Fault Detection And Monitoring Using Pid Controller

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***Abstract* - This paper to develop an automatic tripping mechanism for the three phase supply system. The project output resets automatically after a brief interruption in the event temporary fault while it remain remains in tripped condition in case of permanent fault. The electrical substation which supply the power to the consumers, have failures due to some faults which can be temporary or permanent. These faults lead to substantial damage to the power system equipment. In India it is common, the faults might be LG (Line to Ground), LL (Line to Line), 3L (Three lines) in the supply systems and these faults in three phase supply system can affect the power system. To overcome this problem a system is built, which can sense these faults and automatically disconnects the supply to avoid large scale damage to the control gears in the grid sub-stations. This project is designed to understand about the basic operation of the relay and what are all the advanced techniques that are being used by the people to ensure the safe operation of the electrical appliance. The circuit will isolate the load from the supply if any power fluctuation occurred. The major advantage of the project is, it not only save the appliance but it will also show the type of the fault that has been occurred in the system so that it will be easy for the operator to solve the problem easily. It will also check whether the fault is a permanent or a temporary fault. If the fault is temporary fault then the supply will be restored after a predefined time of 5-10 seconds otherwise a permanent trip signal is given to the relays.**

***keywords* - Three phase fault, tripping mechanism, microcontroller, and ADC.**

I.INTRODUCTION

The Arduino environment has been designed to be easy to use for beginners who have no software or electronics experience. With Arduino, you can build objects that can respond to and/or control light, sound, touch, and movement. Arduino has been used to create an amazing variety of things, including musical instruments, robots, light sculptures, games, interactive furniture, and even interactive clothing.

Figure 1.1: Arduino.

A large number of motors are being used for general purposes in our surrounding from house- hold equipment to machine tools in industrial facilities. The electric motor is now a necessary and indispensable source of power in many industries. The function and performance required for these motor are wide-ranging. IM are the most widely used motor for appliances, induction control, and automation; hence they are roust, reliable and durable. Three phase induction motor generally suffers from under voltage, over voltage, overheating, single phasing and phase reversal problems. Due to this electrical fault the winding of motor get heated which lead to insulation failure and thus reduce the life time of motor. When the three phase induction motor supply with higher voltage than is rated then induction motor starts overheated. When supply voltage is lower than rated then voltage drop across the resistance is higher than it protects the motor from this fault. When supply voltage is lower than voltage drop across the resistance is lower than specified value and motor fails to start. When supply is only one phase, this is single phasing problem and supply voltage fall the rated and once again motor fails to start. It is highly desired that 3 phase induction motor works freely from the seal types' of faults. This fault is generated in induction motor due to variation in induction motor parameters. When three phase induction motor runs continuously, it is necessary to protect the motor from these anticipated faults.

The protection of induction motor plays an important role in its long life service. Researchers have done costly and limited protection for the stator windings protections, broken rotor bars protection, thermal protection etc. Mainly the induction motor needs protection from the variation of the input supply for small motors which is in common use not only in big industry but also in small scale industries.

The small scale industries are not able to provide costly protection to the drives in use as it will increase their capital cost. Hence a cheap and compact design has been done for protection of induction motor against under voltage, over voltage, over current, under current. It has been also designed for critical loads which need to be run even under single phasing condition. Due to the poor power quality the damage of induction motors in small scale industries needs to be taken care of. Because of the increasing advances in technology, smart systems are increasingly being used. These systems allow technicians, administrators, and managers to monitor and control the performance of devices from a safe distance.

The monitoring system is very important when working in the field of three phase systems; some users and companies use smart monitoring software programs [1–4]. These programs are installed on the user's smartphone or company computers to allow employers to make decisions if there is an error. The main objective of this paper is to create a smart monitoring system based on an intelligent control system [5–9]. The proposed system is called a smart voltage and current monitoring system or SVCMS. The SVCMS is designed to monitor the performance of a three phase grid by measuring voltage and current.

The SVCMS design consists of two parts; the first is the control system shown in Figure 1.1. This system has been designed using the Arduino Nano V3.0 as a microcontroller to read and calculate the RMS voltage and current from sensor units [10,11]. The Arduino Nano V3.0 is an open source platform that is very cheap, flexible, and has special-purpose data processing capabilities [12]. Similar applications have been proposed for previous versions of this microcontroller [9].

