Over current and under voltage monitoring system of a three phase induction motor based on IoT

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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled "Over current and under voltage monitoring system of a three phase induction motor based on IoT" is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

Sudden fluctuations in voltage may cause a serious problem in industriesand home application.These fluctuations may significantly impact the power quality and reliability of other voltage-controlling devices. However, this proposed project discussed about the design for under-voltage and over-voltage protection to protect and extend the security of the home, office, and industrial equipment. LDR is used here to detect the voltage of a few percentages below the rated voltage and it is recognized as under voltage while a few percentages of the rated voltage are recognized as over voltage. We are using 3 phase induction motor. Moreover, the sensor is attached to the board WiFi platform so that the user can observe the voltage condition through Blynk application.In conclusion, the combination of voltage protection systems through the Internet of Things (IoT) devices may contribute to the user.

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List of ABBREVIATIONS

DC	Direct Current
AC	Alternating Current.
LCD	Liquid Crystal Display
ADC	Analog-to-Digital Converter
IR	Infrared Receiver
IC	Integrated Circuit
LED	Light Emitting Diode
PCB	Printed Circuit Board
LCD	Liquid Crystal Display
O/V	Over Voltage
U/V	Under Voltage
O/C	Over Current

CHAPTER I

INTRODUCTION

1.1 Introduction

The Internet of things (IoT) might be the network of devices, vehicles, and home appliances that contain electronics, software, actuators, and connectivity which might allow these things to connect, interact and exchange data. Embedded with technology, these devices might communicate and interact over the Internet, and they might be remotely monitored and controlled. However, every electrical appliances need to be designed in such a way that they operate properly within these limits. It is because overheating and insulation failure might happen when electric equipment's are subjected to under or over voltage conditions. An appliance built to operate at 440 V will serve its maximum lifetime at this voltage. If the voltage is too under, the amperage increases, which may result in the components melting down or causing the appliance to malfunction. If the voltage is too high, this will cause appliances to run too fast and too high which will shorten the service life. The paper aims to build a protection system to analyze and monitors voltage high and under voltage that avoids any damage to the load using IoT. This system includes Esp32 dev board which finds out the voltage level which is displayed on the LCD or laptop screen. The LDR sensor not only detects voltage levels but also sends signal via Wi-Fi modems controlled by ESP32 node micro controller unit amica to alert users when voltage levels cross.

1.2 Background Study

Bangladesh power development board (BPDB) has agreed to set the standard MS IEC 60038: 2009 - IEC standard voltages as the nominal voltage for the new under voltage supply system in Bangladesh at 220/440V with at frequencies 50 Hz with ± 1% range, replacing current supply voltage of 230 / 445V with range + 5% and - 10% at the same frequency. It implements a circuit which helps to detect the voltage beunder 214/380 volts it is under voltage condition and in this condition our circuit will remain in open condition so there will on any passage of current. When the voltage rises above 445 volts which is 10% of our rated voltage and it is over voltage condition

1.3 Objectives

Electrical faults may exist in any component of the system faults which nay cause catastrophic results should be cleared out immediately to protect the other parts of the system from further damage for example the failure of switching devices in the in inverter while other faults may undergo a long time of development before break down for example the motor insulation failure usually the fault diagnosis of the drive system can be a manual one by monitoring the voltage current or other variables of the components the accuracy of such diagnosis is much more subjective subject to the experience of the components by simulation is a very efficient approach and the simulated data can be used as bench marks for empirical diagnosis condition monitoring of electrical machines is becoming increasingly essential from both practical and theoretical points of view it plays very important role in the safe operation of industrial plants and hence heavy production losses can be avoided however the choice of adequate monitoring methods is a challenging task most of the indicators used for monitoring electrical machines are currents temperatures voltages and 4 vibrations depending on their varying accessibility and sensitivity.

1.4 In This Project

Chapter one covers introduction, background, objectives. Chapter two represents theory, description of the chip microcontroller, sensor, circuit breaker, magnetic contact, thermal overload relay, phase fault relay, LCD display and other components. Chapter three describes and working principle of the project. In chapter four we have discussed result and discussion, cost estimation, future modification, conclusion.

CHAPTER II
THEORY OF OUR PROJECT

2.1 Introduction

This chapter includes the total over view of the device. In this chapter we have followed-up the theory of MCB, Magnetic contact, phase failure relay, overload relay, LCD, resistor, briefly describe of chip-microcontroller (ESP32 Dev), Crystal, LCD display (16x4), Vero board, and other components. Here we can know that the total system overview of the projects. And we will also know that how the equipment are working with each other.

2.2 Theory

We've developed the system that can handle this critical switching situation perfectly. Our system has several voltage, and current sensors to measure any over, under voltage. Based on those circumstances our system manages that power source switching. For example if any of those power sources get any problems like under voltage, our system immediately switches the power source to other power sources that has no problems. It also can provide stable output voltage depends on the input voltage state.

2.3 Circuit breaker

There are two essential contacts in a circuit breaker, and they are: Fixed contacts. Moving contacts When the circuit is closed, which is a normal condition, the contacts touch each other and carry the current under this condition. Under a closed circuit breaker, current-carrying contacts are known as electrodes that engage each other due to the pressure of a spring. The switching and maintenance of the system are taken care of by either opening or closing the arms of the circuit breaker. The circuit breaker is opened by applying pressure to the trigger. When there is a faulty current flowing through any part of the system, the trip coil of the breaker gets energized thereby moving away from each other, thus opening the circuit.

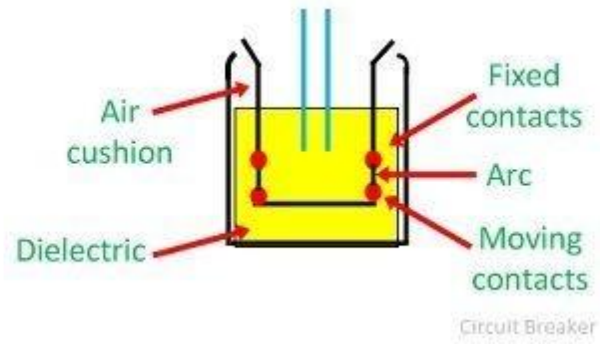

Figure 2.1: Circuit breakers

2.4 Thermal Overload relay

Thermal Overload relay works on the principle of thermal expansion, i.e., as the relay detects an increase in temperature and expands, it is pulled out of the mounding base. Thus, it releases contact from push-on conducts that close when connections are withdrawn. In this article, we've discussed the thermal overload - relay working principle and MEC thermal overload-relay products.

Figure 2.2: Overload relay

2.5 Magnetic contactor

The working principle of the magnetic contactor is that the main contact is closed due to the coil being energized, and the main contact is disconnected due to the de-energization of the coil.

The control circuit is composed of electromagnetic and spring system. The current through the coil activates the magnetism, and the two magnetism approaches each other. This movement shuts off two magnetic forces. Therefore, the contact is closed and the spring provides power to the contact. When the control current is disconnected, the contact is disconnected.

