

## INNOVATIVE MONITORING AND CONTROL SOLUTIONS FOR ADVANCED SUBSTATIONS

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### ABSTRACT

Monitoring is the process of gathering important data from the target assets. The collected data may be utilised to assess and diagnose the state of the assets, which is very helpful for managing failures, scheduling maintenance, and regulating systems. This approach also reduces the amount of time that people spend in close proximity to highvoltage devices. The majority of substation equipment is recognised to produce electromagnetic radiation that is harmful to human health and to have high voltage. The intended system is specifically made to keep an eye on the state of substation transformers that are spread out across several sites. Numerous factors need to be measured and routinely observed.

### 1. 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 economic 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. Today electricity still suffers from power outages and blackouts due to the lack of automated analysis and poor visibility of the utility over the grid. WSN will give the utility provide the needed view by collecting information from the different sub-systems of the grid. A sensor node will decide information or to slightly delay this notification (whether to immediately notify the sink about this information.). 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 purpose of this project is to acquire the remote electrical parameters like voltage, current and frequency and send these real time values over network using IoT module along with temperature at power station. This project is also designed to protect the electrical circuitry by operating an SPDT 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 to the microcontroller to read the remote electrical parameters. This system also can automatically send the real time electrical parameters periodically (based on time

settings). This system can be designed to send alerts whenever the relay trips or whenever the voltage or current exceeds the predefined limits. This project makes use of a microcontroller, in this prototype for demonstration purpose we have used Arduino Uno. 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.

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. Today electricity still suffers from power outages and blackouts due to the lack of automated analysis and poor visibility of the utility over the grid. WSN will give the utility provide the needed view by collecting information from the different sub-systems of the grid. A sensor node will decide information or to slightly delay this notification (whether to immediately notify the sink about this information.). The distance between the generators and load may be in terms of hundreds of miles hence the amount of huge power exchange over long distances has turned out as a result of the lack of quality of the electric power. During the earlier development stages the issues on quality of power were not frequently reported. Demanding the quality of power being delivered at the user side has raised the alarm due to the increase in demand of electricity in the customer side. A huge amount of power is lost during the transportation of the general power which leads to the reduction in the quality of power received at substation. 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.

To improve reliability and compatibility This is one of the main objectives of our project to improve the reliability of the power being delivered by speedy detection and isolation of the fault and maintaining a constant voltage level, which will make the project utmost reliable and compatible. Real time monitoring 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 service. One of the main objectives of this project of ours is to ensure real time monitoring. Remote sensing of observant parameters Although this project is meant for all the substation equipments but we developed this prototype keeping in mind the transformers which are usually deployed in dispersed locations. Through this project we want to ensure remote sensing all the observant parameters. To Maintain Continuity of supply By keeping track on the real time parameters, we want to maintain the continuity of the supply. To Reduce labour cost One of the main objectives of our project is to reduce the labour cost to some extent which will make the facility more economical.

Real time monitoring This is one of the main perspectives why we have chosen this project in the first place. In most of the today's facilities lack in this point, because they don't have proper facility to fetch real time data; they usually rely on the periodically collected data that too manually collected. Thereby it is very tough sometimes to judge the actual health of the machine we are monitoring. What has been overcome though this project. Here we are able to monitor the real time data of the machine irrespective of fault. Remote Access This is one of the main advantages of this project. All the real time data collected by WSN are being

