IOT Based Real Time Transformer Health Monitoring System



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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 "IOT based real time transformer health monitoring system" 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

Transformers are important building blocks in the power system. Any damage to the transformers adversely affects the balance of the power system. The losses are mainly due to overloading and inadequate cooling. The main purpose of real-time monitoring of the health condition of the distribution transformer using IoT technology. Parameters such as temperature, voltage and current of the transformer are monitored, processed and recorded in the servers. For this purpose, we use three sensors with ESP 32. Recorded data can be sent via a Wi-Fi module and accessed anywhere in the world using IoT technology using the HTTP protocol. It helps to identify without human dependence. It helps to identify and solve a problem before the problem occur in our system. And it will protect our valuable equipment and life.

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Chapter 1: Introduction

1.1 Introduction

The distribution transformer provides direct power to low voltage consumers. Thus, the working condition of the transformer plays an important role in the distribution network. Transformers should be rated for their longevity. This is not possible throughout the work cycle. Overloading of transformers and lack of cooling can lead to unexpected failure of transformers which can disrupt power supply to many consumers. Manual check-ups of voltage surges, ambient temperatures, load currents, etc. are more complicated because random parameters cannot be accessed [1]. In IoT, interactions between the physical and digital worlds are made using sensors and actuators. The sensor or sensor network is used to understand the physical parameters or related environment. This processed sensor output is then sent to the main server or cloud with the help of various network devices. Data can be accessed on the Internet from anywhere in the world. Monitoring and control is the main purpose of IoT technology. Therefore, IoT-based monitoring is preferred over manual monitoring. This system is real time monitoring of transformer parameters such as voltage, current and temperature. This will help identify errors before serious failure. To maintain the reliability in grid operation it is important to monitor real time transformer health. We know the importance of transformers in electricity distribution and transmission. They are the main components and constitute the sizable portion of capital investment of the distribution grid. Real time transformer health monitoring systems help to replace the equipment before failure and continuity of the power will not be disturbed. Why it's important to develop IoT Based Transformer Monitoring System? To understand this, we need to find the drawbacks of the conventional transformer monitoring system and the biggest problem in the electricity distribution grid. Most of the distribution transformer are remotely located in a rural area, where regular monitoring by human observation is difficult to perform due to insufficient manpower. Our existing monitoring systems are not supported for real time operations. There is to many transformer failure cases are detected every day. Not allowed for planning operation downtime. Conventional system Don't have any internal fault testing [incipient fault monitoring] To overcome the above drawbacks, we need a smart and reliable solution

to monitor the distribution transformer parameter and send it to the IoT platforms in real time. It enables the grid operator to define the performance of the unit. It also provides valuable information about transformer health. IoT Based Transformer Monitoring System will allow the utilities to optimally run the transformer and keep this equipment in operation for a longer period. [4]

1.2 Proposed Method

The proposed project is about achieving real-time status of Transformer Health Parameters. The temperature, voltage and current of the transformers are monitored and sent over the Internet. Live tracking of these parameters can be done through IoT technology from anywhere in the world. It is cost effective in nature. This way the responsible authority can access any power failure or maintenance information.

1.3 Motivation

Distribution transformers are a key component of the distribution system that supplies power to our electronics. And electrical appliances in our homes and factories. Distribution transformers must be protected from error. Reliable and standard power supply should be provided is at uninterrupted rated voltage. The electricity that is generated. Reducing transmission line losses the voltage dropped to service voltage at different receiving stations. Depending on the needs of potential customers.

1.4 Objective of this Project

We, in this paper using very simple electronic particles we have used to connect the transformer with IoT (internet of things). So that all the parameters of transformer like voltage, current, oil level, temperature etc will be monitored always. So if any problem occur like over voltage, current, temperature then we will be informed real time.

1.5 Proposed System

The proposed project is about achieving real-time status of Transformer Health Parameters. The temperature, voltage and current of the transformers are monitored and sent over the Internet. Live tracking of these parameters can be done through IoT technology from anywhere in the world. It is cost effective in nature. This way the responsible authority can access any power failure or maintenance information.

1.6 Organization of the Project Book

This book consists of six chapters.

Chapter 1:

Gives a brief discussion of the project introduction, project objectives, project motivation and history.

Chapter 2:

Focuses on system design and theoretical background how the project is designed. How the system works. All the system is legit or not.

Chapter 3:

Focuses on hardware we used, their theoretical background and applications. Each hardware's detail. How the hardware works. How the hardware can be implementation.

Chapter 4:

Focuses on experimental result. How we gave our best result from our project that described in this chapter. Also we showed all the results visual here.

Chapter 5:

Concludes overall the project. And advantages of this project. How this project will give it's best in our daily industrial work.

Chapter 2: System Design

2.1 Introduction

In this project we can see about all the equipment of an IOT Based Real Time Transformer Health Monitoring System. How they works and how their behavior, specification and so many thing.

2.2 Block Diagram

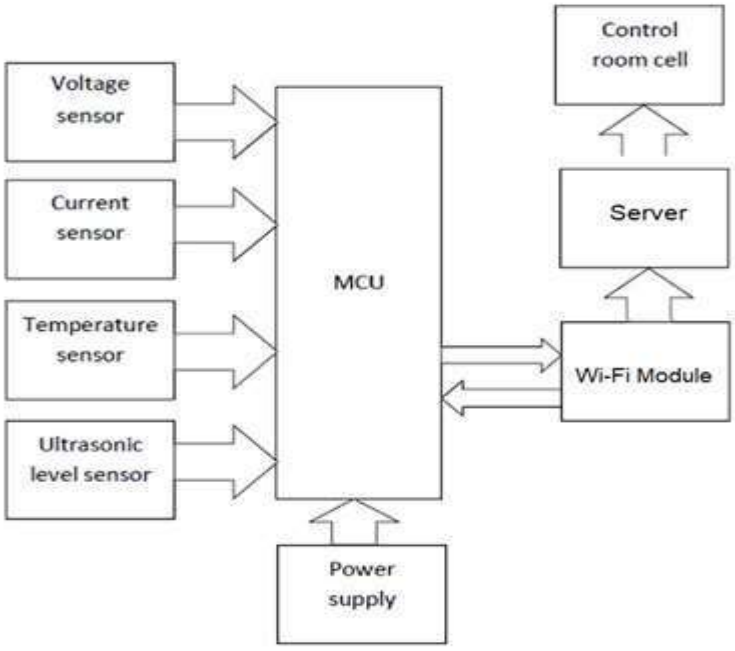


Figure 2.1: Block Diagram.

All the sensors are connected to esp32 MCU. Here we used voltage sensor for voltage measuring, current sensor for current measuring, temperature sensor for measuring the temperature of transformer and an ultrasonic sensor for measuring oil level. And two relay is connected to microcontroller one for opening the exhaust fan and one for the main power supply.

2.2.1 Flow Chart

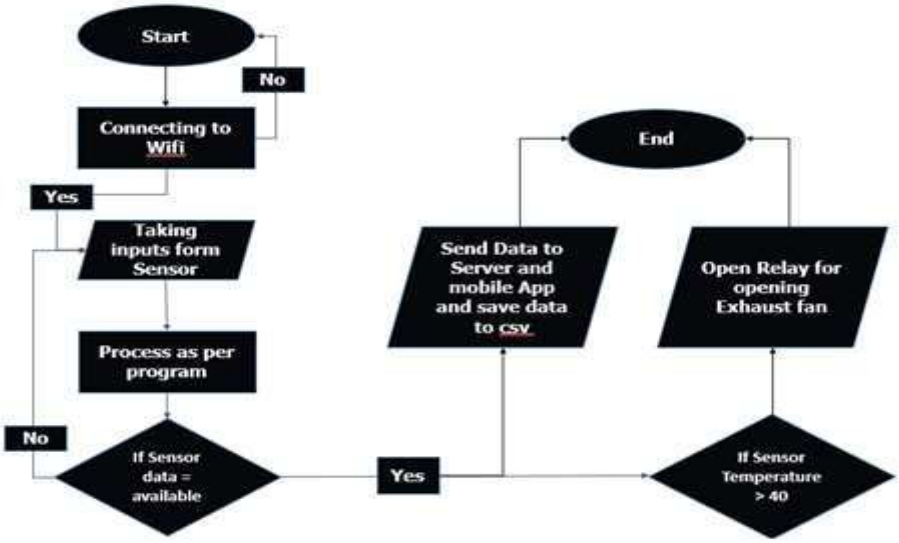


Figure 2.2: Flow Chart of the project

2.3 Idea of the Project

The idea is to build a complete iot based transformer monitoring system that can start without properly improving some areas of the existing substation system that need to be improved to make the system more accurate & efficient & save from accident. In this project, ESP32 will be used to program an application. The voltage sensor, current sensor detects the voltage and current and the temperature sensor measured the temperature and ultrasonic sensor measure the oil level. [5]

