Smart grid system for smart cities to evaluate power quality through remote controlling

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***Abstract*— Transmission line protection is an important issue in power system engineering because 84-89% of power system faults are occurring in transmission lines. This paper presents a technique to detect and classify the different shunt faults on transmission lines for quick and reliable operation of protection schemes. Perception among different types of faults on the transmission lines is achieved by application of evolutionary programming tool. In this paper the system include the remote controlling equipment for monitoring and managing the temperature of transformer and voltage measurement, detection of short circuit of any three phase line, LG fault, LL fault, LLG fault, controlling of street light, receiving all the parameters data using GSM. ARDUINO UNO is the basic component used for programming and remote controlling. All the equipment are connected to Arduino, this control can make a reasonable adjustment according to the latitude, longitude and seasonal variation. Also this system can run in controlled mode. The system is equipped with the power relay output and can be widely applied in all places which need timely control of lights such in streets, stations, mines, electricity sectors, etc. It has been found that the proposed scheme is very fast and accurate and it proved to be robust classifier for digital distance protection.**

***Keywords*— Arduino Uno, Relay, LED, voltage regulator Ic, Temperature Sensor, GSM, Optocoupler, Serial Converter Ic, Transformer.**

I. INTRODUCTION

As cities grow, the challenges they pose—environmental, economic, and social—grow with them. But cities are hubs of diversity and innovation they can also become the source of solutions. Smart cities uses recent advanced in communications and digital technologies, data sharing, analysis and intelligent design. Smart sensors and implant devices to transmission and distribution system work together with an open connected infrastructure to create a distributed layer of intelligence that can save energy, organized operations and make citizens feel happier and safer .A successful Smart Cities strategy relies on smart technology.

Smartness has been built into electricity grids since their inception, super vision, control and protection are already key activities for a distribution system operator. The difference between traditional grids and smart grids is mainly the capability to handle increasing complexity efficiently and effectively.

Today distribution system operators are in various stages of evaluating, specifying and establishing technologies associated with the smart grid of the future based on experience gained in various power distribution system worldwide, CESI is able to provide a wide range of consulting and testing services to support smart grid project, enhancing their reliability and profitability and reducing technical hazards and risks. Today all this is possible by means of technological innovations which has entitled a revolution of the concept of smart city

The main objective of this project is to evaluate the power quality and remote controlling for the smart grid system for smart cities. For this we are using ARDUINO UNO microcontroller which will be the major component of our system. The ARDUINO UNO in our system will analyze, read and give the output by which we can implement the program. Through which we can easily perform the given task.

Detection of temperature sensing of the transformer using temperature sensor, voltage with the help of voltage divider and detection of short circuit of 3-phase transmission line can be possible with this project. As this is for the smart grid system to minimize the manual efforts of controlling and analyzing the faults. The GSM-SIM 900 module is used which will be giving information by means of serial communication between Arduino and GSM, if any unwanted situation occurs. This system is already existing but it requires 15 minute time to sense the fault but our system will analyze the fault within milliseconds and give efficient result and fast conclusion to operator and consumer.

Figure. 1. Pictorial representation of General advantages of smart grid system

II.PROPOSED SYSTEM

The design of our system is explained below with the help of block diagram as shown in fig. 2. Various hardware components involved in the development of the system to enhance power quality and remote controlling are shown in following fig. 2. It shows the block diagram of smart grid system which contain all the main objectives of our system. It consists of various components viz Arduino (atmega328), LM35, GSM-SIM module, B817 optocoupler, led lights, relay, transformer, Max 232 IC, BC547 Transistor, capacitors, resistance and diodes.

As shown in fig.2 the optocouples are connected to the three phases transmission lines, the output terminals of the optocoupler are connected to the analog pins of arduino which will sense the fault and send the command and relay will operate within milliseconds and the supply to the faulted line will trip. Transformer is connected to the temperature sensor which will further connected to the pins of Arduino for sensing the correct temperature and giving accurate readings. In this project we are automatically controlling the switching operation of street lights. Frequently we are checking the voltage ratings of the line. All the parameters such as temperature, voltage using serial converter IC is given in the form of message by using GSM.

