

Faults and Power Quality Problems Smart Alert and Trip System using Aurdino

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Abstract - The Dependence and Infrastructure of power system is becoming larger day to day, In this context the power system protection plays an crucial role to give a huzzle free and undistruped power supply. As the world is moving towards smart power system network with a adopting a newer technologies. Therefore it is important to provide a smart protection mechanism that is capable to deal with various power system problems effectively .This paper work discuss the two main power system problems such as faults and power quality problems which disturbs and effects the power system network. This work tends to bring a effective protection solution with a smart alert and trip system that predicts and detects the overload , shortcircuit type of faults and under voltage, over voltage power quality problems by using aurdino also this smart system is equipped with a alert and trip mechanism to provide instant alerts and load trips.

KeyWords: *Faults; powers system problems; Aurdino; Power quality problems; Smart alert and trip system; Gsm modem; Power system Protection.*

I. INTRODUCTION

An power system is as a network that generates, transfers, and supply electrical power with required equipments to the consumers .Electrical power system is subdivided into three major subsystems such as generation,transmission and subtransmission, distribution subsystem and each subsystem has its specific own function. Generally the electrical power system is monitered and maintained by power utilities,further these utilitises are majorly divided in accordance with the various subsystems types that is generation utility known as genco which deals with generation of power, transmission utility known as Transco this deals with transmission of generated power, and finally distribution utility that is discom which deals with the dibutribution of power to end consumers[1].

As we know today the demand and need for electrical power is drastically increasing these concerns all power utilities in a

world to give a good reliable and efficient power supply to the consumers. The power systems are prone to faults and abnormal condition often occurs in it, These faults associated with high current could cause severe damage to components and further leads to outages of power. Hence to overcome the damages each section of power systems are protected with the suitable protective relays and circuit breakers. The faults of any type must be cleared within a fraction of seconds if not it may cause heavy damage or some time total shut down to the system. This shows the need and importance of the power system protection[2].

Simply the protection system via its protective devices needed to terimate or isolate the faults in any section of system and to maintain a healthy operation of the power system. The protection systems consists of many devices like relays, circuit breakers, auto reclosure, so on. Each devices has its own unique operational fuctions and characterstics, All this devices does not prevent any faults instead it actually terminate occurred faults. More over protection is not only meant for faults but also for the abnormal conditions like loss of excitation, over heating of stator and rotor in a generator and power quality problems like under voltages, over voltages, voltage sag, voltage swell,etc[2]. Now a days the protection system are evolving and upgrading to advanced protection system adopting the modern technologies like Internet of things, artificial intelligence, embedded systems so on. Some examples of the advanced protective devices are Internet of things based protective relay, Aurdino based smart relays,etc.

II. POWER SYSTEM PROBLEMS

The power systems faces many number of problems during its operation. Particularly faults and power quality related problems are two major problems that occurs repeatedly and challenges the smooth operation of power systems

A. Faults

Faults are abnormal conditions of the system which damages electrical equipment and disturb the normal flow of current.

There are many causes for occurrence of faults like a flash over on the insulators surfaces due to switching surges and lightning, falling of tree branches or conducting materials on overhead lines, failure of insulation due to aging or heat and moisture, even a bird by touching its body to overhead lines[1]. The faults are further classified into various types such as

- 1) *Short circuit faults*
- 2) *Open circuit faults*
- 3) *Miscellaneous faults*

Open circuit faults caused by failure two or more conductors this faults takes place in series with a line, when compared with other type of faults this faults rarely occurs in the power system. Short circuit faults can be defined as abnormal connection between two phases or points, ends. The short circuit faults are again classified into symmetrical faults and unsymmetrical faults, the symmetrical faults are rarely occurs when comparing to unsymmetrical faults. It could be three phase fault or three phase to ground fault (LLLG) on the another hand the unsymmetrical faults subdivided into three types SLG, LLG and L-L faults[2]. The short circuit type of faults are very danger at the same it has a various effects on power systems such as damage of equipments due to high currents, industrial loads loss due to reduction of supply voltage in healthy feeders, unbalancing of supply voltages and currents leads to heating in machine, arcing fires which results in burning of element associated with it and chances of spreading fire other parts of powersystem[2].