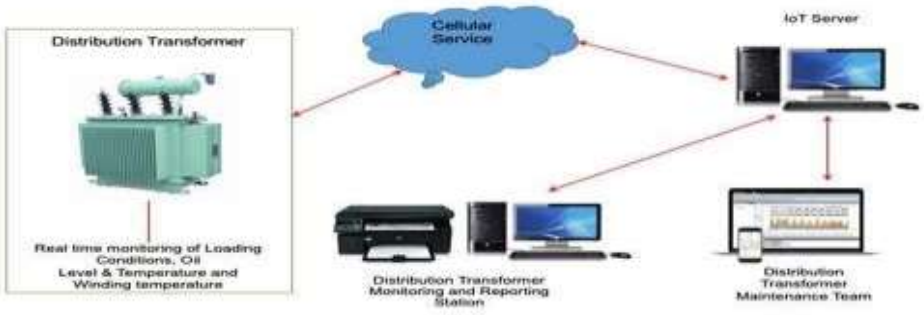


Figure 2.3: Transformer Health Monitoring System by IOT[5]

2.4 What is IoT

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network. Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business. How does IoT work? An IoT ecosystem consists of webenabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. [6]

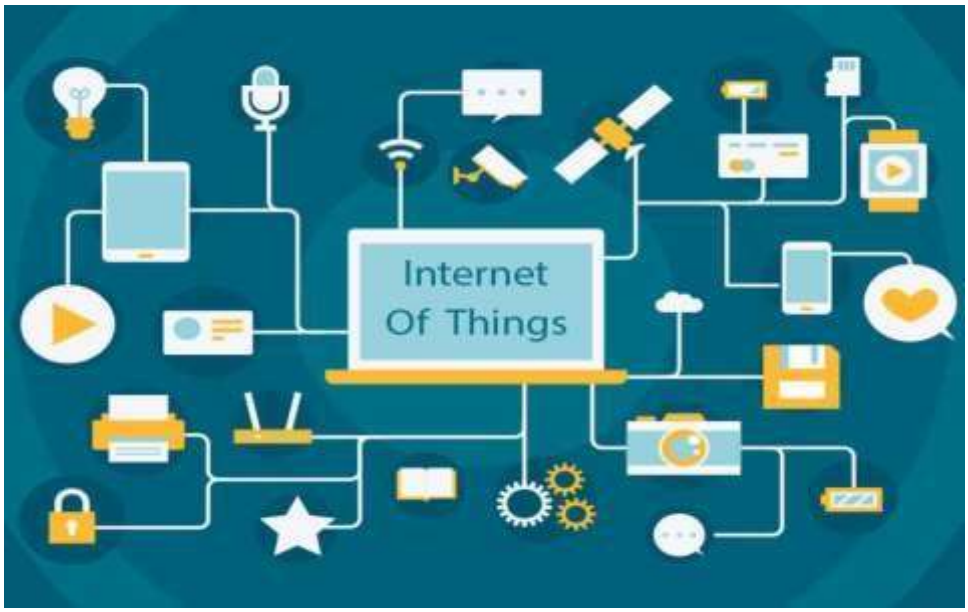


Figure 2.4: IoT (Internet of Things)[9]

Chapter 3: Hardware and Circuit Implementation

3.1 Introduction

In this chapter we are going to describe all the hardware that we used for our project also describing all the circuit diagram block diagram software etc.

3.1.1 Required Components:

1. ESP 32
2. DHT11
3. Voltage Sensor
4. Current Sensor
5. Ultrasonic Sensor
6. Relay Module
7. Transformer
8. Exhaust Fan
9. Battery
10. LCD Display

3.2 ESP32 MCU

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. The ESP32 series of chips includes ESP32-D0WDV3, ESP32-U4WDH, ESP32-S0WD, ESP32-D0WDQ6-V3 (NRND), ESP32-D0WD
(NRND), and ESP32-D0WDQ6 (NRND), among which, ESP32-D0WD-V3, ESP32-D0WDQ6-V3 (NRND), and ESP32-U4WDH are based on ECO V3 wafer.[8]

3.2.1 Pin description of Node MCU

Pin Category	Pin Name	Details
Power	Micro-USB, 3.3V, 5V, GND	Micro-USB: ESP32 can be powered through USB port 5V: Regulated 5V can be supplied to this pin which is we be again regulated to 3.3V by on board regulator, to power the board. 3.3V: Regulated 3.3V can be supplied to this pin to power the board. GND: Ground pins.
Enable	En	The pin and the button resets the microcontroller.
Analog Pins	ADC1_0 to ADC1_5 and ADC2_0 to ADC2_9	Used to measure analog voltage in the range of 0-3.3V. 12-bit 18 Channel ADC
DAC pins	DAC1 and DAC2	Used for Digital to analog Conversion
Input/Output Pins	GPIO0 to GPIO39	Totally 39 GPIO pins, can be used as input or output pins. 0V (low) and 3.3V (high). But pins 34 to 39 can be used as input only
Capacitive Touch pins	T0 to T9	These 10 pins can be used as touch pins normally used for capacitive pads

RTC GPIO pins	RTCIO0 to RTCIO17	These 18 GPIO pins can be used to wake up the ESP32 from deep sleep mode.
Serial	Rx, Tx	Used to receive and transmit TTL serial data.

External Interrupts	All GPIO	Any GPIO can be used to trigger an interrupt.
PWM	All GPIO	16 independent channel is available for PWM any GPIO can be made to work as PWM through the software
VSPI	GPIO23 (MOSI), GPIO19(MISO), GPIO18(CLK) and GPIO5 (CS)	Used for SPI-1 communication.
HSPI	GPIO13 (MOSI), GPIO12(MISO), GPIO14(CLK) and GPIO15 (CS)	Used for SPI-2 communication.
IIC	GPIO21(SDA), GPIO22(SCL)	Used for I2C communication.
AREF	AREF	To provide a reference voltage for input voltage.

Table 3.1: Pin of ESP32 MCU

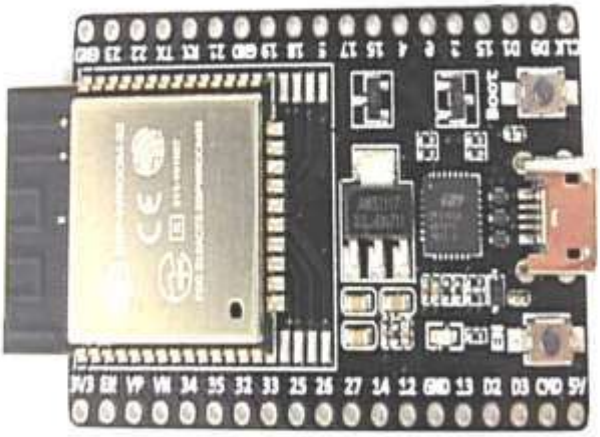


Figure 3.1: ESP 32 MCU

3.2.2 Communication of ESP 32

There are three types of communications that ESP32 MCU use commonly and they are

UART

UART stands for **Universal Asynchronous Reception and Transmission** and is a simple communication protocol that allows the NodeMCU to communicate with serial devices. The UART system communicates with digital pin 0 (RX), digital pin 1 (TX), and with another computer via the USB port.

This peripheral, found on all NodeMCU boards, allows the NodeMCU to directly communicate with a computer thanks to the fact that the Arduino has an onboard USBto-Serial converter. Therefore, programs written on a Windows, Mac, or Linux OS can be used with anNodeMCU connected to a USB port as if it was a serial port (serial port communication is trivial compared to USB communication). [4]

I2C

I2C, which stands for **inter-integrated-circuit**, is a serial communications protocol specially designed for microcontrollers.

While this peripheral is almost never used for PC-device communication, it is incredibly popular with modules and sensors, making it useful for projects that require many parts

working together. In fact, I2C allows you to potentially connect up to 128 devices to your main board!