updated to the server, which enables us to get all the real time data at its ease remotely. Which means we do not need to go the control room to physically check the data. Periodical collection of data Now a days in most of the power facilities the work personnel responsible for collection of data go to the control room and physically jot down all the data and then after coming back again updates all those to the data sheets which is a lot more time consuming. But through our project all these could be done in a matter of seconds. All the real time data being collected will be stored in a external memory periodically. Although as of now we have not included any sort of extremal memory in our prototype, for demonstration purpose we have used the microcontroller memory only. Error free data As we already have discussed by now that data in the power facilities are mostly collected manually, which are error prone. And most importantly we do not get all the data at a single sync because manual collection of data will involve delay to some extent i.e., values of all the machines are not of same time instant, which doesn't matter that much if the facility is smaller, but just imagine the scenario in case of a large power facility where a person need to take hundreds of values there this delay is considerable. Here the data will be error free as we have eliminated any manual involvement in case of data collection Personalised alert over fault By incorporating this project, we can get Personalised alerts over any sort of discrepancies i.e., whenever the electrical parameters exceed the predefined values. We have incorporated relays which acts over and physically isolates the machines where disturbances occur. Reduced hazards In larger switchyards there are lot of high voltage equipments. Which are hazardous for the working personnel. Through our project as we can remotely observe and collect all the required data, thereby it reduces hazards Cost effective After incorporating this project, we do not need to deploy person at every place for collection data, this reduction of manual force reduces the labour cost to some extent. The sensors and transducers employed also does not need regular maintenance which in turn reduces the maintenance cost. That means overall labour cost is reduced.

## 2. LITERATURE REVIEW

This chapter includes all the literature associated to our work, who so ever have done any work in this field, we have mentioned all of them. Let us take you through all of them: - Amol Ram Kate, Girish Baban Dongare, Krishana Maroti Janwade, Payal Burande & Narendra P. Zinjad's "Substation Monitoring System" This project is 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 our project we are 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. This project uses regulated 5V, 500mA power supply. Unregulated 12V DC is used for relay.7805 three terminal voltage regulators is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer. Krupal Dhimar, Mr. Jenish Patel, Mr. Yasin Shaikh, Mr. Anas Musani & Mr. Krishn Patel's "Substation Monitoring and Control Using

Microcontroller & GSM” The purpose of this project is to acquire the remote electrical parameters like voltage, current and frequency and send these real time values over gsm network using gsm modem/phone along with temperature at power station. User can send commands in the form of sms messages to read the remote electrical parameters. This system also can automatically send the real time electrical parameters periodically (based on time settings) in the form of sms. This system can be designed to send sms alerts whenever the relay trips or whenever the voltage or current exceeds the predefined limits. This project makes 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. Ghouse 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 GSM, to ensure that duration of power interruption is decreased. The measured parameters will be sending in the form of SMS messages. The microcontroller will interact with the sensors installed at the local substation and perform task as commanded. Electrical parameters like current, voltage will be compared continuously to its rated value will help protect the distribution and power transformer from burning due to overload, short circuit fault, over voltages and surges. Under such conditions, entire unit is shut down via the control section comprising of relays sensing it, and immediately turning the circuit breaker off. SMS alerts can also be generated to indicate this. The use of GSM makes the substation intelligent in the sense that it is able to transmit alerts and information and receive commands. This enables to reduce labour cost at substation and saves time. Thus the monitoring and working efficiency of the sub-station will drastically increase. Dumitru SACERDOȚIANU, Florica LĂZĂRESCU, Iulian HUREZEANU, Marcel NICOLA, Ion PURCARU, Anca ALBIȚA’s “Contribution to monitoring the condition of substations” By promoting modern and competitive techniques and equipment for online monitoring and diagnosis, it is possible to track natural or accidental degradation over time. If identified in time and remedied, it will not generate serious events which may be sources of extremely costly damage for electric power suppliers and consumers. At the same time it is possible to extend the life of the equipment, optimize the maintenance program and reduce the outages and expenses for planned repairs. The paper presents an analysis of the vital parameters of MV, LV transformer substations and proposes a system for monitoring their working condition. The main objective of the paper is to present a modular system for transformer substation monitoring in order to increase the quality of electric power supply for consumers and reduce the costs of equipment overhaul and maintenance. Based on the considerations on the transformation substation condition monitoring, the paper presents achieved of such a monitoring system, which can be integrated into SCADA. Dirman Hanafi, Mohamed Najib Ribuan, Ignatius Agung Wibowo, Hairulazwan Hashim, Muhamad Izzuddin Ismail’s “Simulation Of Substation Integrated Monitoring System Using LabVIEW” This paper presents the new integrated monitoring system for high voltage electric power substation system. The substation has a crucial

function to maintain the reliability and to keep the quality of an electric power transmission system. On the other hand, the exposure to high voltage environment may also be able to cause risk to human health. Therefore, an integrated monitoring system is crucial to be implemented for easy monitoring and controlling the substation while minimizing interaction of human to the substation devices. All the substation devices conditions are displayed integratedly in Graphical User Interface (GUI) developed using LabVIEW software. The developed display contains several windows and said window display. As a result, the parameters of the substation devices such as: frequency, voltage, load impedance, reluctance, oil level, temperature, cooling condition, power and protection system are successfully displayed and monitored.