The voltage sensor unit design is based on the ZMPT101B current transformer (Interplus Industry Co. Ltd., Shenzhen, China) and it amplifies the signals using a LM358 IC (Texas Instruments, Dallas, TX, USA) [1]. The current sensor unit is designed based on an ACS712 chip (Allegro Microsystems, Worcester, MA, USA) [7]. Both voltage and current units are isolated, very cheap, and easy to use. The last part in the control system is the Bluetooth HC-05 (Guangzhou HC Information Technology Co. Ltd., Guangzhou, China) [1]. This Bluetooth HC-05, is one of several types of wireless communication [2] (ZigBee, Wi-Fi, etc.) unit placed between the control system and the end user (monitoring system).

II. PROJECT OBJECTIVE

2.1 The lack of load-balanced 3 Phase:

Understanding of load balanced is:

- Third current vector / voltage is equal.
- The third vector of each form an angle of 1200 with one another Figure 2.1.

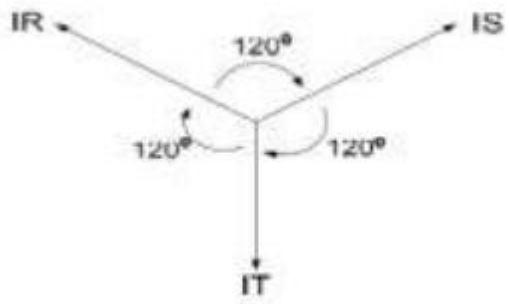


Figure 2.1. Vector diagram of the current state of balance

It can be seen that the vector sum of the three current (Ir + Is + It) is equal to zero, so as not to cause neutral Current. While the definition of an unbalanced state is a state in which one or both circumstances unbalanced condition is not met. Possibility of an unbalanced state, there are three, namely:

Three vectors as great but do not form an angle of 1200 with one another.

The third vector is not as great but forms an angle of 1200 with one another.

The third vector is not as large and not form 1200 to each other.

2.2. Imposition Analysis Unbalanced:

Determine Amount of unbalance the load on each phase (load analysis) In the steady state level of coefficient a, b, c is 1. Therefore, the average load imbalance (in%) can formulated on:

(imbalanced) = $\frac{(a-1)+(b-1)+(c-1)}{3}$ x100%

2.3. Microcontroller Arduino Uno:

Arduino is a microcontroller single-board is an open-source as in Figure 2.2. hardware microcontroller Arduino programmed using programming language wiring-based based syntax and library. Programmed wiring-based This is no different with the C / C ++, but with some simplifications and modification. To facilitate the application development, Arduino microcontroller also Use the Integrated Development Environment (IDE) based processing. Arduino microcontroller can paired with an assortment of sensors and other actuators. As for the sensors and actuators that can be attached to the Arduino such as motion sensors, ultrasonic, heat, sound, Ethernet Shield, LED Display and more.

2.4 system description:

Under normal working conditions the load will receive the supply from the main three phase supply system.

The Arduino and Data Acquisition System will be connected just prior to the load. The main components of this system are Arduino and Data Acquisition System.

Arduino will continuously sense the value of voltage and current and when fault occurs in three phase system the arduino will measure the value of voltage and current and when fault occurs in three phase system the arduino will measure this value of voltage and current and send it to Data Acquisition System where this value is stored.
This value is compared with the reference value of voltage and current .If the measured value is greater than reference value then arduino will trip the circuit breaker .Hence the load will get isolated from faulty system and the transmission system integrity will be maintained.