When connecting two circuits to one another, think of the main device as the “master” and the connected devices—such as sensors, pin expansions, and drivers—as “slaves”. I2C makes it possible to connect multiple masters and slaves to your board while maintaining a clear communication pathway.[2]

Maintaining a clear communication pathway is possible because I2C uses an address system and a shared bus, meaning many devices can be connected to the exact same wires. However, the NodeMCU must first select a specific device by transmitting a unique address before sending data. This provides each slave device with what it needs while also supporting multiple masters. I2C uses fewer wires and all data is transmitted on a single wire, keeping your pin count low. The tradeoff for this simplified wiring is slower speeds than SPI.

SPI

SPI stands for **Serial Peripheral Interface**. Like I2C, SPI is a different form of serialcommunications protocol specially designed for microcontrollers to talk to each other. However, it has some key differences from its I2C counterpart. [7]

3.3 DHT 11

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. So if you are looking to measure in this range then this sensor might be the right choice for you.[2]

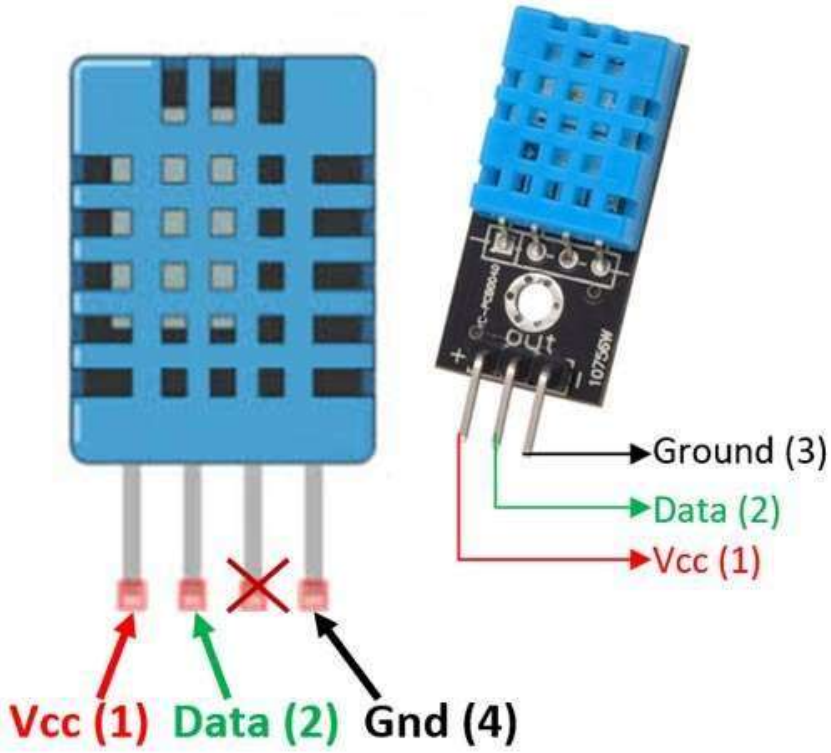


Figure 3.2: DHT 11

3.3.1 Pin Description of DHT 11

No:	Pin Name	Description
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
4	Ground	Connected to the ground of the circuit

Table 3.2: Pin of DHT 11

3.4 Voltage Sensor

The ZMPT101B AC voltage sensor is perfect for DIY project purposes, where we need to measure the correct AC voltage with a voltage transformer. This is an ideal choice for measuring AC voltage using the Arduino / ESP8266 / Raspberry Pi as an

audio source platform. In many electrical projects, the engineer directly deals with a few basic requirements such as measurement. High Galvanized Isolation Wide Range High Accuracy Good Compatibility ZMPT 101B is a high precision voltage transformer. This module makes it easy to monitor AC mains voltage up to 1000 volts. Check ZMPT107 if you want a smaller version of this module. [6]

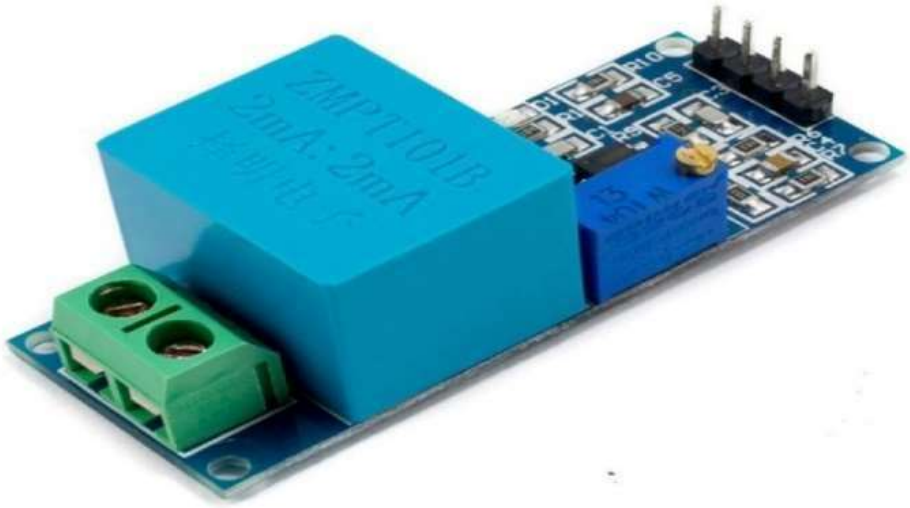


Figure 3.3: Voltage Sensor

3.4.1 Pin Description of Voltage Sensor

No:	Pin Name	Description
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Analog Outputs
4	Ground	Connected to the ground of the circuit

Table 3.3: Pins of Voltage Sensor

3.5 Current Sensor

Wrapped around the supply line, this non-invasive current sensor can measure loads up to 100 MPS, and lets you calculate how much current passes through it. It can be useful to build your own energy monitor or to create an existing current protection device for AC load. This current clamp can be used to detect currents up to 100A. Just clip it around the current source you want to measure and it will produce a very small AC voltage proportional to the current. The cable is terminated at one end with a standard 3.5 mm jack (such as a headphone jack). [3]

Use it to make your own energy monitor and keep your power consumption low, or to make an existing current protection device for AC load. See the link below for an example project. Check the date sheet for the pinout of the 3.5 mm jack.

Current is the rate at which electrons flow past a point in a complete electrical circuit. At its most basic, current = flow. An ampere (AM-pir), or amp, is the international unit used for measuring current. It expresses the quantity of electrons (sometimes called "electrical charge") flowing past a point in a circuit over a given time. A current of 1 ampere means that 1 coulomb of electrons—that's 6.24 billion billion (6.24 x 1018) electrons—is moving past a single point in a circuit in 1 second. The calculation is similar to measuring water flow: how many gallons pass a single point in a pipe in 1 minute (gallons per minute, or GPM). What is current Symbols used for amps: A = amperes, for a large amount of current (1.000). mA = milliamperes, a thousandth of an amp (0.001). µA = microamperes, a millionth of an amp (0.000001). In formulas such as Ohm's Law, current is also represented by I (for intensity). Amps are named for French mathematician/physicist Andrè-Marie Ampére (1775-1836), credited for proving: A magnetic field is generated around a conductor as current passes through it. The strength of that field is directly proportional to the amount of current flowing. Electrons flow through a conductor (typically a metal wire, usually copper) when two prerequisites of an electric circuit are met: The circuit includes an energy source (a battery, for instance) that produces voltage. Without voltage, electrons move randomly and fairly evenly within a wire, and current cannot flow. Voltage creates pressure that drives electrons in a single direction. The circuit forms a closed, conducting loop through which electrons can flow, providing energy to any device (a load) connected to the circuit. A circuit is closed (complete) when a switch is turned to the ON, or closed, position (see diagram at the top of this page). Current, like

voltage, can be direct or alternating. Direct current (dc): Represented by the symbols Direct current symbol 1 or Direct current symbol 2 on a digital multimeter. Flows only in one direction. Common source: batteries or dc generator. Alternating current (ac): Represented by the symbols Alternating current symbol 1 or Alternating current symbol 2 on a digital multimeter. Flows in a sine wave pattern (shown below); reverses direction at regular intervals. Common source: household electrical receptacles powered by a public utility. What is current? Above: Alternating current in the form of a sine wave. Most digital multimeters can measure dc or ac current no higher than 10 amps. Higher current must be scaled down with a current clamp accessory, which measures current (from .01 A or less to 1000 A) by gauging the strength of the magnetic field around a conductor. This permits measurements without opening the circuit. Any component (lamp, motor, heating element) that converts electrical energy into some other form of energy (light, rotating motion, heat) uses current. When additional loads are added to a circuit, the circuit must deliver more current. The size of conductors, fuses and the components themselves will determine how much current will flow through the circuit. Amperage measurements are normally taken to indicate the amount of circuit loading or the condition of a load. Measuring current is a standard part of troubleshooting. Current flows only when voltage provides the necessary pressure to cause electrons to move. Different voltage sources produce different amounts of current. Standard household batteries (AAA, AA, C and D) produce 1.5 volts each, yet larger batteries are capable of delivering greater amounts of current.



