Development of Global System Mobile Modem Based Temperature and Level Monitoring System in Hydro Power plant

(Case Study at Koka Hydro Power Plant)

Melese Silo Erbiko

A Thesis Submitted to the Department of Electrical Power and Control Engineering School of Electrical Engineering and Computing

Presented in Partial Fulfillment of the Requirement for the Degree of Master of Science in Electrical power and control Engineering (Specialization in Power Engineering)

Office of Graduate Studies
Adama Science and Technology University

October 2021
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DECLARATION

I hereby declare that this Master Thesis entitled "Development of Global System Mobile Modem Based Temperature and level Monitoring System in Hydro Power plant *(Case Study at Koka Hydro Power Plant)*" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation

Melese silo		08/10/2021
Name of the student	Signature	Date

RECOMMENDATION

I, the advisor of this thesis, hereby certify that, I have read the revised version of the thesis entitled “Development of Global System Mobile Modem Based Temperature and level Monitoring System in Hydro Power plant *(Case Study at Koka Hydro Power Plant*”. Prepared under my guidance by Melese Silo submitted in partial fulfillment of the requirements for the degree of Master’s of Science in Electrical and Computer Engineering (Specialization in Power Engineering).Therefore, I recommend the submission of revised version of the thesis to the department following the applicable procedures.

Advisor	Signature	Date

APPROVAL SHEET

I, the advisors of the thesis entitled "Development of Global System Mobile Modem Based Temperature and level Monitoring System in Hydro Power plant *(Case Study at Koka Hydro Power Plant*" and developed by Melese Silo, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis .

Advisor	Signature	Date

We, the undersigned, members of the Board of Examiners of the thesis by Melese Silo have read and evaluated the thesis entitled "Development of Global System Mobile Modem Based Temperature and level Monitoring System in Hydro Power plant *(Case Study at Koka Hydro Power Plant)*" and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Electrical and Computer Engineering (Specialization in Power Engineering).

Chairperson	Signature	Date
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External Examiner	Signature	Date

Finally, approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

Department Head	Signature	Date
School Dean	Signature	Date
Office of Postgraduate Studies, Dean	Signature	Date

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LIST OF ABBREVIATIONS

AC	Alternating current
C	Capacitor
DC	Direct Current
DPWL	Drainage pit water level
EEPROM	Erasable electrical programmable read only memory
F	Frequency
GGB	Generator guide bearing
GSM	Global system for mobile
GND	Ground
HEPP	Hydro Electric Power Plant
LCD	Liquid Crystal Display

LED	Light Emitting Diode
LM35	Temperature sensor Multimedia
MMS	Messaging Service
R	Relay
RTD	Resistive Temperature Detector
SMS	Short message service
TGB	Turbine Guide Bearing
VI	Virtual Terminal

ABSTRACT

In electrical power systems, power plant deice is equipment, which generates power to the power system. For proper operation (i.e., under rated conditions) of the generators and turbines, their operational conditions should be monitored and maintained. Overloading and overheating are two sources of devices failure that cause power system for the customers and reduce the life time of the equipments on the power distribution system. Since it is very costly to repair or replace a single generator or turbine, it also has its impacts on the economy of the country. Hence, a system that properly monitors the power system and take corrective action should be in place.

This thesis focuses the detection of parameters failure in hydro power plant and takes reflex action to solve the problem with help of modern sensors and GSM communication. The parameters of like Generator winding temperature, Generator guide bearing oil level turbine guide bearing temperature and derange pit water level, etc., are monitored and communicated to authorized person. The above parameters are recorded using the analog to digital converter (ADC) of the embedded system. The obtained parameters are processed and recorded in the system memory If any abnormality or an emergency occurs the system sends SMS (short message service) messages to the mobile phones containing information about the abnormality according to some predefined instructions programmed in the Arduino mega microcontroller. This GSM system will help the transformers to operate smoothly and identify problems before any catastrophic failure. This system will help the power plant parameters to operate smoothly and identify problems before any catastrophic failure.

Key words: Arduino mega, GNERATOR, turbine, GSM modem,and sensors

CHAPTER ONE

INTRODUCTION

1.1. Background of the thesis

Currently, the new technologies developed strappingly, the reputation for the electric devices is growing, and so the energy utilization is growing day by day. The Energy stand for the vital need of the humansbeing where the energy require is much greater the actual energy production in almost all states. The Energy considered as one of the essential infrastructure for the enlargement of any economy and a key issue in assessing the progress of any country [1]. For well-organized operation of hydropower plants, in order to meet up the electricity,while using these hydro power a number of challenges are faced by consumer such as maintaining the excellence of grid power, asset guards, protection, capturing real time data, distantly monitoring of the hydro power units monitoring, Data compilation Analysis issue ,Human reliance etc. hydro power units Monitoring System (GMS) is intended specifically for power units to supervise turbine and generator and derange system functions and notice pre-alarms or failures. This insures us of increased unit availability and a quick response to service harms.

The GMS monitors the power plants located at the remote regions and amplify its Efficiency by monitoring the variety of parameters of units; Reporting serious Problems reduce downtime and maximize availability by sending units malfunction messages immediately to you for judgment and urgent situation service dispatch if necessary. It works on Global System for Mobile communication (GSM) technology. GMS can monitor a mixture of parameters such as external power supply, the Generator bearing temperature, Generator bearing oil level, turbine-bearing temperature, turbine bearing oil level, drainage water level, dam water level etc.

This system provides perfect solution to the problems caused in circumstances when a wired link between a remote appliance/device and the manage unit might not be feasible. The thesis is aspires to analyzing and simulating the use of mobile phones to distantly, monitoring a machines control system through GSM based wireless communication.

1.1.1. Study area description

Koka Hydroelectric Power Plant is located about 75km southeast of Addis Ababa in Ethiopia and The nearest sizeable town is Adama on the main Addis Abba some 15 km to the north-east.. It is a multipurpose dam providing for irrigation and energy production, Electricity generation through a 43 MW power and annually produces 110 GWH of energy. It has three unit(s). Koka HEPP is the first unit had commissioned in 1960 and it has thee unit with generating capacity of 14.2 mw. The present status of koka Hydroelectric Power Plant is good condition with generation capacity of 36 Mw and all 3 turbines is in operation but the monitoring and controlling systems are outdated it may needs upgrading and re-habitations

Figure 1. 1 Koka hepp top view

1.2. Statement of the Problem

The electrical energy demand is growing in Ethiopia. Keeping the demand and economic growth in viewpoint, new power plant stations are being construction in different areas and with diverse kinds of source. However, with all this expansion at hand we are not currently getting a satisfactory and continuous flow of electric power. There is so many outages and frequent blackouts caused by poor monitoring system, in addition to this auxiliary systems fault, generator guide bearing temperatures and turbine guide bearing temperatures, oil level and the overfull of drainage system, dam water level management main problem in power plant.

When we particularly view the fault that happen in the koka hydropower plant, it may be due to poor monitoring system, generator overheating, turbine bearing wearing by friction or damages and other faults These failures of hydropower devices have a wider impact, not only on the power plant operation performance but also on company income. In fact that, koka hydro power plants have a PLC with SCADA mentoring system and to check different parameter of the devices, but there is no any back up or redundant while the main PLC SCADA system is fail and no any method to that informs the authorized person at remote (SMS message) that any malformation occur on it. Therefore, the aim of this thesis is to enforcement of the existing mentoring system. To do this, these items are ready GSM technology, Modern sensors, Arduino microcontroller and server. Those start the new distant mentoring and develop a cost efficient, up to dated and smart method to reduce the power outage, which comes due to faults happening on koka hydro power plants, and boost the existence of the asset.

1.3. Objectives of the thesis

1.3.1. General Objective

The main objective of this thesis is to monitoring temperature and levels the in koka hydro power plant by developing GSM technology and Arduino microcontroller.

1.3.2 Specific Objectives

The specific objectives of the thesis are states as follows:

- Monitor remote asset condition
- Monitor turbine and generator guide bearing oil temperature and oil level
- Monitor Generator winding temperature
- Monitor drainage system water level
- Utilization of an easy cost effective and interface GSM modem with the Arduino technology to control power plant devices.

1.4. Significance of the thesis

The rising world power plant parameter monitoring has lead to exponential increase in this event has required the need for more areas to be advanced. Due to transform of Hepp parameters patterns approved about by manage through advanced monitoring system, with more and more Hepp parameters, now being under burdens in the parameters there is a need for optimal use oil and spare parts. Over the previous few years, facts in electronics and present day confront. Computation had been used to resolve in the front position of the electronics revolution has been the Arduino microcontroller. The microcontroller has been uses together with various sensors to measure and control physical quantities like temperature, oil, and water level. By controlling this physical quantity using the Arduino microcontroller, automatic systems have been attains. Monitoring systems has also been automates. This solves the challenge brought about by the unpredictability of temperature changes thus need for oil and spar part optimizing. Automation of the monitoring systems is one of the most suitable, competent and successful method of hydropower plant parameters optimization through power plant units.

1.5. Scope of the thesis

The scope of this thesis is to develop continuous real time condition monitoring system for hydro power plants based on Global System for Mobile communication (GSM). All the sensors we installed remotely to acquire data from the power plants and transfer the data they acquire to Arduino microcontroller board. A serial port communication is uses in between Arduino Microcontroller based on Arduino Mega and GSM modem

1.6. Limitations of the thesis

This thesis has certain limitations and a list of such is mentions below:

- The receiver must reside in a location where a signal with sufficient strength can be receives from a cellular phone network.
- Only devices with electrical monitoring input ports will be possible targets for monitor.
- Operation of the monitoring unit is only possible through a cell phone with SMS messaging capabilities.

1.7. Organization of the thesis

This thesis report is organizes into five chapters:

- Chapter 1 introduced the , the thesis statement of the problem, objectives, the scope and limitation.
- Chapter Two is the literature review
- Chapter Three gives a complete technical aspect of the design and a component used in a design.
- Chapter Four analyzed and discussed the system
- Chapter Five provide the conclusion of the whole thesis, if the objective and scope of the thesis were achieved And This chapter also includes appendices and the references used.

CHAPTER TWO

LITERATURE REVIEW

2.1. Theoretical review of the thesis

2.1.1. Hydro power

Hydroelectricity is electricity generated by the force of moving water in the penstock of a hydropower unit. Turbines are uses to capture the kinetic energy of water by converting it to electricity as the falling water spins the turbine. Hydropower plants may be located below reservoirs or built in rivers (run-of-the-river units) with no water storage capacity. Hydropower is considered a renewable source of energy, as it relies on water, which is continuously renews through the natural water cycle [2]. Hydroelectric power is generated by the flow of water through turbine, turning the blades of the turbine.

The main components of a hydro power plant are Dam/Reservoir/Large buffer tank (Spillway, Intake gate Trash tracks). Tunnel, Surge tank, Penstock, Powerhouse, and equipment

Dam - Most hydropower plants rely on a dam that holds back water, creating a large reservoir. Often, this reservoir is used as a recreational lake, Intake - Gates on the dam open and gravity pulls the water through the penstock, a pipeline that leads to the turbine. Water builds up pressure as it flows through this pipe, Turbine - The water strikes and turns the large blades of a turbine; the most common type of turbine for hydropower plants is the Francis Turbine, which looks like a big disc with curved blades. A turbine can weigh as much as 172 tons and turn at a rate of 90 revolutions per minute (rpm), according to the Foundation for Water & Energy Education (FWEE).,Generators - As the turbine blades turn, so do a series of magnets inside the generator. Giant magnets rotate past copper coils, producing alternating current (AC) by moving electrons. (You will learn more about how the generator works later.) And Transformer - The transformer inside the powerhouse takes the AC and converts it to higher [3].

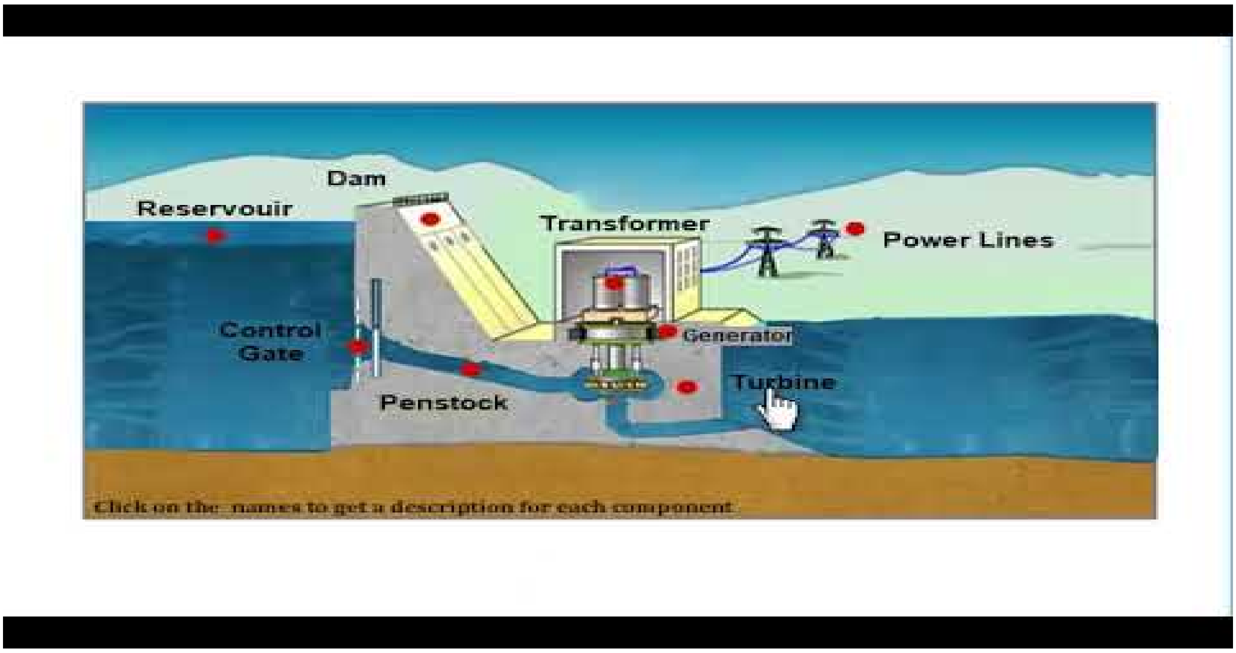


Figure 2. 1 Main components of hydroelectric power plant

2.1.2. Hydro power plants real time monitoring

Hydro power plants are one of the most cost-effective renewable technologies, which have the potential to replace the conventional fuels. However, reliability of the plant varies with time due to irregularity in flow pattern of the river, which depends on the pattern of climatic parameters like precipitation and vapors-transpiration. The reliability of the plant performance also varies with the efficiency of the power equipment and conveyance coefficient of penstock, both of which are time dependent. When reliability reduces, performance efficiency also gets degraded. That is why, monitoring of reliability in hydro power plants is essential and required to be conducts periodically [4].

2.1.3. Thrust and guide bearings

The turbine-generator unit presents remarkable masses under rotation and considerable inertia forces, that increase if masses are not balanced, come into play. The runner may be subject to lateral forces due to the asymmetric flow that strikes it and the generator may be subject to magnetic pull. These forces associated to the weight of the rotating parts must be control by means of the bearings. In the case of horizontal machines, the main loads on the bearings are due to the weights that act in perpendicular with the machine shaft and the axial loads present are smaller than those in the corresponding vertical unit are because in this case there is no weight along the shaft. Referring to a vertical unit, the axial loads are discharges by the thrust bearing and the radial ones by the guide bearing. The number of guide bearings depends on the type of turbine-generator unit and essentially by the length of the shaft line [5].

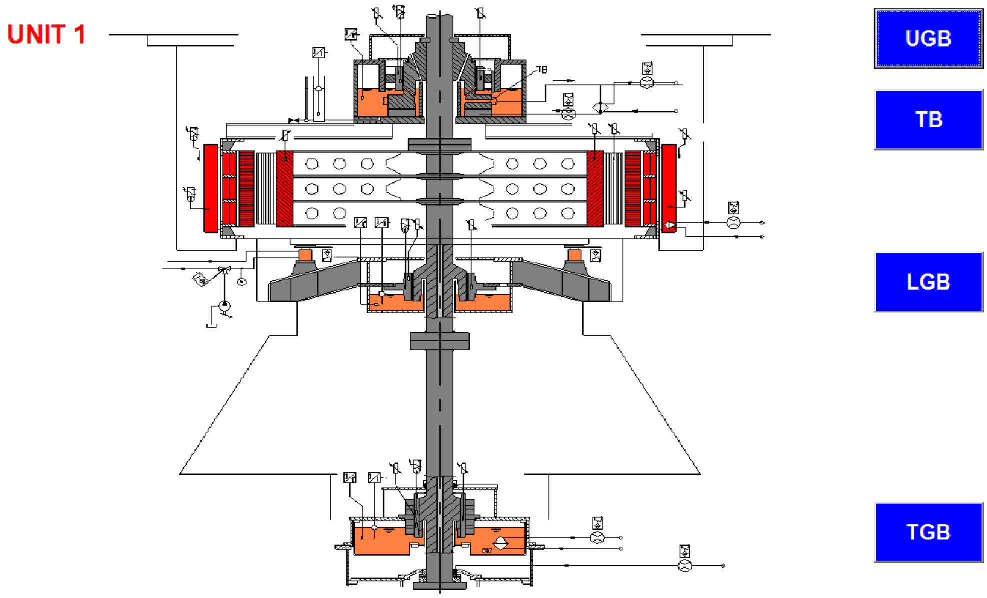


Figure 2. 2. Koka HEPP turbine and generator guide bearing

2.1.4. Generator winding temperature monitoring

2.2. Review of the related literature

Petrescu, et al. [7]. Designed and implemented a system of monitoring and control based on SMS for the application of telemetry. They tested some wireless technologies, but they focused on the GSM modem and the efficiency of using SMS. SMS is uses to report a particular position such as power outages. In addition, a controller is uses as a processing unit and a GSM modem used for communication purposes.

