SUBSTATION MONITORING AND CONTROL

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Abstract – As the complexity of distribution network has grown automation of substation become a need of every utility company to increase its efficiency and to improve the 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 to the microcontroller and make them display on the LCD display along with temperature at power station. It is also designed to protect the electrical circuitry by operating an electromagnetic relay. This relay gets activated whenever the electrical parameters exceed the predefined values. The Relay can be used to operate a circuit breaker to switch off the main electrical supply. And also it is designed to send alerts whenever the circuit breaker trips or whenever the voltage or current exceeds the predefined limits. When we give supply to the system all the sensors start sensing the current, voltage, frequency and temperature and update all the real time values to the microcontrollers well as shows on the display. It compares an all the real time values with the pre-defined 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 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

***Key Words*:** microcontroller, electromagnetic relay,

1.1 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.

1.2 BRIEF OVERVIEW OF THE PROJECT

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. 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.

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1.3 NECESSITY OF THE PROJECT

As complexity of distribution network has grown, automation of substation has become need of every utility company to increase its efficiency and to 1mprove quality of power being delivered. Today electricity still suffers from power outages and blackouts due to the lack of analysis and poor visibility of the utility over the grid. WSN will give the utility provide automated he needed view by collecting information from the different sub-systems of the grid. A sensor lode will decide information or to slightly delay this notification (whether to immediately notify he 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. Therefore, it necessary a monitoring system that is able to automatically detect, monitor, and classify the existing constraints on electrical lines.

1.4 SALIENT OBJECTIVES OF THE PROJECT

4.2.1 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.

4.2.2 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.

4.2.3 Remote sensing of observant parameters

Although this project is meant for all the substation equipment 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.

4.2.4 To maintain continuity of supply

By keeping track on the real time parameters, we want to maintain the continuity of the supply

4.2.5 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.

1.5 BENEFITS OF THE PROJECT

- 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 most 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 overcame 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 to the control room to physically check the data.

- Periodical collection of data

Now a day 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 an external memory periodically

- 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 that is, 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.

- Personalised alert over fault

By incorporating this project, we can get personalised alerts over any sort of discrepancies i.e., whenever the electrical parameters exceeds the predefined values. We have incorporated relays which acts the over electrical 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 collecting data, this reduction of, manual force reduces the labour cost to some extent. It reduces the maintenance cost. That means overall labour cost is reduced.

2. HARDWARE AND SOFTWARE REQUIREMENTS

The Implementation of the project design can be divided into two sections; Hardware and software implementations. The hardware implementation consists of the development of main controller, sensor networks and the smart parking while the software implementation focuses on the programming of the Node microcontroller using Arduino IDE.

2.1 HARDWARE REQUIREMENTS

- Aurduino Uno
- ZMPT101B Voltage Sensor
- ACS712 Current Sensor
- DHT11 Temperature Sensor
- 16x2 LCD Display
- Resistors
- Electromagnetic Relay

2.1.1 ARDUINO UNO

The Arduino Uno open-source microcontroller based the microchip ATmega328F microcontroller and developed by Arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits." The board has 14 digital I/O pins (six capable of PWM output) 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type

B USB cable. It can be powered by the USB cable or byan external 9-volt battery, though it accepts voltages between 7and 20 volts. It is similar to the Arduino Nano and Leonard.

Fig 2.1.1.1 Arduino Uno Board

The hardware reference design is distributed under a creative commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. The word "uno" means "one" in Italian and was chosen to mark the initial release of software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases.[4] The ATmega328 on the board comes pre-programmed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

TECHNICAL SPECIFICATIONS:

- Microcontroller: microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)
- UART: 1
- 12C: 1
- SPI: 1
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25g
- ICSP Header: Yes

DIAGRAM OF ARDUINO UNO:

The Arduino Uno consists of many pins. Each pin has its own functionality. The functionality of 1 these pins will dicuss below in detailed manner.

