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GSM Based Substation Power Monitoring and Controlling

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ABSTRACT The aim of this work is to acquire remote electrical parameters such as voltage, frequency, phase fault and to submit these real time values over GSM network using gsm modem or phone along with power station This project is also designed to protect the electrical circuitry by operating an relay. This relay gets activated whenever the electrical parameters exceed the predefined values. The relay can be used to switch off the main electrical supply. User can send commands in the form of sms messages to read the remote electrical parameters. This system can be designed to send sms alerts whenever the relay trips or whenever the voltage or frequency exceeds the predefined limits. In this we use of a microcontroller. The controller can efficiently communicate with the different sensors being used the controller is provided with some internal memory to hold the code. This memory is used to dump some set of assembly instructions into the controller. And the functioning of the controller is dependent on these assembly instructions. The controller is programmed using embedded c language

Keywords – ATmega328 controller**,** GSM Modem, LCD, Relay driver, Sensors

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I. INTRODUCTION

Electricity is an extremely handy and useful form of energy. It plays an ever-growing role in our modern industrialized society. The electrical power systems are highly non-linear, extremely huge and complex networks. Such electric power systems are unified for economical benefits, increased reliability and operational advantages. They are one of the most significant elements of both national and global infrastructure, and when these systems collapse it leads to major direct and indirect impacts on the economy and national security.

A power system consists of components such as generators, lines, transformers, loads, switches and compensators. However, a widely dispersed power sources and loads are the general configuration of modern power systems. Electric power systems can be divided into two sub-systems, namely, transmission systems and distribution systems. The main process of a transmission system is to transfer electric power from electric generators to customer area, whereas a distribution system provides an ultimate link between high voltage transmission systems and consumer services. In other words, the power is distributed to different customers from the distribution system through feeders, distributors and service mains. Supplying electricity to consumers necessitates power generation, transmission, and distribution.

Electric utility substations are used in both the transmission and distribution system and operate independently to generate the electricity. A substation facility is a small building which contains transformers, switches, voltage regulators, and metering equipment that are used to adjust voltages and monitor circuits. A reliable and efficient process of these networks alone is not very significant when these electricity systems are pressed to their parameters of its performance, but also under regular operating conditions. A substation is classified as: 1) Transmission 2) Distribution. The distribution side of substation is the major focus of the project. Since the power generated at the main stations is transported hundreds of miles using transmission lines before they reach the substations. A huge amount of power loss is reported during the transportation of the generated power which leads to the reduction in the quantity of power received at the substations. Therefore, measurements must be acquired either at sending end stations and user end, to ensure quality of power supply is maintained continuously.

To Improve the quality of power with suffer solution it is necessary to be familiar with

what sort of constraint has occurred. Additionally, if there is any inadequacy in the protection, monitoring and control of a power system. The system might become unstable. Therefore, it necessary a monitoring system that is able to automatically detect, monitor, and classify the existing constraints on electrical lines.

In this our work, system acquires a remote substation's parameters like voltage, frequency, phase etc., via GSM network using GSM modem or mobile. It allows send SMS to operator about physical condition of parameter of power, system can automatically break the lines with circuit breakers. System facilitates the display of various parameters in the LCD, buzzer that is interfaced to the microcontroller. In this a microcontroller acts as a central controlling device that accepts the inputs and correspondingly controls the outputs, in such a way that it sends the input parameters in the field side to a remote GSM mobile through the GSM networks, periodically. Similarly, it receives the control signals that are sent from the operators, and in accordance with those signals, it controls the relays and buzzers automatically. At times when voltage/frequency exceed limits, the microcontroller automatically trips the circuit breakers and sends that information to the operator by SMS.