Xiao, et al [8]. Presented a system depends on the GSM network, which can monitor the power lines reliably. Using the SMS service, the network is realizes for remote data transfer. The system consists of a control center and smart power lines monitoring instruments. This system was mainly bases on information theory and SMS system that are analysis. Instruments consist of hardware and software designs. The hardware design consists of the 89C20 51 microcomputer, the data transmission mode of GSM, the ground line monitoring service, the IC memory card module (the identification card), and so on. Using the SMS G100A serial connection controller, the performance of data transmission could be efficient. The designs of communication protocol and transceiver program were the basic of the software programs. Test results and practicality show that the design of this system can meet user requirements. This system will be strongly applies in many fields and has a great economic level.

Microcontroller based Substation Monitoring and Control System with GSM Modem in (July-Aug. 2012). The 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 Circuit Breaker trips or whenever the Voltage or Current exceeds the predefined limits. This thesis makes use of an onboard computer, which is commonly termed as microcontroller [9].

Control System for a Diesel Generator and UPS Based Micro grid" in (2010) the system the Cellular phone containing SIM (Subscribers Identifying Module) card has a specific number through which communication takes place. The mode of communication is wireless and mechanism works on the GSM (Global System for Mobile communication) technology. Here, the communication is make bi- directional where the user transmits and receives instructions to and from the system in the form of SMS [10].

Base Transceiver station (BTS) safety and fault management" in (2013) the design of BTS safety and fault management system the measures are takes to rectify these problems. The method makes use of GSM modem, which gives the instant message about the each activity happening in the site. The temperature sensors will sense the temperature of the room and if it rises above the threshold value, the GSM module will send the message to the master mobile, which is already set in the system [11].

proposed system by using a cloud-based remote management solution with a communication gateway could help reduce costs, avoid fuel theft and improve power generator control in (2013). It can be difficult to focus on the right actions, simply because there is not enough information on fuel levels, oil pressure or battery status for each generator. With a cloud-based remote management solution, we can have immediate access to generator parameters via a regular web browser being able to analyze each generator remotely enables you to better understand their health and more efficiently schedule field service visits and Fuel theft can be a significant problem[12].

Digital Controller of a Diesel Generator using an Embedded System in (2006) Using remote management; you can check operating hours, oil pressure, battery status, coolant temperatures, generated power output, fuel level, GPS position and more. A notification also could be generates whenever a critical level has been reached, such as when a generator has been running more than expected, or when the running hours exceed the service interval [13].

SMS Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security Computer Programmer", Engineering Dept., Fatima Jinnah Women University, Rawalpindi, Pakistan[14]

Proposed in September 2013 this system is a specially designed computer system that is completely encapsulates by the device it controls. The embedded system has specific requirements and performs pre-defined tasks. The diesel generator operates in analog. The analog type controller cannot be processes precisely due to the distortions and noises coming from the data. In order to increase data accuracy, the controller needs to be digitalized [15].

the distribution transformers have a long service life if they are operats under good and rated conditions. However, their life is significantly reduced if they are overloaded, resulting in unexpected failures and loss of supply to a large number of customers thus effecting system reliability. This system provides flexible control of load parameters accurately and provides effective means for rectification of faults if any abnormality occurs in power lines using SMS through GSM network [16].

SCADA system was applied to a stand-alone photovoltaic system to monitor the current and voltage of PV and batteries. Te results of the experiments demonstrate that SCADA works in real time and can be effectively uses in monitoring a solar energy system [17].

a successful communication based on Ethernet and OPC to integrate Arduino microcontrollers with Lab VIEW based supervisory systems. The open source feature of Arduino offers important benefits like low cost, vast amount of information available in the Internet and easy configuration, just to name a few. On the other hand, Lab VIEW is a well-known software environment to implement monitoring and supervisory systems widely used by both Academia and industry. Indeed, the presented integrative framework is a novelty in scientific literature [18].

The Experiments prove that the proposed low-cost SCADA could monitor an experimental micro grid successfully. Several tests were carries out to validate the system robustness, data collecting and device communication efficiency with a remote DB. As a result, it was obtains a successful validation of the system operability [19].

They developed a distribution automation system for Nigeria's electric power distribution network, which mainly uses a GSM network for communication on the published paper. They stated that lack of up-todate information on efficient operation and maintenance of electric power distribution systems (EPDS), Nigeria is addressed by designing and implementing an indigenous real-time monitoring and diagnosis system[20].

Their system encompasses the development of software driven hardware positioned at the remotely located sub-stations at the low voltage level to keep track of the network in real-time. They achieved fault-reporting time of 2 seconds. The developed system exhibits a high degree of accuracy and manifests no spurious reports during testing. They then concluded that the resultant system limited the effects of interruption and increases power availability by reducing the down time. The system strengthened engineering and management capabilities required to enhance reliability by providing information about the network health status. [21]

GSM based Agriculture Monitoring and Controlling System, proposed a framework, checking data on a farm or rural environment by using wireless sensing element network (WSN) innovation. The following ecological parameters were measured: temperature, luminance, humidity, pH, CO2, with the aid of Keil Micro Vision, the data is ascertained and viewed on the GSM device of the farmer who observes it and takes the necessary precautions or actions. [22] ."SMS based infrastructure for controlling of home appliances". This was done remotely through personal computer and GSM modem, which allow the capability of Computer Engineering and Intelligent Systems sending and receiving SMS. [23].

A GSM based Power Plant Temperature Remote Monitoring and Control System with Real-time Data Acquisition. Power Plants used in the Industries are powered ON steady to carry various loads twenty-four hours each day. This requires real time remote monitoring of the system's parameters to avoid system breakdown or malfunctions. Research pointed out that one of the main challenges of a power generating plant is accurate failure prediction. This has been a serious challenge and to tackle this challenge, a system that will monitor, acquires data and control power generating plant remotely in case of any serious change in the plant's parameters to avoid failure or malfunctioning via GSM is proposed[24]

2.3 Contribution

Presently in Ethiopia power plants, we do not have any research done on the power plant parameters mentoring help of GSM modem nor any developed method or system of real-time monitoring and analysis of the health status of a generators and turbine. For this reason, I investigate ways to monitor these devices and minimize the faults that occur on them, making the system more reliable. In addition, my research motivates the possibility to carry out an extensive research in the area of making the system much cheaper and utilizing the different advanced networking and communication technologies for monitoring the power plant and the role this could play on improving the reliability and efficiency of the power plant.

CHAPTER THREE

SYSTEM DESIGN AND DESCRIPTION

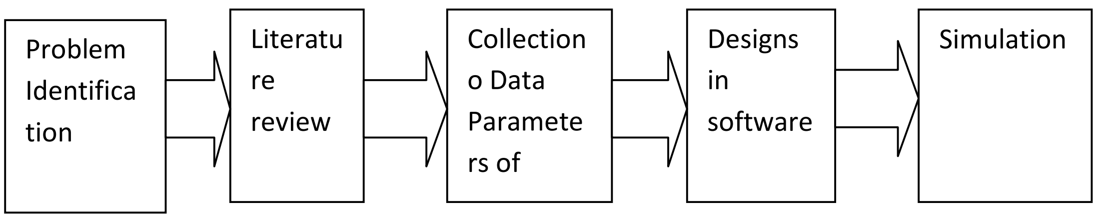
3.1 System development methodology block diagram

The system consists of hardware and software. The hardware part involves Arduino Uno R3 microcontroller, sensors, Relay and power supply. The software part is the Arduino Board, which is a program using the Arduino IDE software used to interface hardware and protues8 professional. The Arduino Based Automatic model atomization of generator monitoring system, have be made in the following steps:

- Complete layout of the whole setup will be drawn inform of a block diagram.
- Sensor will first sense the condition and give its output to the Arduino microcontroller & displayed on the LCD.
- The generator temperature condition is checked by temperature sensor, depending upon the condition, fuel and oil level, fun motor is turned on or off.

The methodology used to address the problem is describes in this section.

- Study state problem and objectives of the theesis.
- The next section describes the procedures used for this study which includes a detailed account of Arduino microcontroller.
- The ARDIUNO software used for implementing the techniques for successful completion of this thesis some steps will be follows to carry out different tasks.



Different literature will be revised relating to this thesis and data will be collected about condition and control parameter of generator. Based on this parameter system model was designed. Some software's and hardware were selects to develop the software programming. All the required materials are not available Arduino software so some sensors like fuel level and oil level sensors, temperature sensor and conditional circuit were replaced by equivalent materials.

3.2. System Development Tools

The development tools used in this project are GSM handset with GSM Modem and a driver circuit, LCD display, Motor pump, Temperature sensors, Level sensors, Battery source, Diesel Generator, LED, Arduino IDM, and Proteus.

3.3. Hardware requirement list

Power supply, GSM modem, LCD display, Motor pump, Temperature sensors, Level sensors, Battery source, Engine Generator.

3.4 Software requirement list

- Arduino IDE
- Proteus 8 software

3.5 Block diagram of the thesis

The thesis was be done with the help of the following block diagram

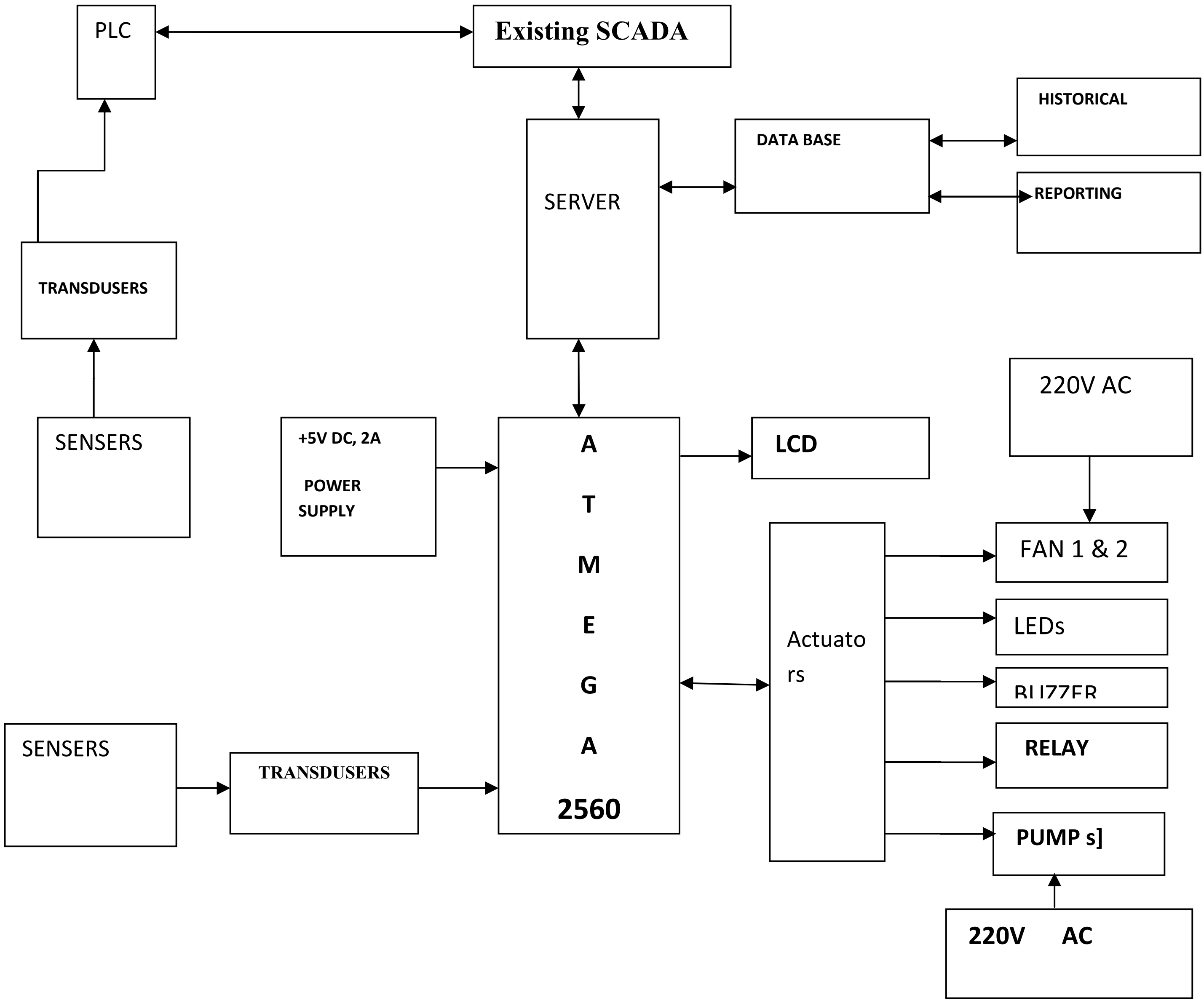


Figure 3. 1. Block diagram of the mentoring system.

3.6. Working principle of block diagram

The system has worked through the form of this block diagram. The block diagram consists of hardware and software. The hardware architecture consists of power plant system that is based on SCADA, Server, SMTP server, VOIP gate way, SMS gate way, database, fun motor; pump motor sensors, Arduino microcontroller(AT MAGA 2560), Transducers, driver circuits, ADC, power supply, indication led, buzzer LCD display. GSM modem and mobile, these all parameters are works at when the units and Arduino communicate each other. Micro controller a GSM handset with GSM Modem and a driver circuit, that means communicates through sensors that transfer information through units and Arduino to give output for LCD and mobile to the authorized person.

The GSM modem provides the communication by means of SMS messages. The SMS message consists of commands had executed. The SMS message is sent to the GSM modem via the GSM public networks as a text message with a definite predefined format. It sends the SMS to the user consisting of status of oil level, drainage water level, GGB temperature and TGB temperature of the coolant, etc.

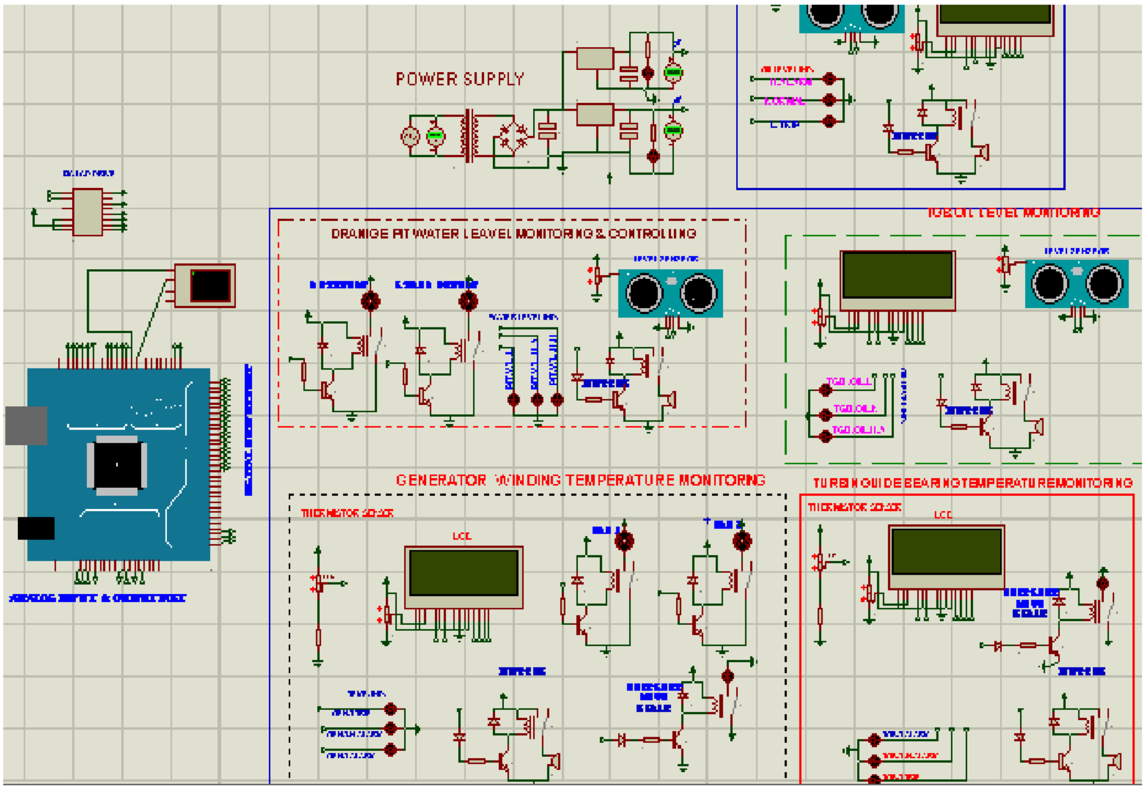


Figure 3. 2. Over all monitoring system

3.7. System description

3.7.1. Power supply circuit

The power circuit design is one of the important parts of this thesis, without a power Supply the electronic devices such as sensors, relay, fan, and LCD display will not function. Similarly, a wrong power supply design will lead to the damaging of the electronic devices used in this thesis. The main power supplies needed for this thesis is 5VDC and +12 VDC in order to power on the relays and other electronic devices. The design had done using a transformer, bridge-rectifiers and filter capacitor. Almost all electronics circuit required DC power supply. DC power supply is the circuit, which converts the AC waveform of power lines to direct voltage of constant amplitude. UN ideal regulated power supply had designed to provide a pre-determined.