### 3. PROPOSED SYSTEM

Here in the proposed prototype we have used Arduino Uno as our primary microcontroller. It will work as the heart of the system; all other measurement circuitries will be interfaced through this. Besides the microcontroller we have used ACS712 current sensor, ZMPT101B voltage sensor, LM 35 temperature sensor, frequency measurement unit, a piezo buzzer and a two-channel relay module; and to demonstrate the load we have used a fan and a bulb. Alongside we also have used a supply unit, consisting of a transformer, which converts 230 Volt AC to 12 Volt AC then it is passed through bridge rectifier unit which converts this 12 Volt AC to 12 Volt DC which is pulsating in nature which is then fed to the capacitor which works as a filter, making the pulsating DC to smooth DC. As a lot of our components like Arduino Uno and some of the sensors as well require 5 Volt regulated DC, that is why this 12 Volt DC is fed to 7805 Voltage regulator which makes it to 5 Volt regulated DC. In case of buzzer and relay need high amount of current for operation, we have to make some arrangements for that. For that amplification arrangement in case of relay we have used a relay driver and for buzzer we have used two BC 547 transistor in Darlington pair configuration. For operation of the green and red LEDs which work as an indicator they also need large amount of current for their amplified current requirement we have used two BC 547 transistors one for each. When we give supply to our prototype the display shows a welcome message and simultaneously all the sensors start sensing the current, voltage, frequency and temperature and update all the real time values to the server as well as show on the display. It compares all the real time values with the predefined values, if any of the values exceeds pre-defined values it sends a fault alert to the relay and buzzer as well as update it on the display. If the fault exists for the pre-set time then relay isolates the loads from the rest of the system. In the meantime, comparison goes on as before, if the fault gets cleared relays reconnect the loads with the rest of the system.