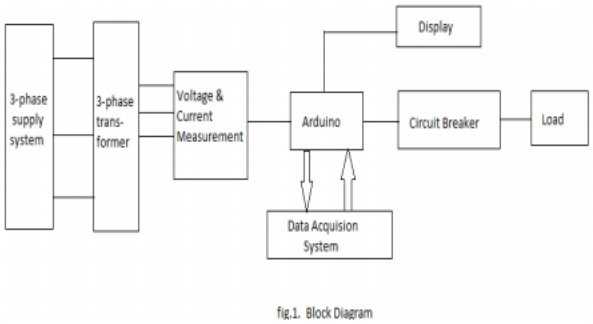


fig.1. Block Diagram

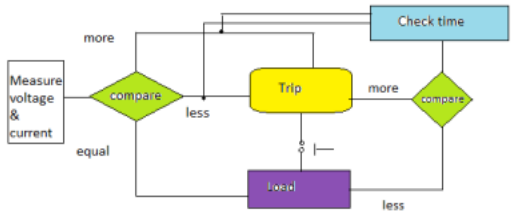
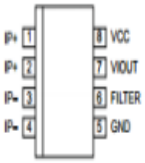


Figure 2.2. block diagram.

2.5. Arduino and data acquisition system:

For controlling operation of the auto reclosing system a comparatively cheaper arduino can be easily interfaced with the transmission line. Interfacing arduino on transmission line makes the protection system comparatively cheaper and easier to maintain and repair. A data acquisition system with Arduino also provides fascility of data storage i.e. it stores the value of corresponding fault voltage and current with the time for which the fault remains in the line. Interfacing Arduino and Data Acquisition System removes hard wired relays from the protection system. Different type of arrangements can provide both primary and backup protection . Arduino having high performance, low power, and 8 bit microcontrollers can be used. Arduino Mega is sufficient for interfacing the transmission line with the Data Acquisition System having many input terminals makes it easily to various input output terminals. Data Acquisition System with the Arduino makes the protection system compact and makes it more reliable since electronics operation is always more faster than the conventional mechanical operation. Conventional current and voltage sensors can be used with Arduino to measure the current and voltage readings of individual phases. Current sensing unit is connected to the each individual phase through a step down transformer. A conventional current sensor like ACS712 can be easily interfaced with the arduino to measure each individual phase current.

Pin-out Diagram



Terminal List Table

Number	Name	Description
1 and 2	IP+	Terminals for current being sampled; fused internally
3 and 4	IP–	Terminals for current being sampled; fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VIOUT	Analog output signal
8	VCC	Device power supply terminal

Figure 2.3 Arduino and data acquuisition system.

2.6. Current & Voltage Comparison:

This measured individual values of current and voltages can be compared with the preset values in the Arduino. This values once measured get immediately stored in the Data Acquisition System. After comparing these values, Arduino checks the time for which these values remains deviated from its original preset values. If the time for which the input remains deviated

is more than the present time then the Arduino disconnects the load from the faulty system i.e. the it Permanently trips the load. If the input gets stabilized (in case of transients) then after tripping the load the Arduino tries to close back the contacts of the Circuit Breaker, this can be termed as Auto reclosing.

III. PROJECT MOTIVATION

The order in which the individual phase voltages attain their respective maximum values in a three phase system is called phase sequence. A three phase supply system needs three single phase EMFS provided they must have same voltage magnitude and frequency but with different phase displacement, usually by 120 degrees. Types of phase sequence 1. Positive phase sequence (RYB) 2. Negative phase sequence (RBY) Now a days, various types of phase sequence indicator are used in the industry for the detection of correct phase sequence. Such as static, non static, rotating, non rotating, micro controller based etc. but finally the logic remains the same.

It is used to detect the phase sequence.

It is widely used in industries to check the phase sequence, so that the correct phase sequence supply is given to machines and the chance of damage of induction machines gets reduced.

The direction of rotation of three phase electric motors can be changed by changing the phase sequence of supply.

It is used for tracking the electrical connection during both, the installation and the maintenance of the electrical connection.

It is also used for wiring switchboards when three phase supply is a matter of concern.

IV. LITERATURE REVIEW

Mr.Ashutosh Ranjan, Mr.Nitish Kumar, Mr.Pankaj Tatla, Mr.Keerthivantha M "Three Phase Sequence Indicator Using Arduino Programming" (2017) During present age i.e. the age of industrialization and growing manufacturing sector/facilities, the machines used in the industries depend on the input three phase supply. Since we are aware that in three phase supply, correct connections of phase sequence is very much necessary otherwise it could lead to serious damages in the machines. The operator who is the in charge of monitoring the machines must know about the phase sequence connection and its adverse effects also. This paper provides the simple arduino programming model based 'three phase sequence indicator' which is helpful in many industrial applications.