A 5V-dc power requirement had used as input supply to the system. The choice of using a transformer is due to the low voltage requirement of the system. A transformer of 240/12V in conjunction with a regulator will be able to provide the needed input 5Vdc. This means that the RMS value of the transformer secondary is Vrms = 12Vdc. The whole section of the system had powered from a 5V dc power source..

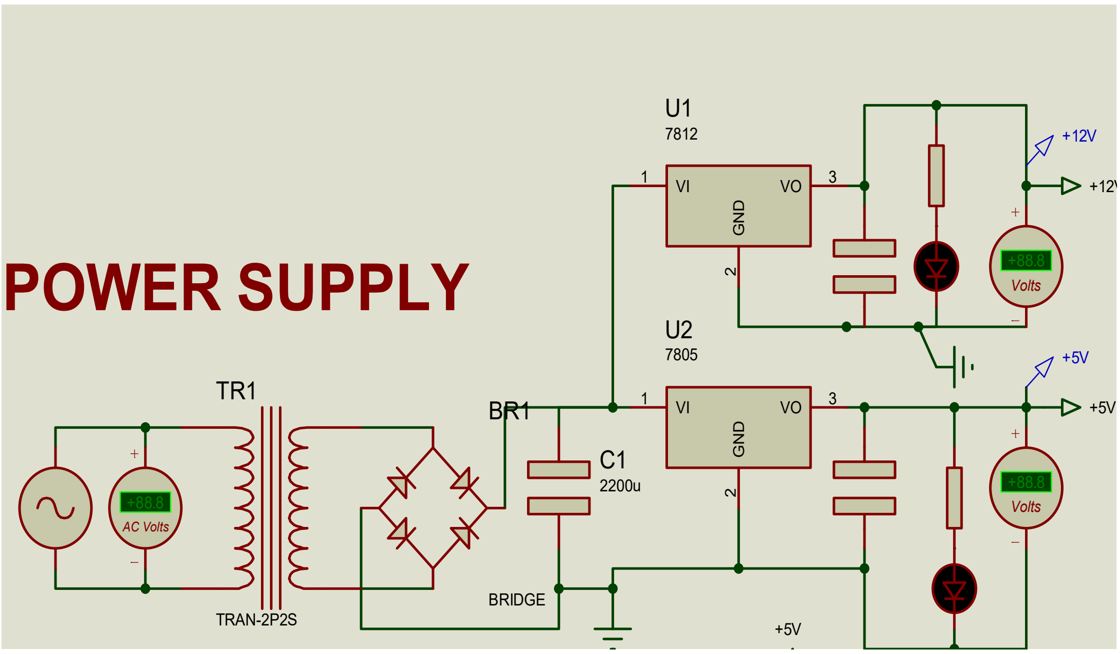


Figure 3. 3. Design of power supply circuit.

3.7.2 Temperature Sensor (Thermostat)

Thermostat: -is a temperature sensor whose name is a combination of the words THERM-ally sensitive res-ISTOR. A thermostat is a special type of resistor which changes in temperature. This thermostat type sensor is LM35,LM35 is an integrated circuit sensor that can be used to measure temperature with an electric output proportional to the temperature (in °C), I select due to the following main advantages;

1. Lower cost

2. Does not require any external calibration

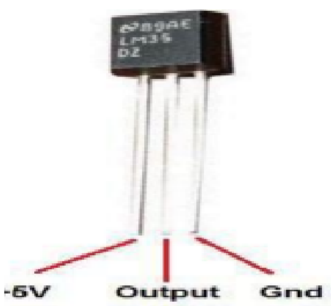
3. Linear output & output voltage is proportional to Celsius temperature

4. Precise and accurate output using thermostat

5. Easily obtained temperature sensors

LM35 is a basic temperature sensor that can be used for experimental purpose. It give the readings in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature that means temperature dependent. It uses the fact that as temperature increases, the voltage across diode increases at known rate (actually the drop across base-emitter junction of transistor). Its disadvantage is it s sluggish response.LM35 has the following main features;

1. Calibrated directly in degree Celsius (centigrade)
2. Linear +10.0 mV/ degree Celsius
3. 0.5 degree Celsius accuracy guarantee able (at +25degree Celsius)
4. Rated for full -55 to +150 degree Celsius range
5. Suitable for remote application
6. Low cost due to wafer-level trimming
7. Operates from 4 to 30 volts
8. Less than 60 Micro ampere current drain



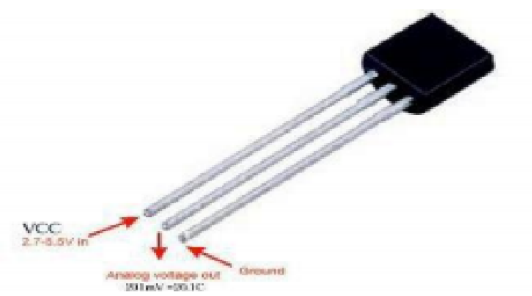


Fig3.4 Schematic diagram of LM35 temperature sensor

As shown in the figure above the sensor has three terminals.

i. Input source; it ranges from 2.7V to 5V
ii. Ground
iii. Output; analogue voltage output ranges from 201mV to 20v

The code will be written in c code. Before we can get a Celsius reading of the temperature, the analog output voltage must first be read. This will be the raw value divided by 1024 times 5000. It is divided by 1024 because a span of 1024 occupies 5V. We get the ratio of the raw value to the full span of 1024 and then multiply it by 5000 to get the mill volt value. Since the output pin can give out a maximum of 5 volts (1024), 1024 represents the possible range it can give out. The raw voltage over this 1024 (value) therefore represents the ratio of how much power the output pin is outputting against this full range. Once we have this ratio, we then multiply it by 5000 to give the mill volt value. This is because there is 5000 mill volts in 5 volts. Once this analog voltage in mill volts is calculated, we then can find the temperature in Fahrenheit by the equation: ((Celsius * 9)/5 + 32).

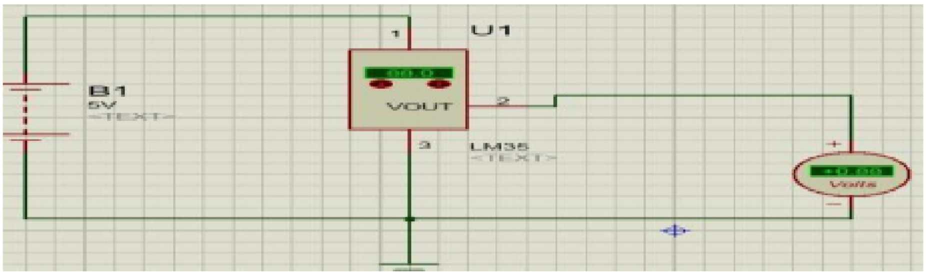


Fig 3.5 Temperature sensing circuit

3.7.3. Ultrasonic level Indicator

The ultrasonic level Indicator is a low-cost, noncontact and easy-to-install measurement device. It is able to meet the every-day needs of commercial production, as well serving a more specialized role in the technologically advanced aerospace industry, thus placing it firmly in the category of high-level measurement technology [14].

The principle of operation of the ultrasonic sensor system is to use the ultrasonic pulses, which had transmitted by the transducer to the surface to monitor and are reflects back to the transducer. The period between transmission and reception of the sound pulses is directly proportional to the distance between the transducer and surface, a micro-controller computes this period for all echoes received and analyses them to determine which is the correct reflection from the material surface; it uses this data as the basis for giving control outputs and displays. The distance D is determined from the velocity of sound and the time period t by the formula: D=.t/2 [14].

3.7.4 Fan motor

When the temperature of the generator exceeds the maximum limit, a SMS text will be sent to the authorized person to take action and based on the command sent from the authorized person the generator will be forced to be switched off, because the temperature is out of its normal working range. This results in power failure for short period. Therefore, in addition to informing the concerned body that the temperature is too high it is also possible to use dc fan motor for cooling purpose. The fan will work only when the temperature exceeds the highest limit and is off for temperatures below the maximum value.   The fan motor coil gets it is power source from the Arduino output and the Arduino output connected to the fan contactor coil will be high when the temperature of the generator is too high.

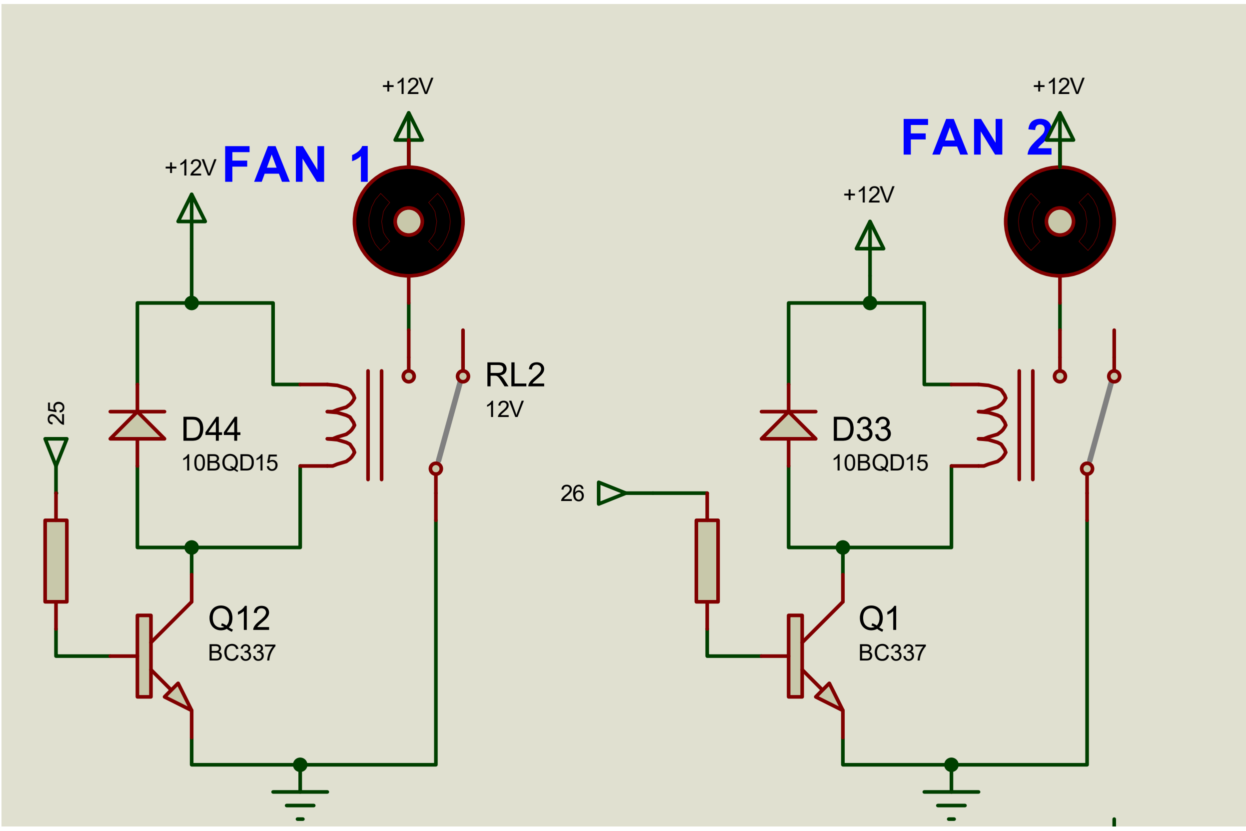


Figure 3. 7. Schematic diagram of fan motor circuit

3.7.5. GSM Modem

A GSM is a mobile communication modem it is standards for global system for mobile communication (GSM). The idea of GSM had developed at Bell laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operate. GSM is modem is a specialized type of modem, which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem was connects to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently uses to provide mobile internet connectivity y, many of them can also be uses for sending and receiving SMS and MMS messages. GSM modems can be a quick and efficient way to get started with SMS, because a special Subscription to an SMS service provider is not required. In most parts of the world, GSM Modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery. A GSM modem exposes an interface that allows applications such as Now SMS to send and receive messages over the modem interface. The mobile operator charge for this message sending and receiving as if it was performs directly on a mobile phone. To perform these tasks, a GSM modem must support an “extended AT command set” for sending/receiving SMS messages. GSM modules had manufactured by different companies. They all have different input power supplies. We need to double check our GSM modules power requirements. The GSM module requires a 12 volts input, so we feed it using a 12V, 1A DC power supply. It can be noticed that GSM modules which require 15 volts and some other which needs only 5 volts. They differ with manufacturers. If we are having a 5V module, we can power it directly from Arduino 5V out.

3.7.6. GSM Architecture

A GSM network consists of the following components, these are: A mobile station: It is mobile phone, which consists of the transceiver, the display and the processor and is controls by a SIM card operating over the network. Base station subsystem: It acts as an interface between the mobile station and the network subsystem. It consists of the base Transceiver station, which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the base transceiver station and acts as an interface between the mobile station and mobile switching center mobile equipment identity.

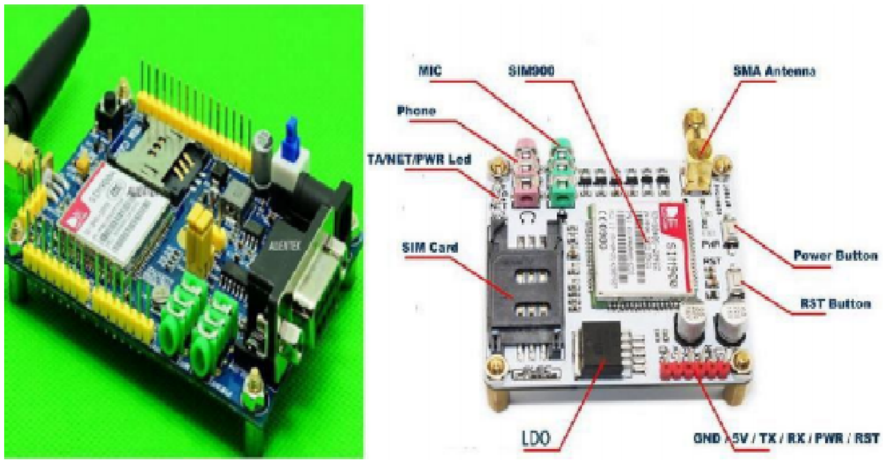


Figure 3. 7. GSM modem and pin configuration

3.7.7. Serial Communication

In this model serial communication from modem to Arduino microcontroller are done by connecting Txd and Rxd pins to modem Rxd and Txd pin respectively and the third pin of modem is grounded. In our hardware architecture, we have interface modem to Arduino microcontroller directly. The use of Max232 or RS232 and having proper results with proper communication.Max232 or RS232 both ha used as logic converter. They both can work in CMOS logic level or TTL logic level. If Arduino microcontroller works in TTL level and GSM Modem works in CMOS level then logic converter like RS232 is interfaces to bring same logic level. However, in our model both Microcontroller and GSM Modem works in TTL logic level so here we have not used Max232 0r RS232.Direct connections between modem and Arduino microcontroller is done.

Figure 3. 8. The configuration of virtual terminal

3.7.8. Liquid crystal display (LCD)

A liquid crystal display (LCD) is a thin, flat panel used for electronically displaying information such as text, images and moving pictures. Its uses include monitor for computers, televisions, instrument panels Gamin device etc. using polarization of light to display objects. A typical liquid crystal producing degree shift in the polarization of the light passing through when there is no electric field present. When a voltage is applied, an electric field is produces in the liquid, affecting the orientation of the molecules. This causes the polarization shift had reduced. Liquid crystal material emits no light of their own. For illumination of light-backlight and reflective method used.

