Design and Implementation of Wireless Live Wire Fault Detector and Protection in Remote Areas

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ABSTRACT
In remote and hilly areas, the faults in the live wires are difficult to analyse. The faults in the wire may be due to breakage in the wire, breakage due to heavy rain, snowfall and land slide, human and animal contact or lightening strike. In an electric power system fault is any abnormal electric current. RF Transreceivers have been proposed for detection of faults in the live wire. This technique can detect the faults in the wires, unapproachable by humans. RF Transmitter units are fixed along the length of wire at regular intervals, the RF receiver unit is placed at approachable area. Signal communication occurs between the transmitter and receiver unit. The transmitter units designed consists of a RF transmitter module which transmits the signal as long as it receives the power. The microcontroller receives the signal through the relay. The voltage fluctuation circuit constantly monitors the voltage level in the wire,and auto cuts-off power in case of voltage fluctuations. The transmitter unit which doesnot transmit the signal, indicates the area of fault in the wire. The receiver unit comprising of the RF receiver module,receives all the signals from the transmitter units accordingly. If all the transmitters' signals are received,this indicates that there is no fault in the wire. The transmitter unit from which the signal is not received,indicates the portion or area of the fault in the wire. The relay circuit in the transmitter unit auto cuts-off power in case of the fault detected. The decoder circuit connected to the RF receiver passes the signal to the microcontroller which is displayed. These messages can be transferred to any desired location through the GSM module present on the receiver unit. Hence the fault location can be detected and the circuit is protected in case of fault and voltage fluctuations in the wire.

Keywords
RF module, LCD,GSM, TDR.

1. INTRODUCTION
Location of faults on wires has become an area of international concern. Away from the earlier concepts of visual inspection and impedence testing, the concept of wireless communication is widely used today to help detecting and locating the faults in live wires. RF(radio frequency) communication is the most extensively used method today for wireless communication.

This project aims at developing a system that will automatically detect the fault location and will provide the information to the receiver unit. This information can be further transferred to any remote location through the GSM module present on the receiver unit. The communication between the RF transmitter and receiver is used for the detection of faults. This system will overcome the difficulty of fault detection in the wires which are unapproachable, at high altitudes or covered with snow. Additionally it also has more features as compared to earlier used methods. The receiver unit is at approachable area which will automatically receive the message regarding the area of fault location. So there is no need to approach the wire manually and detect the fault. GSM module is available on receiver unit, which will send the message regarding the fault location to any desired location. The whole receiver unit operates on battery, thus it can work even if there is no power.

In this project, the protection of whole circuit in case of voltage fluctuations has also been the main target. The voltage control circuit at the transmitter module constantly monitors the input voltage and automatically cuts off the power in case of high or low voltage. The RF transmitter module are fixed along the length of the wire to be tested at regular interval. As long as there is current in the wire, all the transmitter units will send the signal to the receiver unit. In case of fault in the wire, the RF transmitter module corresponding to the area of fault in the wire will not transmit the signal. This gives the location of fault in the wire.

The system is built upon RF transmitters and receiver of 2013 MHz frequency each, Microcontroller AT89S52 and GSM module SIM900. HT12E and HT12D are four channel encoder and decoder ICs directly compatible with specific RF module. The schematic is shown in fig. 1 and fig. 2 respectively.