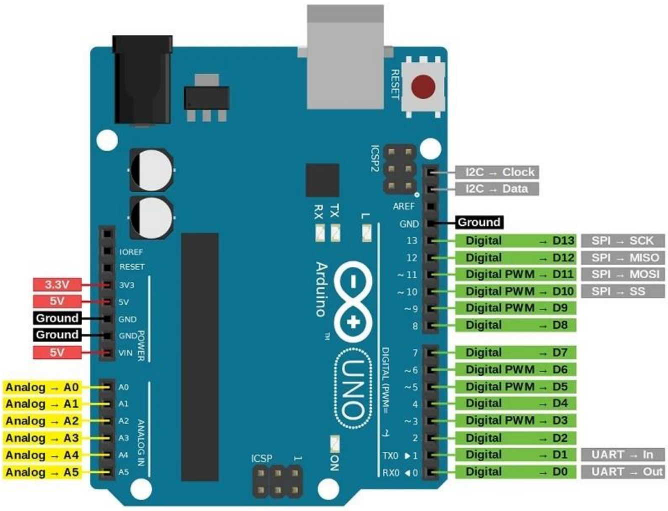

Fig 2.1.1.2 Arduino Uno Pinout

HEADERS:

General Pin Functions:

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- VIN: The input voltage to the Arduino/Genuino board when it is using an external powersource (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7-20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50mA.
- GND: Ground pins.
- IOREF: This pin of Arduino/Genuino board provides the voltage reference with which appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields that block the one on the board.

2.1.2 VOLTAGE SENSOR:

ZMPT101B voltage sensor module is a voltage sensor made from the ZMPT101B transformer. It has high accuracy, good consistency for voltage and power measurement and it can me up to 250V AC. It is simple to use and comes with a multi turn trim potentiometer for adjusting the output. The analysis in this paper tends to find more accurate relationship between the input voltage the ADC output by regression analysis. The ADC output is adjusted using the trimpot to an appro value against a reference input.

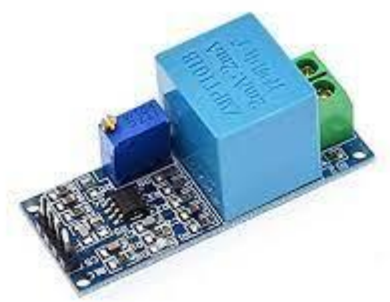

Fig 2.1.2 ZMPT101B Voltage Sensor

Features of ZMPT101B Module:

- within 250 V AC voltage can be measured.
- onboard micro-precision voltage transformer
- Installation: PCB mounting (Pin Length> 3mm)
- Operating temperature: 40°C~+70°C

Advantages:

- Analog output corresponding quantity can be adjusted**.**
- PCB board size: 49.5 (mm) x19.4 (mm)
- Good consistency, for voltage and power measurement.
- Very efficient and accuracy.

Applications:

- Metering (electrical energy meters)
- AC Voltage measurement
- Sensing Overload Current
- Ground fault detection
- Household electrical equipment
- Industrial apparatuses

2.1.3 CURRENT SENSOR: The ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and over current fault protection. The ACS712 Module uses the famous ACS712 IC to measure current using the Hall Effect principle. The ACS712 module has two phoenix terminal connectors with mounting screws. These are the terminals through which the wire has to be passed. On the other side we have three pins. The Vcc is connected to +5V to power the module the ground is connected to the ground of the µC. Then the analog voltage given out by the ACS712 module is read using any analog pin on the µC. These are the terminals through which the wire has to be passed. On the other side we have three pins. The Vec is connected to +5V to power the module. Module uses the famous ACS712 IC to measure current using the Hall Effect principle. The ACS712 module has two phoenix terminal connectors with mounting screws. These are the terminals through which the wire has to be passed.