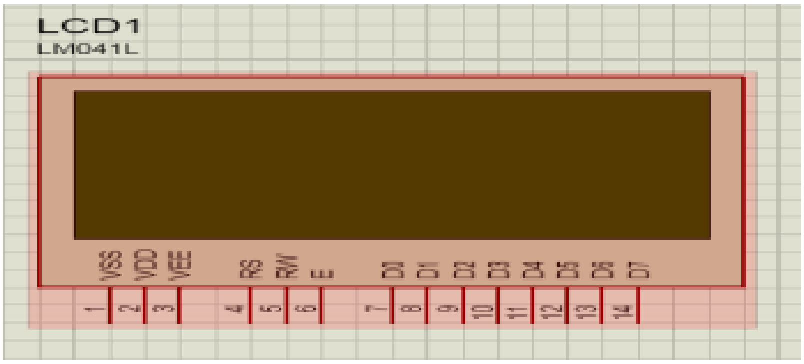


Figure 3. 9. LCD and pin configuration

Reflective: it uses external light reflected by reflector behind the display. Example: watch, Calculator, this is achieved by combining a reflector with rear polarizer.

Backlight: light source is from a backlight, and viewed from the front. Example: computer display built in fluorescent tubes above, besides and sometimes behind the LCD.

LCD pin description for interfacing with Arduino

3.7.9. Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

3.7.10. Arduino Mega 2560 technical specification

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16

DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by boot loader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

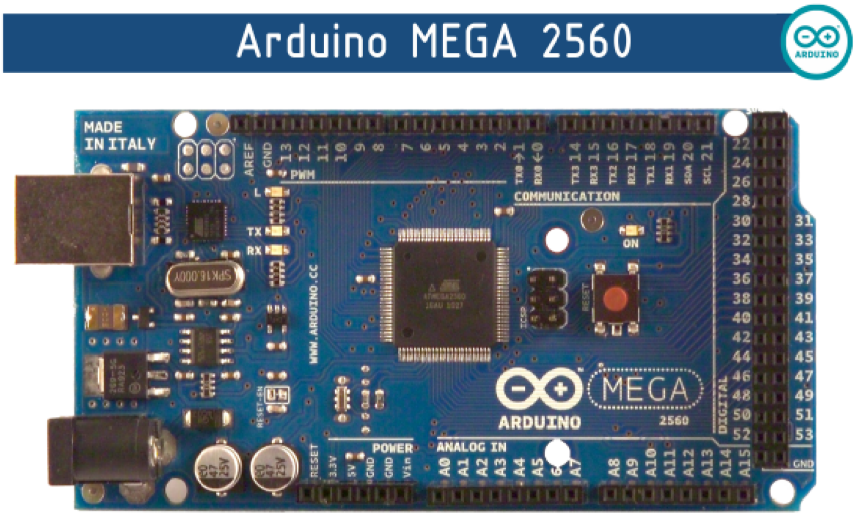


Figure 3. 10. Arduino mega 2560

3.7.11 ATMEGA 256 Connectivity with the Server software

Easily Connect to Your Data:- this approach allows to easily connecting to your industrial data. With a comprehensive library of drivers (such as ATMEGA 256, Siemens and Modbus) and compatibility with OPC UA and OPC DA/COM servers, you can easily pull data directly from ATMEGA 256, PLCs or from established legacy systems.

3.7.12 Data Base

SQL Support: - this approach supports any number or type of SQL databases to store and manage history for alarm events. With SQL it's easy to report alarm statistics such as: events per hour, most frequent alarms, number of floods, unique chattering alarms, and more. **.**

3.7.13 Server software

True Real-Time Monitoring: - the server is engineered to streamline data-throughput so you see true real-time alarm values. Real-time monitoring gives you the power to quickly see the status of your facility, on any device. The SCADA server software comes standard with a comprehensive set of data acquisition tools, which includes built-in OPC UA to connect to practically with ATMEGA 256, and the ability to connect to any SQL database. This approach can also turn any SQL database into a high-performance industrial historian.

CHAPTER FOUR

RESULT ANALYSIS AND DISCUSSION

4.1. Simulation Result

Simulation was carried out in Proteus 7.7 Integrated development Environment to see the visibility of the proposed system and the relay is connects to the load in the normally close position to keep the plant running when the conditions are normal state. LM35 has two buttons; increments (+) and decrements (-) that is used to vary the temperature for the sole purpose of analysis. The overall system contains the above listed sensors as input (temperature sensor and level sensor and fault detector relay) and LCD, to display the parameters, GSM modem (virtual terminal for simulation), pumps, Fan, induction LEDs, buzzer and buzzer as an output. The GSM modem is not available in the protues software so an equivalent component is used to receive the transmitted information from the Arduino i.e. Virtual terminal. Each of the steps i took and the results had shown below.

4.1.1. Generator temperature monitoring simulation result

First condition: (Generator temperature less than 65°c)

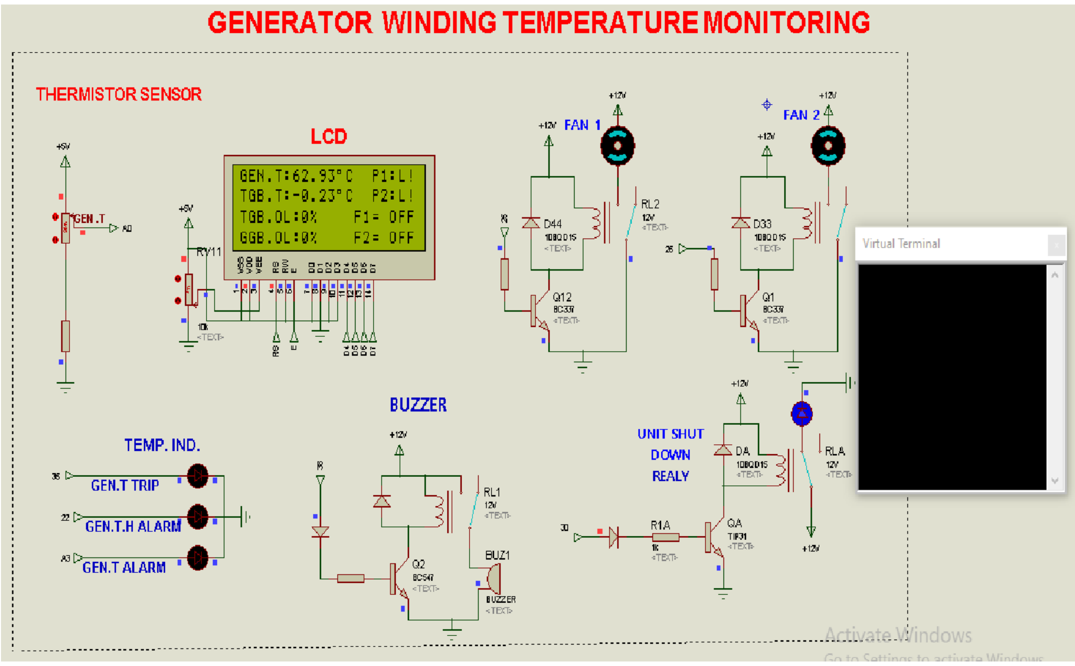


Figure 4. 1. First condition generator temperature monitoring simulation result

The simulation result obtained (figure 4.1) indicates that the actual temperature value in degree Celsius is displayed on LCD this is not more than koka hydropower plant generator prescribed limit and the generator operates in safe operation. Hence, no need for awareness or alert for the authorized person (not send to virtual terminal) since everything is normal. In addition, to this all monitoring parameters, which are both fans statues are OFF, all indications, LED’s are off, and shutdown relay off to keep running the generator and buzzer status is off

Second condition (Generator temperatures in between 65°and 75°c)

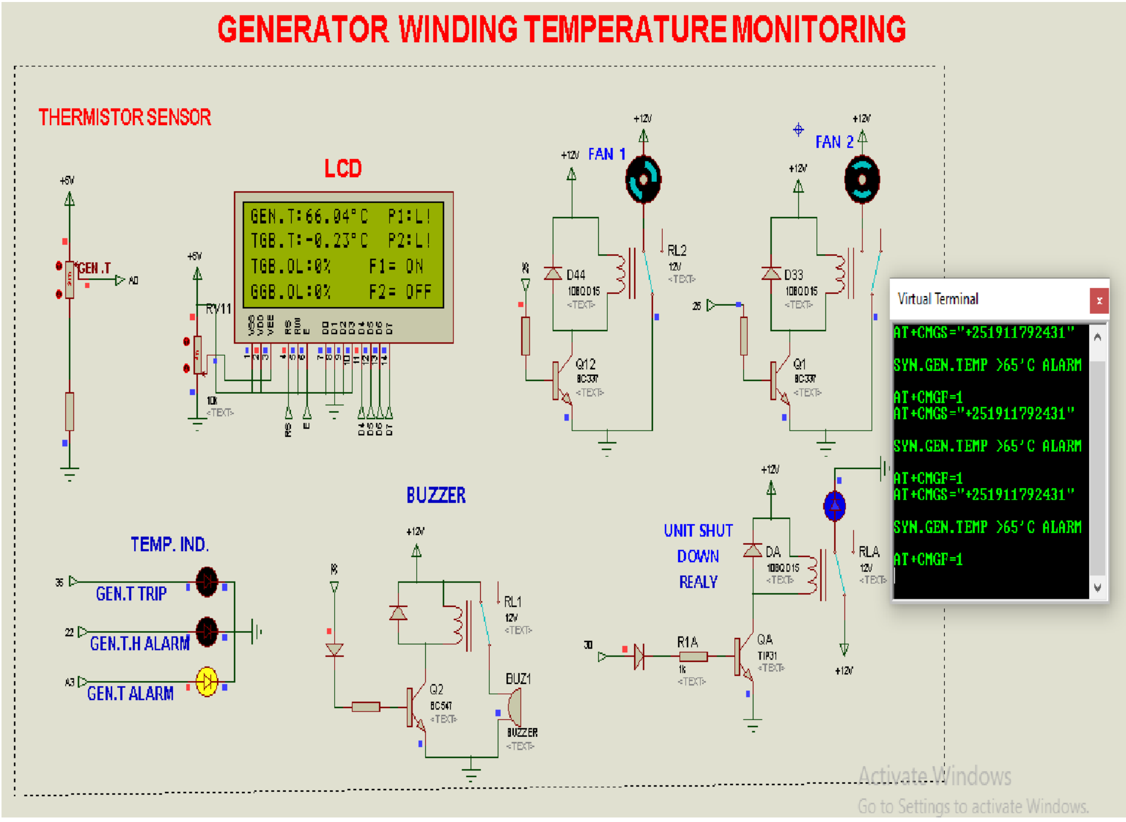


Figure 4. 2. Second condition generator temperature monitoring simulation result

These conditions are suitable conditions but its alert stage, and Simulation result obtained (figure 4.2) indicates that the Generator temperature real-time reading value will be displayed on LCD and the microcontroller (Arduino) send (SMS massage) generator-winding temperature high alarm to the virtual terminal because the temperature rises from normal value. In addition, to this fan number one is ON because of to attempt to cool the generator temperature back to normal condition but fan number two is OFF, indication LED 1 ON, LED 2 OFF, LED three OFF shutdown relay ON to keep running the generator because the actual temperature reading is not critical but alert and buzzer status is ON.

Third (3rd) condition (Generator temperatures in between 75°and 80°c)

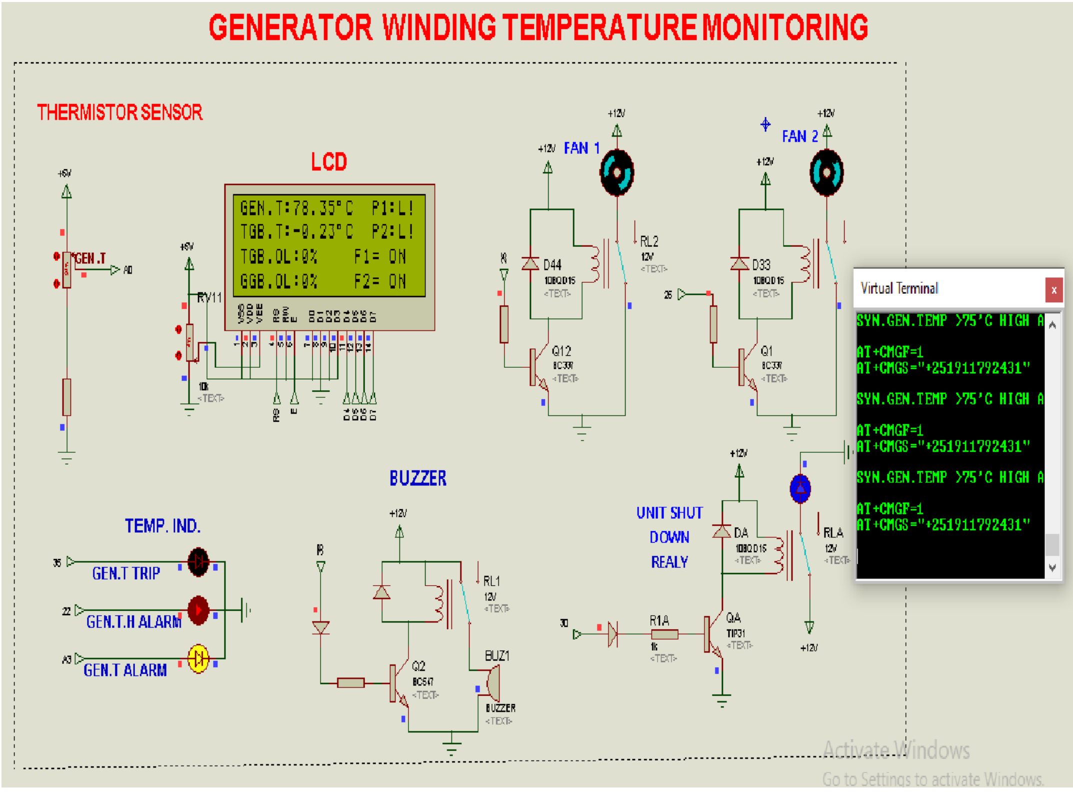


Figure 4. 3. Third condition generator temperature monitoring simulation result

These conditions are not appropriate conditions but go to the near-critical stage, and the Simulation result obtained (figure 4.) indicates that the Generator temperature real-time reading value will display on LCD and the microcontroller (Arduino) send (SMS massage) generator winding temperature too high alarm to the virtual terminal because the temperature rises from normal value. In addition, to this both fan's are ON because of the attempt to cool the generator temperature back to normal condition, indication LED 1 ON, LED 2 ON, LED three OFF shutdown relay ON to keep running the generator because the actual temperature reading is not critical but alert and buzzer status is ON.

Forth conditions (Generator temperatures greater than 80°c)

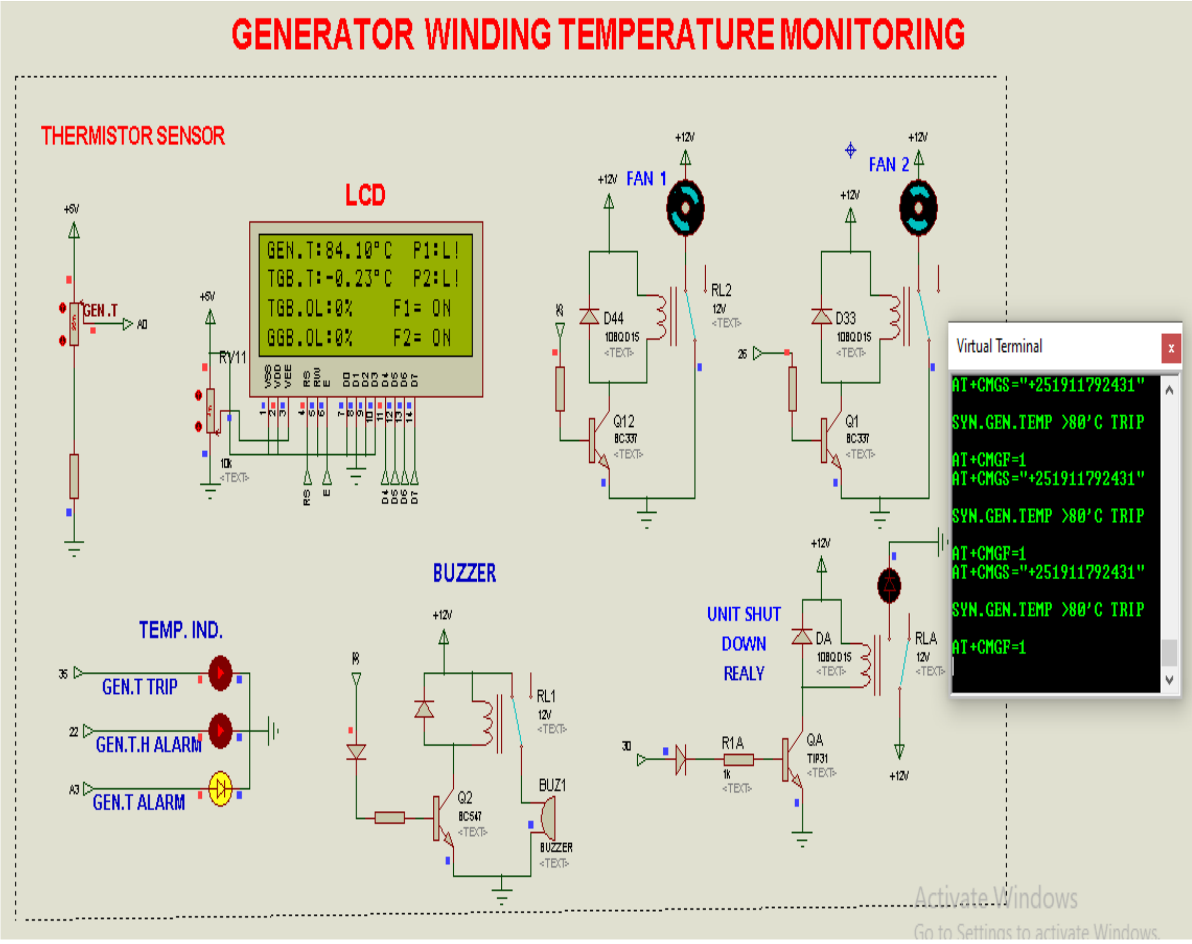


Figure 4. 4. Forth condition generator temperature monitoring simulation result

This condition is a critical condition and the Simulation result obtained (figure 4.4) indicates that the Generator temperature real-time reading value will be displayed on LCD and the microcontroller (Arduino) send (SMS massage) generator winding temperature trip alarm to the virtual terminal because the temperature rises to a critical value. In addition, to this both fans are ON, because of the attempt to cool the generator temperature back to normal condition, indication LED 1 ON, LED 2 ON, LED three ON shutdown relay OFF to shut down the generator to prevent the generator from extra damage and buzzer status is ON.