Nagesh Vasant Bhakare, Laxman Mukinda Ghanvat, Sandesh Balasaheb Patil and Dodamani Sunanda R "Detection of Fault of Three Phase Induction Motor Using Arduino Uno R2 Microcontroller" The main concept of the project is to develop an induction motor protection system for protecting the motors from any damages occurring from single phasing, over current and over voltage. The induction motors are predominant in industrial applications. Thus this project helps to provide protection to the industrial motors if any of the phases misses out of the three phases, or if the voltage of the motor exceeds the threshold value. The proposed system uses three-phase power supply where in three single-phase transformers are connected to it. The system has a set of op-amps used as comparators for comparing input voltages. The motor is operated by switching the main relay, which is operated by other set of relays by sensing single phasing and over /under voltage, over/under current conditions. The project in feature can be enhanced by using current sensors for overload protection and phase-sequence sensor for protecting the motor from applying wrong phase sequence.

Shyam Morzaria, Shreyas Surve, Rajeev Valunjkar, "Arduino Based Autorecloser for Three Phase AC System" (2017) The paper aims to develop micro-controller based auto-recloser for the three phase supply system. The project circuit breaker closes automatically after a brief interruption in the event temporary fault while it remains in tripped condition in case of permanent fault. The electrical substation which supply the power to the consumers i.e. industries or domestic can have failures due to some faults which can be temporary or permanent. These faults lead to substantial damage to the power system equipment if faults are permanent and not cleared immediately. If faults are temporary then faults adversely affect reliability, stability etc. Most of these faults are temporary, therefore to improve reliability, stability of supply auto-reclosers are installed. We are proposing micro-controller based auto-recloser. This system will be built using arduino and a data acquisition system to detect type of fault and the microcontroller will record the severity of fault. After occurrence of the fault CB will trip. After that Arduino micro-controller will check the system voltage and decide if fault is temporary. It will close the CB and if fault is really temporary then system will continue to run normally. However, if fault persists, Microcontroller will trip Circuit Breaker again. The micro-controller will repeat the process for predetermined period. This mechanism will possibly replace the mechanical relays in the system and combine it with data acquisition system which will increase system efficiency and reduce the cost of line equipments.

Mohannad Jabbar Mnati , Alex Van den Bossche and Raad Farhood Chisab "A Smart Voltage and Current Monitoring System for Three Phase Inverters Using an Android Smartphone Application" (2017) In this paper, a new smart voltage and current monitoring system (SVCMS) technique is proposed. It monitors a three phase electrical system using an Arduino platform as a microcontroller to read the voltage and current from sensors and then wirelessly send the measured data to monitor the results using a new Android application. The integrated SVCMS design uses an Arduino Nano V3.0 as the microcontroller to measure the results from three voltage and three current sensors and then send this data, after calculation, to the Android smartphone device of an end user using Bluetooth HC-05. The Arduino Nano V3.0 controller and Bluetooth HC-05 are a cheap microcontroller and wireless device, respectively. The new Android smartphone application that monitors the voltage and current measurements uses the open source MIT App Inventor 2 software. It allows for monitoring some elementary fundamental voltage power quality properties. An effort has been made to investigate what is possible using available off-the-shelf components and open source software.

Doan Duc Tung, Ngo Minh Khoa , "An Arduino-Based System for Monitoring and Protecting Overvoltage and Undervoltage" (2019) In this paper, an experimental system based on Arduino Uno microcontroller board was developed for measuring electrical quantities and protecting overvoltage and undervoltage conditions in a single-phase power supply. The main components are described in detail, including the hardware and software to build the system in which an Arduino Uno platform is implemented as a vital microcontroller to read voltage and current measurement from a voltage sensor (ZMPT101B) and a current sensor (ACS712) respectively. In addition, the Arduino is also used to send all measurement to a PC through a serial port for monitoring the measured data graphically. The proposed method for designing the software uses the root mean square (RMS) method for measuring electrical quantities and then the RMS voltage measurement is compared with the minimum voltage and the maximum voltage to switch on or switch off the load. The monitoring GUI is designed with the use of the free and open-source Telemetry Viewer v0.5 software to monitor RMS voltage, RMS current, active power, and trip signal of the experimental system. The experimental results in this paper demonstrate that the system operated correctly.