Figure 3.4: Current Sensor [3]

3.5.1 Pin Description of DS18B20 Soil Temperature Sensor

Pin Name	Description
Ground	Connect to the ground of the circuit
Vcc	Powers the Sensor, can be 3.3V or 5V
Data	This pin gives analog output

Table 3.4: Pins of Current Sensor

3.6 5V Relay Module

Relay is an electromagnetic switch which his used to defer two circuits electrically and connect magnetically. When Nodemcu transmit the signal then relay driver

receive signal and start its work. They are frequently used to interface an electronic circuit (working at low voltage) to an electrical circuit which works at extremely high voltage. For instance, a hand-off can make a 5V DC battery circuit to switch 230V AC mains circuit. In this way a little sensor circuit can drive, say, a fan or an electric knob. A transfer switch can be separated into two sections: information and yield. The info area has a loop which creates attractive field when a little voltage from an electronic circuit is connected to it. This voltage is known as the working voltage. Generally utilized transfers are accessible in various arrangement of working voltages like 6V, 9V, 12v, 24V and so on. In a basic hand-off there are three contactors: ordinarily shut (NC), regularly open (NO) and normal (COM).At no info express, the COM is associated with NC. At the point when the working voltage is connected the transfer curl gets charged and the COM changes contact to NO. Diverse transfer setups are accessible like SPDT and DPDT which have distinctive number of changeover contacts. By utilizing legitimate blend of contactors, the electrical circuit can be turned on and off. So as to drive the hand-off, we use transistor and just less power can be utilized to get the transfer driven. Since, transistor is an intensifier so the base lead gets adequate current to make increasingly current stream from Emitter of Transistor to Collector. In the event that the

Base once gets control that is adequate, at that point the transistor lead from Emitter to Collector and power the transfer. When the power is transmit to the relay works as switch due to electromagnetic effect so that we can switch ON or OFF our home appliances. [3]



Figure 3.5: 5V Relay Module 3.6.1 Pin Description of 5V Relay Module

Pin Name	Descriptions

DC +	Positive supply voltage
DC -	Ground
IN	Relay control port
COM	Common for NO/NC
NO	Normally Open
NC	Normally Close

Table 3.5: Pin Description of 5V Relay Module

3.7 Ultrasonic Sensor

The HC-SR04 Ultrasonic Sensor is a 4-pin module with pin names VCC, Trigger, Echo and Ground, respectively. This sensor is a traditional sensor used in a large number of applications where distance calculation or product sensing is required. In front of the module are two eyes that make up the ultrasonic transmitter and receiver. [4]

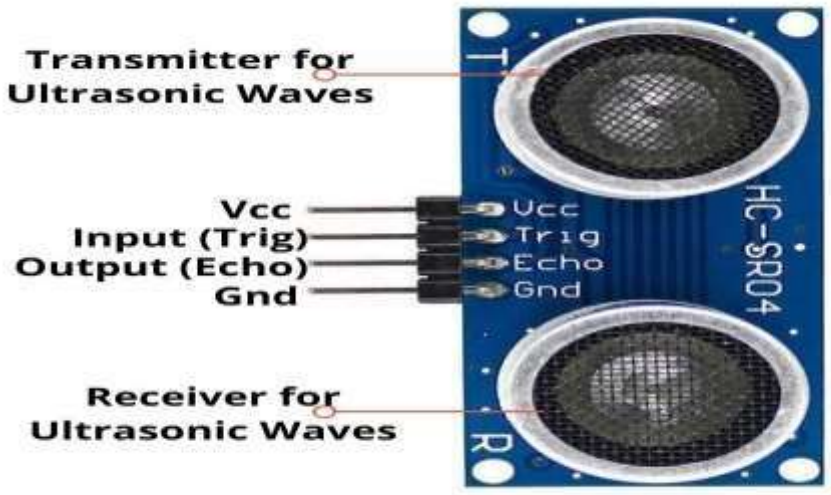


Figure 3.6: Ultrasonic Sensor [4]

The formula for measuring this sensor is distance = speed × time.

The ultrasonic transmitter sends an ultrasonic wave, this wave passes through the air and when it is objected by an element it is felt towards the sensor. This reflective wave is seen by the ultrasonic receiver module as in the picture has been given.

3.8 Transformer

A transformer is a passive component that transmits electrical energy from one electrical circuit to another, or multiple circuits. A different current in one of the coils of the transformer produces a different magnetic flux in the core of the transformer, which generates different electrical force on the wound of another coil around the same core. Electrical energy can be transmitted between two circuits without separate metal (conductive) connections. Fraud's law of induction, discovered in 1831, describes the dynamic voltage effect in any coil due to the changing magnetic flux surrounded by the coil. Transformers are commonly used to increase the low AC voltage at high current (one step up transformer) or to reduce the high AC voltage at low current (one step down transformer) in electric power applications and to connect the phases of signal processing circuits. Is done for. Transformers can also be used for isolation, where the voltage is equal to the voltage out, with separate coils that are not electrically connected to each other. Since the invention of the first permanent potential transformer in 1885, transformers have become essential for the transmission, distribution and use of existing electricity. [2] Electronic and electric power applications face a wide range of transformer designs. Transformers range in size from RF transformers to less than a cubic centimeter in size, to hundreds of tons of units used to connect the power grid. Transformers change voltage through electromagnetic induction; i.e., as the magnetic lines of force (flux lines) build up and collapse with the changes in current passing through the primary coil, current is induced in another coil, called the secondary. The secondary voltage is calculated by multiplying the primary voltage by the ratio of the number of turns in the secondary coil to the number of turns in the primary coil, a quantity called the turns ratio. Aircore transformers are designed to transfer radio-frequency currents—i.e., the currents used for radio transmission; they consist of two or more coils wound around a solid insulating substance or on an insulating coil form. Iron-core transformers serve analogous functions in the audio-frequency range. Impedance-matching transformers

are used to match the impedance of a source and that of its load, for most efficient transfer of energy. Isolation transformers are usually employed for reasons of safety to isolate a piece of equipment from the source of power. [5]



Figure 3.7: Step Down Transformer [5]

3.9 Jumper Wire

A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the Components of a breadboard or other prototype or test circuit, internally or with other.



Figure 3.8: Jumper wires

3.10 LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is a very basic module and is very

commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.



Figure 3.9: LCD Display



Figure 3.10: Exhaust Fan

3.11 5V DC Power Supply

We need two power supply for our system. One for full device and one 9 volts DC for our pump. As 11 volts power supply we use three 18650 Li-Po battery which is connected in series.

The 18650 battery is a lithium-ion cell classified by its 18mm x 65mm size, which is slightly larger than a AA battery. They're often used in flashlights, laptops, and highdrain devices due to their superior capacity and discharge rates. 18650s come in both flat and button top styles, and usually boast 300-500 charge cycles. [8]



Figure 3.11: 18650 Li-Po Battery [8]

3.11 Smart Phone

To see the real time condition of cornfield and also control the pump and other electrical device we need an android or ios device with internet connection.