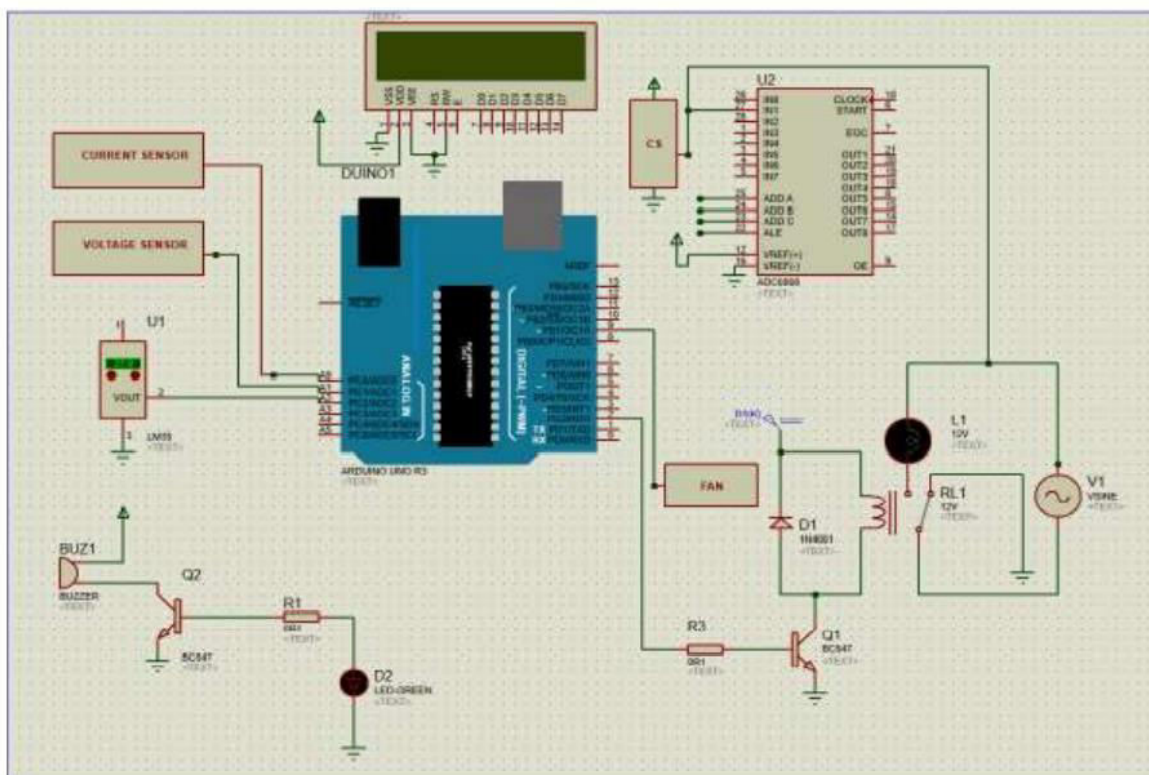


Fig 1 Proposed circuit configuration

### ADVANTAGES OF THE PROJECT

Helpful for Fault Management Monitoring means acquiring parameters from the assets of interest. The data obtained is of great importance for fault management and scheduled maintenance. By promoting modern and competitive techniques and equipment for continuous monitoring and diagnosis, it is possible to track natural or accidental degradation over time; if identified in time and remedied, it will not generate serious events which may be sources of extremely costly damage for electricity suppliers and consumers. At the same time, it is possible to extend the life of the equipment, optimize the maintenance program, and reduce the outages and expenses for the planned repairs of the facility. Reduced hazards This method minimizes time contact between human and high voltage device. As it is known, most substation devices have high voltage and generate electromagnetic that can harm human health. On the other hand, the exposure to high voltage environment may also be able to cause risk to human health. Therefore, an integrated monitoring system is crucial to be implemented for easy monitoring and controlling the substation while minimizing interaction of human to the substation devices. Real time monitoring This is one of the main perspectives why we have chosen this project in the first place. In most of the today's facilities lack in this point, because they don't have proper facility to fetch real time data; they usually rely on the periodically collected data that too manually collected. Thereby it is very tough sometimes to judge the actual health of the machine we are monitoring. What has been overcome through this project. Here we are able to monitor the real time data of the machine irrespective of fault. Remote Access This is one of the main advantages of this project. All the real time data collected by WSN are being updated to the server, which enables us to get all the real time data at its ease remotely. Which means we of data will involve delay to some extent i.e.,

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#### 4. CONCLUSION

Monitoring means acquiring significant parameters from the assets of interest. The acquired data is feasible to be used for analyses and diagnose the condition of the assets which is of great use for maintenance scheduling, failure management and controlling system and this method minimizes time contact between human and high voltage device. As it is known, most substation devices have high voltage and generate electromagnetic that can harm human health. This proposed system is specially designed for monitoring the condition of substation transformers which are deployed at dispersed locations There are many parameters to be quantified and monitored periodically It is quite costly and difficult to monitor the

#### FUTURE SCOPE

Addition of GSM Module By incorporating the GSM module, we will be able to send Personalised SMS to the authorities so that they can remain be updated about the plant while outside. And the microcontroller is programmed in such a way that a particular format of SMS is send which can be used as a input for the microcontroller for required operation. Addition of Wireless Camera We can install wireless cameras in the premises of substation switchyard; through we shall be able to visually monitor the substation in a better way. This particular would be really helpful for monitoring of transformers as we know most of the time they are deployed in the dispersed locations. Development of GUI The window display 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. The blackout condition can be prevented and continuity power supply will be guaranteed. Coolant Management System We can add a coolant management system along with the temperature sensor module; which will be very helpful for the managing cooling flow and temperature management. It can be designed in such a way when the temperature of a module or a particular equipment will exceed a predefined limit the coolant flow will be rapid and continuous, and when temperature is well within range then the coolant flow will be slow and periodic.

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