In this paper overload fault is consider under the miscellaneous type of faults .when a over load condition occurs the circulating current in the circuit becomes higher than the components rated current this causes passage of huge currents in it, further leads to damage of the component.

According to fault statics[1], The distribution of different types of faults occurrence are as follows, short circuit faults 80%, open circuit faults 10%, remaining 10% are miscelleous type of faults.

B. Power quality problems

The power quality term used to define the quality of voltage variations[3]. As per IEEE the power quality is defined as the concept of grounding and powering of sensitive electronic equipment in a manner suitable for equipment operation. There are various types of problems which challenges the quality of power in the electrical power sytems. They are[3]

- 1) *Transeints*
- 2) *Voltage sag*
- 3) *Voltage swell*
- 4) *Over voltages*
- 5) *Under volatges*
- 6) *Interruptions*

- 7) *Noise*
- 8) *Voltage Unbalance*
- 9) *Voltage flickers*

Over voltage is a sudden increase in the normal voltage for short duration. There are mainly caused by direct lightning, atmosphere conditions, resonance effects. Flashover between phase and ground, breakdown of gaseous or solid or liquid, failure of transformer and machines, effects on capacitor bank and power cables are the some of effects of overvoltages[4].

Under voltage is defined as a normal voltage which drops to less rated voltage for short time (i.e 1min). they are caused by poor windings, bad weather conditions, overloaded utility transformer, closing and opening of circuit breaker. The under voltages has various effects to power systems such as slow run of resistive loads, more current usage by electronic devices, over heating of motors which leads to insulation failure[4]. All this above mentioned power quality issue/problems are customer driven problems. It is important to mitigate and reduce the power quality issues to increase productivity at the same time avoid damage and aging of equipment.

III. Smart Alert and Trip System Design and Analysis

A. Block Diagram of Smart alert and trip system

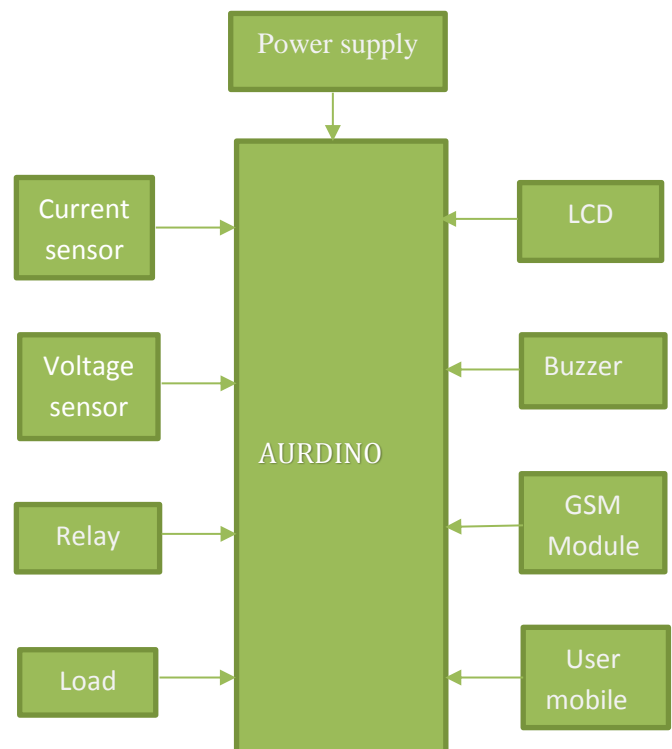


Fig 1: Block diagram of smart system

The block diagram consists of smart alert and trip system consists of hardware and software requirements.