Shubham v. bhanvase, akshay b. damare, santosh b. mane, prof. dhananjay a. kumbhar "protection of three phase induction motor from over voltage review" (2018) This paper describes protection of three phases Induction Motor from over voltage. Induction motors are used in many agricultural applications in a wide range of operating areas because of their simple and robust structure, and low production costs. Providing a protection system is very important in agriculture field. The purpose for development of this project is to provide safety to industrial motors, lift motors, pumps etc. The main purpose of our project is to protect an induction motors from fault such as overvoltage. In this project we are using a three phase supply. If any of the phases, out of the 3 phases is missing or if temperature of the motor during operation exceeds threshold value motor gets heated and hence motor get damaged. And we are using arduino for detection of this fault and a LCD display to display the input voltage.

V.METHOD

Implementation of a prototype Generally current monitoring system is unbalanced Single phase begins by taking the output from current sensor SCT-013-20A and processed by the arduino and shown to a 16x2 LCD (Liquid Crystal Display) as the output of RMS current (A), as well as in the form of a command issued arduino microcontroller output Buzzer and LED in case of 3-phase current imbalance in the program, whose value has setpoint. The system architecture will be made in this study as a whole can be seen in Figure 5.1.

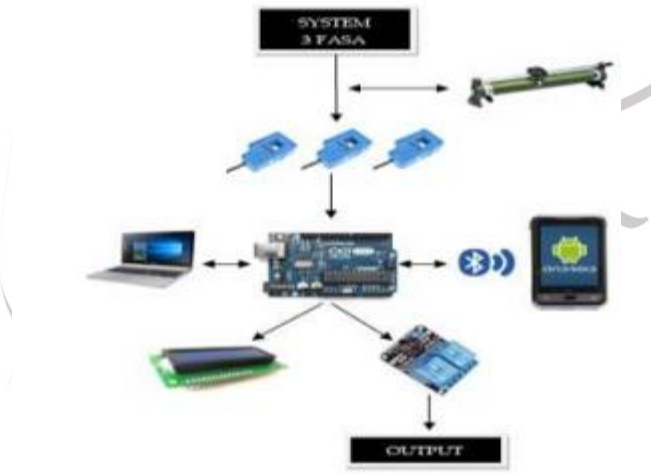


Figure 5.1.Blok Prototype.

Current Sensor SCT-13-20A YHDC will read the current conditions at the observation point. Values have not issued the sensor can read well by the Arduino Uno to it required a series of preconditions which is a limit sensor output voltage is around 1 volt, so as not to damage the pin Analog arduino (A0, A2, and A3). Furthermore Arduino Uno will process and calculate the value of the current readings to be displayed on the LCD. While the output is in the form Buzzer and LED indicators as arduino output commands when there load unbalanced 3-phase and the output is also wearing a HC-05 Bluetooth module as an additional medium flow monitoring that will be displayed on your smartphone (Android).

5.1 TRANSFORMER

Used to convert the voltage down the input incoming voltage from the three phase supply. And feed to the zero crossing detector.

Figure 5.2.Transformer.

5.2. SYSTEM IMPLEMENTATION:

From three phase supply, each phase is stepped down to 12V-0-12V using step-down. transformer and then it is given to half wave rectifier and the output of the half wave rectifier is fed to the voltage divider circuit which is 12V.Here,we are eliminating the negative half of the supply. From the voltage divider circuit approximately 1.17 volts is tapped. As in arduino the maximum voltage we can feed is 5Volts. This is the logic behind giving the output of rectifier to voltage divider circuit, so that we can trap voltage less than /equal to 5V. The output of the voltage divider circuit is given to the analog pins of arduino i.e. A0,A1 and A2 and by programming in arduino (using basic C and arduino IDE) we are able to detect the phase sequence by the concept of zero crossing and the output is displayed on computer screen. In arduino there is 10 bit-ADC (210=1024). The ADC on the Arduino is a 10-bit ADC, meaning it has the ability to detect 1,024 (210) discrete analog levels. The way an ADC works is fairly complex. The microcontroller monitors the number of clock cycles that pass before the capacitor is discharged. This number of cycles is the number that is returned once the ADC is complete.

