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## “SMART MONITORING AND PROTECTION OF ELECTRICAL EQUIPMENTS USING IOT”

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**Abstract:** The project, "Smart Monitoring and Protection of Industrial Equipment Using IoT," employs Arduino as the main controller for monitoring and safeguarding industrial equipment. Current sensor technology is employed to measure the current of an AC load, specifically a bulb, while a voltage sensor is utilized to measure the voltage of a DC circuit. The DHT11 sensor is incorporated to monitor the ambient temperature, ensuring optimal operational conditions. Additionally, the system integrates a fire sensor to identify potential fire accidents and a gas sensor to detect smoke within the industrial environment. The gathered data from these sensors is displayed on an LCD screen, providing real-time information on crucial parameters.

To enhance safety measures, the system is designed to respond dynamically to sensor readings. If any monitored parameter surpasses a predefined threshold value, the system triggers protective actions. Specifically, if a critical condition is detected, the AC load (bulb) is automatically turned off, and a DC fan is shut down. This real-time monitoring and automated protection mechanism contribute to a safer and more secure industrial environment.

**Index Terms** - Arduino, Flame Sensor, Gas sensor, Current sensor, Voltage sensor, Node MCU

## I. INTRODUCTION

- The concept of "Smart Monitoring and Protection of Industrial Equipment using IoT" represents a transformative approach to industrial management, leveraging the capabilities of the Internet of Things (IoT). In the realm of industrial operations, ensuring the health and safety of equipment is paramount. Traditional methods often fall short in providing real-time insights into critical parameters, leaving industries susceptible to potential risks and inefficiencies. This project aims to address these challenges by integrating IoT technologies to monitor, protect, and optimize industrial equipment.

- In today's industrial landscape, the demand for more intelligent and interconnected systems is rapidly growing. The existing methods for equipment monitoring often lack the ability to provide instantaneous updates and proactive responses to varying conditions. This project sets out to revolutionize conventional industrial practices by introducing a system that utilizes a range of sensors such as current, voltage, temperature, fire, and gas sensors. These sensors act as the eyes and ears of the industrial setup, continuously collecting data on crucial parameters. The integration of an Arduino controller facilitates the processing of this data, enabling real-time monitoring and analysis.

- The significance of real-time monitoring cannot be overstated in industries where the slightest deviation from optimal conditions can lead to operational disruptions or safety hazards. By incorporating IoT, the project establishes an online platform hosted on a server, allowing stakeholders to access the status of industrial equipment remotely. This not only ensures quick response times in case of irregularities but also offers the convenience of monitoring multiple industrial setups from a centralized location. The system employs a responsive mechanism, automatically shutting down the AC bulb and DC fan in the event of threshold breaches, thereby preventing potential damages.

- The project's holistic approach goes beyond mere monitoring; it introduces a level of autonomy and intelligence to industrial equipment. The seamless integration of IoT components not only

enhances connectivity but also paves the way for data-driven decision-making. The online

- platform provides a comprehensive view of historical data, enabling industries to identify patterns, optimize processes, and implement preventive measures. As industries transition towards Industry 4.0, this project embodies a forward-looking solution that aligns with the evolving needs of smart, efficient, and secure industrial operations.

## II. LITERATURE REVIEW

In contemporary times, society's dependence on electricity has reached an extreme level, with power consumption showing a consistent increase over recent years [4]. It becomes imperative to prioritize the monitoring and measurement of electrical systems and appliances in both residential and commercial buildings. Specifically focusing on the residential sector, which comprises small-scale energy consumers like houses and apartments, it's notable that research indicates a substantial waste of 41% of the power supplied to homes by residential energy consumers [5].

Numerous studies and trials have demonstrated that employing a home energy monitoring system can lead to significant savings in home energy usage, ranging from 7.8% to 16.7% on average [6, 7]. Furthermore, several case studies have underscored the potential for reducing energy consumption by instilling proper habits and behaviors [8–10].

The implementation of a NodeMCU microcontroller unit with a WiFi-based gateway has enabled the connection of various sensors, facilitating the updating of data to the Adafruit IO cloud server [11]. Such a power monitoring system aids users in efficiently monitoring their electricity usage. Moreover, improving electricity efficiency through habit changes is emphasized [12].

In today's era, monitoring systems must effectively organize, record, and exploit data to extract intrinsic information, leveraging innovative visualization techniques, and accessing the internet for efficient data visualization [13]. A power monitoring system is positioned as a user-friendly and comprehensive solution for reliable electricity management [14],

providing users with real-time feedback to encourage changes in usage patterns [15].