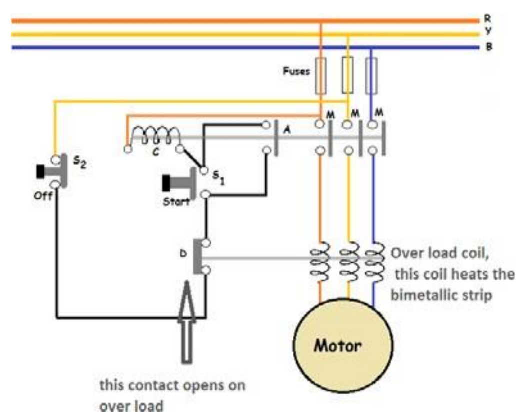

Figure2.3: Magnetic Contact

This basic principle has been used for more than 100 years, and no new methods have emerged so far. You can also watch the video below to better understand how the magnetic contactor works.

2.5.1 Meta-MEC Contactors

- Compact size (3 frame size)
- Offering complete ranges (3 poles and 4 poles)
- Easy to mount and separate on DIN rail
- Common use auxiliary contact unit
- Various kinds of accessories are available
    - Auxiliary contact block (front side)
    - Mechanical interlock, mechanical latch unit
    - Direct mounting structure without additional brackets
    - Delay opening device lug terminals
    - Certificates : CE, VL, KEMA, KR, LR

2.6 Phase fault relay

A Phase Failure Relay will have one or multiple relay outputs which are normally in a fail safe configuration. These relays will energies and close the circuit when the supply conditions are within acceptable tolerances. Under one of the above mentioned fault conditions the outputs will become open which will break the circuit and switch off the control system or machinery further down the line to protect it from any damage which may be caused due to unsuitable supply conditions..

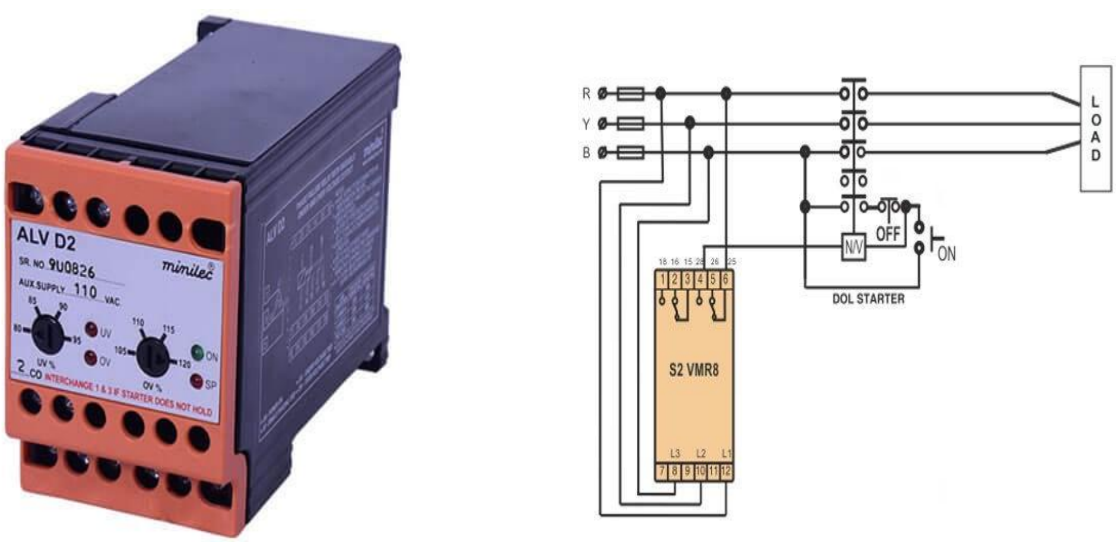

Figure 2.4: Phase failure relay

2.6.1 Phase Failure Fault Conditions

2.6.1.1 Phase Loss - This is when one or more phases are no longer present. A Phase Loss can stop a motor from starting or stall if it is already running. If the motor does not stall this will cause a massive imbalance on the supply and can lead to a current increase of up to 600% in the operating phases which can damage your motor by overheating. Monzingers rule states that if a motor runs 10% above it maximum rated temperature, it's working life is reduces by 50%. Heat is your enemy!

2.6.1.2 Under Voltage - This is when the voltage of one or more phases is under the pre-set minimum limit. Under voltage will make your motor demand more current which may cause damage over time.

2.6.1.3 Over Voltage - This is when the voltage of one or more phases is over the pre-set maximum limit. Over Voltage its self can cause damage a Motor.

2.6.1.4 Phase Sequence - This is when the three phases are not connected in the correct sequence. If a motor is started with an incorrect phase sequence it will cause them to start in reverse which may cause damage.

2.6.1.5 Phase Asymmetry - This is when the load on all three phases is not balanced correctly. If supply is more than 5% out of balance then this can cause damage to AC motors and pumps through thermal stress. Only Phase Failure Relays with Phase Asymmetry monitoring can detect this fault condition.

2.6.1.6 Neutral Loss - Loss of neutral can cause over-voltage of up to 2 x on down-stream single-phase devices connected between 1 phase and neutral.

2.7 Push button switch

A push button switch is basically an electric switch and is used to control the current flowing through a circuit. The working of a push button switch is that when the switch opens, pushing the switch closes and when the switch closes, pushing switch.

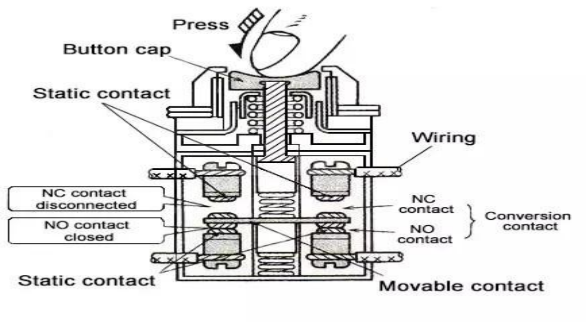

Figure2.5: push button

2.8 Three phase induction motor

A three phase induction motor has a stator and a rotor. The stator carries a 3-phase winding called as stator winding while the rotor carries a short circuited winding called as rotor winding. The stator winding is fed from 3- phase supply and the rotor winding derives its voltage and power from the stator winding through electromagnetic induction. Therefore, the working principle of a 3-phase induction motor is fundamentally based on electromagnetic induction.
Consider a portion of a three phase induction motor (see the figure). Therefore, the working of a three phase induction motor can be explained asfollows −
When the stator winding is connected to a balanced three phase supply, a rotating magnetic field (RMF) is setup which rotates around the stator at synchronous speed (Ns). Where,

Ns=120f/p
The RMF passes through air gap and cuts the rotor conductors, which are stationary at start. Due to relative motion between RMF and the stationary rotor, an EMF is induced in the rotor conductors. Since the rotor circuit is short-circuited, a current starts flowing in the rotor conductors.

Now, the current carrying rotor conductors are in a magnetic field created by the stator. As a result of this, mechanical force acts on the rotor conductors.

The sum of mechanical forces on all the rotor conductors produces a torquewhich tries to move the rotor in the same direction as the RMF.
Hence, the induction motor starts to rotate. From, the above discussion, itcan be seen that the three phase induction motor is self-starting motor.
The three induction motor accelerates till the speed reached to a speed justbelow the synchronous speed.