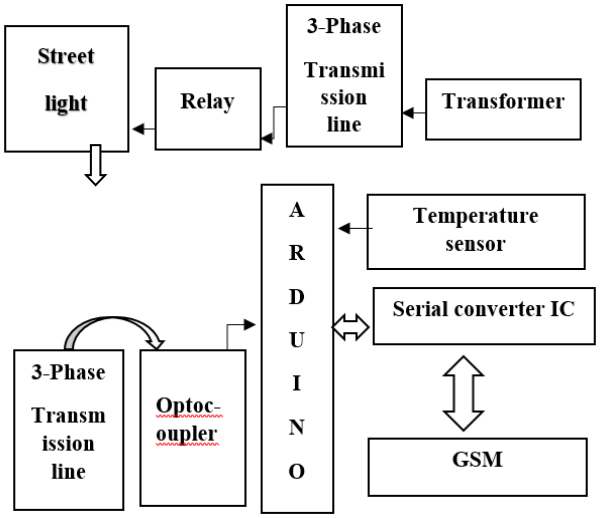

Figure. 2. Block diagram of smart grid system

III. COMPONENTS USE

3.1 Arduino UNO

Arduino is an open-source physical platform based on microcontroller board having the Atmega32 series controller and development environment for writing and uploading codes to the microcontroller. It has input and output pins for communication with the world outside such as with switches, relays, sensors, IC's and so on. To be clear-cut it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, 16 MHz quartz crystal, a USB connection, power jack, an ICSP header and a reset button. It contains everything need to support the microcontroller. It can take supply through USB or we can power it with an AC-to-DC adapter or a battery Arduino acts as a processing module of the system. The Arduino board feature serial communications interface, USB on some models, for loading programs from personal computers. The microcontrollers are primarily programmed using a local parlance features from the C and C++ programming languages. Arduino boards are available commercially in preassembled form, or as do-it- yourself kits. Arduino is the heart of our project which will be working as the

major component of our system. Through Arduino, system will analyze, read and will give the output by which we can implement the program. All the major components are connected to the pins of Arduino. The Arduino atmega328 diagram is as shown in below fig. 3.

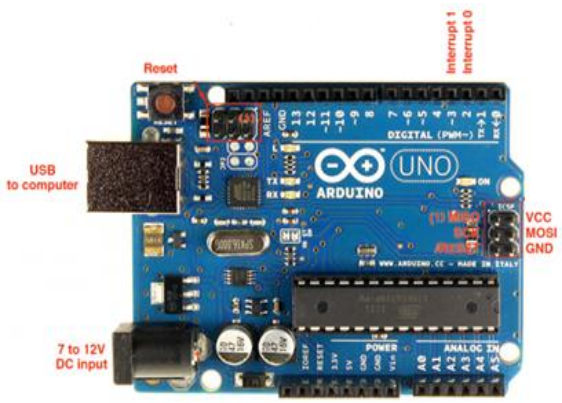

Figure.3. ARDUINO (Atmega328)

3.2 7805 IC

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator 7805IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

3.3 BC547 TRANSISTOR

BC547 is an NPN bi-polar junction transistor. A transistor stands for transfer of resistance is commonly used to amplify current. A small current at its base controls a larger current at collector & emitter terminals. BC547 is mainly used for amplification and switching purposes.

3.4 B817 OPTOCOUPLER

Is a device that contains a light-emitting diode (LED) and a photo sensor. The purpose of an opto coupler is to transfer signals from one circuit to another yet keep them galvanically isolated.

