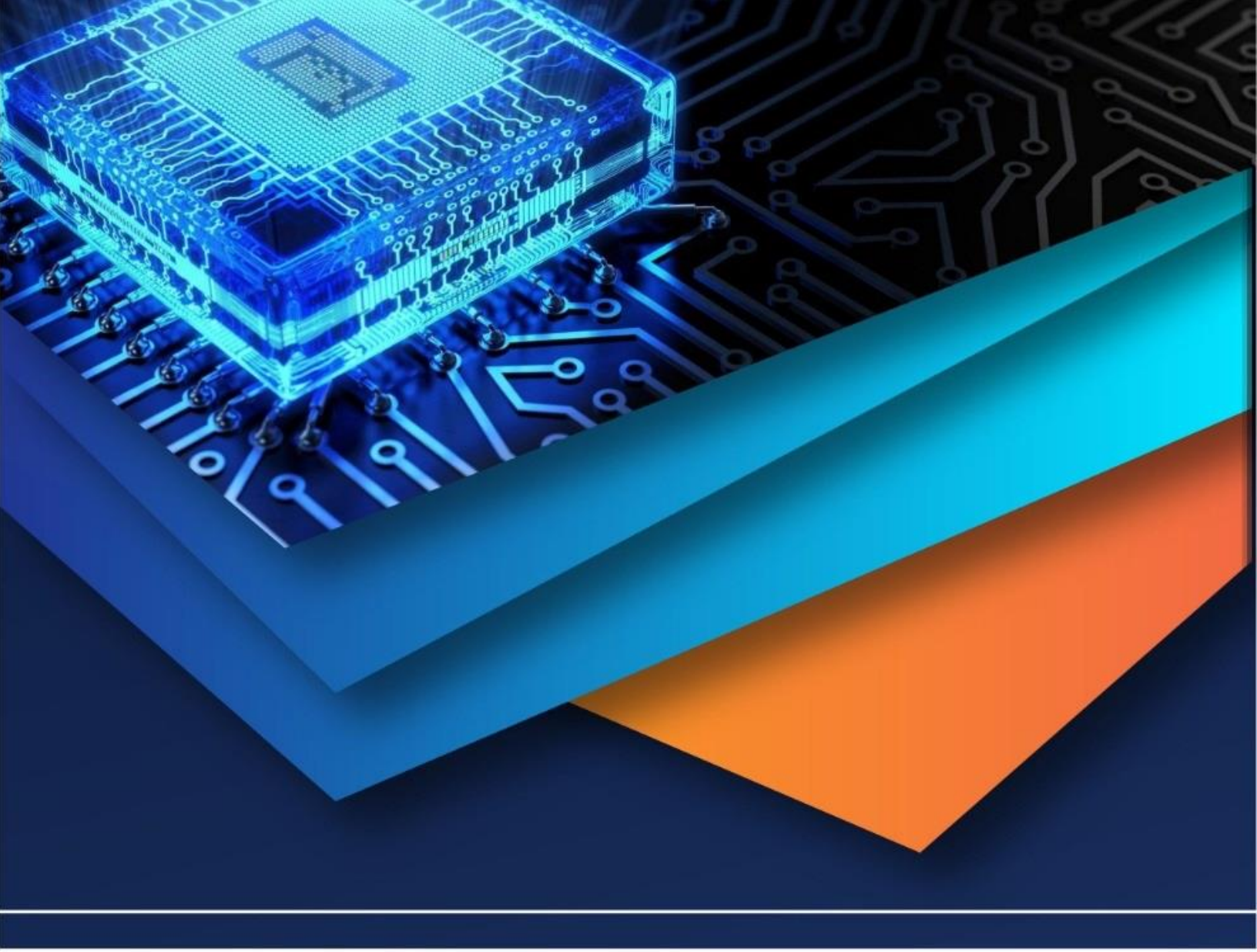
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