B. Hardware Requirements

The smart system consists the following hardware equipments such as aurdino uno, acs 746 current sensor, lcd Display, dht sensor, buzzer, transformer, voltage regulator, rectifier, power supply board, capacitor, potentiometer, voltage sensor.

1) *Aurdino uno Hardware*: An arduino uno is generally a microcontroller or mcu board made by aurdino. which uses ATmega328p microchip. In this aurdino version (R3 smd) the microchip was soldered to the board where as in other versions the chips has flexibility for replacing. Arduino is open-source, which means that is reasonably priced and development software is free. The aurdino programming language is a supports the c/c++. if you know c programming the aurdino will be familiar. [5] The aurdino does not require any separate hardware piece to load code into the board unlike the other programming circuit boards. The aurdino consists of 25 pins such as vcc, gnd, port b, port c, pc6/reset, port d, accc, Aref, Adc7, Gnd, each pin has Separate pin configurations [5].

2) *Lcd Display (16*2)*: Lcd is abbreviated as Liquid crystal display which is one kind of display that has wide range of usage while using with aurdino. Usually this type of displays consume less power compared to LED. This display consists 16 pins and each pin has specific configurations. It requires 5volts supply for effective operation. There are two types of bit modes one is 4bit and other is 8 bit, for text displaying 4bit is used. It high accurately reads and excutes data. Two registers used in LCD are command and data [6].

3) *Dht11 Sensor*: Digital and humidity Sensor (Dht 11) senses and measures the humidity and temperature in the air around. This sensor uses a capacitive measuring element and thermistor for measuring humidity and temperature. the temperature measuring range of sensor varies from 0 degree celsuis to 50 degree celsuis where as its humidity range from 20 to 80%. It consists of 4 pins called vcc, data, nc, Gnd. A resistor is used between micro controller and sensor for proper communication. It used in this thesis for measuring humidity and temperature around the smart alert and trip system.

4) *Buzzer*: Buzzer is a electronic audio signal device which is used in alarm devices, timers, computers, electronic toys, so on. It consists of two pins positive and negative. A dc 6v input supply is required for its operation. there are four types of buzzers exists they are piezo electric, electro mechanical, magnetic and electro magnetic, based on application type different type of buzzers are utilized accordingly

5) *Transformer*: A Transformer is a static electrical equipment which is used to step down or step up voltage levels and reduces voltages/currents from high level to low. In step fown transformer usually the number of coils turns is greater than the secondary coil. The working principle of transformer is actually based on the faradays law of electro magnetic

induction. Transformers are classified according to the usage, voltage level, material used, and arrangement of windings. It plays a importat role in the entire power systems including all types of subsystems.

6) *Voltage Regulator (7805 & 7812)*: voltage regulators are Used to maintain a fixed voltage. The voltage regulator (7805 & 12) is a Ic integrated regulator and the 05 and 12 in regulator speaks to the voltage delivered to the specific gadget by the voltage controller as the yield. It consists of three pins namely gnd, input and output. its max and min voltage input is 7v and 35v. These regulators are also used in various range of circuits [7].

7) *Acs 712 Current Sensor*: A current sensor is used to detect and measure the current in conductor. The relation between voltage and current is given by Ohm's law. In an electronic device, the amount of current value increased above its requirement leads to overload and can damage the device. Measurement of current is necessary for the proper working of devices. This type of sensor detects both dc and ac current. The acs current sensor uses the method of indirect sensing to measure the current in conductor. It requires the voltage supply of 5v.

8) *Voltage Sensor*: A voltage sensor is used to measure and monitor the voltage. It consists of three pins knowly vcc, data, gnd. each pin has different configuration. voltage sensor is classified into two types they are resistive type and capacitive type of voltage sensor. when this voltage sensor interface with aurdino it has a several advantages. It detect/measures both dc and ac voltages. voltage sensors techinques become a good choice than the conventional measuring techniques.