Control systems play a pivotal role in managing energy consumption, offering both local and remote control functionalities. Local control involves actions initiated autonomously by the control unit, while remote control mechanisms enable the remote manipulation of IoT-based systems [15]. Monitoring the operational status of electrical equipment holds promise for reducing building power consumption costs and optimizing energy usage [16]. Through effective management facilitated by control systems, users can handle their energy consumption more efficiently. The control system implemented in this study manages the current, automatically disconnecting it in the event of an overcurrent, thereby raising awareness of household appliance consumption among users.

### III. EXISTING SYSTEM

The existing method of the project involves the utilization of traditional monitoring systems in industrial settings. Typically, industrial equipment is monitored manually or through basic sensor systems that lack smart and automated functionalities. In the conventional setup, there is limited integration of diverse sensors to comprehensively monitor crucial parameters such as current, voltage, temperature, fire, and gas levels. Additionally, the absence of an intelligent controller like Arduino means that there is no automated response mechanism to potential hazards or deviations from normal operating conditions. The absence of real-time data visualization on a single display makes it challenging for operators to promptly detect and respond to abnormal situations.

Overall, the existing method relies on separate, non-integrated monitoring systems, which may lead to delays in identifying critical issues and implementing protective measures in industrial environments. The lack of an automated shutdown

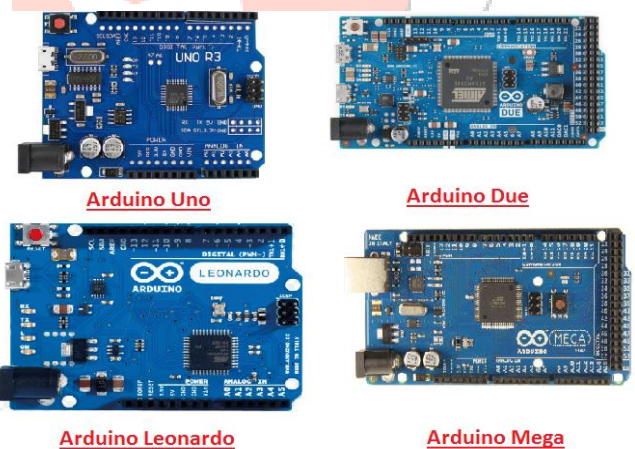
mechanism for specific equipment in response to abnormal conditions poses potential risks to both personnel and equipment safety.

#### Drawbacks:

1. Manual Monitoring:
2. Limited Sensor Integration:
3. No Automated Response:
4. Delayed Hazard Detection:
5. Absence of Real-time Visualization:

### IV. PROPOSED SYSTEM

In the proposed method, we introduce significant enhancements to the existing system by incorporating Node MCU, an IoT-enabled microcontroller. Node MCU is integrated to enable seamless communication and data transmission to online IoT platforms. This addition transforms the system into a smart, interconnected industrial monitoring solution.



Node MCU facilitates the real-time uploading of sensor data to an online IoT platform, providing users with instant access to critical information. The integration of an online platform enhances the monitoring capabilities, allowing stakeholders to remotely visualize and analyze the status of industrial equipment. This not only improves efficiency but also enables timely decision-making.

V. Furthermore, the inclusion of Node MCU enables the implementation of automated

responses based on sensor data. In case any parameter surpasses predefined thresholds, Node MCU can trigger automated actions, such as shutting down the AC bulb and DC fan, preventing potential hazards. The proposed method ensures a more advanced and proactive approach to industrial equipment monitoring through seamless connectivity and real-time data processing.

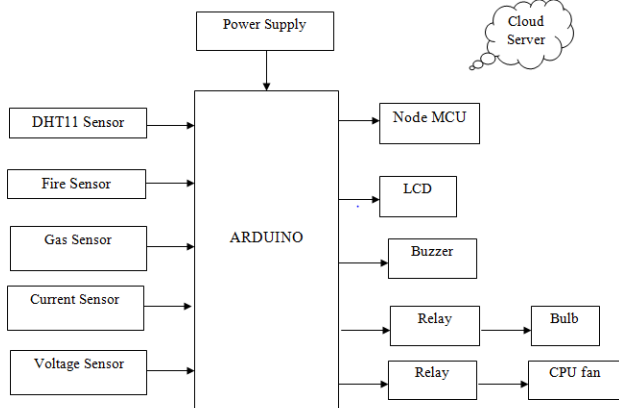
It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality. The software used for Arduino While learning microcontroller requires some expertise and skills.

Nevertheless, we can say every Arduino is basically a microcontroller but not every microcontroller is an Arduino.

input-output pins and makes uploading or burning of the program very easy.

