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An Investigation of Fault Detection in Distribution System

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ABSTRACT:

The distribution of the electrical energy is one of the prime concern of the electrical board so that electricity can be provided to the houses, company, hospitals and other institutions without interruption. It is also desirable to control the voltage and current rating. Some of the quality parameters are also to be maintained. There should be fluctuation in the electrical parameters in the safety range. For the proper operation of the electrical and electronic equipment it is desirable to control the electrical system in the proper manner. However; distribution system are not immune to the power outages and it happens due to the faults. These fault interrupt the power supply hence it is desirable to clear the fault. Since distribution system is spread in the wide range hence it is important of make a system so that fault can be located in less time so that it can be overcome and supply can be restored. In this paper; a robust system is to be design which can detect the fault in the distribution system

Introduction:

The distribution of the electricity must be done in such a manner so that there should not be interruption in the power supply. The electricity parameters such as voltage rating, current rating and other quality factors must be proper so that all the electrical equipments must be operated in the proper manner. However; in practice it is not possible all the time. There are always be fluctuations in the electrical parameters. Electrical distribution systems are prone to various types of faults. Due to these faults; power supply is interrupted. This interruption depends upon various types of the factors. Since distribution system is spread in a large area and any fault may come in any of the location in which distribution is spread. Hence it would be very difficult to recognise the location where fault occurred. The fault location process is affected by various factors for example topology which includes length of the feeder, length and number of division and geographic characteristics of area. Due to these parameters; it would become very complicated to find the faulty location. The main objective is to enhance the social and economic life associated with the power holding capacity of the distribution line. From the study it is clear that there is about 70 to 80% of faults occurs in distribution lines which can lead to prolonged service interruptions. Therefore, it is desire to maintain the lines to minimize frequent service interruptions. This system can be installed between 10 to 15 poles to help identify fault zones. This project provides fault location information through the IoT monitoring system and sends notifications via SMS to the operator's mobile device. It consists of a single pole double throw relay with 12 volts DC, which supports 250V AC/10Amp and 110V DC/15Amp. This is interfaced with an ESP12-based controller for monitoring and controlling purposes. Under normal conditions, the system periodically records performance reports, if there is an event of faults, it immediately alerts operators.

Faults in Distribution System:

In the present scenario; the size of electrical power system is increasing day by day. As the size is increasing; the complexity of the system is also increasing. Electrical power system has various parts viz. Power generation, power transmission, power distribution and load systems. In such a huge and complicated electrical system there are very high chances of fault occurrence. System reliability is inversely proportional to the fault occurrence. The less the number of fault occurrence; the more the system is reliable. In the case of fault occurrence, excessive amount of current flow, under voltage condition, reverse power, phase imbalance and high voltage surges due to which equipment and electrical devices may damage. Hence it is very important to prevent the system by fault. Below is the discussion of various types of faults which exist in the power system.

Open Circuit Faults:

In open circuit fault; fault occur due to failure of one or more conductors. This fault is also referred as series fault. Except 3 phase open circui fault, all types of faults are considered as unsymmetrical fault.

Short Circuit Faults:

This fault may occur due to the abnormal condition of very low impedance between two points of different voltages. It may be created accidently or intentionally. This is also known as shunt faults. They may arise from insulation failure between conductors or between phase conductors and earth. Below is the description of symmetrical and unsymmetrical faults which happen in the power systems.

Symmetrical Faults:

These faults may occur infrequently. If a line is accidentally energized or if a mechanical excavator inadvertently cuts through an entire cable. These faults are divided into two types.

- Line to Line to Line (L-L-L) Fault: In this fault all three phases of the system are short-circuited with one another.
- Line to Line to Line to Ground (L-L-L-G) Fault: In this fault all three phases of the system are grounded. The probability of occurrence of such faults is nearly 2-3 percent in the power system network.