4.1.2. Generator winding temperature mentoring systems

The all conditions simulation results and status of each monitoring parameters according to koka HEPP generator prescribed limit in the following table.

Table 1. Generator Winding Temperature mentoring system simulation result summery

Mentoring Parameters & status	Gen. Winding, Temp. value <65°c	Gen. Winding, Temp. value >65°c & <75°c	Gen. Winding, Temp. value >75°c & <80°c	Gen. Winding, Temp. value >80°c
On LCD	Temp. val. Displayed in °c	Temp. val. Displayed in °c	Temp. val. Displayed in °c	Temp. val. Displayed in °c
On virtual terminal SMS message	No SMS	Gen. Winding, temp alarm (SMS)	Gen. Winding, temp TOO high alarm (SMS)	Gen. Winding, temp. trip (SMS)
Fan no.1 RUN/STOP	STOP	RUN	RUN	RUN
Fan no.2 run/stop	STOP	STOP	RUN	RUN
Buzzer (ON/OFF)	OFF	ON	ON	ON
Shutdown relay (ON/OFF)	OFF	OFF	OFF	ON
Alarm indication led n0.1 (ON/OFF)	OFF	ON	ON	ON
Too high alarm indication led no. 2 (ON/OFF)	OFF	OFF	ON	ON
Trip indication led no. 3 (ON/OFF)	OFF	OFF	OFF	ON

4.1.3. Turbine temperature mongering simulation result

First condition: (TGB temperature less than 65°c)

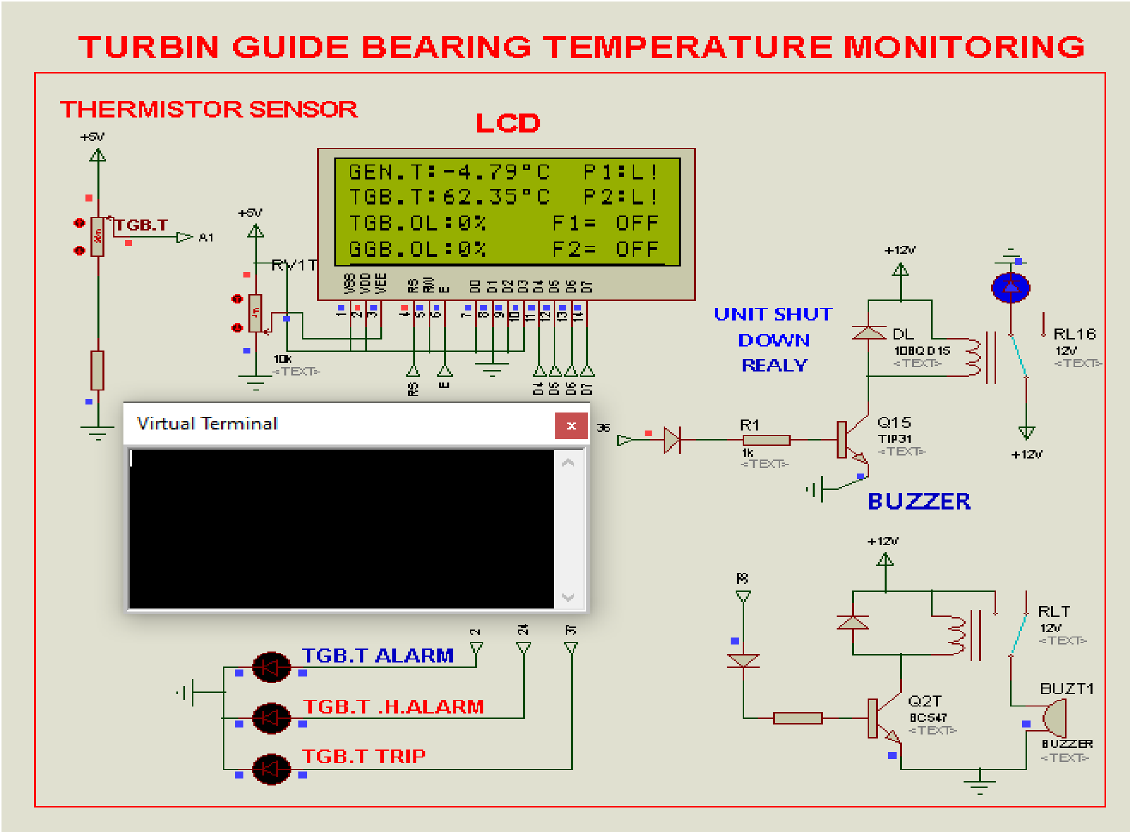


Figure 4. 5. First condition TGB temperature monitoring simulation result

The simulation result obtained (figure 4.5) indicates that the actual temperature value in degree Celsius is displayed on LCD but not send to the virtual terminal because normal conditions no need of awareness to the responsible person. In addition, to this both fans statues are OFF, all indications, LED's are off, and shutdown relay ON to keep running the generator and also buzzer status is off

Second condition (TGB temperatures in between 65°and 75°c)

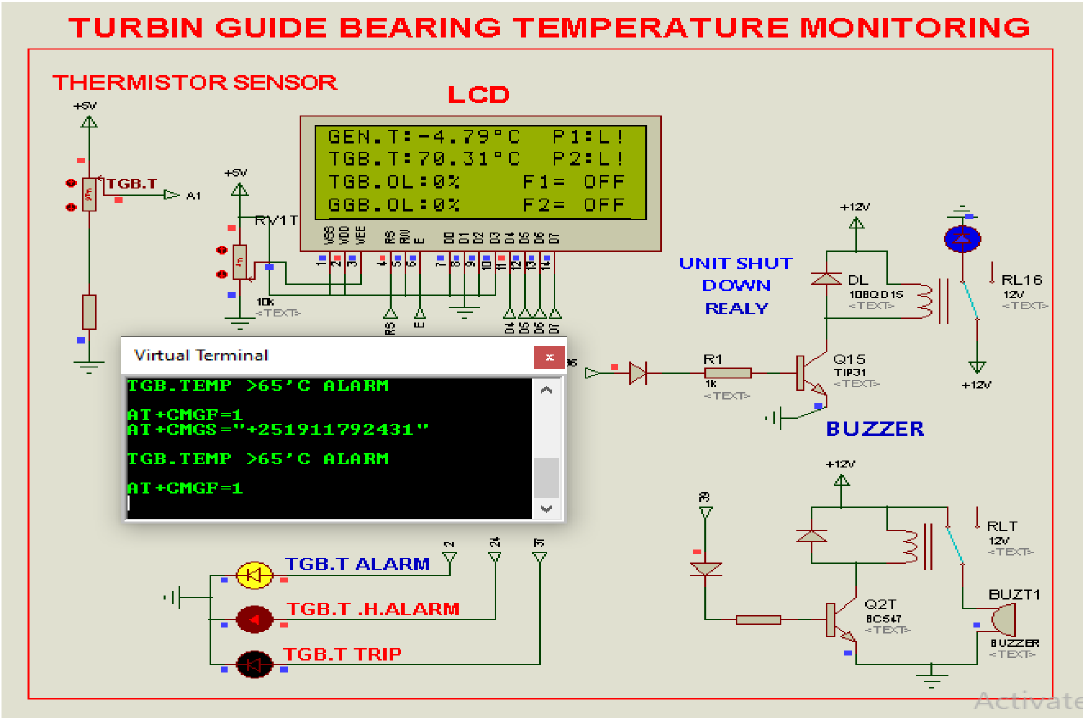


Figure 4. 6. Second condition TGB temperature monitoring simulation result

These conditions are suitable conditions but its alert stage, and Simulation result obtained (figure 4.6) indicates that the turbine guide bearing temperature-time reading value will be displayed on LCD and the microcontroller (Arduino) send (SMS massage) turbine guide bearing temperature high alarm to the virtual terminal because the temperature rises from normal value. In addition, to this, indication LED 1 ON, LED 2 OFF, LED three OFF shutdown relay ON to keep running the generator because the actual temperature reading is not critical but alert and buzzer status is ON

Third (3rd) condition (TGB temperatures in between 75°and 80°c)

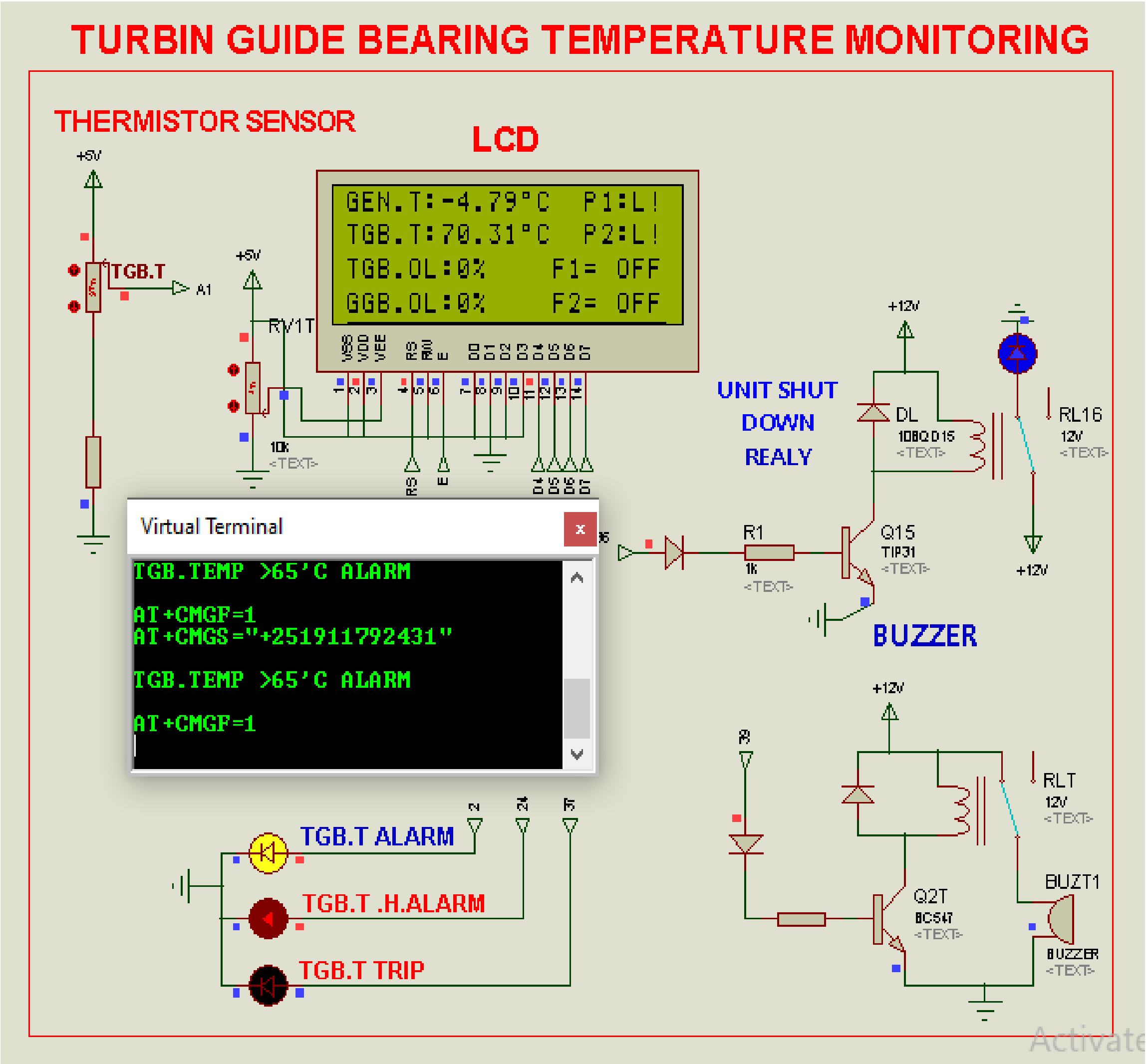


Figure 4. 7. Third condition TGB temperature monitoring simulation result

These conditions is not appropriate conditions but goes to near critical stage, and the Simulation result obtained (figure 4.7) indicates that the turbine guide bearing temperature real-time reading value will display on LCD and the microcontroller (Arduino) send (SMS massage) generator winding temperature too high alarm to the virtual terminal because the temperature rises from normal value. In addition, to this indication LED 1 ON, LED 2 ON, LED three OFF shutdown relay ON to keep running the generator because the actual temperature reading is not critical but alert and buzzer status is ON.

Forth conditions (TGB temperatures greater than 80°c)

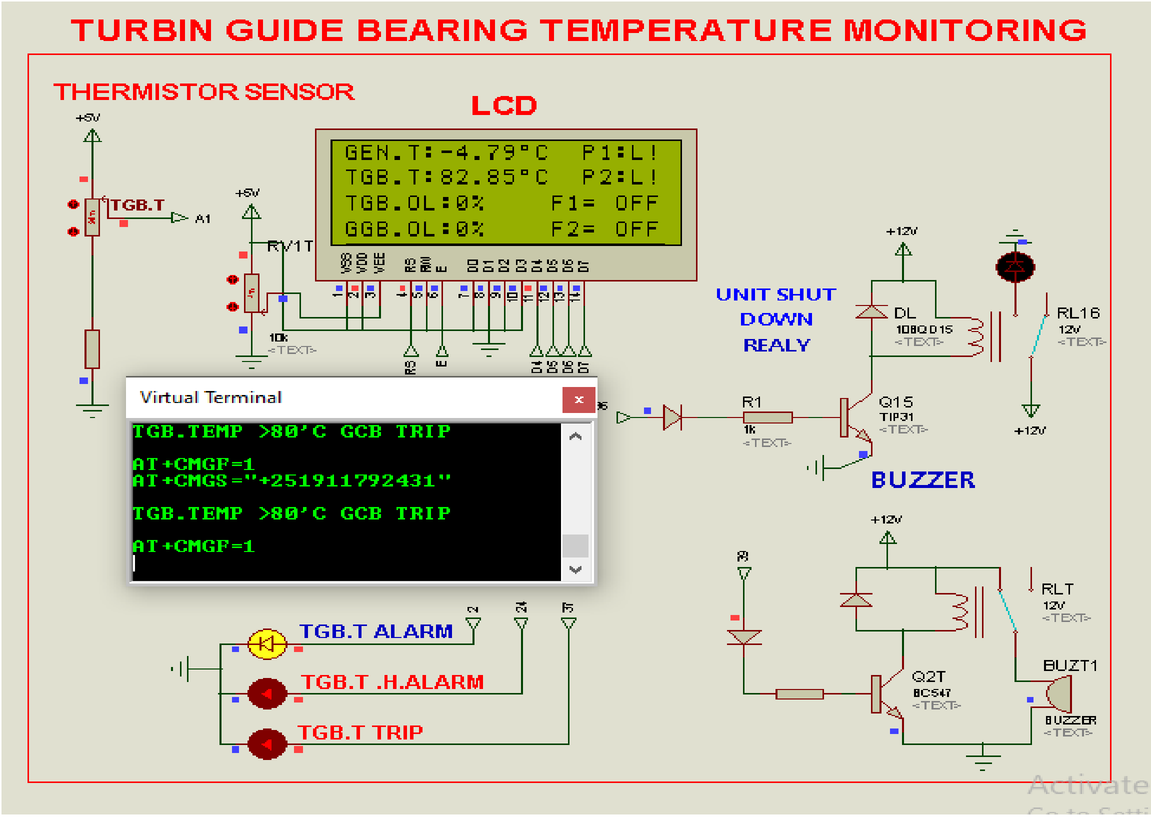


Figure 4. 8. Forth condition TGB temperature monitoring simulation result

This condition is a critical condition and the Simulation result obtained (figure 4.8) indicates that the turbine guide bearing temperature real-time reading value will be displayed on LCD and the microcontroller (Arduino) send (SMS massage) turbine guide bearing temperature trip alarm to the virtual terminal because the temperature rises to the critical value. In addition, to this indication LED 1 ON, LED 2 ON, LED three ON shutdown relay OFF to shut down the turbine to prevent the turbine from extra damage and buzzer status is ON state.