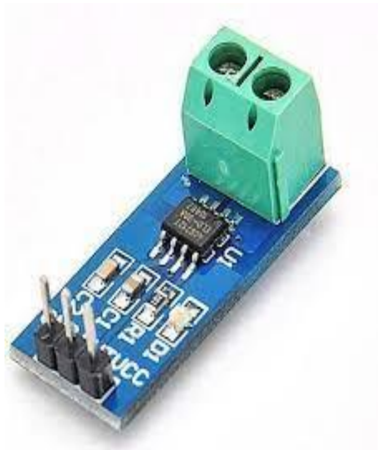

Fig 2.1.3.1 current sensor

Pin Diagram of ACS712:
Table 2.1.3 Pin Diagram specifications of ACS712

Specifications:

- Measures both AC and DC current
- Available as 5A, 20A and 30A module
- Provides isolation from the load
- Easy to integrate with MCU, since it outputs analog voltage

Working Principle:

- Current Sensor detects the current in a wire or conductor and generates a signal proportional to the detected current either in the form of analog voltage or digital output.
- current-carrying conductor also gives rise to a magnetic field in its surrounding. In Indirect Sensing, the current is measured by calculating this magnetic field by applying either Faraday's law or Ampere law. Here either a Transformer or Hall effect sensor or fiberoptic current sensor are used to sense the magnetic field.
- ACS712 Current Sensor uses Indirect Sensing method to calculate the current. To sense current a liner, low-offset Hall sensor circuit is used in this IC.
- The proximity of the magnetic signal to the Hall sensor decides the accuracy of the device.

The features of ACS712 include:

- 80kHz bandwith
- 66 to 185 mV/A output sensitivity
- Low-noise analog signal path
- Device bandwith is set via the new FILTER pin
- Total output error of 1.5% at TA = 25°C
- Stable output offset voltage.
- Near zero magnetic hysteresis

ACS712 Current Sensor Applications

- Motor speed control in motor control circuits
- Electrical load detection and management
- Switched-mode power supplies (SMPS)
- Protection for over-current
- Stable output offset voltage.

2.1.4 TEMPERATURE SENSOR

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc... Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

What is a DHT11 Sensor?

- DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc... to measure humidity and temperature instantaneously.
- DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

Working Principle of DHT11 Sensor:

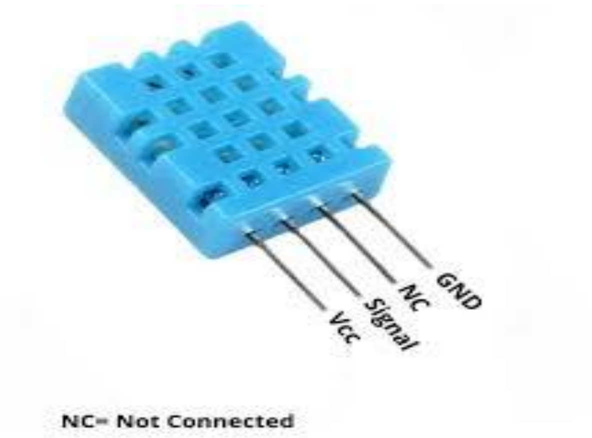

Fig 2.1.4 DHT11 Temperature Sensor

- DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

- For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

- The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

Applications:

This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity.

2.1.5 16X2 LCD DISPLAY

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mos display module used computers, TV sets, etc. These displays are mainly preferred for multisegment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc

Fig 2.1.5.1 LCD Display

LCD 16×2 PIN DIAGRAM:

• Pin l (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.

• Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.

• Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.

• Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).

• Pin5 - Read/Write/Control Pin

• Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.

Fig 2.1.5.2 Pin diagram of LCD

• Pin15 (+ve pin of the LED): This pin is connected to +5V

• Pin 16 (-ve pin of the LED): This pin is connected to GND.

FEATURES OF LCD16x2:

• The operating voltage of this LCD is 4.7V-5.3V

• It includes two rows where each row can produce 16-characters.

• The utilization of current is 1mA with no backlight • Every character can be built with a 5×8pixel box

• The alphanumeric LCDs alphabets & numbers

• Is display can work on two modes like 4-bit & 8-bit

• These are obtainable in Blue & Green Backlight • It displays a few custom generated characters

• Is display can work on two modes like 4-bit & 8-bit

• These are obtainable in Blue & Green Backlight

LCD I2C MODULE:

Adapter Module is used for 16×2 LCD Display. It uses the PCF8574T IC chip which converts I2C serial data to parallel data for the LCD display. Also, this interface module simplifies connecting an Arduino to a 16×2 Liquid Crystal display using only 4 wires.