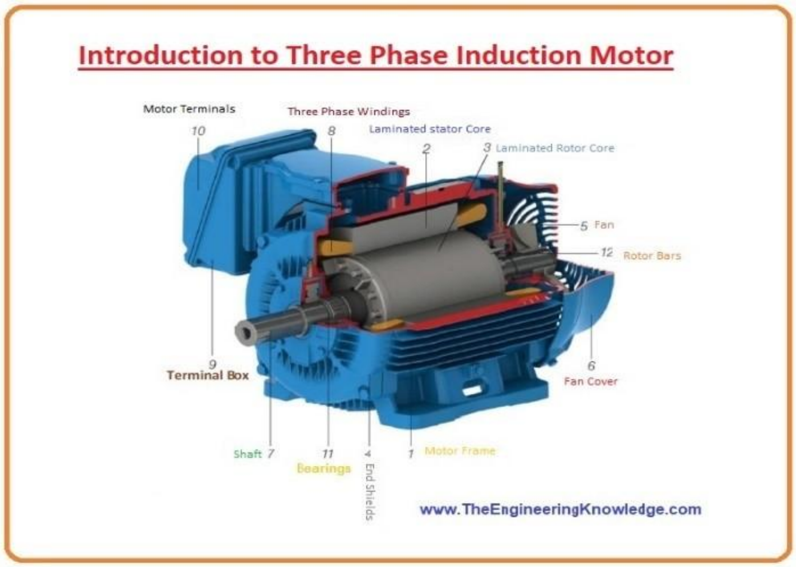

Figure 2.6: Three phase induction motor

2.9 ESP32 dev board

ESP32 is a series of low cost,low power system on a chip- microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual- core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

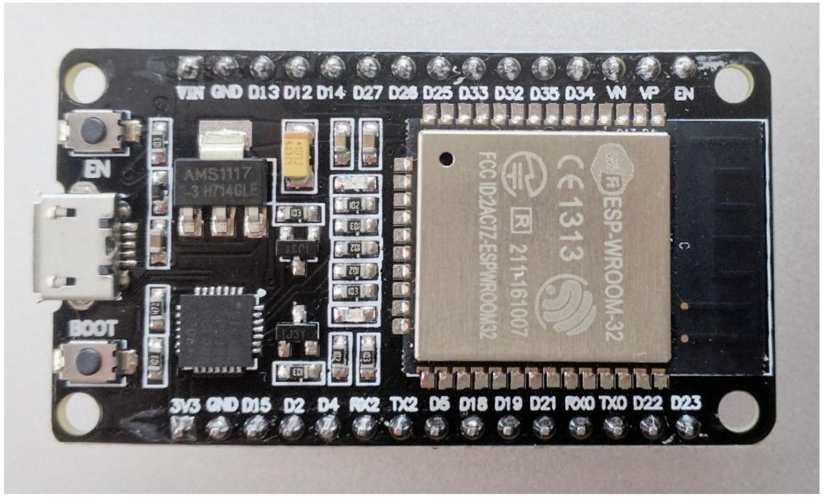

Figure 2.7:ESP32 Dev board

2.9.1 Features of the ESP32 include the following

2.9.1.1 Processor:

- CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
- Ultra low power (ULP) co-processor

2.9.1.2 Memory: 320 KiB RAM, 448 KiB ROM

2.9.1.3 Wireless connectivity:

- Wi-Fi: 802.11 b/g/n
- Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)

2.9.1.4 Peripheral interfaces:

- 34 × programmable GPIOs
- 12-bit SAR ADC up to 18 channels
- 2 × 8-bit DACs

- 10 × touch sensors (capacitive sensing GPIOs)
- 4 × SPI
- 2 × I²S interfaces
- 2 × I²C interfaces
- 3 × UART
- SD/SDIO/CE-ATA/MMC/eMMC host controller
- SDIO/SPI slave controller
- Ethernet MAC interface with dedicated DMA and planned IEEE 1588 Precision Time Protocol support[4]
- CAN bus 2.0
- Infrared remote controller (TX/RX, up to 8 channels)
- Pulse counter (capable of full quadrature decoding)
- Motor PWM
- LED PWM (up to 16 channels)
- Hall effect sensor
- Ultra low power analog pre-amplifier

2.9.1.5 Security:

- IEEE 802.11 standard security features all supported, including WPA, WPA2, WPA3 (depending on version)[5] and WLAN Authentication and Privacy Infrastructure (WAPI)
- Secure boot
- Flash encryption
- 1024-bit OTP, up to 768-bit for customers
- Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)

2.9.1.6 Power management:

- Internal low-dropout regulator
- Individual power domain for RTC
- 5 µA deep sleep current
- Wake up from GPIO interrupt, timer, ADC measurements, capacitivetouch sensor interrupt