In summary from figure 4.1.4. It can be observed that, all-conditions simulation results and status of each monitoring parameter according to Koka Hepp generator prescribed limits are illustrates in the following table.

This conditions is critical condition and Simulation result obtained (figure 4.9) indicates that, the turbine guide bearing temperature real time reading value will displayed on LCD and the micro controller (Arduino) send (SMS massage) turbine guide bearing temperature trip alarm to virtual terminal because the temperature rises to critical value. In addition, to this indication LED 1 ON, LED 2 ON, LED three ON shutdown relay OFF to shut down the turbine to privent turbine from extra damege and buzzer status is ON sate.

4.1.4. Turbine guide bearing (TGB) temperature mentoring system simulation summery

The all conditions simulation results and status of each monitoring parameters according to koka hepp generator prescribed limits are illustrates in the following table.

Table 2. TGB temperature mentoring system simulation result

Mentoring Parameters & status	TGB Temp. value <65°c	TGB Temp. value >65°c & <75°c	TGB, Temp. value >75°c & <80°c	TGB Temp. value >80°c
On LCD	Temp. val. Displayed in °c	Temp. val. Displayed in °c	Temp. val. Displayed in °c	Temp. val. Displayed in °c
On virtual terminal SMS message	No SMS	TGB, temp alarm (SMS)	TGB temp Too high alarm (SMS)	TGB, temp. trip (SMS)
Buzzer (ON/OFF)	OFF	ON	ON	ON
Shutdown relay (ON/OFF)	OFF	OFF	OFF	OFF
Alarm indication led n0.1 (ON/OFF)	OFF	ON	ON	ON
Too high alarm indication led no. 2 (ON/OFF)	OFF	OFF	ON	ON
Trip indication led no. 3 (ON/OFF)	OFF	OFF	OFF	ON

First condition (the TGB sump oil level in b/n 30% and 70)

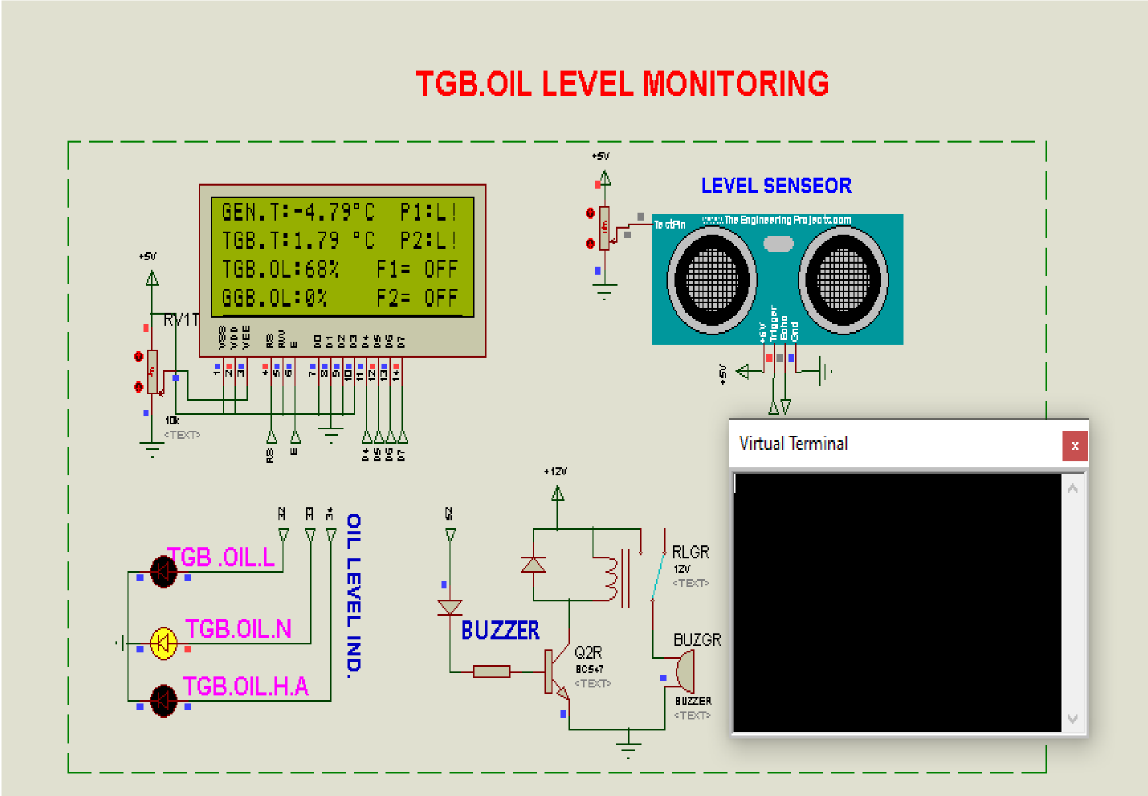


Figure 4.9. *First condition TGB oil level mentoring simulation result*

The turbine guide oil level normal and Simulation result obtained (figure 4.9) indicates that the actual temperature value in degree Celsius is displayed on LCD but not send to the virtual terminal because normal condition no need of awareness to the responsible person. In addition, to this, LED 2 yellow ON, LED 1, OFF, LED, OF, and also buzzer status is off

Second condition (TGB oil level greater than 70%)

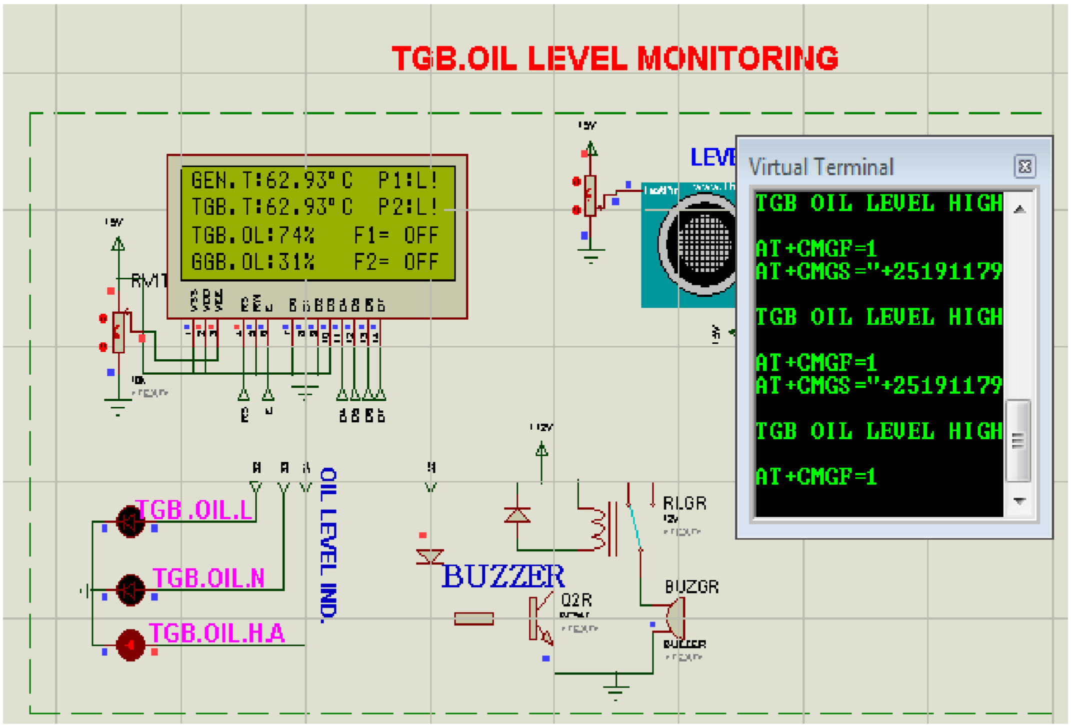


Figure 4.10. Second condition TGB oil level mentoring simulation result.

This condition is not a suitable condition its second Simulation result obtained (figure 4.10) indicates that s real-time reading value displayed on LCD, TGB oil level high alarm (SMS message) send to the virtual terminal. In addition, the indication LED's 1 red ON, led 2 OFF, led 3 OFF buzzer status is ON.

Third condition (the TGB sump oil level less than 30%)

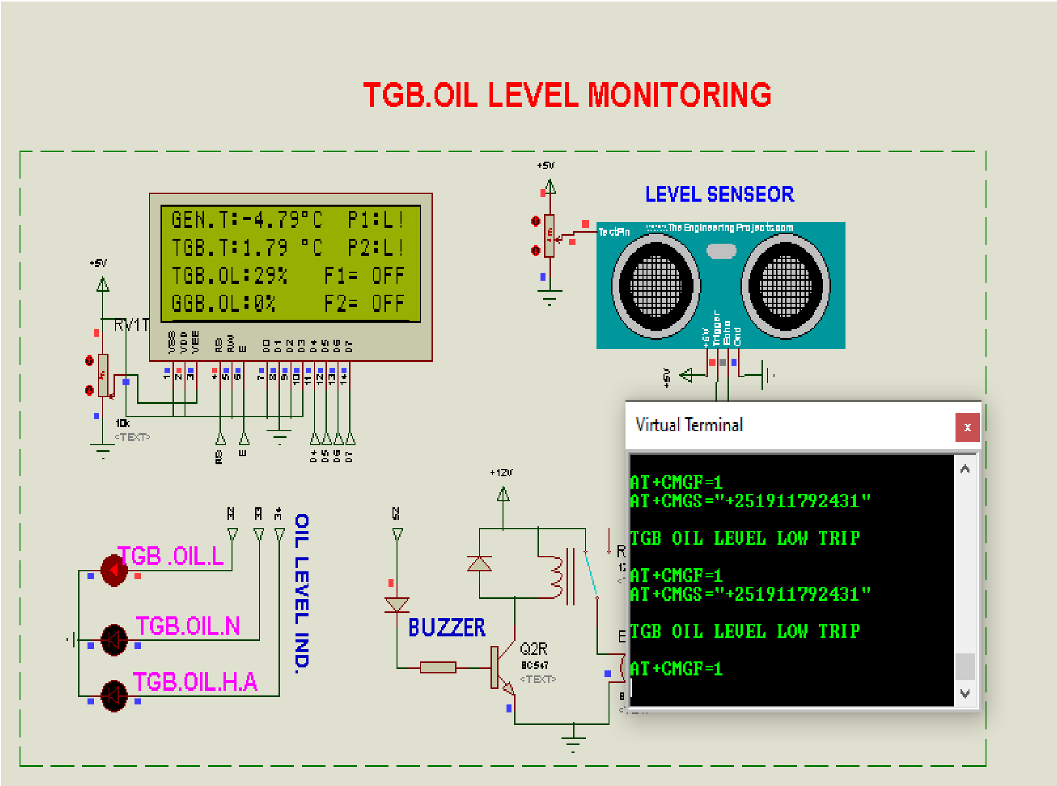


Figure 4. 11. Third condition TGB oil level mentoring simulation result.

This condition is a critical condition and the Simulation result obtained (figure 4.11) indicates that s real-time reading value displayed on LCD, TGB oil level too low trip (SMS message) send to the virtual terminal. In addition, indication LED’s 1 red ON, led 2 OFF, led 3 OFF buzzer status is ON.

4.1.5. Turbine guide bearing (TGB) oil level mentoring system simulation result summery

The all-conditions simulation results and status of each monitoring parameter according to the Koka Hepp turbine prescribed limit are illustrated in the following table.

Table 3. TGB oil level mentoring system simulation result summery

Mentoring Parameters & status	TGB oil sump level. In % >30% & <70%	TGB oil sump level. In % >70%	TGB oil sump level. In % <30%
On LCD	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %
On virtual terminal SMS message	No SMS	TGB sump level high alarm (SMS)	TGB sump level too low alarm (SMS))
Buzzer (ON/OFF)	OFF	ON	ON
Alarm indication led n0.1 (ON/OFF)	OFF	ON	ON
Too high alarm indication led no. 2 (ON/OFF)	OFF	OFF	ON
Trip indication led no. 3 (ON/OFF)	OFF	OFF	ON

4.1.6. Generator guide bearing (GGB) oil level mentoring system

First condition (the TGB sump oil level in b/n 30% and 70)

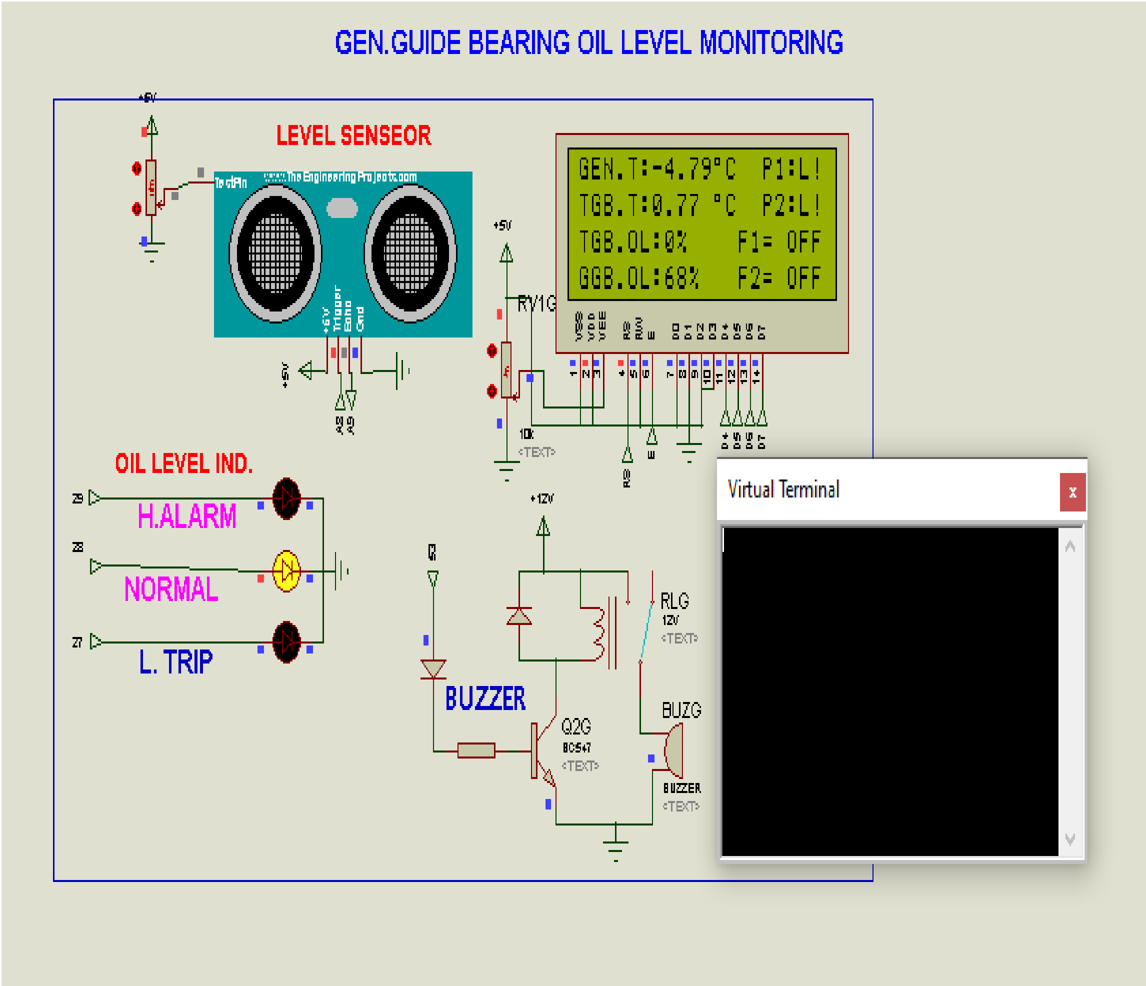


Figure 4. 22. Second condition GGB oil level mentoring simulation result

This condition is a normal oil level and the Simulation result obtained (figure 4.12) indicates that No (SMS message) send to a virtual terminal. In addition, indication led one OFF, led two yellow ON, led three red, and buzzer status is OFF. The second condition (GGB oil level greater than 70%). This condition is not suitable condition its second alert stage and had seen the following results in simulation; the real-time reading value will be displayed on LCD, GGB oil level high alarm (SMS message) send to the virtual terminal. In addition, indication LEDs 1 red ON, led 2 OFF, led 3 OFF buzzer status is ON. This all status is shown in the figure below.

