GSM BASED SELF HEALING MONITORING GRID IN DISTRIBUTION SYSTEM USING ARDUINO NANO MICROCONTROLLER

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***Abstract*: This paper represents the self-healing monitoring grid in distribution network in real time and predicts the abnormal condition in distribution side. When fault or abnormal state of system occur in system, automatically system takes a control actions like fault detection, fault isolation and then system takes a restorative action. Relay switch senses the operating parameters in real time if the fault current is increased in system, the relay switch should automatically disconnect the faulted area. The fault current stays longer time in line, microcontroller sends a message to substation. The station which quickly send a repair crew to the area as soon as repairing is finished and then the outage part is reconnected to power supply and reduces the outage duration for customers on the non-faulted sections of the faulted location. This paper also provides power theft detection in consumer side using current difference between supply line and load.**

Index Terms: Self-healing grid, GSM modem, Power theft detection and Electricity distribution network

I. INTRODUCTION

Electricity network of centralized concept is going to next step that means smart grid concept. We have to add an intelligent communication to existing grid and provide a bidirectional communication. The conventional grid consists of power generation, transmission and distribution system but smart grid is the combined function of electrical and intelligence infrastructure [1]. The main advantage of smart grid is to make existing grid to smarter one using communication technology and consumer friendly one. In the smart grid, self- healing play important role and target the system to automate the healing process of the entire system. A self-healing technology can automatically reduce power outages and power disruptions using real time data from different embedded sensors kept at different working locations and the system responds to unwanted problems and the system frequently communicate with the station [2]. The FDIR (Fault Detection Isolation and Restoration) method gives the action of self-healing by supplying power from alternate feeders during a feeder fault but isolate the fault section from supply line [3]. Self-healing gives better improvements in reliability, security of the grid and reduce the power outages. Persistently, in our electricity network outage management is complex and restorative action takes more time and also affects the consumer side equipment due to fault current and voltage dip. Smart grid considered as different layers such as power or energy layer, communication layer and information technology layer. The concept of smart grid provides great response to adequate disturbances, reducing impacts, swiftly restore the electrical service and aiming thus to an intelligent network with capacities of self-recovery or self-regeneration [4]. Electricity theft creates the non-technical power losses in system. Theft detection algorithm is able to detect thefts at both consumer line and at the distribution line with the help of consumer load profiling. Once a theft is analyzed, firstly disconnects illegal consumers and sends a message to utility side and easily we can easily find hooking. A current sensor is used to detect current flow in supply line. Types of electricity thefts such as 1. Meter tampering 2. Direct tapings or Hooking system 3. Physical destruction of meter 4. Stopping the rotating disk of the meter using some mechanism [5]. Whether the tapings are drawn more current from its usual value, then a hooking is detected easily. The occurrence of theft is noted and indicate it into operator in station through GSM module.

II. EXISTING GRID FDIR IN DISTRIBUTION SIDE

Persistently in our distribution network consists of electric fuse for protection purpose. Electric fuse is installed at each pole in consumer side. If abnormal condition occur in system, it will rise the fault current in line. Due to fault current fuse coil is melts down. Fault affected area is disconnected from supply line in long hours of duration until affected consumer inform the station and later crews comes from substation and clears the faulty area. It also affects the non-faulted section area consumers and critical loads. So, the regulation of power system is diminished. Two-way communication is not possible in centralized grid. We can't do easily FDIR (Fault Detection Isolation and Restoration). System takes more time return to its original state. Existing system doesn't classify the fault and electric fuse permanently opens the service, incase of fault. Conventional system requires manual fault logging and no provision for fault correction intimation.

III. SELF-HEALING IN SMART GRID

Self-healing of the grid is the ability to act against power disturbances in the grid and protect the grid from abnormal condition by doing FDIR actions. Self-healing the system can identify and minimize the interruption in the system by its own. This is important phenomena in distribution automation in distribution side. It will ensure the minimum restoration time and consistent power supply to maximum possible loads. Smart grid gives better integration of prosumer power generation systems, including distributed energy generation.