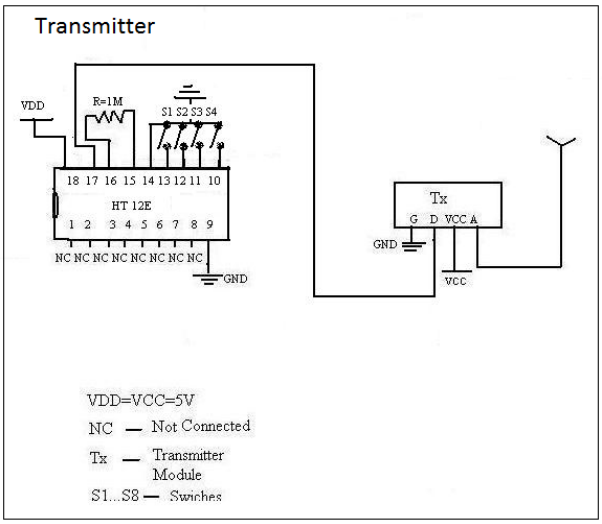


Fig 1: Connection of RF transmitter to HT12E IC

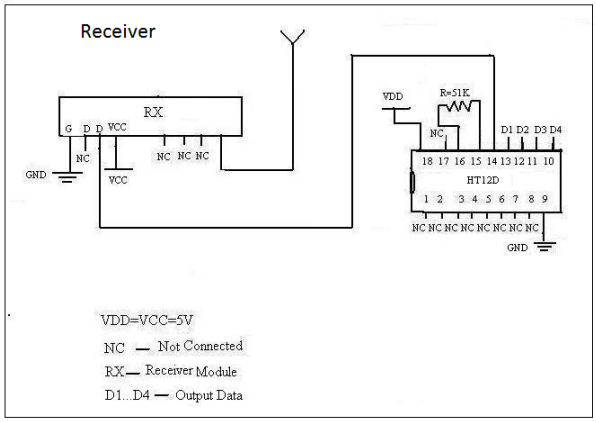


Fig. 2: Connection of RF receiver with HT12D IC

2. RELATED WORKS

Presently, the approach of fault detection include visual inspection and Impedence Matching. This paper presents Time-domain reflectometry (TDR) as one of the standard methods for detecting faults in electrical wiring and networks, with a long standing history focused mainly on hardware development of both high-fidelity systems for laboratory use and portable handheld systems for field employment. S-parameter based forward modeling is used in this technique [1].

This project, focused on a new concept of fault detection in wire networks, based on the properties of time reversal. This method is called the Matched Pulse approach (MP). In this, the testing signal is made to adapt to the analysed network, instead of using a predefined signal, in contrast to existing reflectometry methods. Mathematical study and numerical simulations have been used to show the benefits of this technique. A physical interpretation is also used to better understand this approach [2].

This work proposed a combine treatment of information from computer analysis and the monitored protection devices. Simulated variables are trained with self-organising map (SOM) to represent a portion of the distribution system in each neuron [3].

A fault detection method with antennas has been developed in contrast to the conventional methods in this paper. An artificial fault using metal electrode system, and an artificial void as breakdown was applied to the communication wire. The results showed the precision of detecting distance of the order of meters [4].