5.3. SYSTEM REQUIREMENTS AND ITS OPERATION:

Developing an arduino based programming model of three phase sequence indicator has enabled us to analyze and survey about the necessity of the requirement to make unique and based on the latest techniques and features to make it cheap and easily available for the consumers. The required components are listed below:

- Step down transformers
- Diodes
- Resistors
- Arduino

5.4. CURRENT SENSOR:

Unit The current measuring circuit, shown in Figure 3.2., is based on the Allegro ACS712 IC sensor [17]. The ACS712 IC is a linear current sensor used for measuring AC and DC currents. This device comes in three types from the manufacturer according to the maximum current sensed (±5, ±20, and ±30 A). In this paper, the ACS712-30A was used as the current sensor. The ACS712-30A can measure currents up to ±30 A and with 66 mV/A output sensitivity on a +5 V DC power supply.

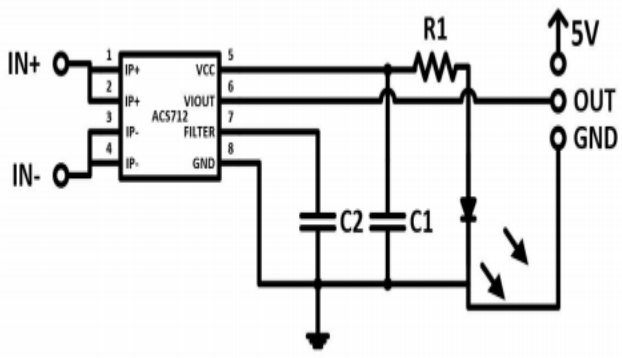


Figure 5.3. Current sensor circuit

5.5. REAL-TIME MEASUREMENT OF ELECTRICAL QUANTITIES:

In general, the output signals of the voltage sensor ZMPT101B and the current sensor ACS712 are sinusoidal voltage waveforms which have their amplitude between 0V and 5V in order to coincide with the analog input of the Arduino Uno. The signals are continuously sampled with a specific sampling time which depends on the processing speed of the microcontroller board. For the Arduino Uno microcontroller board, both voltage and current signals from the voltage and current sensors have sampling time Ts=4ms. The AC voltage source used to supply the experimental system in this work has a fundamental frequency f=50Hz so the cycle duration is 20ms. This means there are 5 samples per cycle of the fundamental frequency.

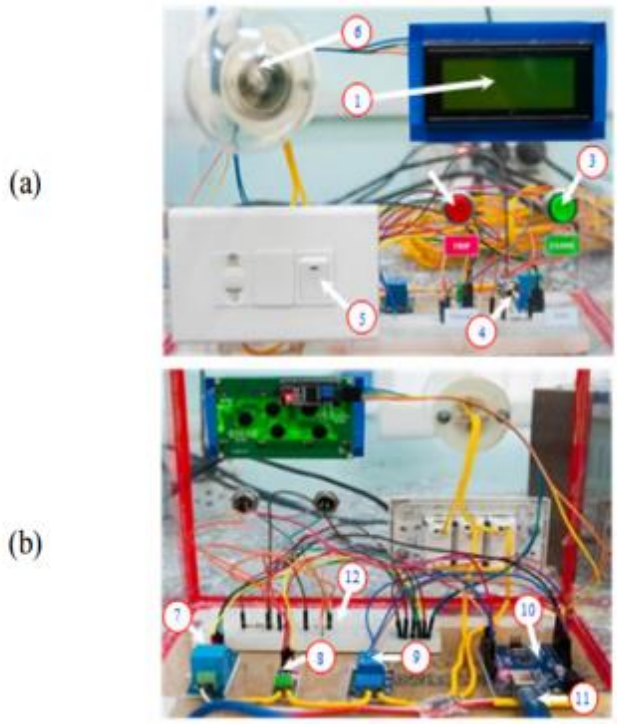


Fig. 5.4. The overvoltage and undervoltage protection system: (a) front (b) back

5.6 DESIGN HARDWARE

A. The power supply or adapter:

Is a device electronic components that function is used as a modifier of the AC voltage generated enumerated by the transformer into DC voltage 9 VDC and 5Vdc to be used for supply voltage at the microcontroller arduino and equipment other where there is a 16x2 LCD, Relay Module and Bluetooth Module HC-05, show in Figure5.5.