IV. TYPES OF FAULT

Faults are physical conditions that cause a device to fail to perform in the required manner. Fault in system associated with abnormal change in current, voltage, frequency and temperature. Fault is classified as temporary fault and permanent fault. Very high fault current flow occurs in the grid resulting severe damage to the electrical power system equipment.

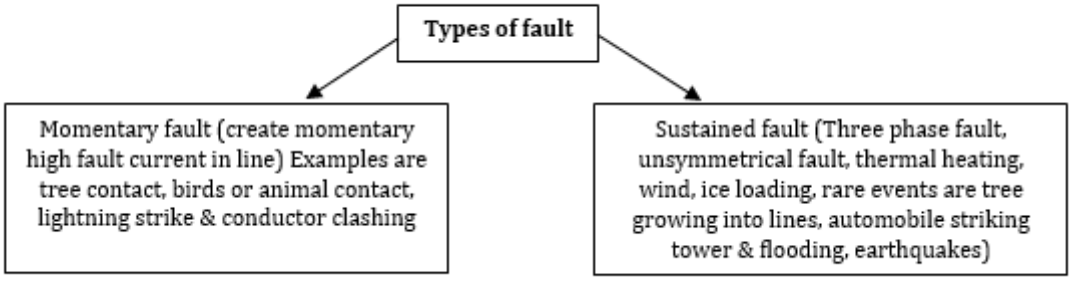


Fig-1: Types of fault

V. FUNCTIONALITY OF PROPOSED SYSTEM

The system identifies the fault occurrence and immediately disconnects the load from supply line. After a back-off delay, the smart switch checks whether the fault persists or not. If the fault persists, the information is communicated to the substation. If the fault is expired, the supply is connected and load is through. If there is a power theft, the system informs the remote station. Fault is handled by a smart re-closure relay interfaced with a current transformer and measures the real time current value of supply line. Fault is classified with the help of current transient parameters. Automatic fault and rectification logging provided by Arduino Nano microcontroller. Uses wireless communication for fault logging automatically.