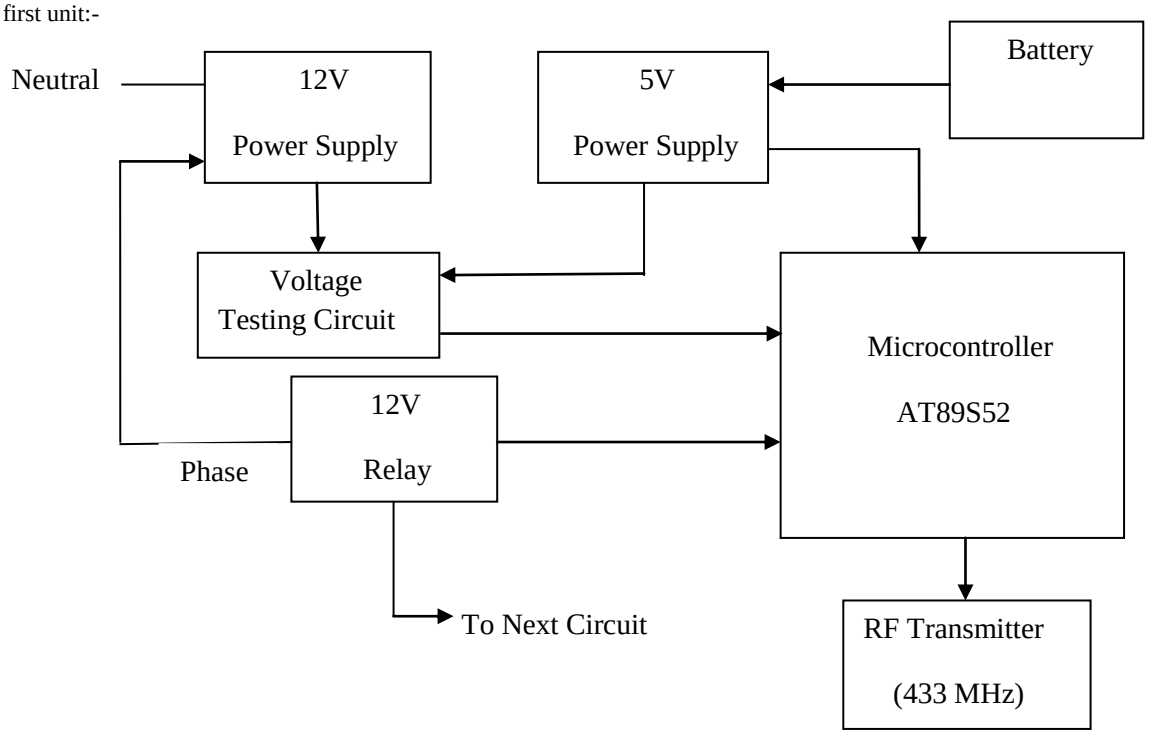
This paper describes a novel pulse tester correlation strategy, using pseudonoise (pN) sequences, as an improvement to Time Domain Reflectometry (TDR) for fault location and identification. This fault detection procure is used in a number of essential industries involving overhead power lines and underground cables in unapproachable locations. In this paper the Pseudorandom Binary Sequences (PRBS) method of cable fault diagnosis is presented, along with a single phase transmission line model, for fault distance measurement. The results gave the accuracy of PRBS diagnostic CCR method of fault identification and location using a range of resistive fault terminations. The accuracy of this method is further calculated through theoretical calculation via estimated fault reflection coefficients and comparison with known fault resistance terminations [5].