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2.1.6 RESISTORS:

Fig: 2.1.6 Resistors

The main purpose of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. It is made of copper wires which is coiled around a ceramic rod and the outer part of the resistor is coated with an insulating paint.

2.1.7 ELECTROMAGNETIC RELAY

A relay is basically a switch which is operated by an electromagnet. The electromagnet requires a small voltage to get activated which we will give from the Arduino and once it is activated, it will pull the contact to make the high voltage circuit. The relay module we are going to use is the SRD-05VDC-SL-C. It runs on 5V and we can control it with any micro-controller but we are going to use Arduino. Typically, the relay has 5 pins, three of them are high voltage terminals (NC, COM, and NO) that connect to the device we want to control. The mains electricity enters the relay at the common (COM) terminal. While use of NC & NO terminals depends upon whether you want to turn the device ON or OFF. Between the remaining two pins (coil 1 and coil2), there is a coil that acts like an electromagnet. When current flows through the coil, the electromagnet becomes charged and moves the internal contacts of the switch.

Fig 2.1.7 Electromagnetic Relay

At that time the normally open (NO) terminal connects to the common (COM), and the normally closed (NC) terminal becomes disconnected. When current stops flowing through the coil, the internal contact returns to its initial state i.e. the normally closed (NC) terminal connects to the common (COM), and the normally open (NO) terminal reopens. This is known as a single pole, double throw switch (SPDT). In this prototype demonstration we are going to use two channel relay modules. However, there are other modules with one, four and eight channels. This module is designed for switching two high powered devices from your Arduino. It has two relays rated up to 10A per channel at 250VAC or 30VDC. There are two LEDs on the relay module indicating the position of the relay. Whenever a relay is activated, the respective LED will light up. One of the best things about these modules is that they come with two Optocoupler ICs which provide good isolation between relay and Arduino.

Two Channel Relay Module Pinout

- **Control Pins**:

  Vcc pin supplies power to the built-in optocoupler and optionally to the electromagnet of the relay (if you keep the jumper in place). GND is the common Ground connection. IN_1 & IN2 pins are used to control the relay. These are active low pins, meaning the relay will be activated when you pull the pin LOW and it will become inactive when you pull the pin HIGH.

- **Power Supply Selection Pins**:

  JD-Vcc supplies power to the electromagnet of the relay. When the jumper is in place, it takes power from the Arduino's 5V line. Without the jumper cap, you have to connect it to an independent power source. Vcc with the jumper cap on, this pin is shorted to the JD-VCC pin. If you remove the jumper, keep this pin unconnected. GND is the common Ground connection.

- **Output Terminals**:

  COM pin is connected to the signal you are planning to switch. NC pin is connected to the COM pin by default, unless you send a signal from the Arduino to the relay module to break the connection. No pin is open by default, unless you send a signal from the Arduino to the relay module to make the connection.

2.2 SOFTWARE REQUIREMENTS:

2.2.1 ARDUINO IDE:

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programsto an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus. The source code for the IDE is released under the GNU General Public License, version 2.

The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main () into an executable cyclic executive program with the GNU tool chain, also included with the IDE distribution. The Arduino IDE employs the program to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. A program written with the Arduino IDE is called a sketch. Sketches are saved on the development computer as text files with the file extension. ion. Arduino Software (IDE) pre-1.0 saved sketches with the extension. ide. A minimal Arduino C/C++ program consist of only two functions: setup (): This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch. Loop (): After setup () has been called, function loop () is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. Blink example Most Arduino boards contain a light-emitting diode (LED) and a load resistor connected between pin 13 and ground, which is a convenient feature for many tests and program functions. A typical program for a beginning Arduino programmer blinks a LED repeatedly. This program uses the functions pin Mode (), digital Write (), and delay (), which are provided by the internal libraries included in the IDE. The Arduino integrated development environment (IDE) is a cross-platform. A program written with the Arduino IDE is called a sketch. Sketches are saved on the development computer as text files with the file extension. ion. Loop (): After setup () has been called, function loop() is executed repeatedly in the main program. It controls the board until the board is powered off or is reset. Blink example most arduino boards contain a light-emitting diode (LED) and a load resistor connected between pin 13 and ground, which is a convenient feature for many tests and program functions. A typical program for a beginning digital Write(), and delay (), which are Arduino programmer blinks a LED provided by the internal libraries included in the IDE. This function is called once when a sketch starts after power-up orreset.