Figure 3.12: Mobile Phone [1]

3.12 Wi-Fi Router

A wireless router connects directly to a modem by a cable. This allows it to receive information from devices and transmit information to the internet. The router then creates and communicates with your home Wi-Fi network using built-in antennas. As a result, all of the devices on your home network have internet access.[2]



Figure 3.13: Wi-Fi Router [2]

3.13 Arduino IDE Software

To make this project we used 2 software. One is programming code editor software which name is Arduino Ide. The one is an Android app which is for controlling our appliances For coding for Node MCU we need an IDE which is compatible to our NodeMCU. The Arduino IDE is one of the most easiest and compatible IDE for Node MCU. So we choice Arduino IDE for our coding. [5]

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. [2]

The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to

flash the user code onto official Arduino boards. Arduino Pro IDE Developer(s)Arduino Software Preview release v0.0.2 / 28 October 2019; 10 months ago Repository github.com/arduino/Arduino Edit this at Wikidata Written in C, C++ Operating system Windows, macOS, Linux Platform IA-32, x86-64, ARM TypeIntegrated development environment License LGPL or GPL license Website blog.arduino.cc/2019/10/18/arduino-pro-ide-alpha-preview-with-advanced-features/ With the rising popularity of Arduino as a software platform, other vendors started to implement custom open source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers. [4]



Figure 3.14: Arduino IDE [4]

3.14 Controlling Blynk App

We create this app through an app named Blynk. Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, and it can store data, visualize it and do many other cool things. There are three major components in the platform. Blynk Server - responsible for all the communications between the smartphone and hardware. [4]

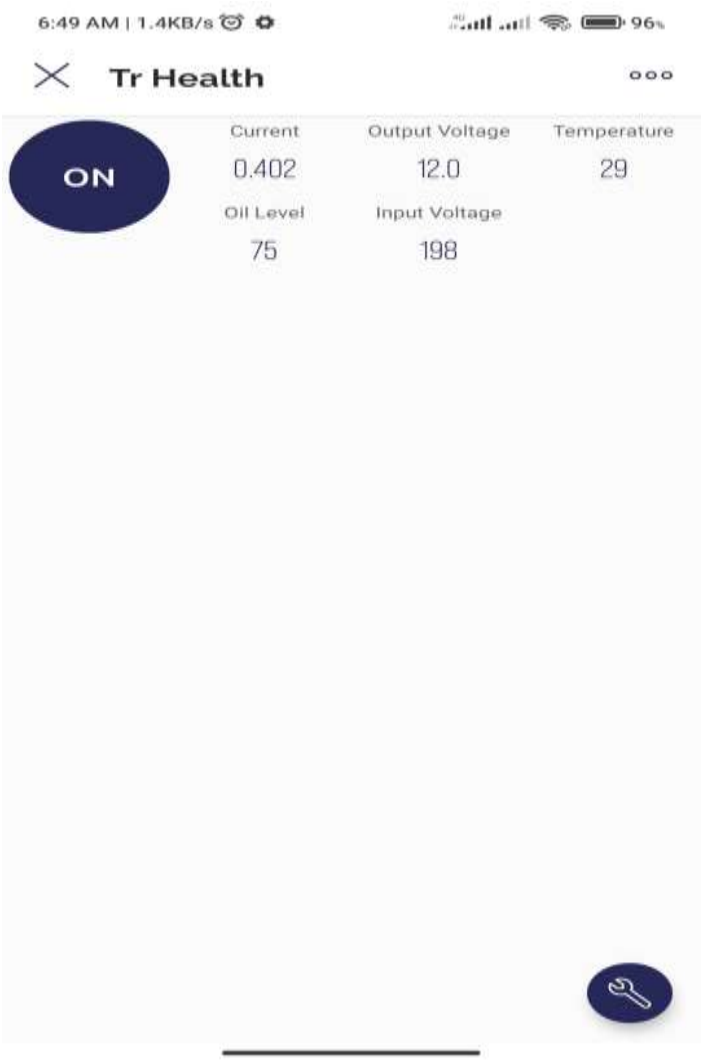


Figure 3.15: Android app for our Project.

3.15 Switch

In electrical engineering, a switch is an electrical component that can disconnect or connect the conducting path in an electrical circuit, interrupting the electric current or diverting it from one conductor to another. The most common type of switch is an electromechanical device consisting of one or more sets of movable electrical contacts connected to external circuits. When a pair of contacts is touching current can pass between them, while when the contacts are separated no current can flow. [4]

Switches are made in many different configurations; they may have multiple sets of contacts controlled by the same knob or actuator, and the contacts may operate

simultaneously, sequentially, or alternately. A switch may be operated manually, for example, a light switch or a keyboard button, or may function as a sensing element to sense the position of a machine part, liquid level, pressure, or temperature, such as a thermostat. Many specialized forms exist, such as the toggle switch, rotary switch, mercury switch, pushbutton switch, reversing switch, relay, and circuit breaker. A common use is control of lighting, where multiple switches may be wired into one circuit to allow convenient control of light fixtures. Switches in high-powered circuits must have special construction to prevent destructive arcing when they are opened. [4]

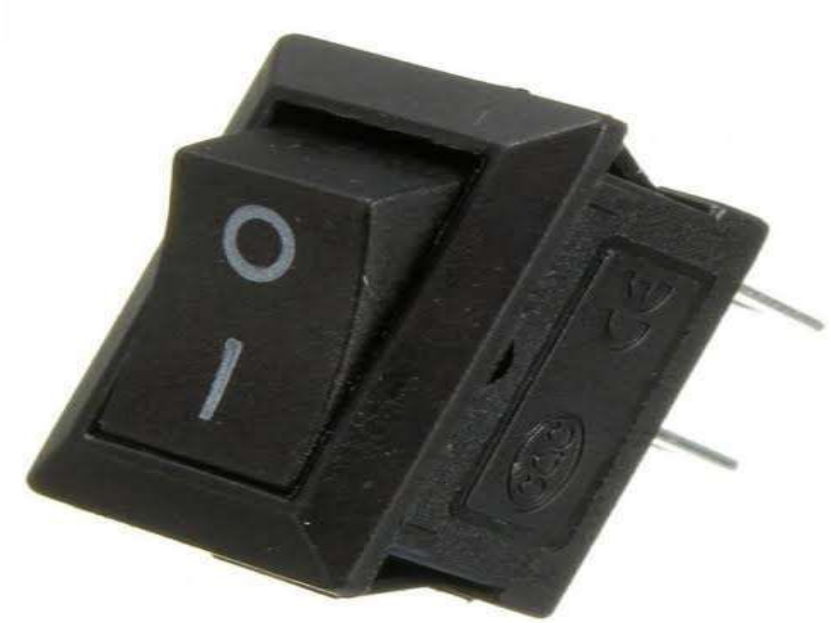


Figure 3.16: Switch [4]

3.16 Capacitor

A capacitor is a device that stores electrical energy in an electric field. It is an irresistible electronic element with two outstations. The effect of a capacitor is known as capacitance. While there is some capacitance between any two nearby electrical operators in a circuit, a capacitor is an element designed to increase the capacitance of a circuit. The capacitor is first known as a capacitor or capacitor. (1) This name and its associates are widely used in many languages, but rarely in English, a notable exception is condenser microphones, also called capacitor microphones. The physical shape and construction of practical capacitors are different and many types of capacitor are

commonly used. Most capacitors have at least two electrical operators that are always in the form of essence plates or shells separated by a dielectric device. The captain can be antipode, thin film, sintered essence blob, or electrolyte. The non-conductive dielectric acts to increase the charging capacity of the capacitor. Materials commonly used as dielectrics include layers of glass, ceramic, plastic, paper, mica, air, and oxide. Capacitors are widely used as corridors in electrical circuits in many common electrical appliances. Unlike a resistor, an ideal capacitor does not lose power, even if real -life capacitors dissipate a small amount of quantum (see Non - ideal gesture). If an electric implicit difference (voltage) is applied to the outstations of a capacitor, for illustration if a capacitor is connected to a battery, an electric field will develop around the dielectric, causing it to collect a net positive charge on a plate and a negative net. collection fee on the other plate. No current actually passes through the dielectric. However, there is a flow of charge from the source circuit. However, the current from the source circuit will stop, If the condition is maintained for a sufficient time. However, the source gests a direct current due to the charging and discharging cycles of the capacitor, if a time-varying voltage is applied to the capacitor lead. The main forms of capacitors were invented in the 1740s, when European researchers discovered that electric charge could be stored in glass jars filled with water known as Leyden jars. Previously, capacitors were widely used in electronic circuits for blocking the direct current while allowing interspersing flow. In analog mud networks, they break down the activity of power inventories. In reverberative circuits they turn on the radios for specific frequency. In power transmission systems, they amplify voltage and energy flow. (2) The energy storehouse property of capacitors was exploited as a dynamic memory in early digital computers, (3) and still in ultramodern DRAM. [3]

Capacitance is the ability of a component or circuit to collect and store energy in the form of an electrical charge. Capacitors are energy-storing devices available in many sizes and shapes. ... The insulator is also known as a dielectric, and it boosts a capacitor's charging capacity.