3. BLOCK DIAGRAM

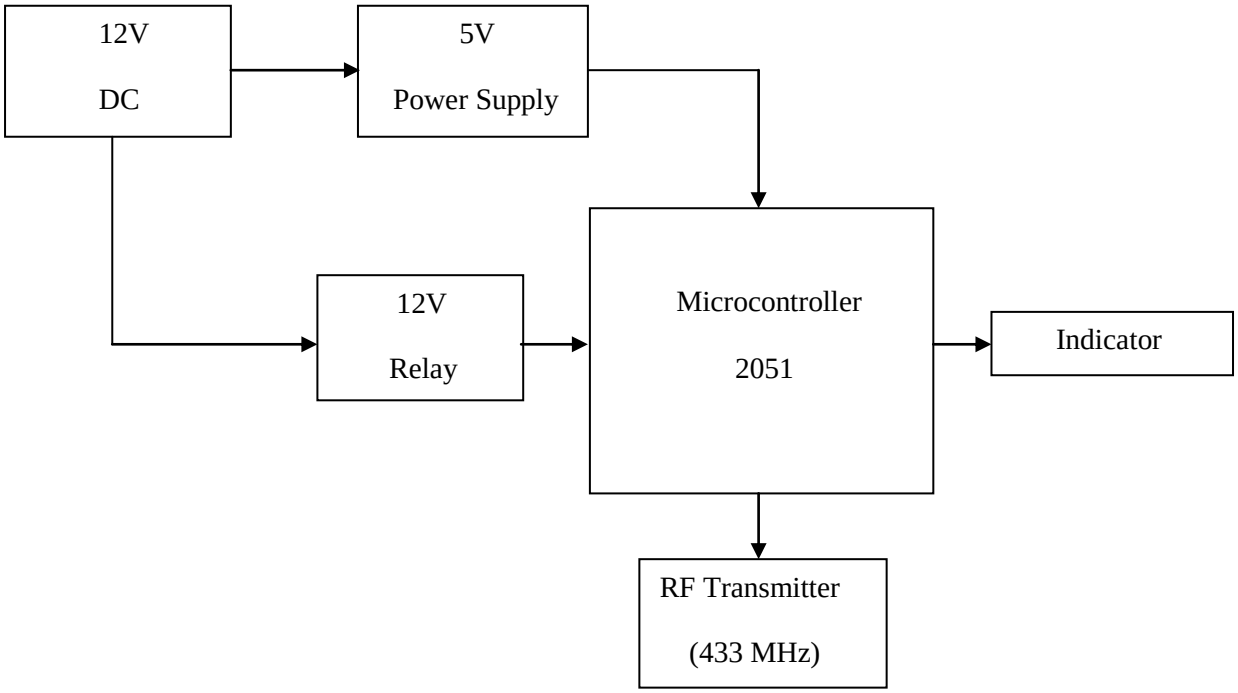
The block diagram of proposed system “Wireless Live Wire Fault Detector and Protection” has been shown in Figure 3. It consists of two parts: transmitter unit and receiver unit. The first Transmitter module is an integration of Power supply unit (12V,5V), AT89S52 microcontroller, RF transmitter (433 MHz), 12V relay and Voltage Testing Circuit. As long as the power is received by the transmitter from the microcontroller, it transmits the signal. The controller gets the signal through a 12V relay, so that it only sends the signal when the bit is high. The Voltage Testing Circuit consists of two variable resistances and constantly monitors the voltage level. It auto cuts-off the power in case of voltage fluctuations. The design of rest of the transmitter units is also same with the only change that, the Voltage Testing Circuit is not used and instead of AT89S52 microcontoller, we use 2051 controller as per our requirement. The core part of the Receiver Unit consists of RF Receiver (433MHz), Power supply unit (12V,5V), AT89S52 microcontroller, LCD (LMB162A), MAX 232, GSM module (SIM900). AT89S52 microcontroller is energized by 5V power supply. For this 5V power supply a circuit of 1000uF Filter Capacitor, LM7805 3PIN Voltage Regulator, 1 LED indicator and 1k resistor is made. Other components also operate on 5V power supply. AT89S52 microcontroller is preferred over other microcontrollers because of features like: it is low power, high performance CMOS 8-bit microcontroller with 8K Bytes of in-system programmable Flash memory, 256 bytes of RAM, 32 I/O lines, three 16-bit timer/counters, a full duplex serial port, on-chip ascillator, and supports two software selectable power saving modes: low power Idle and Power-down mode. The RF receiver receives all the signals from the transmitter modules, and passes it to the microcontroller. It also receives the signal of voltage fluctuation from the Voltage Testing Circuit. The controller displays the result on LCD. The message received by the microcontroller is in the form of ASCII characters. The MAX 232 circuit is used to level the voltage difference between the GSM module and microcontroller. The GSM module utilizes different AT commands for its operation, and then sends the message regarding the fault location to the desired location. HT12E and HT12D are four channel encoder and decoder ICs directly compatible with specific RF module.