9) *Rectifier*: Rectifier is an electrical device which converts the alternating current (AC), into direct current (DC). The PN junction diode acts as rectifier. The process of conversion of Ac to Dc is called rectification this can be done by using forward and reverse bias condition of diode. rectifiers has a numerous application such as used in electric welding, traction motor, and voltage multipliers, Am radio etc., Rectification can be used in the roles other than direct current generation for use as a power source.

10) *Power Supply Board*: A power supply board is a component that provides at least one electrical charge with power. It typically converts one type of electrical power to another, but it can also convert a different Energy form in electrical energy, such as solar, mechanical, or chemical. generally power supply board consists of voltage regulator, capacitor, rectifier components. each component functions are explained in previously In smart alert and trip system 12v and 5v dc power supply board is used. It has two output 5v pin sets and one 12v pin set. this 12v supply was required to gsm.

11) *Capacitors*: Capacitors are used to attain the immaculate and smoothest Dc voltage from the connector[7].and also mainly used for storage of energy. It consists of a parallel plates that are not connected each other.there are many types of capacitors available in market depending on the usage different capacitors are used.

12) *Relay*:A relay is device which acts as electromagnetic switch that can turn a much higher current on or off or relay is device which sense the faults and open or close the circuit.This 4-channel 5v relay board,needs a 15-20mA current for each channel.It is used to control the various equipment and appliances with a large current.it has a standard interface which can be controlled directly by the microcontroller[6].

13) *Potentiometer*: A potentiometer (or potmeter) is a instrument with a three terminal variable resistor that is used to vary the resistance to control the flow of a current.A potentiometer acts as an adjustable voltage divider.It has several useful applications. In a potmeter, the input voltage is always applied across the resistor, and output voltage is the dropped voltage between the sliding and fixed contact and the different type of potentiometers available in market are trimmer type, single turn type, servo type,concentric and digital type of potentiometers[9].Potmeters hasdifferent resistance range.In the smart alert and trip system trimmer type potmeter with an range of 10 k Ω is used.

14) *Gsm Module*: Gsm(global mobile commuunication) enables link from a device to a gsm system.It operates effectively on diffrent bands across the world.Gsm make use of time division multiple assess technique which is used for transmitting the signals.It digitizes and compress the data and then sends it through a channel that uses two streams of data. It also provides many user servies like voice(including roaming), gprs, sms,etc.when gsm intefaced with aurdino it is mainly used for sms alerts to mobile and used in many thesis works[10].

C. Software Requirements

The smart system requires the Aurdino ide frame work to develop,the required source code for implmententing the functions of aurdino uno.

1) *Aurdino IDE*: Arduino IDE (Integrated Development Environment)is a software introduced by Arduino, which is used for compiling ,writing, and uploading the code into the Arduino. Almost all Arduinos are compatible with this software.It makes coding compilation too easy that even a person with no prior coding knowledge can easily learn.It is easily available for operating systems like, Windows, Mac and runs on Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment,This Ide supports both C and C++ languages[11].

IV. Implementation and Results of Smart alert and Trip System

A. Implementation of smart alert and trip system for prediction and detection of faults

The smart system effectively predicts the overload by monitoring the current with the help of current sensor attached to the load and aurdino. When loads(bulbs) are gradually increasing the current in the system gets increased whenever current exceeds the predefined first threshold current the aurdino predicts the overload fault showing "fault to occurred" in lcd display and gives 2 buzzer alerts to user.Similarly when the current exceeds the second threshold current. the system detects and gives buzzer alerts with tripping off the load. In the similar manner the two connected wires in the system are shorted with and with out load,the aurdino detects shortcircuit fault and trips off load after giving 2buzzer alerts to it user.

B. Implementation of smart alert and trip system for detection of power quality problems

The under voltage and over volatges are created by using the variable potentiometer in the smart alert and trip system when the voltages are varied below the set threshold voltage the aurdino in the system detects under voltage and gives buzzer alerts and trips off supply to the load. similarly when the volatges are varied above the set pre defined voltage the aurdino in prototype detects over voltage and gives alerts and trips off load by using buzzer and relay connected to it.