2.9.2 Programming

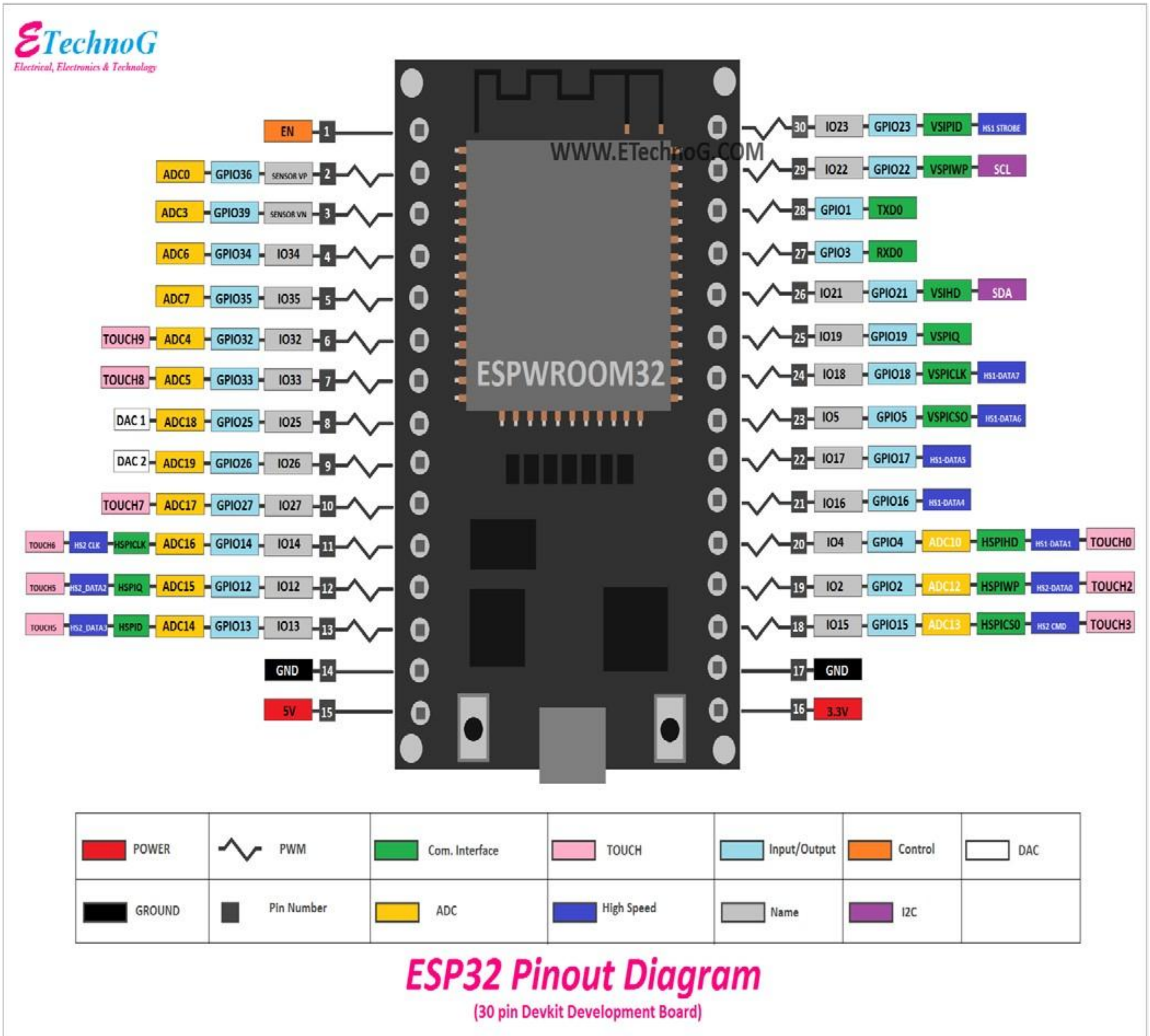

Figure 2.8:ESP32 dev board diagram

2.10 Blynk Application Fundamental

There are many apps to control the wi-Fi communication with our smartphones or laptop. In our project we have used Blynk apps for controlling our project using our smart phone or laptop. Blynk app for ios and Android is the easiest way to build our own mobile or laptop app that work with the hardware of our choice.Blynk Library is an extension that runs on top of the hardware application.It handles all the connection routines and data exchange between our hardware, Blynk cloud,and our project.

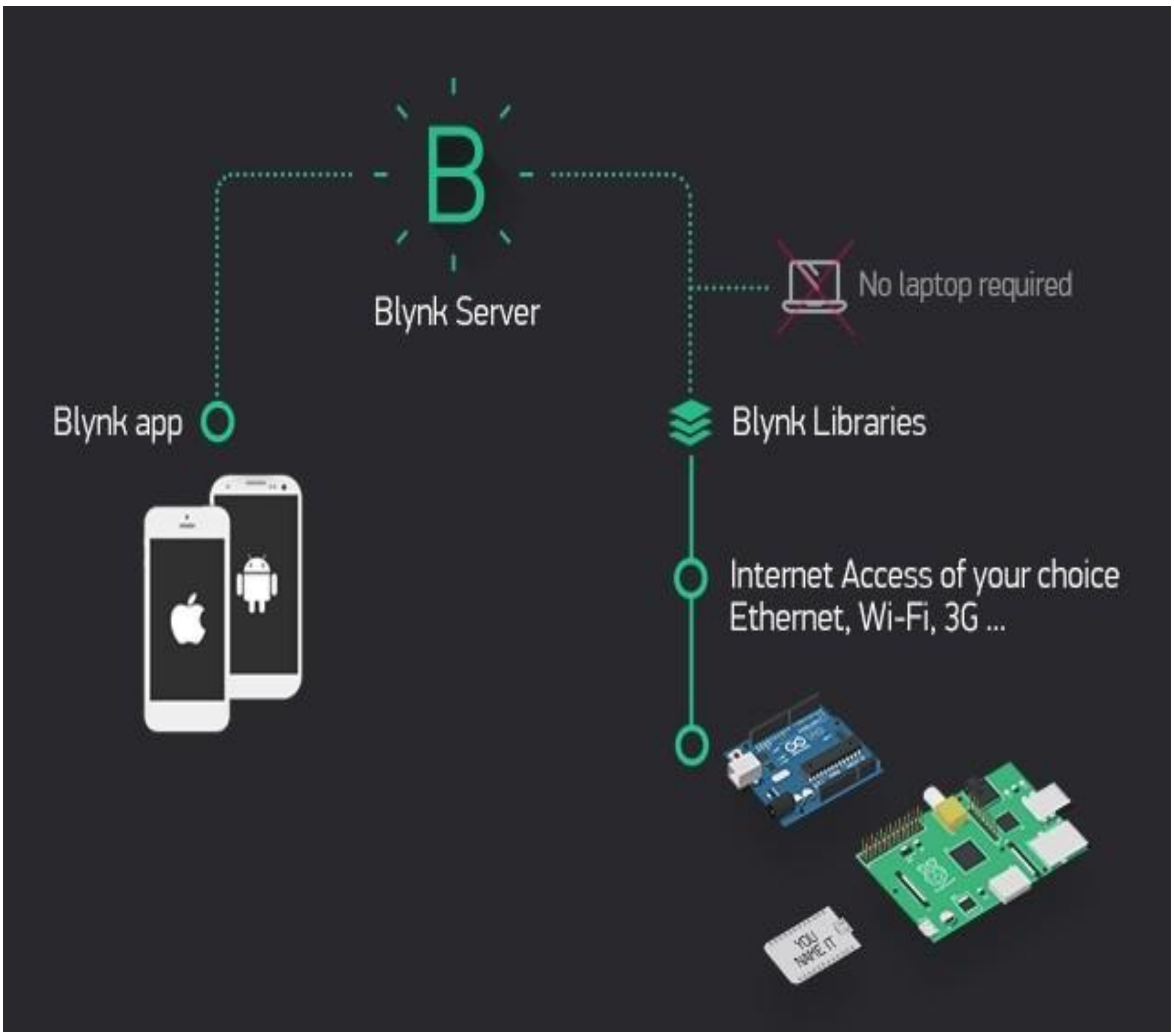

Figure 2.9: Blynk application communication feature

2.10.1 Major features

"Blynk app"It can control hardware remotely, it can display sensor data,it can store data visualize it and do many other cool things .There are three major components in the platform: Blynk App-allows to you create amazing interfaces for our projects using various widgets.