Unsymmetrical Faults:

Unsymmetrical fault is also referred as an unbalanced condition. It describes a connection or situation which causes an imbalance among the three phases. A series fault denotes an imbalance in the line impedances, lacking any connection between lines or between a line and ground at the fault point. There are three types are faults discussed below:

- Line to Ground (L-G) Fault: It is the very common fault. It is accounting for 65-70 percent of faults. It causes when conductor contact to earth or ground.
- Double Line to Ground (L-L-G) Fault: It is about 15 to 20 percent of faults. It occurs when two conductors contact the ground.
- Line to Line (L-L) Fault: This faults occur if two conductors make contact with each other. It is about 5-10 percent of faults fall into this category. The main reason is due to wind.

Distribution System for Study:

In this ring main feeder; an 11 kV source is utilized to supply the entire feeder. The feeder is a closed loop. This arrangement is illustrated in Fig. 1, where ABCDEFA forms a complete ring. The distributors are connected at points A, B, C, D, E, and F as depicted in Fig. 1. There are two parallel paths for the feeders: one is A-B-C and the other is D-E-F. The advantage of this setup is that it provides greater reliability of supply in the event of a fault in any section of the feeder. For instance, if a fault occurs at point X, the supply to all consumers can continue by isolating the faulty section between B and C.

Proposed Methodology

In this project; detection of fault occurrence and identification of their location on the distributed lines are focussed. The equipment in this system operates sequentially, as illustrated in the block diagram shown in Fig. 2.