3.5 MAX232 IC

The MAX-232 IC is an integrated circuit which consists of 16 pins and it is a resourceful IC mostly used in the voltage level signal problems. Generally, the MAX-232 IC is used in the RS232 communication system for the conversion of voltage levels on TTL devices that are interfaced with the PC serial port and the Microcontroller. This IC is used as a hardware layer converter like to communicate two systems simultaneously.

3.6 GSM 900 MODULE

This is an ultra-compact and reliable wireless module. The SIM900A is a complete Dual-band GSM/GPRS solution in at designations.

SMT module which can be embedded in the applications allowing benefit from small dimensions and cost-effective solutions. SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption.

3.7 TRANSFORMER

Transformer: 230V, 50 Hz AC transformer step down in 12V

3.8 DPDT type relay.

Capacitors: the 10µF,1000µF and 470µF.
Resistance: 100K ohm and 1K ohm.
D15 RED LED light.
Single layered PCB.

IV. WORKING OF THE SYSTEM

4.1 Working of power supply circuit

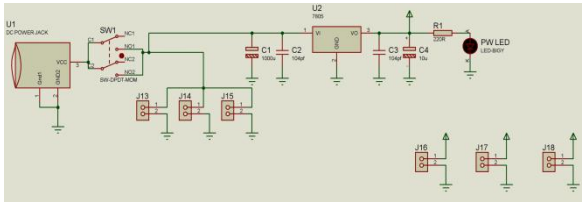

Figure.4. Supply circuit

Fig. 4. Shows the power supply circuit consist of DC power jack through which adaptor is connected. The whole circuitry is followed by a push to on off SPDT switch, diode, capacitors (C1-1000µf, C2-104pf), 7805 voltage regulator IC, resistor (220Ω) and red led. This circuit is used to give power supply to the microcontroller i.e. ARDUINO UNO. The IC 7805 converts 12v to 5v any given input to the ARDUINO which is of 5V.

4.2 Voltage and temperature checking circuit of transformer

For checking the temperature and voltage of transformer a temperature sensing device is used. And for calculating the time to time varying voltage of transformer with the help of voltage divider we can identify the value of the voltage. The analog pins of the ARDUINO are connected to the temperature sensing device and voltage checking circuit. For this, the voltage checking circuit consists of diodes, capacitor of (1000F) and resistances are connected to the Arduino. This voltage checking circuit will measure the transformer voltage and divide the voltage and send it to Arduino to make it from 12V to 5V.
Also LM35 i.e. (temperature sensing device) is connected to Arduino analog pins. This sensing device sense the temperature of the transformer and if the temperature is higher than the desirable value the system will detect it automatically and there will be a resistance and a fan which will inhales the heat and this will protect from burning. The fig.5. Below shows the circuit diagram of voltage checking circuit and temperature sensing device.

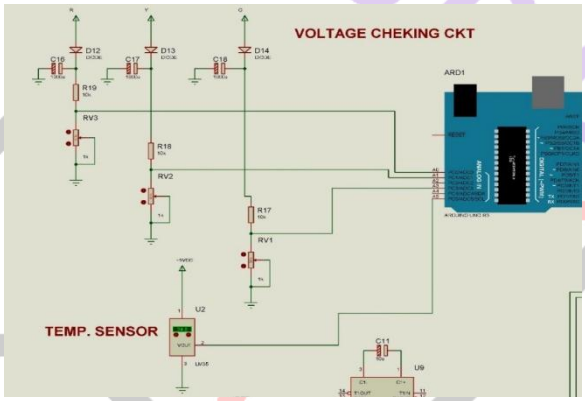

Figure. 5. Circuit diagram of voltage checking and temperature sensing device.

4.3 Detection of short circuit in any three phase transmission line

For the detection of short circuit in any three-phases of transmission line, we are using six opto coupler for the three poles which is connected to the input/output pins of Arduino. Each opto coupler is connected to the resistance, capacitor of 1000 F and diode. This will ensure that, if there will be any cut-off of any of the three phase transmission line by some natural disaster or some external or internal fault, then the system will detect it within a milliseconds and the supply will be cut-off. This will enhance the power quality and controlling and will also avoid the fatal accidents caused due to short circuit in transmission, distribution lines.