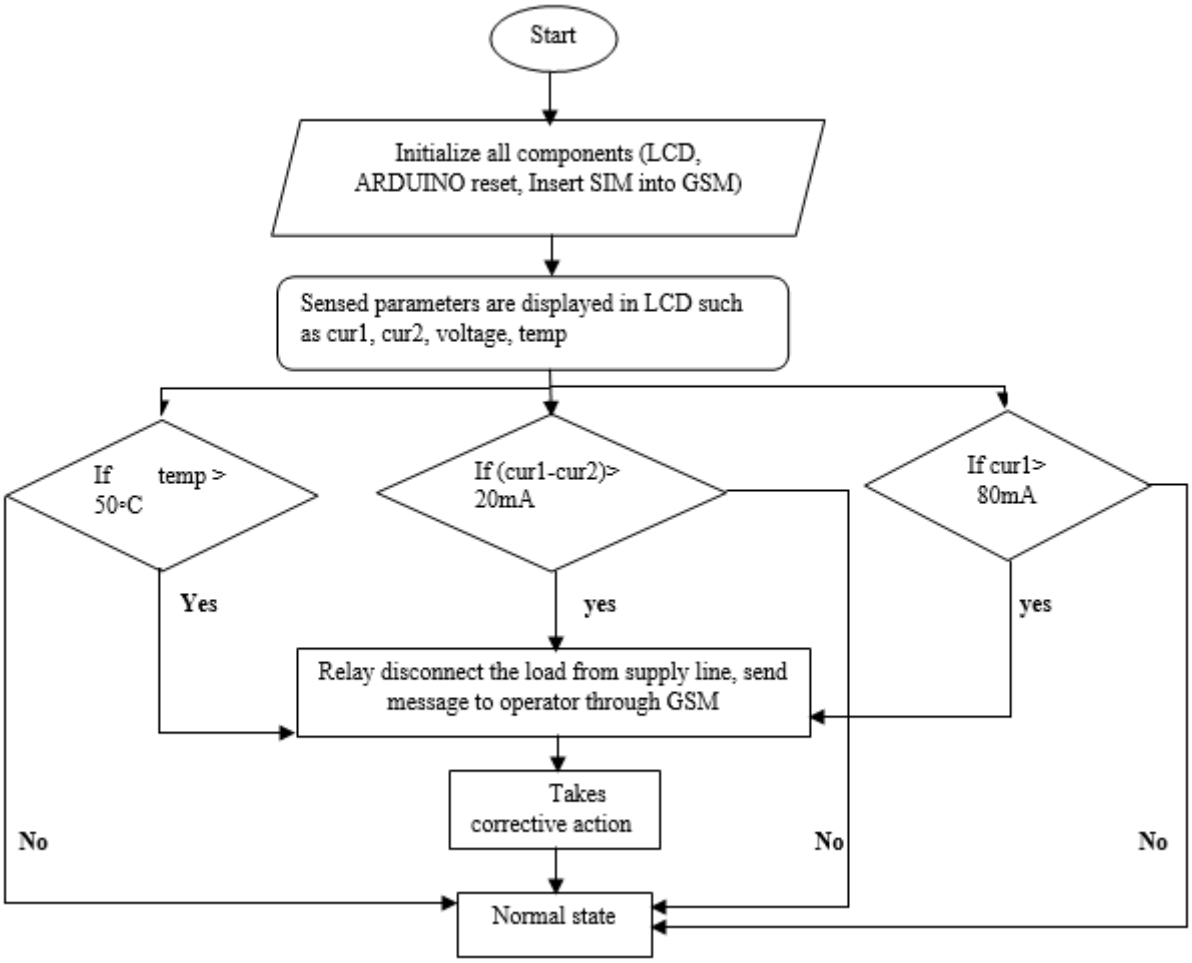


Fig-2: Flowchart of proposed system

VI. BLOCK DIAGRAM OF HARDWARE COMPONENTS IN PROPOSED SYSTEM

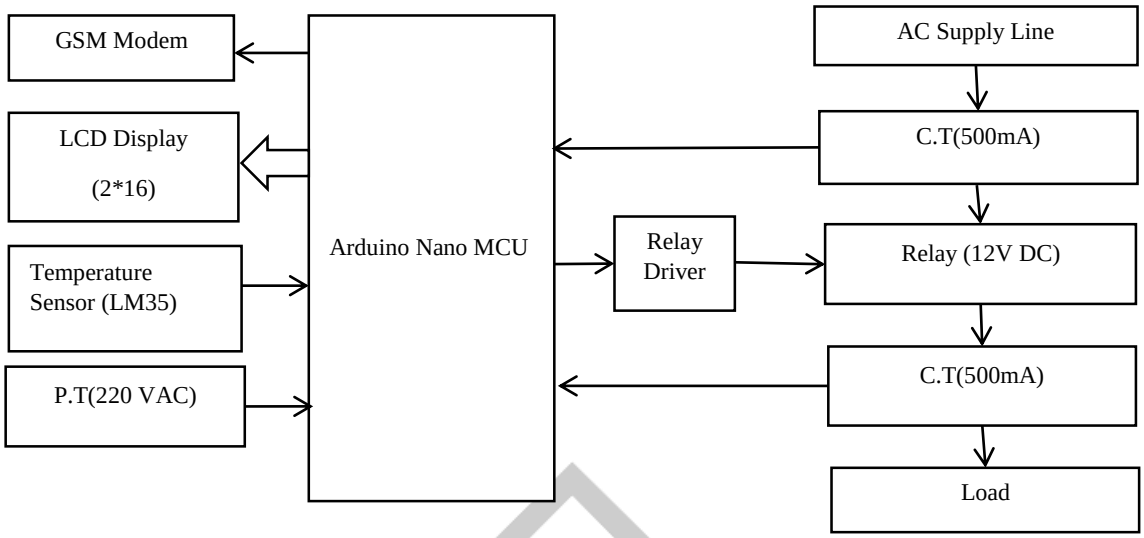


Fig-3: Block diagram of hardware components

Fig. 3 shows the block diagram of hardware components used in proposed system. The main unit of component is Arduino Nano microcontroller and GSM. The conditions are fed in controller using Arduino IDE software. As per the condition the operation performed by system. The system goes abnormal state the message will send to the operator otherwise system stays in normal state. 2*16 LCD display is used for displaying operational parameters running in system. Temperature rise is also creating permanent fault so, LM35 sensor is used to detect