Figure 3.17: Capacitor [5]

3.17 Diode

A diode is a two -terminal electronic element that conducts primary current in one direction (asymmetric conductance); it has low resistance (no immaculate zero) in one direction, and high resistance (no immaculate zero) in the other. A diode tube |thermionic tube electron tube thermionic valve electronic device"> tube or thermionic diode may be a vacuum tube with two electrodes, a heated cathode and a plate, during which electrons can flow in just one direction, from the cathode to the plate. A semiconductor diode, the commonly used moment type, is a crystal piece of semiconductor material with a p - n junction connected to two electrical outstations. (4) Semiconductor diodes are the first semiconductor electronic bias. The discovery of asymmetric electrical conduction along the contact between crystalline minerals and essence was made by the German physicist Ferdinand Braun in 1874. Currently, the highest diodes are made of silicon, but other semiconductor accoutrements are similar to gallium arsenide and germanium also used. [7]



Figure 3.18: Different kind of Diode [7]

3.18 7805 Voltage Regulator IC

The 7805 Voltage Regulator IC is a commonly used voltage regulator that finds its application in most of the electronics projects. It provides a constant +5V output voltage for a variable input voltage supply.

Voltage regulators are very common in electronic circuits. They provide a constant output voltage for a varied input voltage. In our case the 7805 IC is an iconic regulator IC that finds its application in most of the projects. The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So our 7805 will provide a +5V output voltage. The output current of this IC can go up to 1.5A. But, the IC suffers from heavy heat loss hence a Heat sink is recommended for projects that consume more current. For example if the input voltage is 12V and you are consuming 1A, then (12-5) * 1 = 7W. This 7 Watts will be dissipated as heat. [4]

This is a typical application circuit of the 7805 IC. We just need two capacitors of vale

33uf and 0.1uf to get this IC working. 7805 Voltage Regulator Circuit Diagram The input capacitor 0.33uF is a ceramic capacitor that deals with input inductance problem and the output capacitor 0.1uF is also a ceramic capacitor that adds to the stability of the circuit. These capacitors should be placed close to the terminals for them to work effectively. Also they should be of ceramic type, since ceramic capacitors are faster than electrolytic.[3]

3.18.1 Features

- 5V Positive Voltage Regulator
- Minimum Input Voltage is 7V
- Maximum Input Voltage is 25V
- Operating current(IQ) is 5mA
- Internal Thermal Overload and Short circuit current limiting protection is available.
- Junction Temperature maximum 125 degree Celsius
- Available in TO-220 and KTE package

3.18.2 Pins of 7805 IC

Pin Number	Pin Name	Description
1	Input (V+)	Unregulated Input Voltage
2	Ground (Gnd)	Connected to Ground
3	Output (Vo)	Outputs Regulated +5V

Table 3.5: Pin Description of 7805 IC

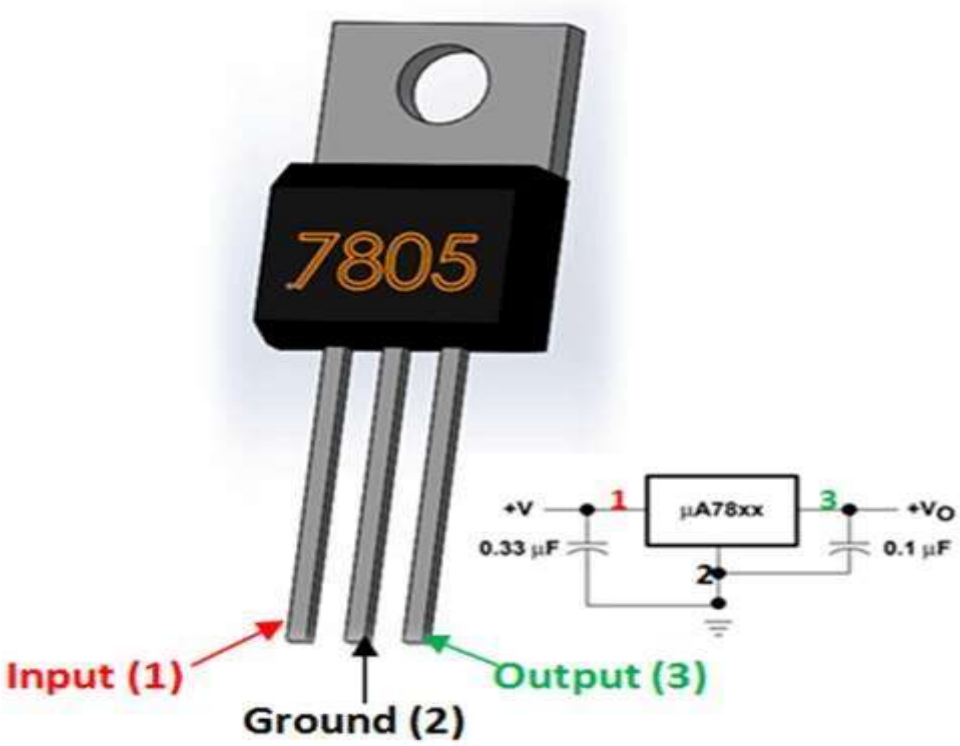


Figure 3.19: 7805 IC [3]

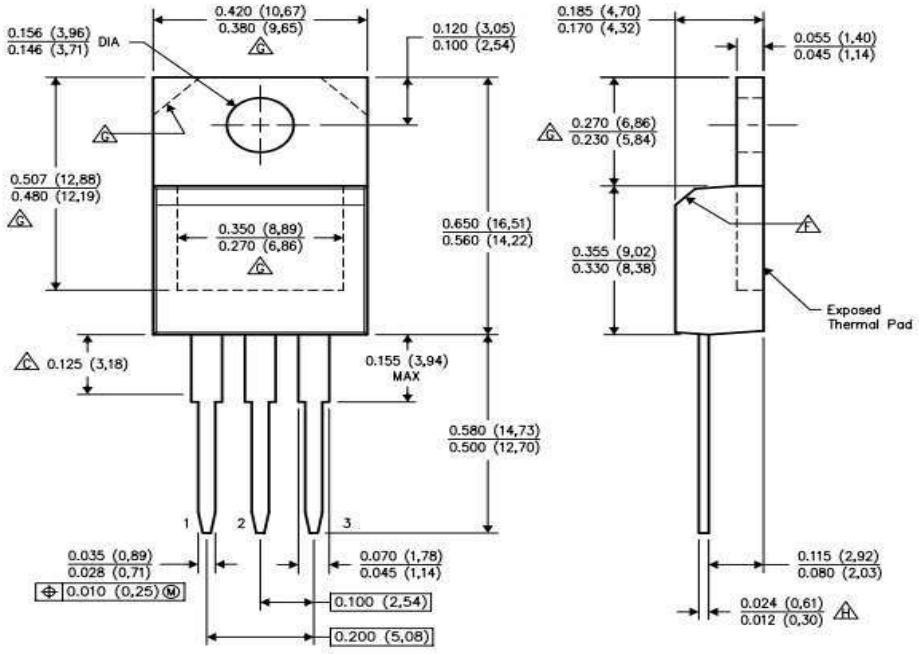


Figure 3.20: 2D Model of 7805 IC [3]

3.19 Circuit Diagram

Hardware connection is same as like as the circuit diagram.1st we program the Nodemcu then we connect all the equipment as per our circuit diagram.