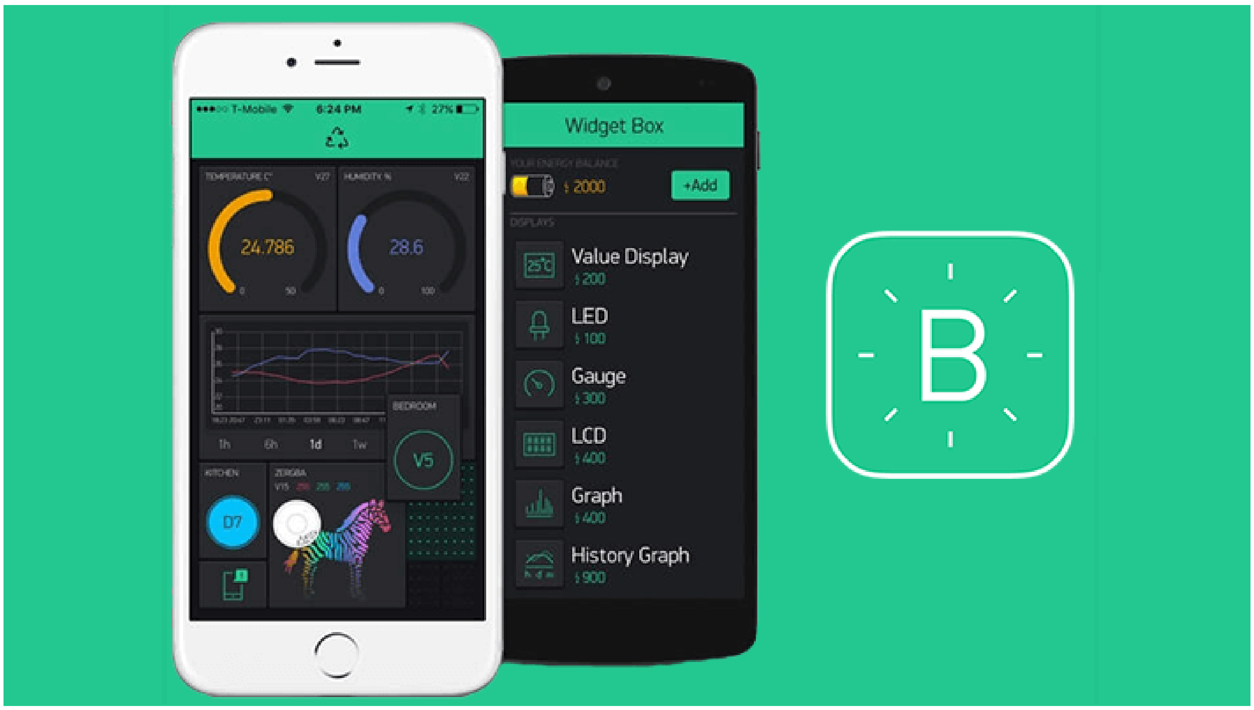

Figure 2.10: Blynk application widget box

2.11 Clamp current sensor

This non-invasive current sensor (**SCT-013-000 Non-invasive**)clamped around the supply line can measure a load up to 100 Amps, and allow you to calculate how much current pass through it. It can be useful for building your own energy monitor or for three phase induction motors an over-current protection device for an AC load. This current clamp can be used to detect a current of up to 100A. Simply clip it around the current source that you wish to measure and it will produce a (very) small AC voltage proportional to the current. The cable is terminated on one end with a standard .

Use this to build your own energy monitor and keep your power usage down, or use it to build an over-current protection device for an AC load. This non-invasive current sensor(**SCT-013-000 Non-invasive**) with ESP32 dev board & Send the data to Mobile Application.

Figure 2.11: Current sensor

2.12 LDR Sensor

LDR or light-dependent resistor is responsive to light. Once light rays drop on it, then immediately the resistance will be changed. The resistance values of an LDR may change over several orders of magnitude. The resistance value will be dropped when the light level increases.The resistance values of LDR in darkness are several megaohms whereas in bright light it will be dropped to hundred ohms. So due to this change in resistance, these resistors are extremely used in different applications. The LDR sensitivity also changes through the incident light’s wavelength.

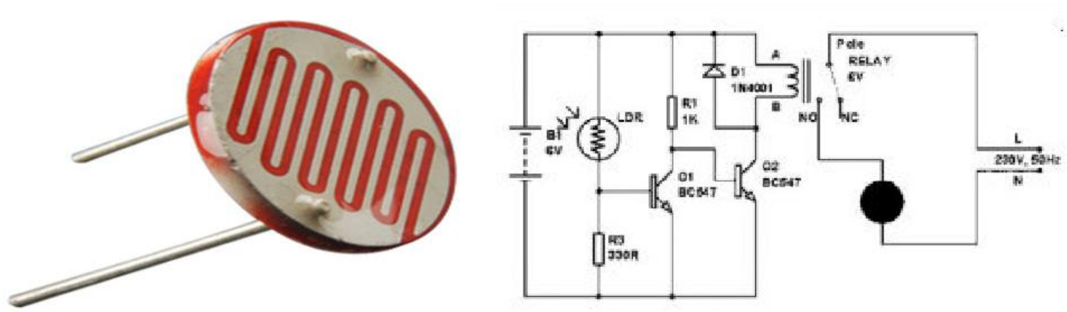

Figure 2.12: LDR SENSOR

The working principle of an LDR is photoconductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the LDR, then the electrons in the valence band of the material are eager to the conduction band. But, the photons in the incident light must have energy superior to the bandgap of the material to make the electrons jump from one band to another band (valance to conduction).

CHAPTER III
DESING & IMPLEMENATION

3.1 Introduction

In this chapter fully cover with discuss design and fabrication of this project. Here we will discuss about developed block diagram and briefly describe about the circuit description and also learn about working principle. Total project flow chart is also available in this chapter.

3.2 Block diagram

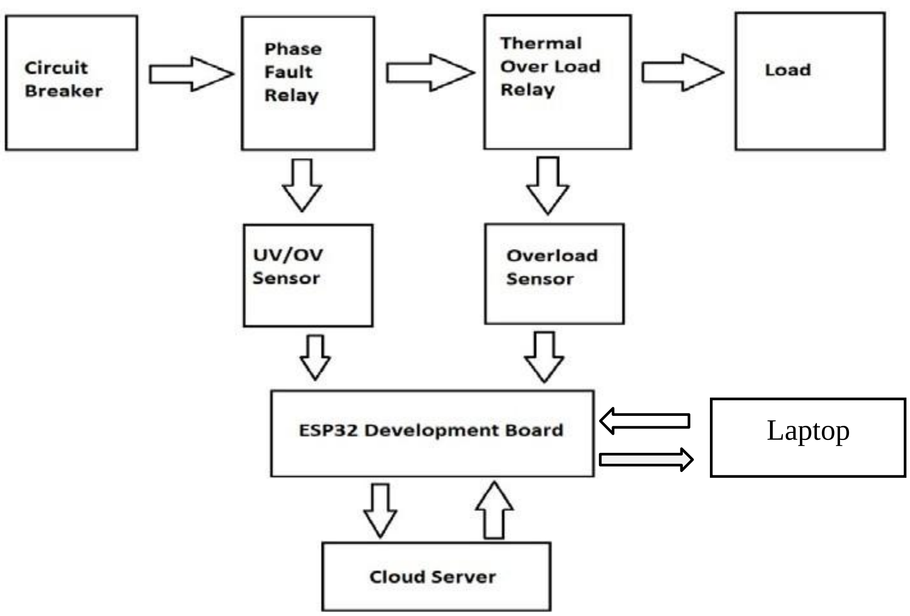

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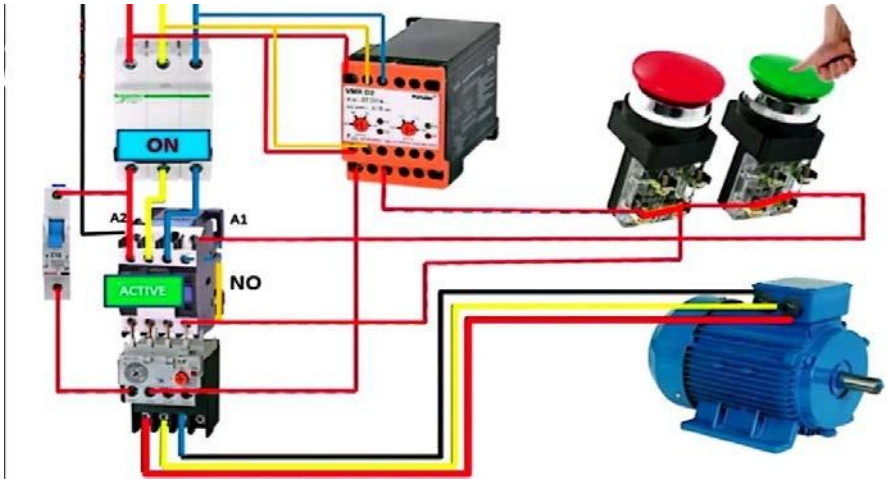
Figure 3.1: Block diagram