C. Results of the smart alert and trip system

The following tabular column 1and 2 shows the predefined and observed current and voltage values of smart system.

Table 1 : predefined and observed values in prediction and detection of overload fault

S.No	Bulb Load(Watt)	predefined current 1 (mA)	predefined current 2 (mA)	observed current (mA)
1	0	800	1100	240
2	60	800	1100	540
3	100	800	1100	890*

4	200	800	1100	1491 [#]
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* fault current(above normal load) , # fault current(over load)

Table 2 : predefined and observed voltage values in detection of under and overvoltage

S.No	Variable potentiometer	Predefined Voltage(v) 1	Observed voltage(v)
1	1 st variation	2	3.04
2	2 nd variation	2	2.26
3	3 rd variation	2	1.46*
S.No	Variable potentiometer	Predefined Voltage(v) 2	observed Voltage(v)
1	1 st variation	4	2.29
2	2 nd variation	4	3.34
3	3 rd variation	4	4.21 [#]

* under voltage , # over voltage

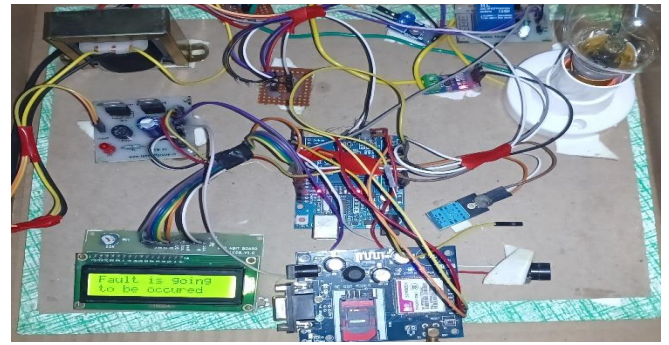


Fig 4 : Fault predicted in bulb load(100w)

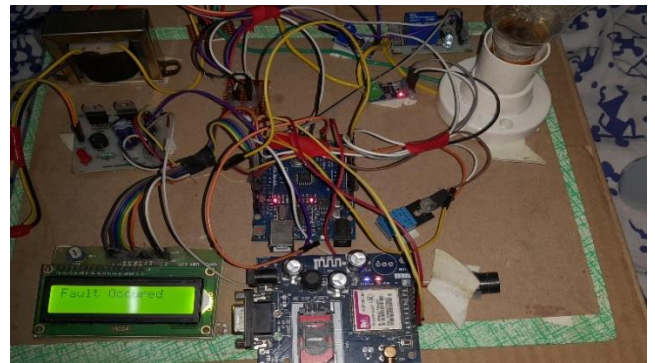


Fig 5 : Fault detected in bulb load(200w)

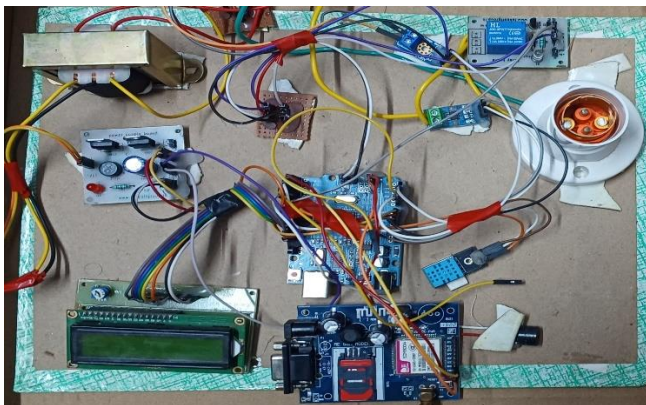


Fig 2 : Prototype of the smart alert and trip system

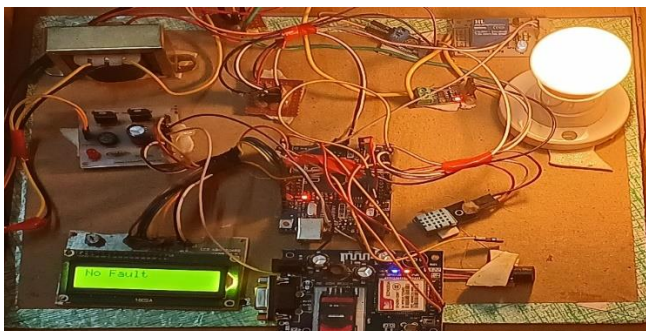


Fig 3 : No fault detected in bulb load(zero watt)