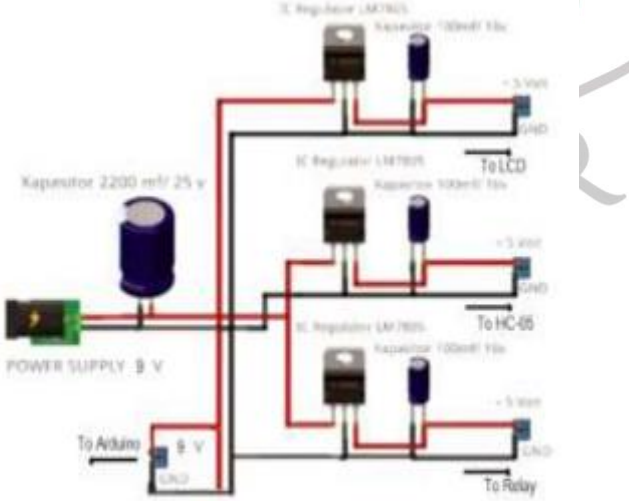


Figure 5.5. Circuit power supply

B.SCT013-20A Current Sensor

Current Sensor to the design of this tool serves as a place to input current sensor, so that when the current sensor is mounted on the cable system 3 phase then the current sensor will work and through the microcontroller arduino. The circuit is made as much as 3 pieces, due to input itself requires 3 circuits as reading the current value of R, S, and T. In 3feeder system phase in the execution of the circuit using Proteus 7.9 software.

C. Design of the overall circuit

Design of the circuit as a whole covers a series of power supply or adapter, current sensor circuit SCT-013, a series of LCD, LED and alarm circuits and Bluetooth circuit HC-05. Stage to the whole starts with a flow chart on the show in Figure 5.6.

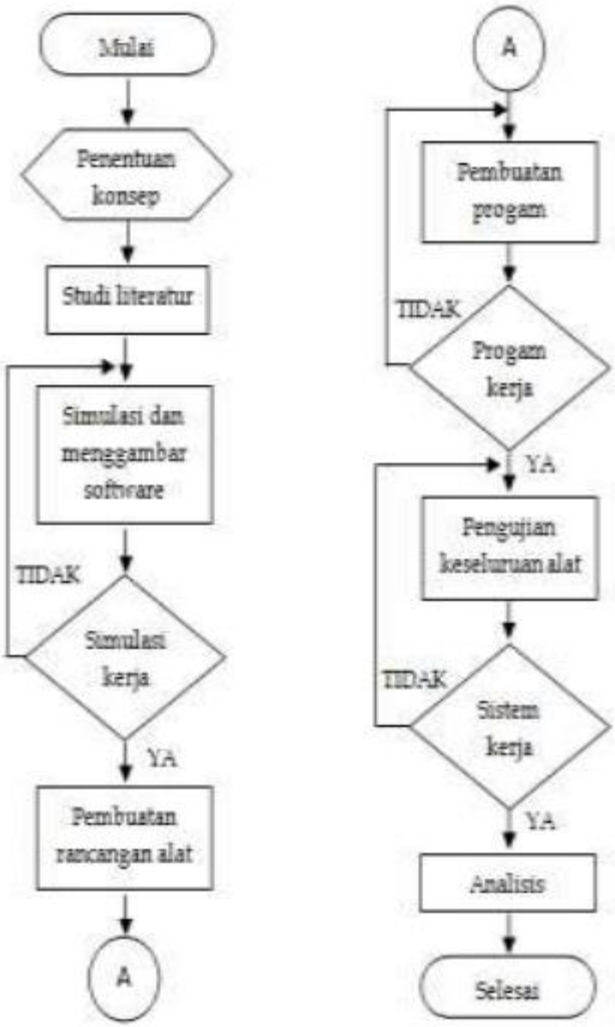


Figure 5.6. Flowchart

5.7. WIRELESS COMMUNICATION

The Bluetooth HC-05 module shown in Figure5.6 was used as the wireless communication device between the microcontroller and the end user (smartphone device). This model is connected directly to the Arduino Nano V3.0. The Bluetooth HC-05 properties are shown in Table 1.