II Related Work

The "Microcontroller Based Substation Monitoring System and Control System by Gsm Modem" of Amit Sachan This project is pointed to acquire the remote electrical parameters like Voltage, Current and Frequency and send these real-time values through the GSM network using a GSM Modem/phone end to end with the temperature at the power station. This Relay gets triggered whenever the electrical parameters beat the predefined values. The Electromagnetic Relay can be used to handle a Circuit Breaker to switch off the main electrical supply. [1]" A 16X2 LCD is also associated with viewing the system's status. This project uses a 5V, 500mA operated power supply. The AC output of the secondary 230/12V step-down transformer is rectified by the bridge-style full-wave rectifier".[1] Yet, again important challenges remain. The major challenge is to observe the temperature of the transformer

Prof. Kunal V. Ranvir and Mayuri A. Solanke [2] have clarified the summary of the Substation Monitoring System that might be obliging for data illustration. Techniques such as 1) guarding 2) overloading and 3) Monitoring must prove to be quite useful. Here yet, the important challenges remain. The major challenges are 1) lack of automation 2) the risk of blackouts 3) brownouts and fires are rapidly increasing.

In "Substation Monitoring and Control"Loganathan N, PrasanthJ,Shankara aravanan R, Jayasuriya V, Karthikeyan S Managed to explain the complexity of the distribution centre has grownup, substation automation has become an obligation for any limited helpfulness, increasing its dependability and enhances the effectiveness of electricity provided. The proposed project manages the substation with the assistance of the required components to ensure that it can be remotely controlled and supervised to provide the intensity of intrusion is decreased. The microcontroller can combine and undertake a role as dictated by the sensors implemented at the substation. Electrical parameters include current and voltage only. [3]

Anurudh Kumar, Ashish raj, Abhishek Kumar, 4Sikandar Prasad & Balwant Kumar featured Distribution transformers are one of the most important pieces of the shipment in the power network. Because of, the large number of transformers distributed over a wide area in power electric systems, data acquisition and condition monitoring are important issues. This project presents the design and implementation of a mobile embedded system to monitor and diagnose the condition of transform recordings and record key indicators of a distribution transformer like load currents, transformer oil, ambient temperatures and voltages. Data of operation condition of transformer receives in form of SMS Using the suggested online monitoring system will help utility operators to keep transformers in service for longer of time.[4]

Amol Ram Kate, Girish Baban Dongare, Krishana Maroti Janwade, Payal Burande & Narendra P. Zinjad's "Substation Monitoring System" [5] aimed to design a system which can monitor and control the substation by using a wireless technology called IOT. An IOT module provides the communication interface. By using IOT module we can update data on web server. In this considering substation parameters, voltage and current, frequency, temp. The project will be

designed in such a way that an sensor will be interfaced to the controller. Here the inputs for the ADC are the analog values of voltage, current .In this project microcontroller is connected to IOT module through serially. By varying these two pots microcontroller detects voltage and current frequency, temp fluctuations and sends that particular values to the web server. According to voltage and current fluctuations relays has to be triggered for protecting substation at that time bulb will OFF. A 16x2 LCD is also provided to display the status of the system.

In[6]Ghous Buksh Narejo, Shahyan Pervez Bharucha, Danny Zarir Pohwala's "Remote Microcontroller Based Monitoring of Substation and Control System through GSM Modem" As complexity of distribution network has grown, automation of substation has become a need of every utility company to increase its efficiency and to improve quality of power being delivered. The proposed project which is GSM cellular network-based controlling of substation will help the utility companies, by ensuring that their local-substation faults are immediately realized and reported to their concerned departments via

III SYSTEM ARCHITECTURE

The block diagram of the Proposed work Gsm based Substation Power Monitoring and controlling system is shown in fig 1. It is used for monitoring the voltage, frequency of a distribution transformer in a substation and to protect the system from the rise in mentioned parameters. The objective is to monitor the electrical parameters continuously and hence to guard the burning of distribution transformer due to the constraints such as overload, over input high voltage. If any of these values increase beyond the limit then the entire unit is shut down by operating an Electromagnetic Relay. This relay is activated as soon as the parameters exceed the predefined threshold values. The relay also works as a circuit breaker to switch off the main power supply. The system is designed to send a SMS alerts to the authorized person whenever the parameters (Voltage, frequency and phase) exceed the predefined limits.Supplying electricity to consumers necessitates power generation, transmission, and distribution [4]. Initially electric power is generated by using electric generators such as: nuclear power generators, thermal power generators and hydraulic power generators and then transmitted through transmission systems using high voltage. Power departs from the generator and enters into a transmission substation, where huge transformers convert the generator's voltage to extremely high voltages (155kV to 765 kV) for long-distance (up to about 300 miles) transmission [7]. Then, the voltage level is reduced using transformers and power is transferred to customers through electric power distribution systems. Power starts from the transmission grid at distribution substations where the voltage is stepped-down (typically to less than 10kV) and carried by smaller distribution lines to supply commercial, residential, and industrial users [7]. Monitoring and controlling of substations is an important task for supplying healthy power to the consumers in this automated era. But due to the aging infrastructure of the distribution grids (substations) and lack of automation systems that monitors the critical conditions at the substations, the risk of blackouts, brownouts and fire of rapidly Substations consist of different electronic components like transformers, circuit breakers, relays etc. Includes periodic manual checking of the system which is time consuming and with very low accuracy. Also the substations in the rural areas are even more difficult to monitor manually and hence requires more time to take respective actions. The solution to all these problems is automation of the substations.