3.3 Circuit diagram



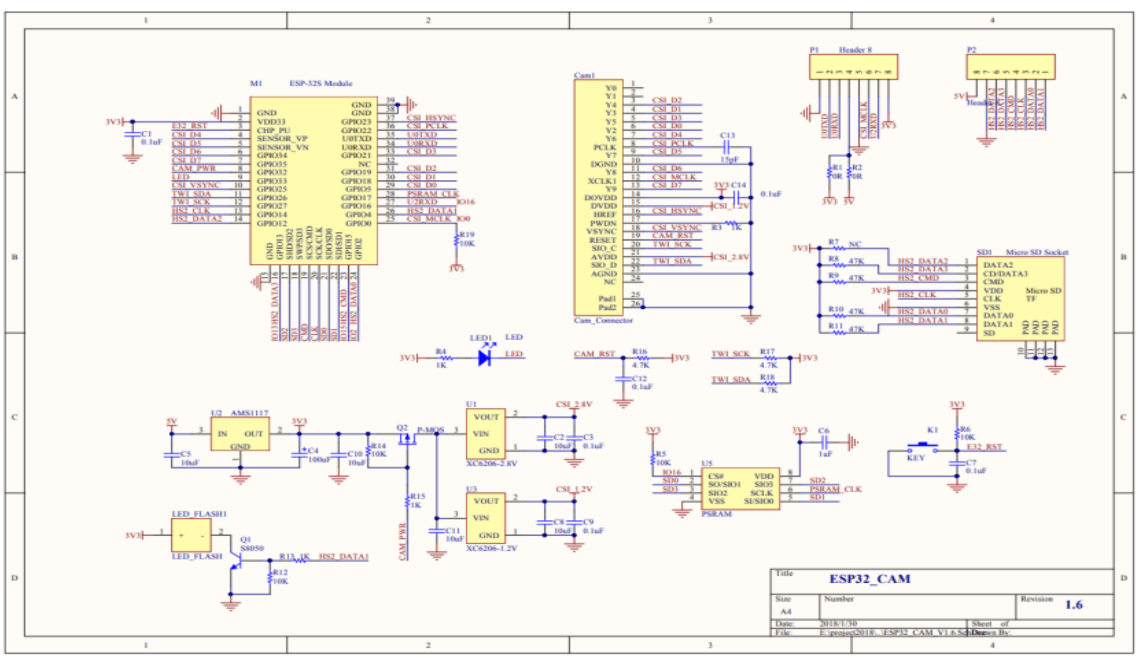


Figure 3.2: Circuit diagram

3.4 Working principle

IOT based induction motor is very important for industries.

In this project we need to use different protect actives to create a three phase motor. First we use phase fault relay, thermal overload relay, magnetic contactor, fuse, wire, Esp32 dev board as protection to run the three phase motor. Now if we flow power from the source then if due to some reason the voltage is low through three phase then the red light will light on the phase fault relay and it will be displayed on the phone app the motor will not run.

If the voltage is too high, the red light on the phase fault relay will flash and the connection with the magnetic contactor will be closed and display on the phone app, and the motor will stop immediately. It will not harm .If for some reason the current is high then the thermal overload relay will trip and the connection with the magnetic contactor will be closed and the motor will be stopped and it will show on the mobile app. And in this way we can run a three phase motor.