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3. IMPLEMENTATION AND RESULTS

3.1 FLOW CHART:

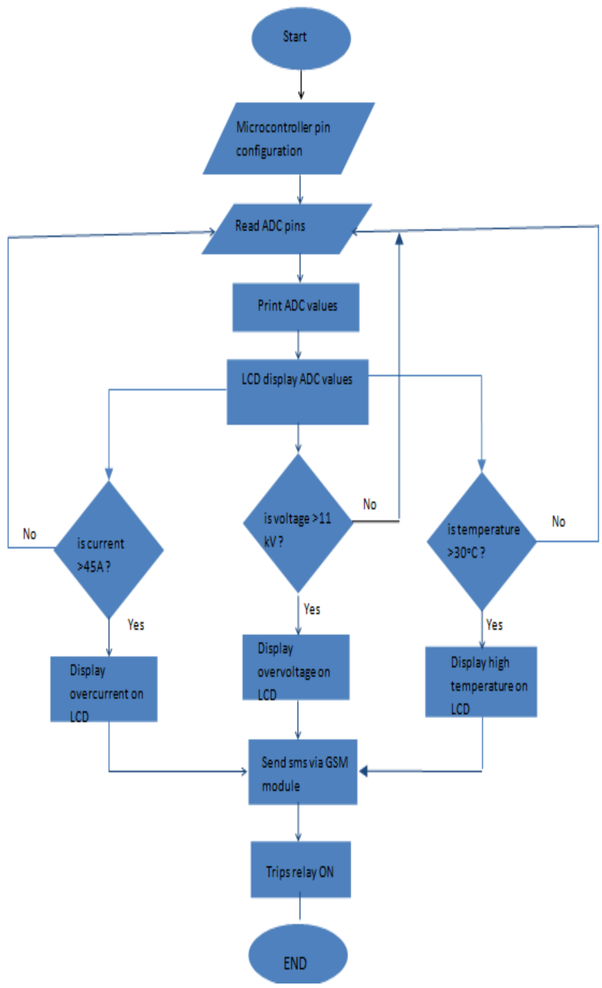

Fig 3.1 Flow chart of Substation monitoring and control system.