Parameter	Value
Frequency	ISM band, 2.4 GHz
Synchronous	1 Mbps/1 Mbps
Power Supply	+3.3 VDC 50 mA
Working Temperature	(−25~+75) °C
Transmit Power	Class 2, ≤4 dBm

Table 1. Properties of Bluetooth HC-05.

VI.CONCLUSION

The paper aims to design an Autorecloser for three phase system with Data Acquisition System. This system will reduce the human efforts of closing the Circuit Breaker and also reduce the cost of the protection system. Auto reclosing will improve the transmission system stability and integrity. Also use of comparatively cheap Arduino and Data Acquisition System will make it more easy and simple to understand. The dissertation is based on the protection of three phase induction motor under single phasing condition, over voltage, under voltage, overloading and it is implemented using controller, step down transformers, current transformers, sensing circuits and protective relays. The system is very cheap as compared to present protective devices available. The protection system can protect three phase induction motor from under voltage, over voltage, overloading and single phasing. By using sensing circuits we can sense voltage and current and these values given to controller. Controller will give the command to relay to ON-OFF the motor

VII. FUTURE SCOPE

The future implications of the project are very great considering the amount of time and resources it saves. The project we have undertaken can be used as a reference or as a base for realizing a protection scheme to be implemented in other transmission lines of higher level. Also the current system can be made to work with conventional SCADA or other Communication Services like GSM to operate remotely.

VIII. REFRENCES

[1] Kimbark, Edward Wilson, ScD; Power System Stability; John Wiley & Sons, Inc., N.Y., London
[2] HAVRAN, F.J. 1999. Fault investigation on power transmission system. ESKOM. Internaldocument: 38, 96-99KELLER, P. 1998. Correct fault analysis. Eskom internal document
[3] "Microprocessor-Based Transmission Line Relay Applications"- Presented at the American Public Power Association's Engineering & Operations Workshop Salt Lake City, Utah March 25–28, 1996
[4] Paul M. Anderson, "Analysis of Faulted Power Systems", The Institute of Electrical and Electronics Engineers, Inc., 1995.
[5] Turan Gonen, "Electric Power Transmission System Engineering, Analysis and Design", Crc Press Taylor and Francis Group.
[6] Miroslav D. Markovic, "Fault Analysis in Power Systems by Using the Fortescue Method", TESLA Institute, 2009.
[7] Jun Zhu. "Analysis Of Transmission System Faults the Phase Domain", Texas A&M University. Master Thesis, 2004.
[8] D. C. Yu, D. Chen, S. Ramasamy and D. G. Flinn, "A Windows Based Graphical Package for Symmetrical Components Analysis", IEEE Transactions on Power Systems, Vol. 10, No. 4, pp 1742-1749, November 1995.
[9] Larry Wright ,68th Annual Conference for Protective Relay Engineers, March 2015
[10] Lee Ayers, IEEE Rural Electric Power Conference Asheville, North Carolina.
[11] Javed A. and Izhar T., "An improved method for detection of faults in induction motor." Third International Conference on Electrical Engineering, 2009,ICEE09,ppp.1-6,9-11 April 2009,Lahore.
[12] Chattopadhyay S.,ChattopadhyayA. And Sengupta S., "Analysis of stator current of Induction motor used in transport t system at single phasing."Electrical Systems of Transportation , IET, Vol. 4, no. 1, pp. 1-8, March 2014.
[13] Ching-Yin Lee, "Effects of unbalanced voltage on the operation performance of a three phase induction motor," IEEE Transactions on Energy Conversion, Vol. 14, no. 2pp.202- 208, June 199 [9] Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey " PICController and Embedded system using Assembly and C for PIC18.