3.5 Image of our project 1

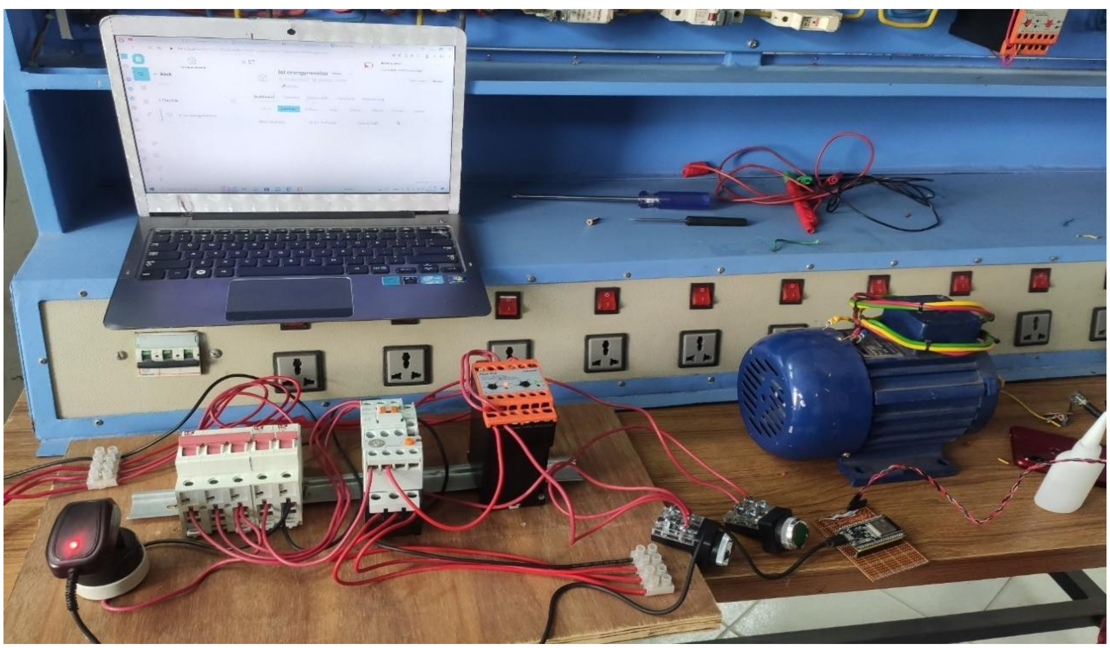


Figure 3.3: Real image 1

3.5.1 Image of our project 2

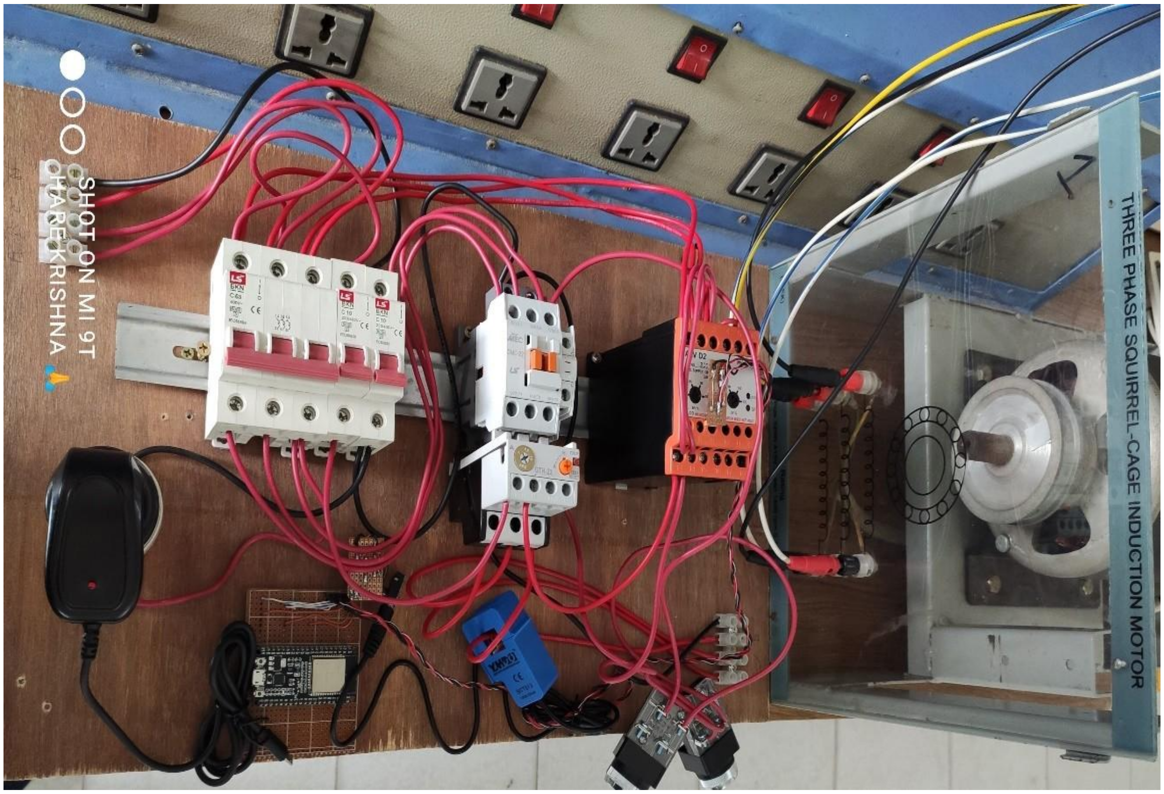


Figure 3.4: Real image 2

3.6 Used materials

1. Magnetic contactor (1)
2. Three phase motor (1)
3. Wire
4. Thermal overload relay (1)
5. Phase fault relay(1)
6. Fuse (3)
7. ESP 32 dev board(1)
8. Sensor(1)
9. Phone app

3.7 Flow Chart

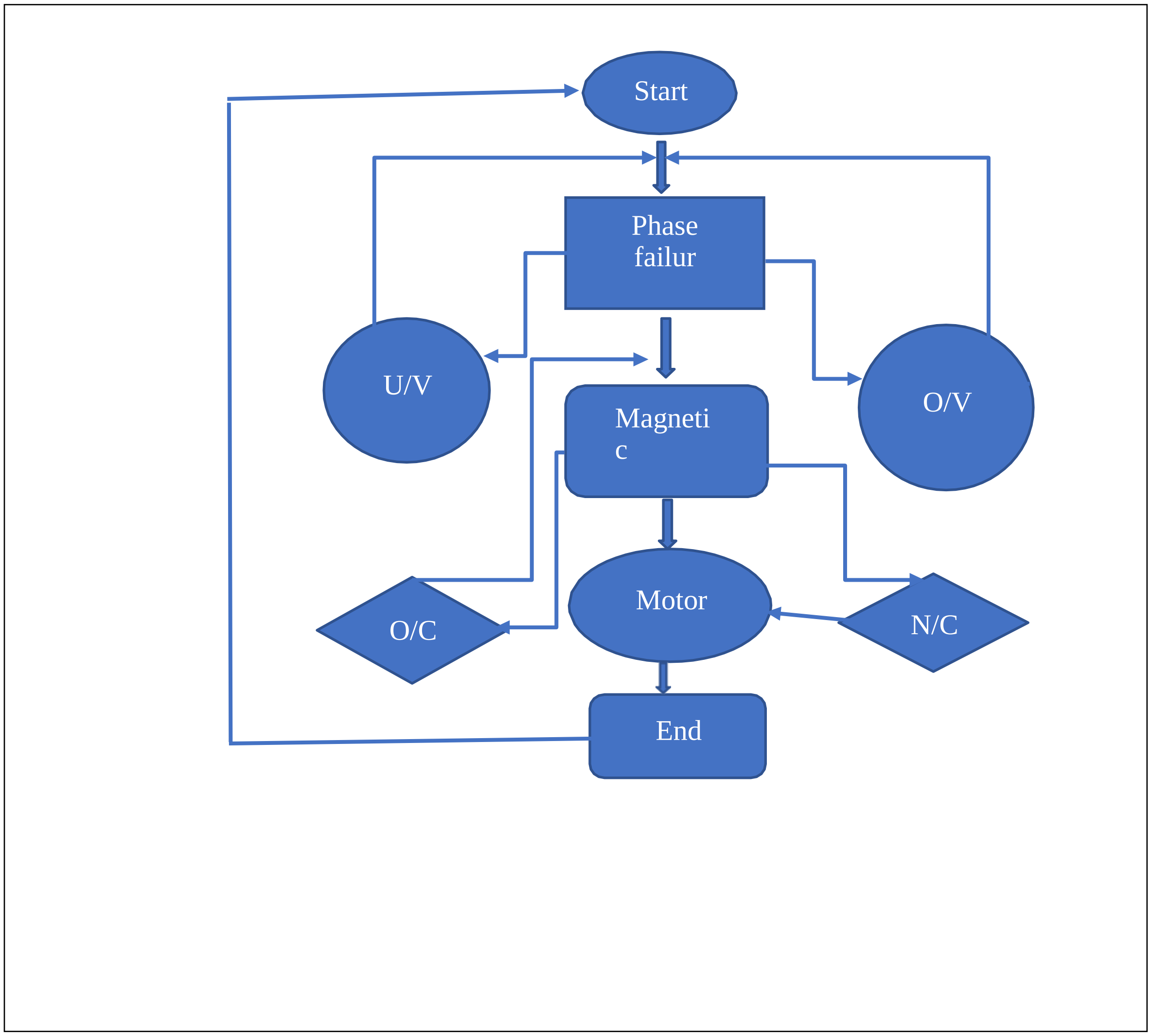


Figure : 3.5 Flow Chart

Chapter IV
RESULT & DISCUSSION

4.1 Introduction

This chapter contains the results obtained and discussion about the project. We have also covered discussions about advantages, disadvantages and limitation of current version of the protection system.