temperature in line. To detect power theft we have to use current transformers connected between supply line and load. Use this current difference value we can easily analyse the power theft in line. Single throw double switch relay is used for connecting and disconnecting purpose. To eliminate noise we have to use capacitor filter and voltage regulator is used for stabilizing the incoming voltage.

VII. BLOCK DIAGRAM OF PROPOSED SYSTEM

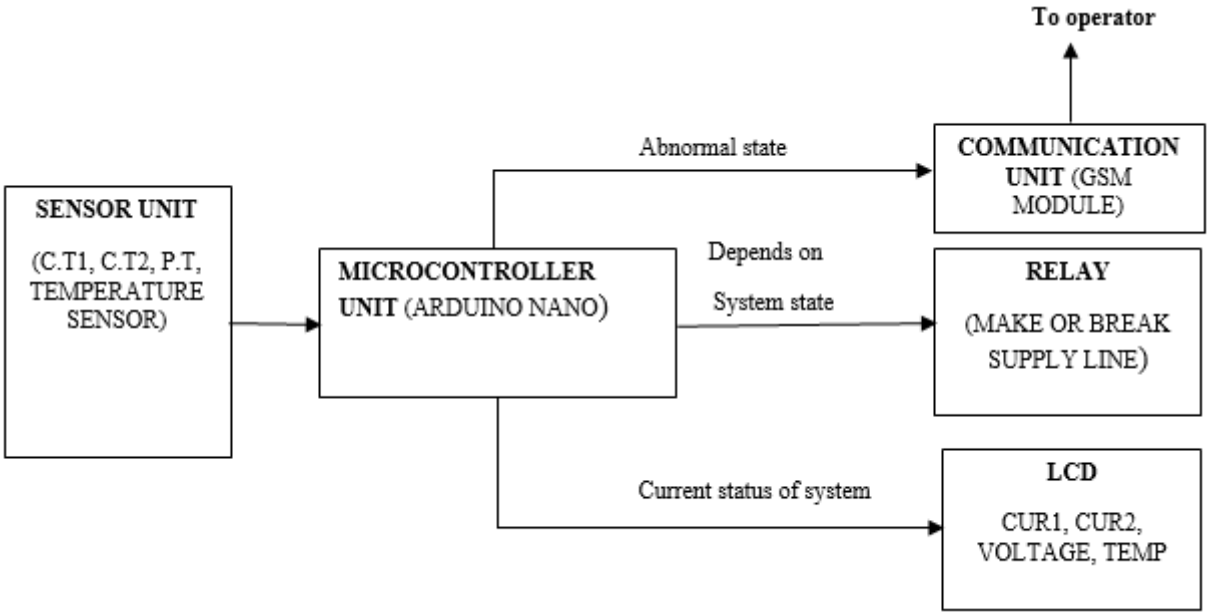


Fig-4: Block diagram of proposed system

Where,
C.T1 - Measured current value from current transformer 1 in mA
C.T2 - Measured current value from current transformer 2 in mA
P.T - Measured voltage value from potential transformer in V
TEMP- Measured temperature value from LM35 in ◦C