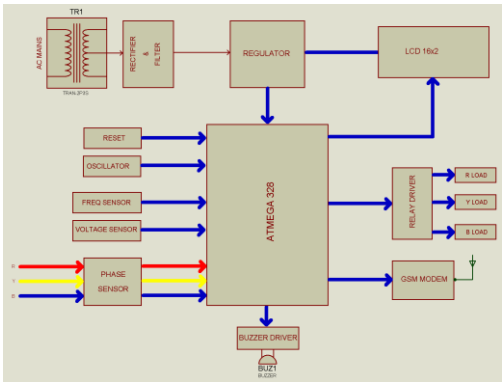

Fig.1: Block diagram of the system

3.2 Hardware Components

3.2.1 Power Supply

Circuit requires 5V DC for LCD module, microcontroller and sensors. GSM board required 12V. This power supply can be provided 12V transformer with rectifier, filter, and 5V with regulator.

3.2.2 ATmega328 microcontroller

In this (atmega328 28 pin microcontroller) works with 16MHz frequency used for (timer configuration), the unwanted frequency produced is bypassed by the capacitor of 27pf capacitor.

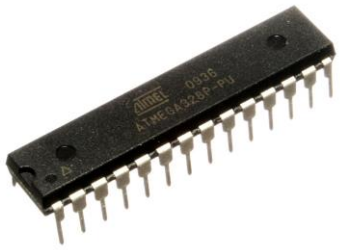

Fig. 2: AT mega 328 microcontroller

Reset pin is connected to resistor of 10K whenever reset requires the reset switch (2 lead push to ON switch/ micro push to switch) required pressing. 6 channel 10 bit inbuilt ADC available, 6 PWM pins available, multiple serial communication available, up to 20 programmable pins available.

3.2.3 Sensor Module

In all sensor modules physical condition sensor is used to sense physical conditions like voltage sensor, and frequency sensor are connected with analog pins of microcontroller to sense.

3.2.4 Buzzer

Buzzer is also known as beeper. It is an audio signaling device. The types of buzzer includes mechanical, electromechanical, and piezoelectric. In this project, piezoelectric buzzer is used which alert the surrounding peoples.

3.2.5 GSM Modem

A GSM modem or GSM module is a device that uses GSM mobile telephone technology to provide a wireless data link to a network. GSM modems are used in mobile telephones and other equipment that communicates with mobile telephone networks. They use SIMs to identify their device to the network. A GSM modem is a type of wireless modem that connects to a GSM network. A wireless modem functions similarly to a dial-up modem. The main distinction is that a dial-up modem sends and receives data through a fixed telephone line, whereas a wireless modem sends and receives data via radio frequency (GSM 900/1800 bands). A GSM modem needs a SIM card from an operator to function Shown in fig.3

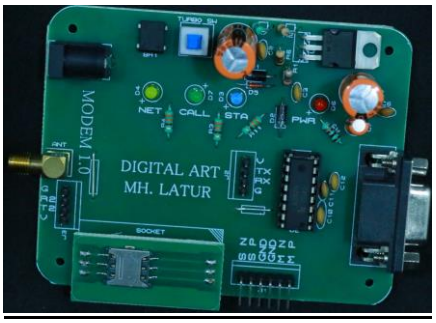

Fig.3: GSM Modem

Serial connections between the modem and the microcontroller are accomplished in the system by connecting Txd and Rxd pins to the modem Rxd and Txd pins, respectively. The modem's third pin is also grounded. We have an interface modem to microcontroller directly without the usage of Max232 or RS232 in our hardware architecture, and we are getting good results with good communication. Logic converters such as Max232 and RS232 are also utilized [8].
They may both operate at the CMOS and TTL logic levels. If the microcontroller is TTL and the GSM modem is CMOS, a logic converter such as RS232 is used to bring the two logic levels together. However, because both the Microcontroller and the GSM Modem in our model operate at the TTL logic level, we have not used Max232 or RS232. The modem and the microcontroller are connected directly.