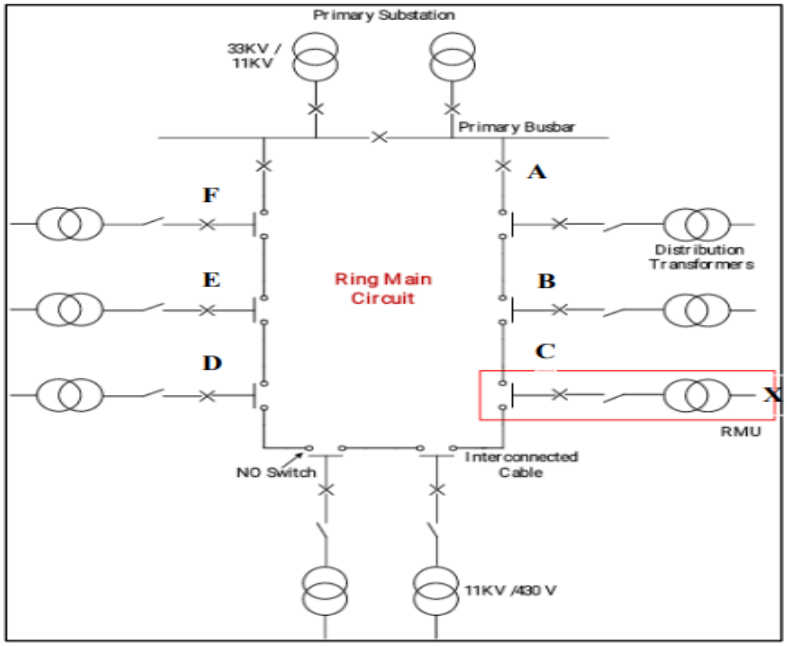

Fig.1 Single Line Diagram of ring main System

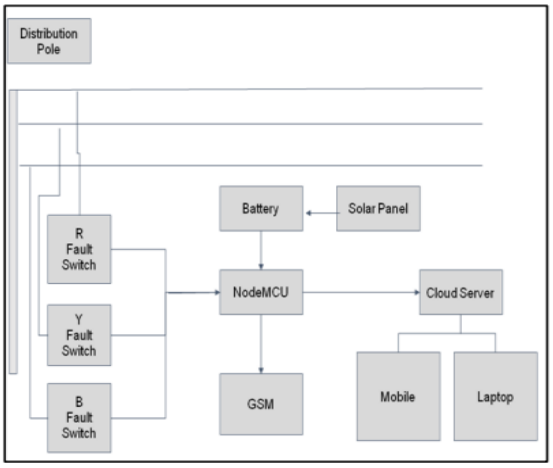

Fig.2 Block diagram of the system

The signal from relay COM goes to Nodemcu and Nodemcu detects the 0 or 1 as per the phase ON and OFF. If Nodemcu pin is 1 then phase is ON command goes 0 then phase is OFF. As soon as relay 0 signal goes to nodemcu it sends alert via Short Messaging Services (SMS). Similarly for all phases the signal is from relays. Nodemcu is a WI-FI Controller when it power on the IP Address is assigned by hotspot to see the status on web browser. The equipments in this scheme operate sequentially as per the block diagram shown in Fig. 2. In this paper; a system is designed for the fault detection. It can be locate the location where fault occurs in the distribution system. This system can used to monitor the individual phase. In each phase a relay is used. Relay work with the power supply of +5V dc supply which is given to then using the three pin voltage regulator 7805 IC. Relays are connected to the each phase. The signal from the relay goes to the Nodemcu which detect 0 or 1 as per the phase ON or OFF. When it is logic 1 then phase is ON when command becomes 0

Logic Used for Fault Detection:

Fault Type	Detected Pins	Relay(s) Activated	LCD Message Example	Buzzer	Fault Distance (km)
Line 1 to Ground	A0	Relay 1 (Line 1)	Line 1 to Ground at 2km	ON	1–4
Line 2 to Ground	A1	Relay 2 (Line 2)	Line 2 to Ground at 3km	ON	1–4
Line 3 to Ground	A2	Relay 3 (Line 3)	Line 3 to Ground at 1km	ON	1–4
Line 1 to Line 2	A3 & A4	Relay 1 & Relay 2	Line 1 to Line 2 at 2km	ON	1–4
Line 2 to Line 3	A4 & A5	Relay 2 & Relay 3	Line 2 to Line 3 at 4km	ON	1–4
Line 1 to Line 3	A3 & A5	Relay 1 & Relay 3	Line 1 to Line 3 at 1km	ON	1–4
All 3 Lines Fault	A3, A4 & A5	All Relays	3 Line Fault at 3km	ON	1–4
Overheat (Thermistor)	Digital Pin 11 (HIGH)	All Relays	Overheat! Shutdown	ON	Not Applicable
No Fault / Healthy	None	None	System Healthy	OFF	—

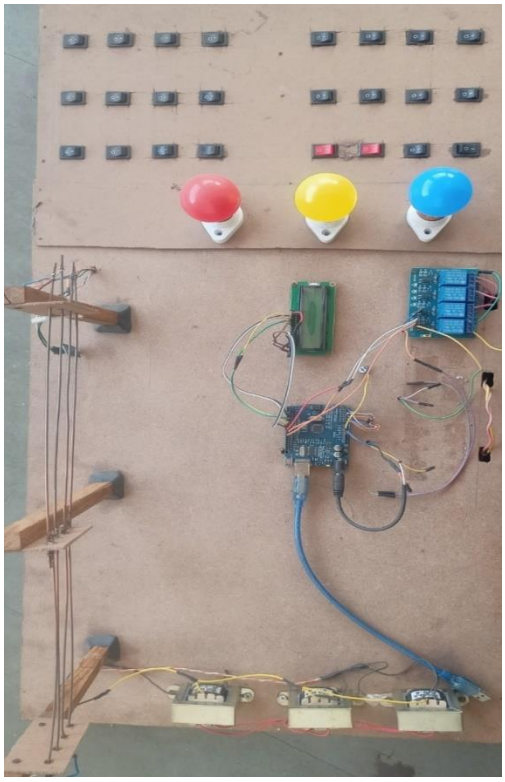

Fig. 3 Proposed system

Results:

From the experiment performed with the implemented system it may be concluded that; the system is directly correlated with the logic used. The hardware is shown in fig. 3. The proposed logic is displayed in fig. 4

Fig. 4 Results as per proposed logic

Conclusion:

This system is capable for the online supervision of distribution transformer. GSM module is used in is system which is to be used to transmit the effective message to the designated receiver system. The GSM technology is to be used for the fault detection. In this system a 3 phase line is used in which fault may occur. As soon as any fault occurs a message is sent to the mobile phone to the in-charges and operators so that they can identify the location. This system identify the exact location of the fault occurrence even in the abnormal conditions. This system enhances the safety of the staff and saves the time. This system is economical and can be installed easily. Online monitoring can be achieved using IoT.

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