Transmitter Unit:-

For first unit:-



For rest of the units:-



Receiver Unit:-

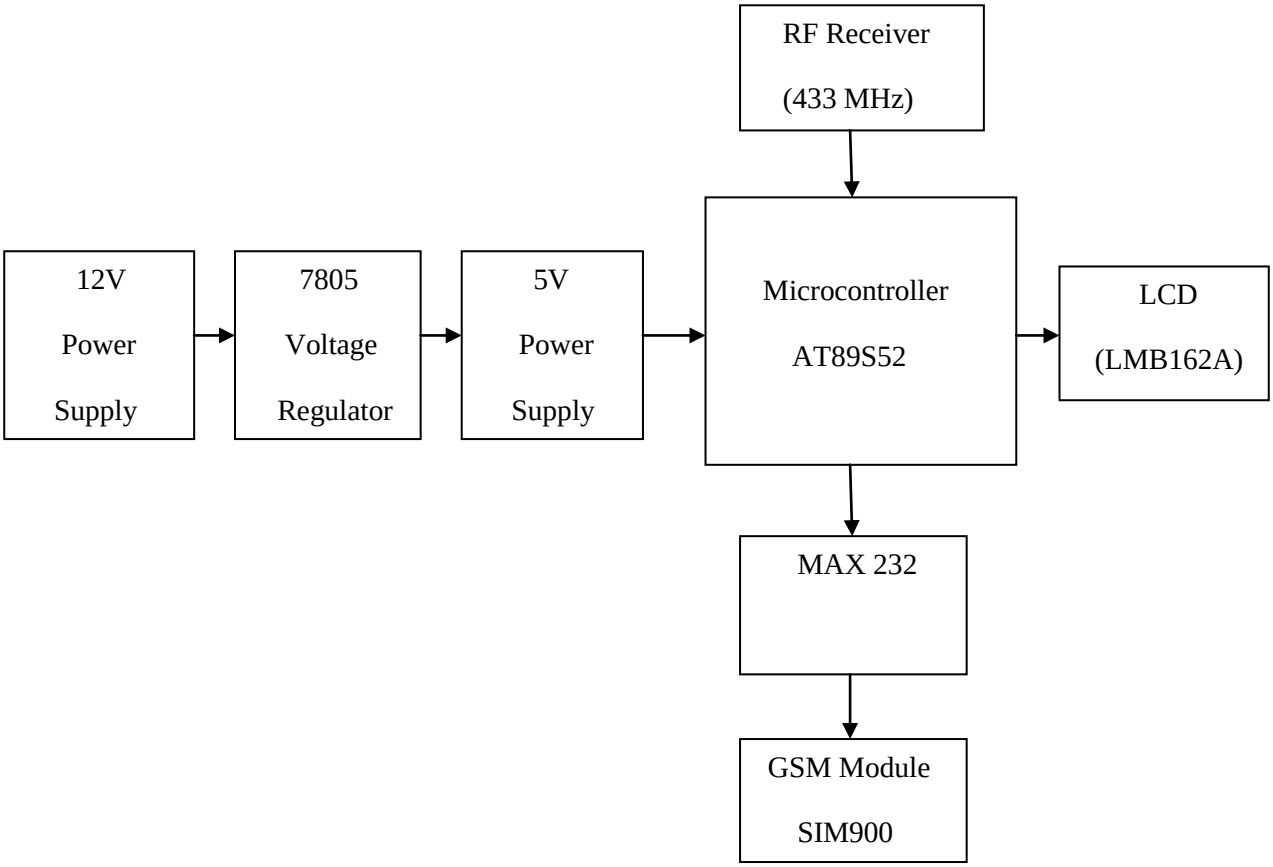
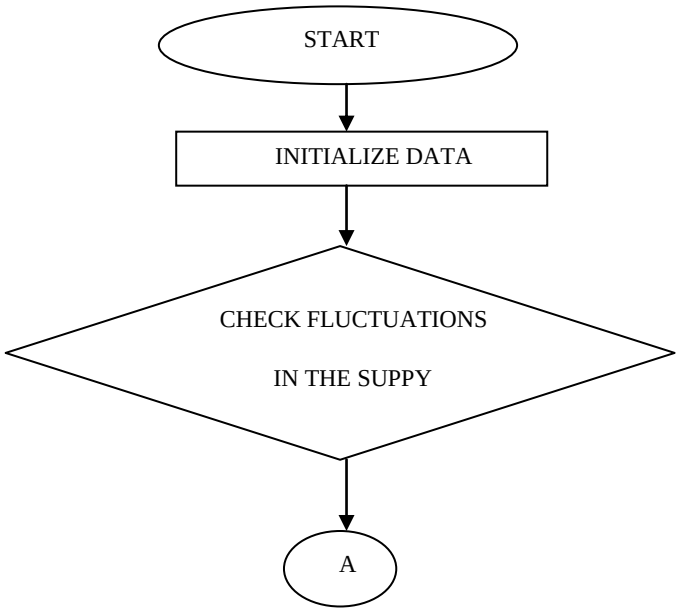