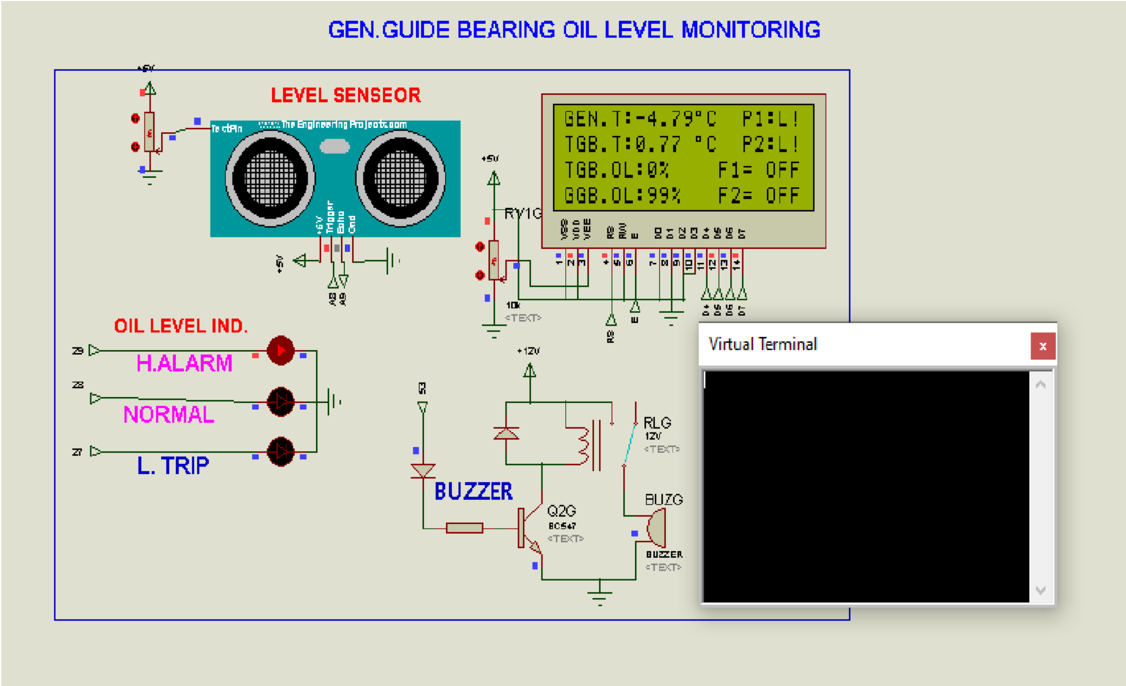


Figure 4. 14. Second condition GGB oil level mentoring simulation result

Third condition (GGB sump oil level less than 30%)

This condition is a critical condition and had Simulation result obtained (figure 4.15), indicates that the TGB too low trip (SMS message) send to the virtual terminal. In addition, indication LEDs 1 red ON, led two yellow OFF, led three red OFF and buzzer status is ON. This all status is shown in figure 14 below.

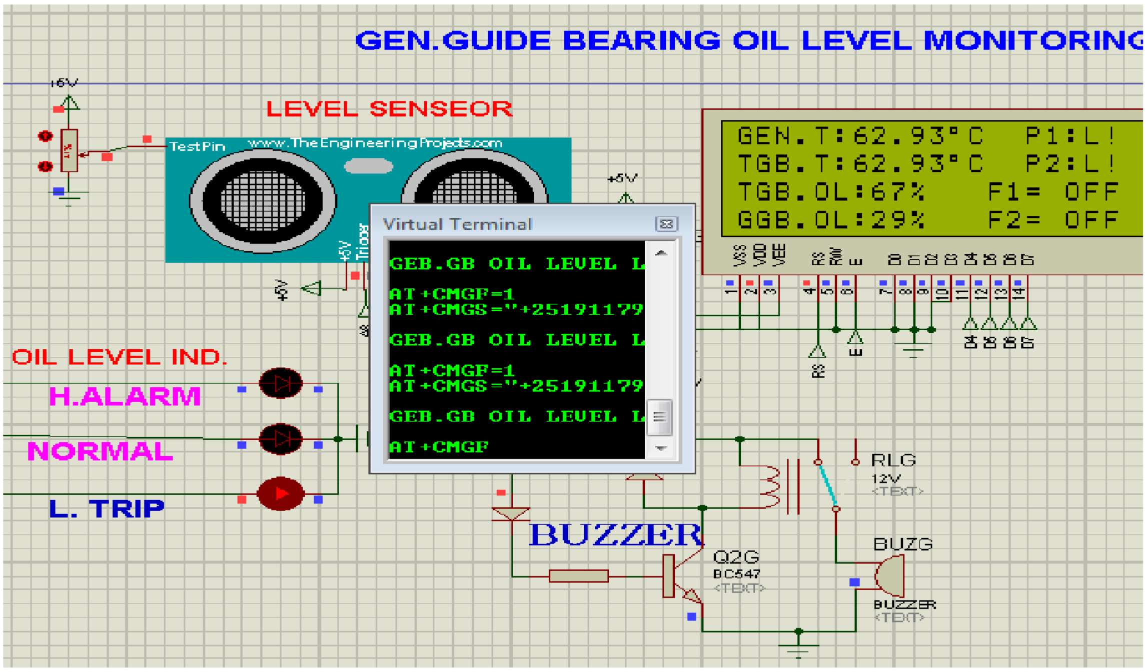


Figure 4. 15. Third condition GGB oil level mentoring simulation result.

4.1.7. Generator guide bearing (GGB) oil level mentoring system simulation result summery

The all conditions simulation results and status of each monitoring parameters according to koka HEPP Generator guide bearing prescribed limit are illustrates in the following table.

Table 4. GGB oil level mentoring system simulation result summery

Mentoring Parameters & status	GGB oil sump level. In % >30% & <70%	GGB oil sump level. In % >70%	GGB oil sump level. In % <30%
On LCD	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %
On virtual terminal SMS message	No SMS	TGB sump level high alarm (SMS)	TGB sump level too low alarm (SMS))
Buzzer (ON/OFF)	OFF	ON	ON
Alarm indication led n0.1 (ON/OFF)	OFF	ON	ON
Too high alarm indication led no. 2 (ON/OFF)	OFF	OFF	ON
Trip indication led no. 3 (ON/OFF)	OFF	OFF	ON

4.1.8. Drainage pit water level mentoring system

First condition (Drainage pit water level less than 30%)

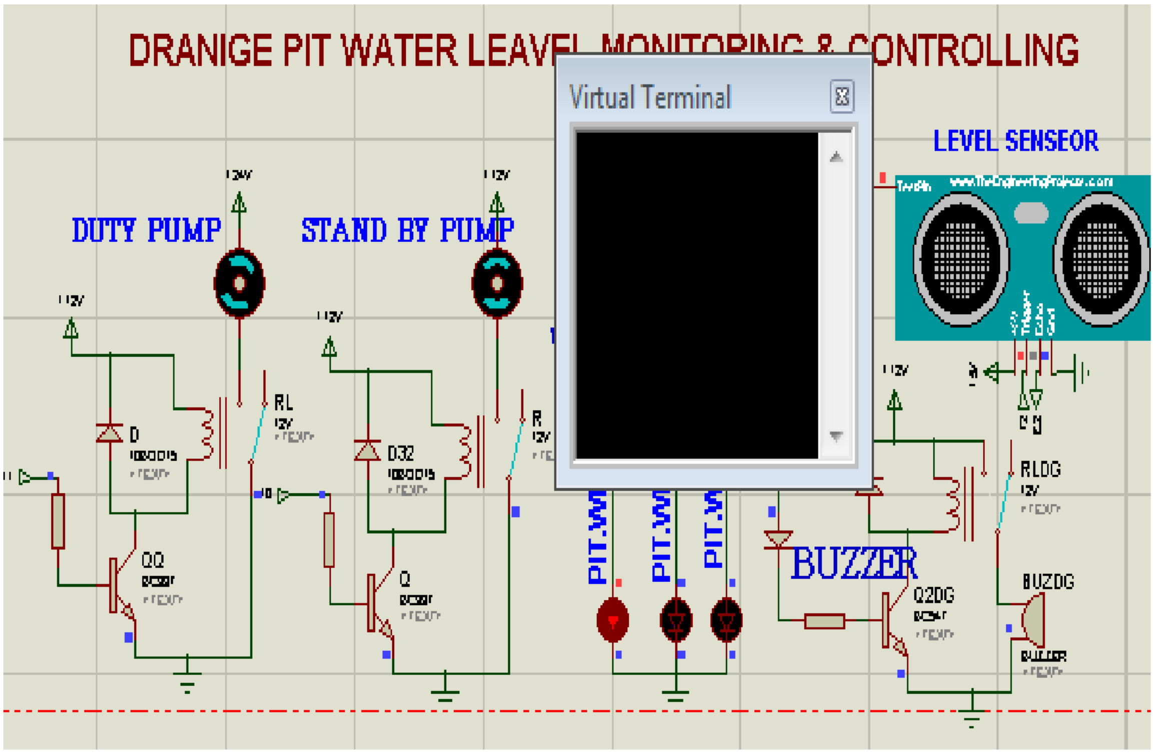


Figure 4. 3. First condition DPW level mentoring simulation result

This condition is a low pit water level and normal operational condition Simulation result obtained (figure 4.16) Indicates that the drainage pit water low level (SMS message) was sent to the virtual terminal just for awareness creation for the responsible person. In addition, indication led one red ON, led two yellow OFF, led three OFF, buzzer status is OFF and both pumps are OFF

Second condition (the DPW level in b/n 30% and 70%)

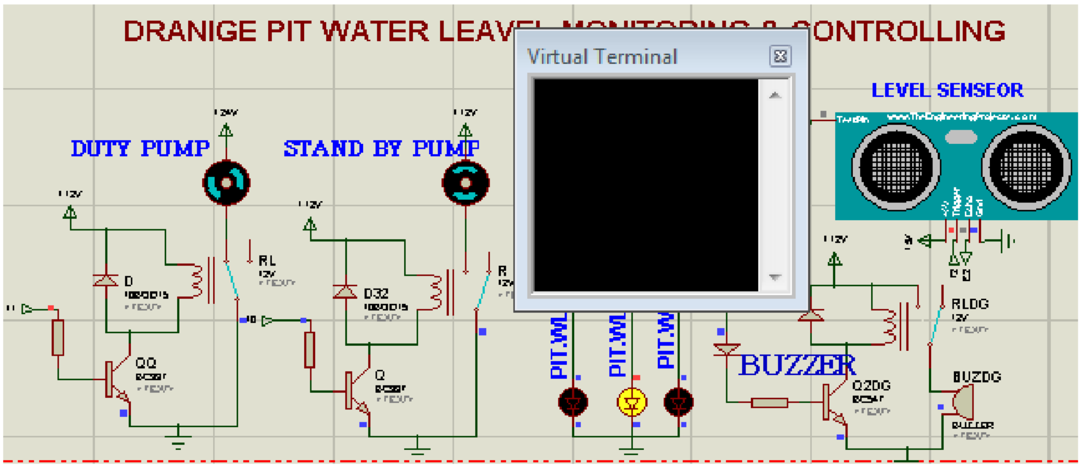


Figure 4. 4. Second condition DPW level mentoring simulation result

This condition is normal water level on the derange pit and the Simulation result obtained (figure 4.17) Indicates that the drainage pit water low level (SMS message) was not sent to the virtual terminal. In addition, indication led one red OFF, led two yellow ON, led three OFF, buzzer status is OFF, Duty pumps are ON and stand by the pump is OFF.

Third condition (the DPW level more than 70%)

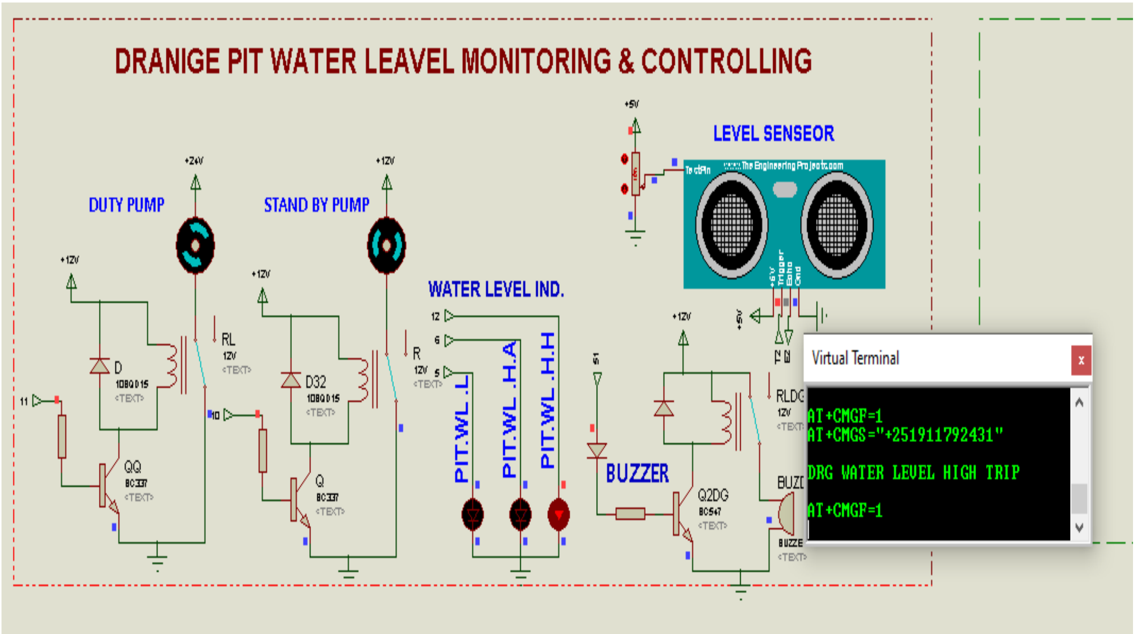


Figure 4. 5. Third condition DPW level mentoring simulation result.

This condition is the critical condition on Koka hepp because the DPW level rises usually as the result may go-to power plant flooded and damages of the device, thus to prevent this strong mentoring system is mandatory and Simulation result obtained (figure 4.18) Indicates that the drainage pit water low level (SMS message) sent to the virtual terminal. In addition, to this indication led one red ON, led two yellow OFF, led three OFF, buzzer status is ON and both pumps are ON

4.1.9. Koka hepp derange pit water (DPW) level mentoring system simulation result summery

The all conditions simulation results and status of each monitoring parameters according to koka hepp DPW prescribed limit are illustrates in the following table.

Table 5. DPW level mentoring system simulation result summery

Mentoring Parameters & status	DPW level. In % >30% & <70%	DPW level. In % >70%	DPW sump level. In % <30%
On LCD	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %	TGB sump oil level. val. Displayed in %
On virtual terminal SMS message	No SMS	TGB sump level high alarm (SMS)	TGB sump level too low alarm (SMS))
Buzzer (ON/OFF)	OFF	ON	ON
Pump1 on duty	ON	ON	OFF
Pump 2	OF	ON	OFF
Alarm indication led n0.1 (ON/OFF)	OFF	ON	ON
Too high alarm indication led no. 2 (ON/OFF)	OFF	OFF	ON
Trip indication led no. 3 (ON/OFF)	OFF	OFF	ON

4.2. Discussion of the result

In present days, they are facing major problems in equipment failure in power plants; it is because they have no proper idea about mentoring and controlling. Thus, the “Adriano based hydropower plant monitoring system using GSM modem had been designed and simulated successfully. Integrated features of all the hardware components used had developed it. The presence of every parameter futurity had reasoned out and placed carefully, thus contributing to the best monitoring of the unit. The system had simulated to function automatically. The temperature sensor measures the turbine guide bearing temperature and generator winding temperature value, if the value is found above the desired value the sensors send to Adriano sends to authorized person and relay, and also the level sensors measure the derange pit water level and oil level of the generator and turbine. If the water level of deranging pit and oil level is found to be below the desired level, the level sensor sends the signal to the Arduino board, which triggers the output to the authorized person through the virtual terminal and the temperature sensor measures the temperature of the generator. If the temperature generator bearing and turbine bearing are found to be above the desired value, the temperature sensor sends the signal to the Arduino board, which triggers a message to the authorized person and Relay to turn ON the fan motor and cools the bearings. When the desired drainage water level reaches, the pump is turned ON, for dewatering, the system halts on its own failure and the temperature sensor less than the desired value the fun motor turned OFF. Thus, the functionality of the entire system had been simulates thoroughly and it is said to function successfully.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The feeling delineate of this system is huge in the ever changing power plants technological world. It allows a greater degree of freedom to an individual to sway via GSM. In particular the suggested system had a powerful, flexible and secure tool that will offer this service at any time, and from anywhere with the constraints of the technologies being applied. The embedded controllers are capable of sensing and monitoring the various parameter of power plant in normal and abnormal condition. This proposed system provides the immediate solution for terrible failure of power plants using GSM communication and can provide a convenient method for effective monitoring of temperature and oil level in real time. The embedded controller offers a wide scope of application in the field of remote digital controllers in power plants, compact to some extent, and cost effective.

5.2 Recommendation

Any work and investigation on power plant protection is very advantageous and challenging based on the present time, it can be observes that the number of power plants is increasing rapidly which means the need of a reliable managing is also increasing. Therefore, demands on electricity will be high and these will lead to demands of highly sophisticated protection devices, which will be incorporates in power plant protection schemes. Based on the work done in this thesis, which protecting power plants using Arduino kit, some improvements need to be make in the future work such as

- **SMS Gateway:** Quickly let key people know about any alarm by sending a text message to any cell phone. The server software SMS Alarm Notification Module enables both alarm notification and acknowledgment via text messages. You can enable phone-call alerts by adding the Voice Notification Module to your Ignition system.
- **SMTP Server**: While the alarm notification system allows you to set up an Email Notification Profile that is separate from the SMTP Profile, you can instead choose to use the settings configured in the SMTP Profile.