4.2 Result

After the final assembly as distribution boards, switches and lights are installed, these components mainly controlled by a programmable chip- microcontroller (ESP32 dev) and supported with Wi-Fi module ESP32 and LCD. The system reads the AC voltage and compares the AC voltage with the predefined limits and display the warning message via computer and LCD accordingly. The system will analyze the condition of voltage. The input signals will be displayed to Thinger. IoT application which is obtained from Blynk. A ESP 32 dev Wi-Fi module is attached which act as a bridge between the Thinger.Io application and the chip-microcontroller that enables the user to see the device by using Thinger. Io application. It will be detecting under and over voltage by using a LDR sensor and feed its output to chip-microcontroller (ESP32 dev) for taking action by code.

4.3 Advantage of IOT based protection three phase induction motor.

1. Looking at this project we can see that if there is any problem we caneasily know through an app.
2. We can measure the minimum voltage at which the motor turns on,the maximum voltage at which it turns off with a phase-fault relay.
3. At what current the motor turns on and off we can find out throughthe thermal overload relay.

4. As soon as the thermal overload relay trips, we will know through the sensor at APPS.
5. If the source current is too high for some reason then the thermal overload relay works as a motor protect to protect the motor from burning.

4.4 Disadvantage of IOT based three phase induction motor.

- If there is a problem in this project we can know but we cannot controlIt.
- Initially the cost to build the project is high.
- Since I am using only one magnetic contactor, if the contactor is broken due to some reason, then the phase fault relay and thermal overload relay will not work and this will cause a big problem in the motor.
- If fuses or circuit breakers are not used, if for any reason high current or voltage flows from the source, the entire system will be destroyed.

4.5 Equipment list

SI	Particulars	Specification	Qty.
1	Magnetic contactor	GMC -22	1
2	Thermal overload relay	7-10A	1
3	MCB -TP		1
4	MCB-SP		2
5	Push -switch		2
6	Aluminum channel		1
7	Phase fault relay (V.D)		1
8	Bsp-32		1
9	LDE Sensor		3
10	Current sensor		1
11	Board (wood)		
12	Clip		
13	wire		30fit
	Others		

Table; 4.1 Equipment list

4.6 Application

Voltage and current display relay used in Administrative, industrial and residential buildings and has the function of protecting three-phase lines:

- Undervoltage protection;
- Overvoltage protection;
- Overcurrent protection;

.

Chapter V
CONCLUSION

5.1 Conclusion

By using this process of three phase induction motor any factory can do any work safely. And if you want, you can control it from anywhere through an app in the future. It will require less labor and save money.
The study and development of workplace For Induction Motor. The no load check is meant to search out the no load current, core loss, friction and winding losses and also the blocked rotor check is disbursed to see the copper loss of motor. Also, temperature check primarily supposed to see the temperature rise at the bearing and also the winding of the motor .By exploitation these bench we've conducted 2 mode operation that is Run Mode and check mode. In run mode we will conducted over voltage , over current , over temperature in addition as beneath voltage ,three phasing motor protection.

5.2 Future Work

At present we can use easily.We can control it by ourselves.Due to the use of phase fault relay and thermal overload relay, there will be no damage to the motor in future. Again, we can control it from anywhere using an app later. As a result, time will be less and cost will be reduced and we will be able to control the motor better.

References

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Appendix

Programmin Code

```
#define BLYNK_TEMPLATE_ID "TMPLiAbNIYiv" #define
BLYNK_DEVICE_NAME "IOT Energy Monitor"
#define BLYNK_AUTH_TOKEN "3tbs80wBF8DSjCBM9_tuanlbU1EzLI4x"#define
BLYNK_PRINT Serial

#include <WiFi.h> #include
<WiFiClient.h>
#include <BlynkSimpleEsp32.h>

char auth[] = BLYNK_AUTH_TOKEN;char
ssid[] = "RAKIBULSHARIF";
char pass[] = "rakib01963946768";

int prevCur=0;//Previous Currentint
nowCur=0;//Previous Current int overLDR=0;
int underLDR=0;

BlynkTimer timer;
WidgetLED led1(V5);//Over Voltage WidgetLED
led2(V6);//Under VoltageWidgetLED
led3(V7);//Over Load
// This function is called every time the Virtual Pin 0 state changesBLYNK_WRITE(V0)
{
   // Set incoming value from pin V0 to a variableint value =
   param.asInt();

   // Update state Blynk.virtualWrite(V1,
   value);
}
// This function is called every time the device is connected to theBlynk.Cloud
BLYNK_CONNECTED()
{
   // Change Web Link Button message to "Congratulations!"Blynk.setProperty(V3,
   "offImageUrl", "https://static-
image.nyc3.cdn.digitaloceanspaces.com/general/fte/congratulations.png");Blynk.setProperty(V3, "onImageUrl",
   "https://static-
image.nyc3.cdn.digitaloceanspaces.com/general/fte/congratulations_pressed.png");
   Blynk.setProperty(V3, "url", "https://docs.blynk.io/en/getting-started/what-do-i-need-to-
blynk/how-quickstart-device-was-made");
}

// This function sends Arduino's uptime every second to Virtual Pin 2.void myTimerEvent()
{
               overLDR=digitalRead(14);underLDR=digitalRead(12);
```

```
    if(overLDR==1 && underLDR==1)
    {Serial.println("No fault found");
      prevCur=1;//Your current sensor value here when no fault found
    }
    // You can send any value at any time.
    // Please don't send more that 10 values per second.
    // put your main code here, to run repeatedly:
if(overLDR==0){//overvoltage
            led1.on(); Serial.println("LED1
ON");}else
{              led1.off();
Serial.println("LED1 OFF");}

  if(underLDR==0)//undervoltage
{              led2.on();
Serial.println("LED2 ON");}else
{              led2.off(); Serial.println("LED2 OFF");}
nowCur=1;//Connect sensor data here
if(prevCur!=nowCur)
  led3.on();else
  led3.off();

    Blynk.virtualWrite(V2, millis() / 1000);
}

void setup()
{
    // Debug console
    Serial.begin(115200);
pinMode(12,INPUT);
pinMode(14,INPUT);
    Blynk.begin(auth, ssid, pass);
    // You can also specify server:
    //Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
    //Blynk.begin(auth, ssid, pass, IPAddress(192,168,1,100), 8080);

    // Setup a function to be called every second
    timer.setInterval(2000L, myTimerEvent);
}

void loop()
{
    Blynk.run();
    timer.run();
    // Check other examples on how to communicate with Blynk. Remember
    // to avoid delay() function!
}


/*
// EmonLibrary examples openenergymonitor.org, Licence GNU GPL V3&&  // Include Emon
Library
```

```
EnergyMonitor emon1;                                    // Create an instance

void setup()
{
    Serial.begin(9600);
    emon1.current(7, 60.606);                            // Current: input pin, calibration.(100 ÷ 0.050) ÷ 150
Ohm = 13.33
}

void loop()
{
    int val;
    val = analogRead(7);
    Serial.println(val);
    unsigned long previousMillis = millis();int count = 0;
    double Irms = 0;
    while ((millis() - previousMillis) < 1000)
    {
        Irms += emon1.calcIrms(1480); // Calculate Irms onlycount++;
    }
    Irms = Irms/count;
    Serial.print(Irms * 241.0);                          // Apparent power
    Serial.print(" ");
    Serial.print("W ");
    Serial.print(Irms); Serial.print("
    "); Serial.print("Irms ");




}
*/
```