Figure 3 : Block diagram showing different components

4. FAULT DETECTION METHODOLOGY



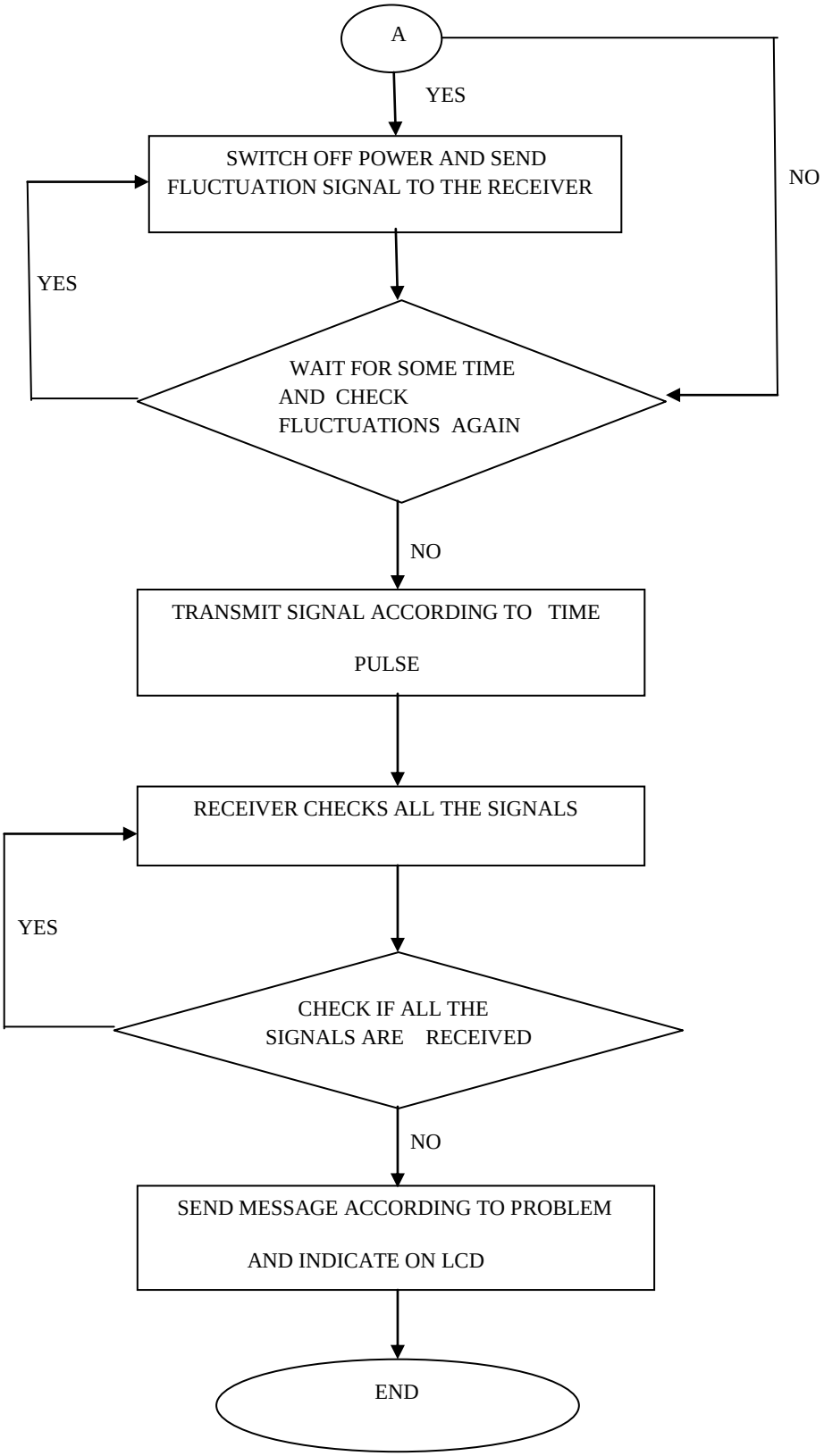


Figure 4 : Software flow graph

Figure 4 shows the Software Methodology of Live Wire Fault Tester. Firstly, the first transmitter unit cheks for the voltage fluctuations. If the voltage is high or low, it automatically switch offs the power and transmits the voltage fluctuation signal to the receiver. If there is no voltage fluctuation, it transmits the signal according to time pulse. Further it waits for some time and checks fluctuation again and repeats the same process. The rest of the transmitter units initialize data and according to time pulse transmit data. The receiver unit checks all the signals. If all the signals from the transmitter modules are received, it again checks the signals. If all the signals are not received by the RF receiver, it indicates the microcontroller. The microcontroller then recognizes the Transmitter module which did not transmit the signal, and then displays the message regarding the fault location on LCD. Further this message is passed to the GSM module through MAX 232. The GSM module transfers the message to the registered mobile number.

5. RESULTS AND DISCUSSION

Firstly, the program will initialize by testing the whole wire for the faults and it will take some time as shown in figure 5.

Figure 5 : Testing of whole wire

Then the program checks the voltage fluctuations in the wire. If there is fluctuation, the voltage testing circuit will indicate it to the receiver as shown in figure 6.

Figure 6 : Voltage fluctuation displayed on LCD

If there is no voltage fluctuation, then it will transmit OK signal to the receiver as shown in figure 7.

Figure 7 : OK signal displayed on LCD

Then rest of the transmitter modules also come into operation and they transmit data according to time pulse. The receiver unit then initializes data and checks for all the signals. If all the signals are received, it again checks the signals. If all the signals are not received, it indicates the microcontroller and displays the fault location on LCD as shown in figure 8.