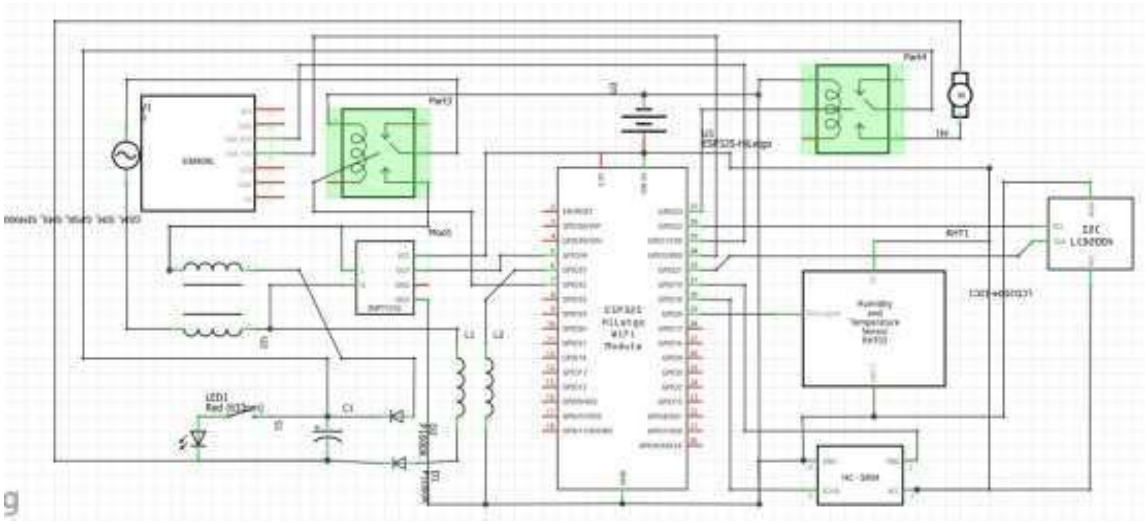


Figure 3.21: Circuit Diagram of our Project

3.20 Required Software and Their Setup Process

To complete our project, we need many types of software, most important of them are following

1. Arduino IDE-1.8.9

3.21 Software

The software that is used to program the microcontroller is open-source-software and can be downloaded for free on www.arduino.cc. With this “Arduino software” we can write little programs with the microcontroller. These programs are called “Sketch”.

In the end the sketches are transferred to the microcontroller by USB cable. More on that later on the subject “programming”. [8]

3.21.1 Arduino IDE Installation

Now one after another the Arduino software and the USB driver for the board have to be installed.

3.21.2 Installation and setup of the Arduino software

1. We have downloaded the Arduino software from www.arduino.cc and installed it on the computer (This was NOT connected to the PC). After that we opened the software file and installed the program named arduino.exe. [4]

Two set ups on the program are important and should be considered.

a) The board that we want to connect has to be selected on the arduino software. The “Arduino Uno” is here known as “Arduino / Genuino Uno ,Nano, Lilipo or any name can be”.

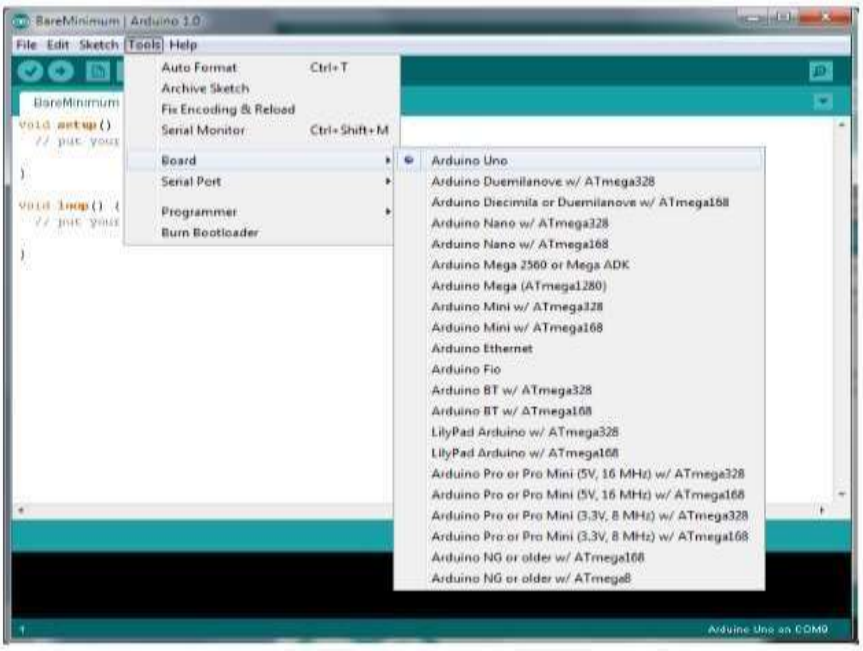


Figure 3.22: Program installation process -1 [4]

b) We have to choose the right “Serial-Port”, to let the Computer know to which port the board has been connected. That is only possible if the USB driver has been installed correctly. It can be checked this way:

At the moment the Arduino wasn’t connected to the PC. If we now choose “Port”, under the field “Tool”, we will already see one or more ports here (COM1/ COM2/ COM3…).

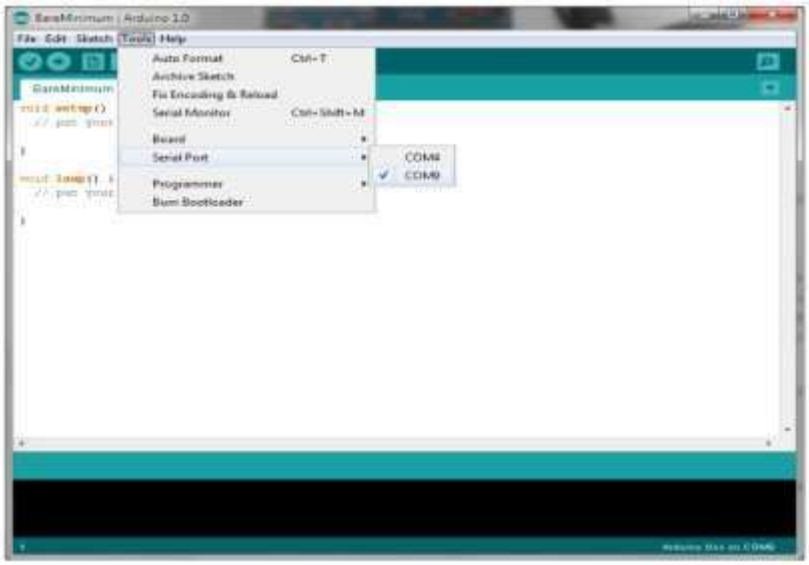


Figure 3.23: Program installation process -2 [4]

3.22 Programming

The development cycle is divided into 4 phases:

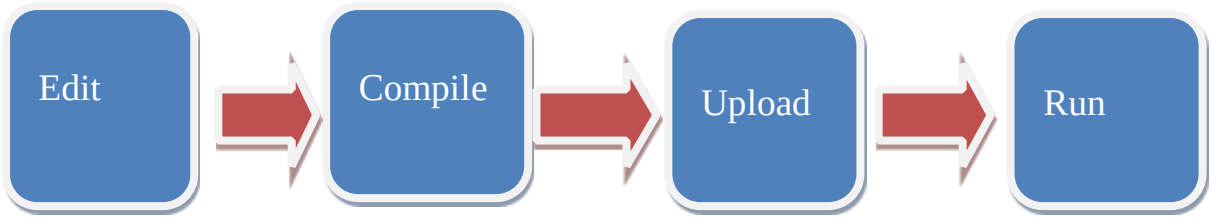


Figure 3.22: Flowchart of the compiling process

Compile: Compile means to translate the sketch into machine language, also known as object.

Code Run: Arduino sketch is executed as soon as terminates the step of uploading on the board.

3.22.1 Arduino Program Development

• Based on C++ without 80% of the instructions.

• A handful of new commands.

• Programs are called 'sketches'.

• Sketches need two functions:

• void setup ( )

• Void loop ( )

• Setup ( ) runs first and once.

Chapter 4: Result and Discussion

4.1 Introduction

Transformers are the main building block in a power system. Any damages in transformers adversely affects the balance of a power system. The damages are mainly occurring due to overloading and inefficient cooling. The main objective of the is real time monitoring of the health conditions of the distribution transformer using IOT technology. The parameters such as temperature, voltage and current of a transformer are monitored, processed and recorded in servers. For this purpose, we use three sensors interfaced with Arduino. The recorded data can be send using Wi-Fi module and accessed from anywhere around the world using IOT technology using HTTP protocol. This helps in identifying without human dependency. This helps in identifying and solving a problem before a failure without human dependency.

4.2 Result

The final result of our project is it able to measure voltage, current, oil level and temperature of a transformer. It can runnable using mobile app.



Figure 4.1: Controlling view of mobile app & output result.