3.2 BLOCK DIAGRAM OF THE PROTOTYPE:

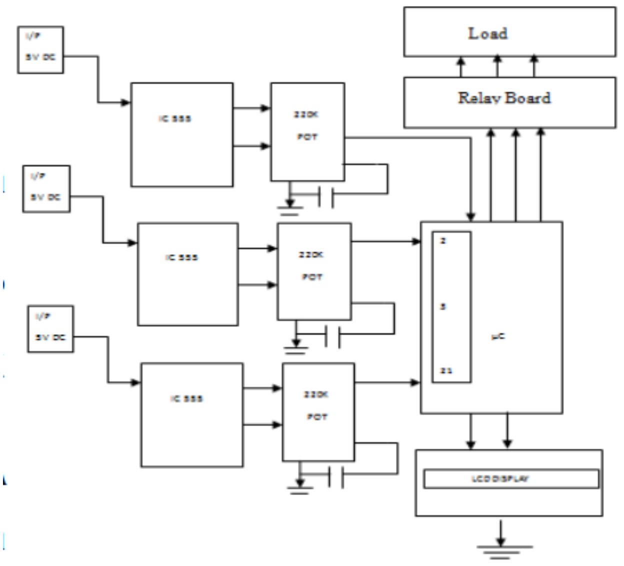

Fig 3.2 Block Diagram of substation monitoring and control system

3.2 SOURCE CODE:

```
#define SAMPLES 300    //Number of samples you want to take everytime you loop
#define ACS Pin A1 /ACS712 data pin analong input
float High_peak,Low_peak;    //Variables to measure or calculate
float Amps_Peak_Peak, Amps_RMS;
#include<LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);
#include<DHT.h>
DHT dht(4,DHT11);

void setup()
{
Serial.begin(9600);
pinMode(5,OUTPUT);
pinMode(ACS_Pin,INPUT);  //Define pin mode
}
Uint16 get_max()
{
Uint16 t max_v=0;
for(uint8_t i=0; i<100;i++)
{
unit16_t r=analogRead(A3);   //read from analog channel 3 (A3)
if(max_v< r) max_v=r;
delayMicroseconds(200);
}
return max_v;
}
void loop()
{
read_Amps();         //Launch the read_Amps function
Amps_RMS = Amps_Peak*0.3536*0.06;  // Now we have the peak to peak value normally the formula requires only multiplying times 0.3536 //
                                    //but since the values will be very big you should multiply by 0.06, you can first not use it,
                                    //do your calculations and compare them to real values measured by an Ammeter. eg: 0.06=Real value/Measured value

Serial.print(Amps_RMS);   //Here I show the RMS value and the peak to peak value, you can print what you want and add the "A" symbol...
Serial.print("\t");
Serial.println(Amps_Peak_Peak);
delay(400);
char buf[10];
// get amplitude (maximum - or peak value)
uint32_t v= get_max();
// get actual voltage (ADC voltage reference= 1.1V)
v=v* 1100/1023;
// calculate the RMS value (= peak/√2 )
v/= sqrt(2);
sprintf(buf, "%03u", v);
int vol =v*4;
Serial.println(v);
Serial.println(vol);
  lcd.clear();
      // set up the LCD's number of columns and rows
lcd.setCursor(0, 0);
lcd.print("V:"):
lcd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
Serial.print("vol:");
Serial.println(vol);
Serial.print("I:");
Serial.println(Amps_RMS);
Serial.print("temperature =");
int temp=dht.readTemperature0);
lcd.setCursor(0,1);
lcd.print("Temperature:");
Serial.println(dht.readTemperature();
lcd.setCursor(13,1);
lcd.print(temp);
lcd.setCursor(16,1);
lcd.print(" ");
delay(1000);
lcd.clear();

if(vol<-200 && temp<=40)
  {
lcd.setCursor(0, 0);
lcd.print("V:");
Icd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd.print(""Under Voltage ");
delay(500);
lcd.setCursor(2,1);
lcd.print("Normal Temp ");
```

```
delay(500);
digitalWrite(5,1);
  }
If(vol<=200 && temp>=40)
lcd.setCursor(0, 0);
lcd.print("V:");
lcd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
Icd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd.print("Under Voltage");,
delay(500);
lcd.setCursor(2,1);
lcd.print("Over Temp");
delay(500);
digitalWrite(5,l);
  }
if(vol>=300 && temp>=40)
  {
   lcd.setCursor(0, 0);
lcd.print("V:");
lcd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd.print("Over Voltage");
delay(500);
lcd.setCursor(2,1);
lcd.print("Over Temp    ");
delay(500);
digitalWrite(5,1);
{
if(vol>=300 && temp<=40)
 {
   lcd.setCursor(0, 0);
lcd.print("V:");
lcd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd.print("Over Voltage ");
delay(500);
lcd.setCursor(2,1);
lcd.print("Normal Temp ");
delay(500);
digitalWrite(5,1);
 }
if(vol>=200 && vol<=300 && temp<=40)
 {
lcd.setCursor(0, 0);
lcd.print("V:");
lcd.setCursor(4, 0);
lcd.print(vol);l1cd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd,print("Normal Voltage ");
delay(500);
lcd.setCursor(2,1);
lcd,print("Normal Temp ");
delay(500);
digialWrite(5,0);
 }
if(vol>=200 && vol<=300 && temp>=40)
 {
lcd.setCursor(0, 0);
lcd.print("V:");
lcd.setCursor(4, 0);
lcd.print(vol);
lcd.setCursor(9, 0);
lcd.print("I:");
lcd.setCursor(12, 0);
lcd.print(Amps_RMS);
lcd.setCursor(2,1);
lcd.print(" Over Temp  ");
delay(500);
digitalWrite(5,1);
  }
}
Void read_Amps()    //read_Amps function calculate the difference between the high peak and low peak
{                          //get peak to peak value
int cnt;                   //Counter
High_peak =  0    //We first assume that our high peak is equal to and low peak iS 1024, yes inverted
Low_peak = 1024;
for(cnt=0; cnt<SAMPLES; cnt++)      //everytime a sample (module value) is taken it will go
through test
{
float ACS_Value =analogRead(ACS_Pin);  //We read a single value from the module through test
if(ACS_Value > High_peak)      //If that value is higher than the high peak (at first is 0)
{
High_peak = ACS_Value;         //The high peak will change from 0 to that value found
}
   if(ACS_Value < Low_peak)  //If that value is lower than the low peak (at first is 1024)
        {
   Low_peak= ACS Value;   //The low peak will change from 1024 to that value found
         }
     }       //We keep looping until we take all samples and at the end we will have the high/low peaks values

   Amps_Peak_Peak = High_peak - Low_ peak;
//Calculate the difference.
}
```