Figure 8 : Fault location displayed on LCD

Further the message is passed to the GSM module through MAX232, which transfers the message to the registered mobile number as shown in figure 9.

Figure 9 : Message of fault location displayed on mobile

6. CONCLUSION

This project provides for the detection of faults in the live wires and their protection in a purely wireless manner. This system checks the voltage fluctuations in the wire, indicates it on the receiver and auto cuts-off power in case of voltage fluctuations. Further, the RF transmitter modules transmit the signal to the RF receiver unit as long as they receive power. The RF receiver unit then identifies the transmitter module from which the signal is not received, and passes the information to the microcontroller. The microcontroller displays the message regarding the fault location on the LCD. GSM module present on the receiver unit transfers this message to the desired location. Thus fault detection and protection of the circuit is achieved. Nonetheless, there are still new ideas to improve it and to add new functionality to it. Parameters such as Current Rating and Impedence can be calculated. As a future enhancement, Zigbee modules of Pro Series can be used to improve the range of the communication.

Table 1. Comparison with previous work

S.NO	Features	Previous Work	Present Work
1.	Cost	More than Rs 10000.	Rs 9000.
2.	Voltage Control	Not	Available for checking voltage

	Circuit	available.	fluctuations in the live wire.
3.	RF module	Not available.	Available for transmitting and receiving fault and voltage fluctuation signal.
4.	GSM module	Not available.	Available for sending message to the desired location.
5.	LCD	Not available.	Available for displaying authentication results.
6.	Battery Back Up	No.	Yes.
7.	Portability	No	Receiver unit is portable and battery operated.

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