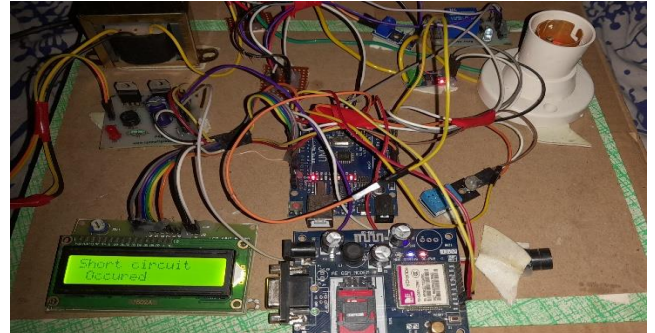


Fig 6 : Short circuit detected without load

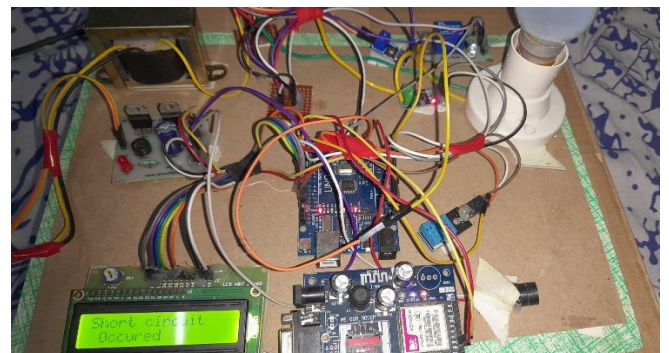


Fig 7: Short circuit detected with load



Fig 8 : under voltage detected

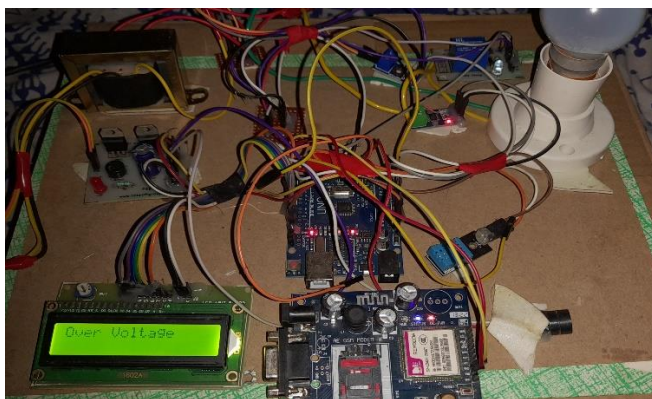


Fig 9: Over voltage detected

2:11 pm

Texting with Gsm (SMS/MMS)



Voltage is high

Fig 10 : Over voltage detected

2:34 pm



Voltage is low

Fig 11: Under voltage detected

V. CONCLUSION

Hence the single system(Smart alert and trip System) which uses the Aurdino for Predicting and Detecting the faults and PQ Problems and successfully gives the buzzer alerts at the same time trips off the load and also it detects the occurrence of the under/over voltages to its user via sms massage .With this

system effort,First time overload fault is predicted thus helps to the reduce faults and helps to protect the Electrical appliances from fault conditions arising in the power supply and overload similarly with this system the problem of power Quality is reduced and with this consumer and Industrial Loads was Protected against over/under volatges.Overall monitoring of under/over voltages helps to the Improve the power quality and At the same time helps to protect consumer&Industrail Loads.

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