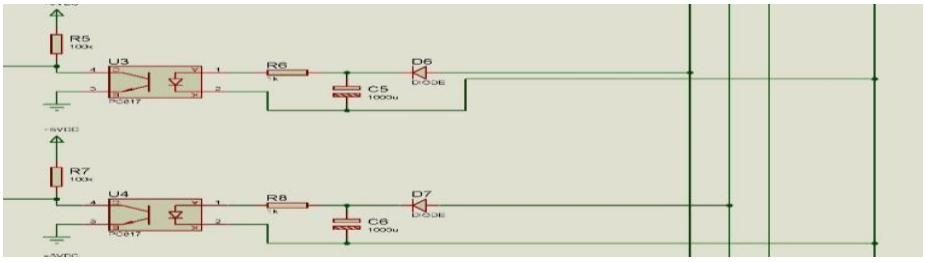

Figure.6. Circuit for detection of short circuit line.

The power lines R Y G and neutral are shown in fig.6 above are connected to the opto coupler and the output is connected to the pins of Arduino. Opto coupler will detect the line power supply, if any fault occurs it immediately send signal to Arduino. The

ARDUINO will sense the signal from opto coupler and controls the line parameters with the help of connected relay as per the requirements.

4.4 Automatic controlling of street lights

Controlling of street lights is done using relays. Three relays are connected to the Arduino. The arrangement consists of diode, BC547 transistor, resistance (4k7) and relay of DPDT i.e. (Double pole double throw) and three red LED's for street lights. Relay switches will be used for ON/OFF purpose. The remote terminal unit serves as relay station between the control and sensor nodes. This will make controlling of streetlights easier.

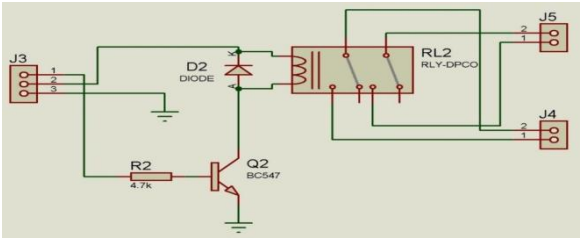

Figure. 7. Circuit arrangement of relay circuit.

Fig.7 shows the arrangement of relay circuit. Here we use BC547 transistor to on /off relay as a switching property it is a negative-positive-negative (NPN) transistor. In a typical configuration, the current flowing from the base to the emitter controls the collector current. For the three phases such three connections of relay circuit are used. Each one of the terminal is connected to the pins of ARDUINO UNO, and other terminal is connected to the transformer each phase to each relay circuit. The transformer is of 230V ac which is stepped down to 12V, the relay is of 12V. A BC547 transistor

4.5 Receiving all the parameters using GSM

The receiving unit consists of Max 232 IC and GSM- SIM 900. This arrangement is connected to the pins of Arduino which is pin 1 i.e. TX (transmitter) and pin 0 i.e. RX (receiver). Max 232 IC is an serial data converter between Arduino and GSM. From this Max 232IC the GSM 900 module is connected, through which parameter such as temperature, voltage, current and frequency data can be receive in the form of message on the display.

V. CONCLUSION

The Arduino based project will provide a competent method for controlling and monitoring the system. This protection system is an improved method because it is a very low cost device as compared to other controlling devices. In this project an accurate technique of identification of faults on transmission line has been proposed. The accurate results of voltage and temperature of transformer can get easily within a second without going through long time causing techniques. The usage of smart lightning system will undoubtedly change the world that we see today. The system can be extended easily, is flexible and also adjustable according to the need of user. Use of GSM technology made the system wireless, less complex.

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