- **VOIP gateway:** Ensure no serious issue is over looked by speeding alarm notification delivery to the right people as soon as possible. The server software Voice Notification Module uses state-of-the-art text-to-speech technology to add phone-call notification to your alarming / alerting process. Add text alerts with the SMS Notification Module for even more options.

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Parameters setting reference from koka hepp manufacturer data

Seting List for Temperature Warning

	UNIT 1 Measurement [°C]	UNIT 1 Setings [°C]	UNIT 2 Measurement [°C]	UNIT 2 Setings [°C]
TGB Pad1 High	0.00	65.00	29.50	65.00
TGB Pad1 Too High		85.00		85.00
LGB Pad1 High	0.00	73.00	64.50	73.00
LGB Pad1 Too High		85.00		85.00
TB Pad1 High	0.00	67.00	53.00	67.00
TB Pad1 Too High		85.00		85.00
UGB Pad1 High	0.00	65.00	48.50	65.00
UGB Pad1 Too High		85.00		85.00
Cold Air 1 Temp. High	0.00	50.00	27.50	50.00
Cold Air 1 Temp. Too High		60.00		60.00
Cold Air 2 Temp. High	0.00	50.00	28.50	50.00
Cold Air 2 Temp. Too High		60.00		60.00
Hot Air 1 Temp. High	0.00	60.00	35.50	60.00
Hot Air 1 Temp. Too High		70.00		70.00
Hot Air 2 Temp. High	0.00	60.00	34.00	60.00
Hot Air 2 Temp. Too High		70.00		70.00

Ardiuno code

- #include <EEPROM.h>
- #include <Wire.h> // to comm. with I2c 6input to 2 output on lcd
- #include <LiquidCrystal_I2C.h>
- #include <SoftwareSerial.h>
- SoftwareSerial SIM900(7, 8); // GSM module
- #define trigpin A8
- #define echopin A9
- int led11 = 27; // GEB.TGB LOW OIL LEVEL TRIP INDICATION
- int led12 = 28; // GEN TGB NORMAL OIL IND
- int led13 = 29; // GEN TGB HIGH OIL LEVEL TRIP INDICATION
- #define trigpin1 A10 // ULTERASONIC FOR TGB OIL LEVEL INDICATION
- #define echopin1 A11
- int led14 = 32; // TGB LOW OIL LEVEL TRIP INDICATION

- int led15 = 33; // TGB NORMAL OIL INDICATION
- int led16 = 34; // TGB HIGH OIL LEVEL TRIP INDICATION
- #define trigpin2 9
- #define echopin2 8
- int led1 = 5; //DRENGE PIT WATER LEVEL LOW INDICATION
- int led2 = 6; //DRENGE PIT WATER LEVEL NORMAL INDICATION
- int led3 = 12; //DRENGE PIT WATER LEVEL HIGH INDICATION
- int PUMP = 11; //DRENGE PIT PUMP DUTY
- int PUMP1 = 10; //DRENGE PIT PUMP STANDBY
- int TRIPT = 35; // GEN T.TRIP INDICATION
- int BUZ = 38; // Buzzer
- int BUZ1 = 39; // Buzzer
- long duration, inches;
- int set_val,percentage;
- bool state,pump; long duration1, inches1;
- int set_val1,percentage1;
- bool state1,pump1;
- long duration2, inches2;
- int set_val2,percentage2;
- bool state2,pump2;
- long duration3, inches3;
- int set_val3,percentage3;
- bool state3,pump3;
- int GREEN = A3;// GEN.TGB TEMERATURE ALARM INDICATION
- int YELLOW =3;//
- int RED =2; // TGB TEMERATURE ALARM INDICATION
- int TRIP = 22;// GEN.TGB TEMERATURE HIGH ALARM INDICATION
- int TRIP1 = 23;//
- int TRIP2 = 24;// TGB TEMERATURE HIGH ALARM INDICATION
- int FAN1 = 25;// GEN fan 1
- int FAN2 = 26;// GEN fan 2int led4 = 10;
- int led5 = 13;
- //int led4 = 10; // DREINGE STAND PUMP
- //int led5 = 13; int GCB = 30; //GEN GCB TRIP

- int GCB1 = 36;//TGB GCB TRIP
- int TGB1 = 37;//TGB TRIP
- int genbuz = 53;//GEN BER.OIL LEVEL BAZ
- int tgbbuz = 52;//TGB OIL LEVEL BUZZER
- int drgbuz = 51;//drange pit water LEVEL BUZZER
- //int led15 = 31;
- int ThermistorPin = A0; //GEN THERMISTOR TEMP. INPUT // NTC_PIN, Analog pin
- int ThermistorPin1= A1; // TGB THERMISTOR TEMP. INPUT // NTC_PIN, Analog pin
- int ThermistorPin2= A2; // EXT THERMISTOR TEMP. INPUT // NTC_PIN, Analog pin
- int Tcom=40;
- int Vo;
- int V1;
- int V2;
- float R1=10000; // Value of the series resistor
- float R3=10000; // Value of the series resistor
- float R5=10000; // Value of the series resistor
- float logR2, R2, T; // GEN TEMPERATURE
- float logR4, R4, TO; // TGB TEMPERATURE
- float logR6, R6, TC;
- float A = 1.484778004e-03, B = 2.348962910e-04, C = 1.006037158e-07; // Steinhart-Hart and Hart Coefficients
- int buttonState = 0; // variable for reading the pushbutton status
- LiquidCrystal_I2C lcd(0x27,20,4); // set the LCD address to 0x27 for a 20 chars and 4 line display void setup()
- {
- Serial.begin(9600); // SERAL INTALIALIAZED
- lcd.begin(20, 4); // LCD INTIALIZED
- pinMode(8, OUTPUT); // DRANGE PIT WATER LEVEL ECHO OUTPUT PIN
- pinMode(9, INPUT); // DRANGE PIT WATER LEVEL TRIG INPUT PIN
- pinMode(10, INPUT_PULLUP); // DRA. PIT STAND BY PUMP OUTPUT PIN
- pinMode(11, INPUT_PULLUP); // DRANGE PIT DUTY PUMP OUTPUT PIN
- pinMode(12, OUTPUT); // DRANGE PIT WATER LEVEL HIHG HIGH INDICATION
- pinMode(led11, OUTPUT);
- pinMode(led12, OUTPUT);

- pinMode(led13, OUTPUT);
- pinMode(BUZ, OUTPUT);
- pinMode(BUZ1, OUTPUT);
- pinMode(GCB, OUTPUT);
- pinMode(GCB1, OUTPUT);
- pinMode(TGB1, OUTPUT);
- pinMode(led14, OUTPUT);
- pinMode(led15, OUTPUT);
- pinMode(led16, OUTPUT);
- pinMode(led1, OUTPUT);
- pinMode(led2, OUTPUT);
- pinMode(led3, OUTPUT);
- pinMode(PUMP1, OUTPUT);
- pinMode(PUMP, OUTPUT);
- digitalWrite(led11, LOW);
- digitalWrite(led12, LOW);
- digitalWrite(led13, LOW);
- digitalWrite(GCB, LOW); //GEN.TEMP
- digitalWrite(GCB1, LOW); //TGB.TEMP
- digitalWrite(TGB1, LOW); //TGB.TEMP
- digitalWrite(led14, LOW);
- digitalWrite(led15, LOW);
- digitalWrite(led16, LOW);
- digitalWrite(led1, LOW);
- digitalWrite(led2, LOW);
- digitalWrite(led3, LOW);
- pinMode(GREEN,OUTPUT);
- pinMode(YELLOW,OUTPUT);
- pinMode(RED, OUTPUT);
- pinMode(TRIP,OUTPUT);
- pinMode(TRIP1,OUTPUT);
- pinMode(TRIP2,OUTPUT);
- pinMode(FAN1,OUTPUT);
- pinMode(FAN2,OUTPUT);

- pinMode(TRIPT, OUTPUT);
- pinMode(genbuz, OUTPUT)
- pinMode(tgbbuz, OUTPUT);
- pinMode(drgbuz , OUTPUT);
- digitalWrite(TRIPT, LOW);
- digitalWrite(led4, LOW);
- digitalWrite(led5, LOW);
- digitalWrite(BUZ, LOW); //FOR GCB TEMP
- digitalWrite(BUZ1, LOW); //FOR TGB TEMP
- digitalWrite(genbuz, LOW); //FOR TGB oil buz
- digitalWrite(tgbbuz, LOW);
- // pinMode(drgbuz , LOW);
- // GEN.TGB OIL LEVEL
- set_val=EEPROM.read(0);
- if(set_val>1000)set_val=1000;
- // TGB OIL LEVEL
- set_val1=EEPROM.read(0);
- if(set_val1>1000)set_val1=1000;
- // DRANGE PIT WATER LEVEL
- set_val2=EEPROM.read(0);
- if(set_val2>1000)set_val2=1000;
- }
- void loop()
- {
- lcd.setCursor(0, 0); // LCD FIREST COLOMON DESPLAY
- lcd.print("GEN.T:");
- lcd.setCursor(11, 0);
- lcd.print((char)223); // LCD desplay degree
- lcd.setCursor(12, 0); //(13, 0)
- lcd.print("C");
- lcd.setCursor(0, 1); // LCD SECOND COLOMON DESPLAY
- lcd.print("TGB.T:");
- lcd.setCursor(11, 1);//(12, 1)
- lcd.print((char)223); // LCD desplay degree

- lcd.setCursor(12, 1);
- lcd.print("C"); lcd.setCursor(0, 2); // LCD THIRED COLOMON DESPLAY
- lcd.print("TGB.OL:");
- lcd.setCursor(0, 3); // LCD FOURTH COLOMON DESPLAY
- lcd.print("GGB.OL:");
- lcd.setCursor(13, 2);
- lcd.print("F1=");
- lcd.setCursor(13, 3);
- lcd.print("F2=");
- lcd.setCursor(15, 0);
- lcd.print("P1:");
- lcd.setCursor(15, 1);
- lcd.print("P2:");
- SIM900.print("AT+CMGF=1\r"); //Sets the GSM Module in Text Mode
- delay(10);
- SIM900.print("AT+CMGS=\"+251911792431\"\r"); //Sets the GSM Module and sent sms to the number
- delay(10);
- Vo = analogRead(ThermistorPin); // read ADC value of thermister
- R2 = R1* (1023.0 / (float)Vo - 1.0);
- logR2 = log(R2);
- T = (1.0 / (A + B*logR2 + C*logR2*logR2*logR2)); // Steinhart and Hart Equation. T = 1 / {A + B[ln(R)] + C[ln(R)]^3}
- T = T - 273.15; // lcd first // Convert Kelvin to Celcius V1 = analogRead(ThermistorPin1);
- R4 = R3* (1023.0 / (float)V1 - 1.0);
- logR4 = log(R4);
- TO = (1.0 / (A + B*logR4 + C*logR4*logR4*logR4)); // Steinhart and Hart Equation. T = 1 / {A + B[ln(R)] + C[ln(R)]^3}
- TO = TO - 273.15; // lcd middel
- /* V2 = analogRead(ThermistorPin2);
- R6 = R5* (1023.0 / (float)V2 - 1.0);
- logR6 = log(R6);
- TC = (1.0 / (A + B*logR6 + C*logR6*logR6*logR6)); // Steinhart and Hart Equation. T = 1 / {A + B[ln(R)] + C[ln(R)]^3}

- TC = TC - 273.15; // last *
- if ((T <= 65)) // buzzze off
- {
- digitalWrite(BUZ,LOW); // FAN START
- digitalWrite(GREEN,LOW);
- digitalWrite(FAN1,LOW);
- digitalWrite(FAN2,LOW);
- lcd.setCursor(17 ,2); // fan 1 off
- lcd.print("OFF!");
- lcd.setCursor(17 ,3); // fan 2 off
- lcd.print("OFF!");
- if ((T < 80)) // GCB CLOSED
- {
- digitalWrite(GCB, HIGH);//GCB
- }
- }
- if ((T > 65 && T <= 75)) // alarm
- {
- digitalWrite(GREEN,HIGH); // alarm led on
- digitalWrite(FAN1,HIGH); // FAN START
- digitalWrite(BUZ,HIGH); // bazz on
- lcd.setCursor(17 ,2);// fan 1 on
- lcd.print("ON !");
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("SYN.GEN.TEMP >65'C ALARM");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- if ((T > 75 && T <= 80)) // TRIP
- {
- digitalWrite(GREEN,HIGH); // alarm led on
- digitalWrite(TRIP,HIGH); // alarm led on

- digitalWrite(FAN1,HIGH); // FAN1 START
- digitalWrite(FAN2,HIGH); // FAN2 START
- digitalWrite(BUZ,HIGH);
- digitalWrite(TRIPT,LOW); // alarm led on
- lcd.setCursor(17 ,2); // fan 1 off
- lcd.print("ON !");
- lcd.setCursor(17 ,3); // fan 1 off
- lcd.print("ON !");
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("SYN.GEN.TEMP >75'C HIGH ALARM");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- else
- {
- digitalWrite(TRIP,LOW);
- }
- if ((T >= 80)) // TRIP GCB
- {
- digitalWrite(GREEN,HIGH); // alarm led on
- digitalWrite(TRIPT,HIGH); // alarm led on
- digitalWrite(TRIP,HIGH); // alarm led on
- digitalWrite(FAN1,HIGH); // FAN1 START
- digitalWrite(FAN2,HIGH); // FAN2 START
- digitalWrite(BUZ,HIGH);
- digitalWrite(GCB,LOW);
- lcd.setCursor(17 ,2); // fan 1 off
- lcd.print("ON !");
- lcd.setCursor(17 ,3); // fan 1 off
- lcd.print("ON !");
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode

- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("SYN.GEN.TEMP >80'C TRIP");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- else
- {
- digitalWrite(TRIPT,LOW);
- }
- if ((TO <= 65)) // buzzze off
- {
- digitalWrite(BUZ1,LOW); // FAN START
- }
- if ((TO < 80)) // GCB CLOSED
- {
- digitalWrite(GCB1, HIGH);//GCB
- digitalWrite(TGB1, LOW);
- }
- if ((TO > 65 && TO <= 75)) // alarm // if ((T >= 10) && (T <= 50))//if(val==HIGH && valu==HIGH && T<=15)//else if
- {
- digitalWrite(RED,HIGH);
- digitalWrite(TRIP2,HIGH);
- digitalWrite(TGB1,LOW); // alarm led on
- // digitalWrite(TRIP2,LOW); // alarm led on
- digitalWrite(BUZ1,HIGH);
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("TGB.TEMP >65'C ALARM");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }

- else
- {
- digitalWrite(RED,LOW);
- }
- if ((TO > 75 && TO <= 80)) // TRIP
- {
- digitalWrite(RED,HIGH);
- digitalWrite(TRIP2,HIGH); // alarm led on
- digitalWrite(TGB1,LOW); // alarm led on
- digitalWrite(BUZ1,HIGH);
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("TGB.TEMP >75'C HIGH ALARM");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- if ((TO >= 80)) // TRIP GCB
- {
- digitalWrite(RED,HIGH);
- digitalWrite(GCB1,LOW); // alarm led on
- digitalWrite(TGB1, HIGH);
- digitalWrite(BUZ1,HIGH);
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("TGB.TEMP >80'C GCB TRIP");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- // digitalWrite(echopin, LOW);
- // delayMicroseconds(2);
- digitalWrite(trigpin, HIGH);
- delayMicroseconds(10);

- digitalWrite(trigpin, LOW);
- duration = pulseIn(echopin, HIGH);
- inches = microsecondsToInches(duration);
- percentage=(set_val-inches)*100/set_val;
- lcd.setCursor(7, 3);
- if(percentage<0)percentage=0;
- lcd.print(percentage);
- lcd.print("% ");
- if(percentage>0 & percentage<30)//GEN.OIL LEVEL LOW TRIP
- {digitalWrite(led11, HIGH);
- digitalWrite(genbuz, HIGH);
- Serial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
- delay(300); // Delay of 1 second
- Serial.println("AT+CMGS=\"+251911792431\"\r"); // sent to mobile number
- Serial.println("GEB.GB OIL LEVEL LOW TRIP");// The SMS text you want to send
- Serial.println((char)26);// ASCII code of CTRL+Z for saying the end of sms to the module
- delay(100);
- }
- else
- {
- digitalWrite(led11, LOW);
- digitalWrite(genbuz, LOW);
- }
- if(percentage>=30 & percentage<70)// GEN.OIL LEVEL NORMAL
- {
- digitalWrite(led12, HIGH);
- }
- else
- {
- digitalWrite(led12, LOW);
- }
- if(percentage>=70 & percentage<100)// GEN.OIL LEVEL HIGH TRIP
- {
- digitalWrite(led13

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