3.3.6 LCD 16 x 2 Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

Fig.4: LCD Display

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

IV. Result

The working model of the proposed system is shown in fig.5. It detects the voltage, frequency and phase if it is different than we have set in our system. System can send SMS through the GSM modem to the operator and controls circuit breakers automatically to cut off the load.

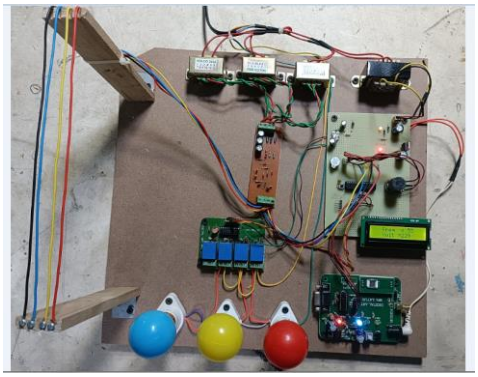

Fig.5: Proposed System

- When all condition are ok

Fig.6: Frequency and Voltage Reading

Fig.7: Phase Fault Detection

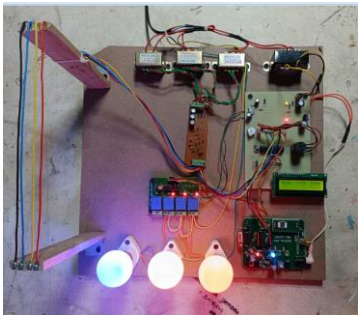

Fig.8: All Phases are ON

- When fault detects in blue phase

Fig.9: Fault in blue phase

Fig.10: sending SMS

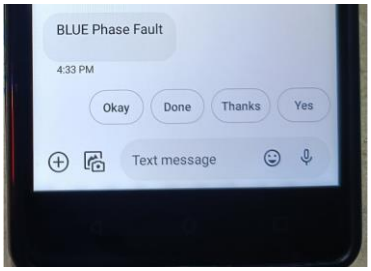

Fig.11: SMS on mobile

- When Fault detect in Yellow Phase

Fig.12: Fault in yellow phase

Fig.13: Sending SMS

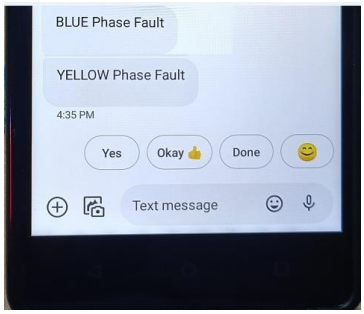

Fig.14 SMS on mobile

- When Fault detect in Red phase

Fig.15: Fault in Red phase

Fig.16: Sending SMS

- Voltage and Frequency Reading

Fig.15: Voltage and Frequency Reading

Fig.16: Sending SMS

Fig.17: SMS on mobile

V. Conclusion

In this project we have designed a GSM based substation Power monitoring and controlling system. It provides the way to detect the faults such as voltage, frequency and phase fault. The system continuously monitors various parameters such as voltage, frequency, phase of the system and sends SMS by using GSM modem. It also helps to detect the fault at the appropriate time and hence provide safety system for power management. The implementation of the system will prevent short circuit, provides power quality. This circuit mainly used in substation to operate circuit breaker and also use in single phase fault identification.

In future the system is developed using Graphical User Interface (GUI). The devices and their parameters such as frequency, voltage, load impedance, reluctance, oil level, temperature, cooling condition and power can be monitored integratedly in a displayer. This method helps the operator monitoring in real time the condition of each device easily. Furthermore, in the case of any failure, the operator will be acknowledged immediately that a specific device is experiencing some difficulty or failure.

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