3.3 CIRCUIT DIAGRAM AND WORKING:

Here in the proposed prototype we have used Arduino Uno as primary microcontroller. It will work as the heart of the system; all other measurement circuitries will be interfaced through this. All the detailed specifications will be discussed in the next chapter, nevertheless let me take you through the basic components for better understanding the rest of the operation. Besides the microcontroller we have used current sensor, voltage sensor, temperature sensor, frequency measurement unit, buzzer and relay; and to demonstrate the load we have used a fan and a bulb. Alongside we also have used 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 work as a filter, makes 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 12 Volt DC is fed to7805 Voltage regulator which makes it to 5 Volt regulated DC. In case of buzzer and relay need high amount for operation, we have to make some arrangements for that. For operation of the green and red. When we give supply to our prototype the display shows welcome message and simultaneously all the sensor start sensing the current, voltage, frequency and temperature and update all the real time values to the server as well as shows 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.

3.5 RESULTS

The proposed work is intended for a fully programmed route with the use of IoT. To assemble the data and control the cycling voltage, current and temperature information is collected on the Arduino Uno regulator, and it thinks about the appropriate feed around it. Here on the yield side, we can take the boundary of the feeder data and the breaker circuit. IoT and PC show progress in that event or honor. The regulator transmits data to the client or administrator in the same way as data control activity does when a feeder or breaker fails. These can be readily controlled without any institutional constraints. A PC problem handles all interactions. As a result of this, the substation surveillance of the breaker circuit may be completed. The LCDs all terms associated with our guarantee. The Proteus Programming Entertainment Exam device shows facts in a more exact investigation in both form and presentation. The main advantages are if the sub-station characteristics change, quick attention may be required. The problem in any form of IOT-based control is straightforward to spot. The different parameters may be changed and examined in real time through a network.

5. CONCLUSION AND FUTURE SCOPE

5.1 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 parameters by appointing a person at all locations and furthermore the data would also be error prone if the monitoring is manual. The greatest issue is to have all the transformers data at single sink when the data is collected manually. Through our proposed system all the problems discussed above can be reduced to some great extent.

5.2 APPLICATIONS:

- Power generation
- Sub-station.
- Distribution area.

FUTURE SCOPE:

Addition of GSM Module:

By incorporating the GSM module, we will be able to send Personalized SMS to the authorities so that they can remain be updated the about the plant while outside. And the microcontroller is programmed in such a way that a particular format of SMS is sent which can be used as an input for the microcontroller for required operation.

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