VIII. HARDWARE PROTOTYPE

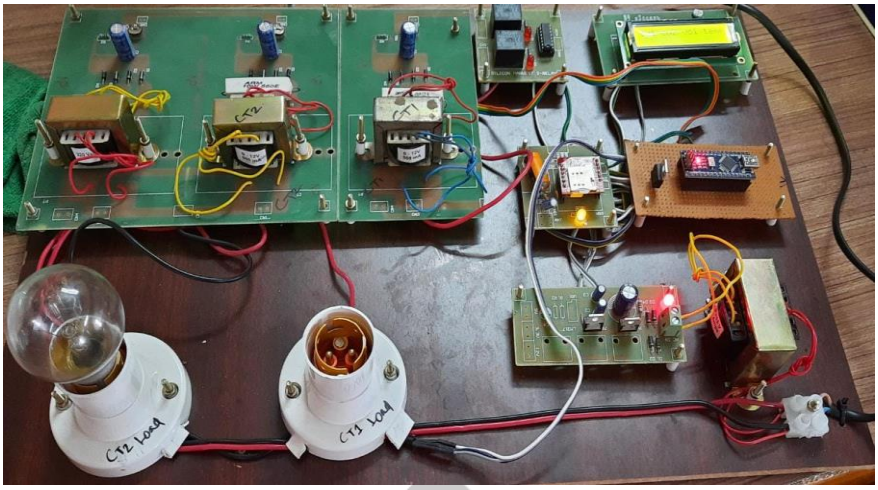
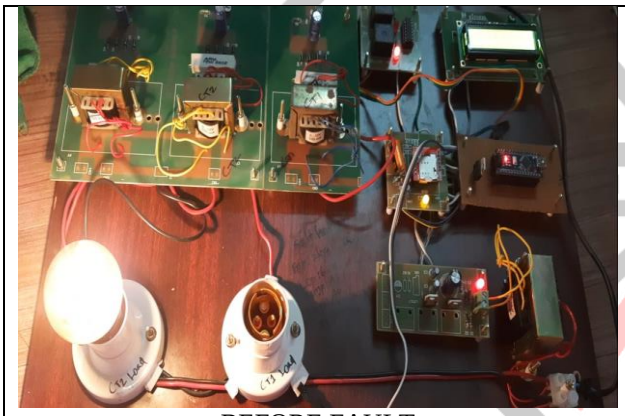


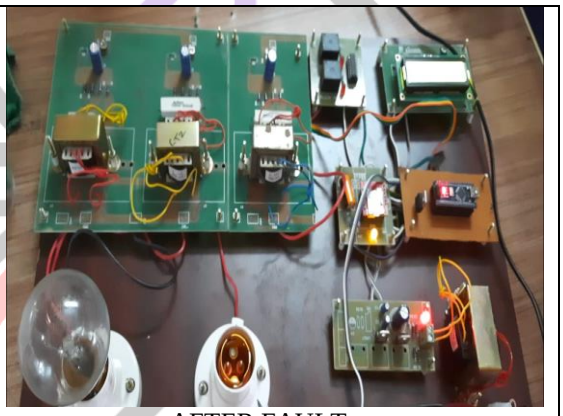
Fig-5: Hardware prototype of proposed system

IX. RESULT AND DISCUSSION

Self-healing feature of smart grid was implemented in active distribution side based on FDIR scheme. When a fault occurs in the system, the relay at various positions senses the corresponding fault current, detects the location of the fault and sends a signal to operator. Current values, voltage rate and temperature all these parameters are displayed in LCD. When current value goes to above 80mA, the supply is cut-off and the system classifies the fault based on the fault current persists or not on the line. When temperature go to above 50◦C, the supply is cut-off. Current difference between loads may go to 20mA, it denotes hooking is happened in line. All the alerts are sending to the respective operator in the form of SMS using GSM.



BEFORE FAULT



AFTER FAULT

Fig. 6. Result of proposed system

X. CONCLUSION

The FDIR (Fault Detection Isolation and Restoration) operation is successfully implemented in system i.e. the system can effectively heal itself. This increases the reliability and efficiency of the system by reducing the number of power outages and chances of blackouts and system can easily communicate with the operators. The aim of improving the performance of the conventional electric grid, so that it is able to respond sufficiently to disturbances, minimize their unwanted impacts on supply line, swiftly restore the electrical service, enhances the steadiness of the system.

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