4.3 Outlook

Here is our projects outlook. This is how look like our project. The hardware project has performed the basic operations of transformer monitoring system.

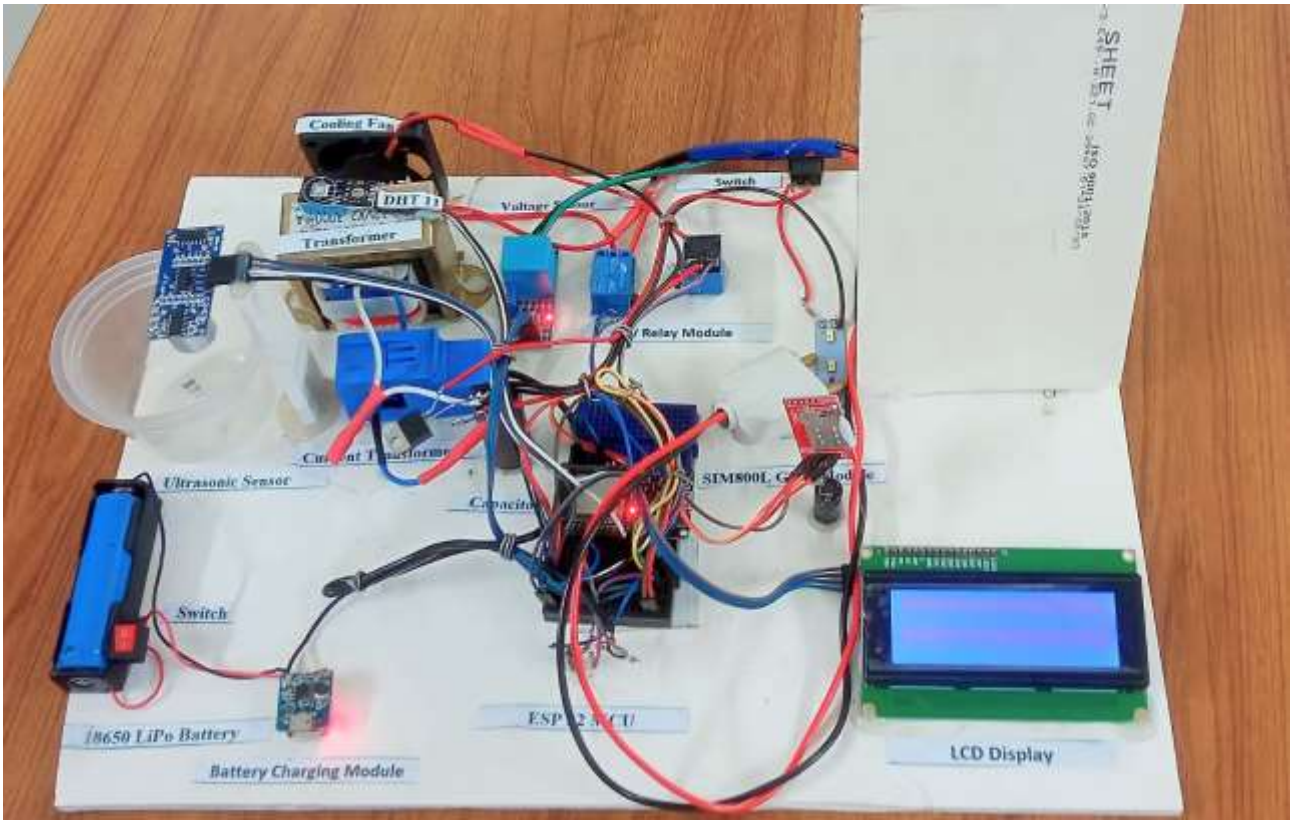


Figure 4.2: Project Outlook

4.4 Discussion

The transformers play a vital role in distribution part of power system. Therefore the monitoring and protection of transformer is very crucial. This system introduces a new and improved method of transformer health parameter monitoring using IoT. The sensors incorporated in the system collect the data of transformer health parameters such as voltage, temperature and current. These data arre send to an IoT platform, Blynk using. These data can be sent and accessed using HTTP protocol. Thus the real time data collection, storage and monitoring of the transformer health parameters are possible with the system.

Chapter 5: Limitation and Future Improvement

5.1 Introduction

In this chapter we are going to describe our project's advantages, limitations and future Improvement.

5.2 Advantages

1. Able monitor Transformer's data over internet from anywhere.
2. Able to cool the transformer when the transformer is hot.
3. Able to shut down the system when any unexpected error happens.
4. Show voltage, current, temperature, oil level of the transformer.
5. Save from any dangerous fault of transformer.
6. Less human power needed.
7. Cost efficiency.

5.3 Limitations

1. If the Internet speed will be slow then the system won't work properly.
2. Sometime sensor won't work properly due to its quality.

5.4 Future Improvement

1. We will add AI with this.
2. We will add our own server.
3. We will update our app's security system.

5.5 Cost Analysis

Equipment	Price
ESP 32	880
Voltage Sensor	550
Current Sensor	780
Ultrasonic Sensor	150
DHT 11	280
Power Supply	500
Relay Module	80
Transformer	220
PVC Board	200
Others	1000
Total	4640 Taka

Table 5.1 Cost Analysis

5.6 Conclusion

The conclusion of the proposed system is that it could be intelligent in detecting faults in transformers and it could take some preventive measures to cool down the transformer. It also helps to intimate the amount of transformer oil present in it but counter action couldn’t be done to solve it.

References

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Appendix

A. Programming Code for the Project

```
#define BLYNK_PRINT Serial
 #include "DHT.h"
#include "EmonLib.h"  //https://github.com/openenergymonitor/EmonLib
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

#define DHTTYPE DHT11
#define DHTPIN 4

#define trig 18
#define echo 19
#define f 23
EnergyMonitor emon;
#define vCalibration 106.8
#define currCalibration 0.52

DHT dht(DHTPIN, DHTTYPE);

BlynkTimer timer;

char auth[] = "uZikbZYbuA4dOyWIYWlTdsFqR8je3Xlo";

char ssid[] = "iot"; char pass[] =
"iot12345";  int v = 14; float kWh
= 0; unsigned long lastmillis =
millis(); void myTimerEvent() {
```

```
emon.calcVI(20, 2000);
Serial.print("Vrms: ");
 Serial.print(emon.Vrms, 2);
 Serial.print("V");
 Blynk.virtualWrite(V0, emon.Vrms);
 Serial.print("\tIrms: ");
 Serial.print(emon.Irms, 4);
 Serial.print("A");
 Blynk.virtualWrite(V1, emon.Irms);

 Blynk.virtualWrite(V3, v);

}


void sendSensor()
{  float h= dht.readHumidity();  float t = dht.readTemperature(); // or
dht.readTemperature(true) for Fahrenheit


 if (isnan(h) || isnan(t))
  {
  Serial.println("Failed to read Data from sensors!");
return;   }   else
  {
    Serial.print(t);
   Serial.println("ºC");
   Serial.println("----------------------------------");
   Serial.print(h);
   Serial.println("----------------------------------");
   Serial.println("ºC");
  }

 Blynk.virtualWrite(V5, t); // Virtual Pin V5 for Temprature
```

```
if( t>40)
{digitalWrite(f, LOW);} else
{digitalWrite(f, HIGH);}

}


void setup() {
Serial.begin(9600);
dht.begin();

 pinMode(f,     OUTPUT);
pinMode(trig,  OUTPUT);
pinMode(echo, INPUT);

 emon.voltage(35, vCalibration, 1.7); // Voltage: input pin, calibration, phase_shift
emon.current(34, currCalibration); // Current: input pin, calibration.
Blynk.begin(auth, ssid, pass);  timer.setInterval(1000L, sendSensor);
timer.setInterval(5000L, myTimerEvent);
}              void
oillevel()
  {  digitalWrite(trig,
LOW);
delayMicroseconds(4);
digitalWrite(trig, HIGH);
delayMicroseconds(10);
digitalWrite(trig, LOW);
long t = pulseIn(echo,
HIGH);  int cm = t / 29 /
2;  int
Olvl=map(cm,0,10,0,100
);
Serial.println("lvl");
```

```
 Serial.println(Olvl);

 Blynk.virtualWrite(V6,          Olvl);                  if
(Olvl>60){Blynk.notify("Please put oil ASAP");}
 }

void loop() {
Blynk.run();
timer.run();  oillevel();
}
```