It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality. The software used for Arduino devices is called IDE (Integrated Development Environment) which is free to use and required some basic skills to learn it. It can be programmed using C and C++ language. Some people get confused between **Microcontroller and Arduino**. While former is just an on system 40 pin chip that comes with a built-in microprocessor and later is a board that comes with the microcontroller in the base of the board, bootloader and allows easy access to input-output pins and makes uploading or burning of the program very easy.

## V. BLOCK DIAGRAM



## VI. HARDWARE COMPONENTS

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## SOFTWARE COMPONENTS

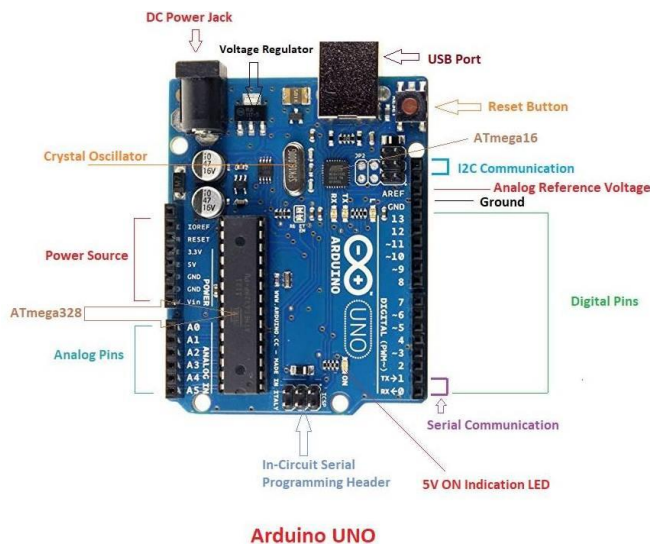


While learning microcontroller requires some expertise and skills.

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## Introduction to Arduino

- **Arduino Uno** is a microcontroller board developed by Arduino.cc which is an open-source electronics platform mainly based on AVR microcontroller Atmega328.
- First Arduino project was started in Interaction Design Institute Ivrea in 2003 by David Cuartielles and Massimo Banzi with the intention of providing a cheap and flexible way to students and professional for controlling a number of devices in the real world.
- The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output.
- It allows the designers to control and sense the external electronic devices in the real world



using IDE (Integrated Development Environment) software, mainly developed to program Arduino. IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. Programming languages like C and C++ are used in IDE.

- Apart from USB, battery or AC to DC adapter can also be used to power the board.
- Arduino Uno boards are quite similar to other boards in Arduino family in terms of use and functionality, however, Uno boards don't come with FTDI USB to Serial driver chip.
- There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32KB.
- When nature and functionality of the task go complex, Micro SD card can be added in the boards to make them store more information.

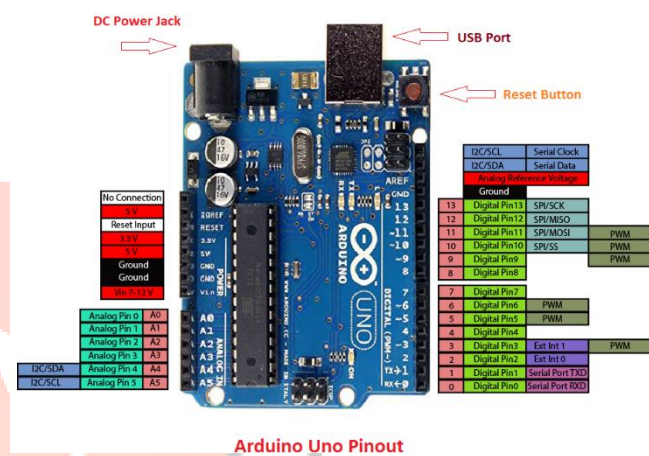
## Features of Arduino

- Arduino Uno comes with USB interface i.e. USB port is added on the board to develop serial communication with the computer.
- Atmega328 microcontroller is placed on the board that comes with a number of features like timers, counters, interrupts, PWM, CPU, I/O pins and based on a 16MHz clock that helps in producing more frequency and number of instructions per cycle.
- It is an open source platform where anyone can modify and optimize the board based on the number of instructions and task they want to achieve.
- This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller

- This board comes with a built-in regulation feature which keeps the voltage under control when the device is connected to the external device.
- Reset pin is added in the board that reset the whole board and takes the running program in the initial stage. This pin is useful when board hangs up in the middle of the running program; pushing this pin will clear everything up in the program and starts the program right from the beginning.
- There are 14 I/O digital and 6 analog pins incorporated in the board that allows the external connection with any circuit with the board. These pins provide the flexibility and ease of use to the external devices that can be connected through these pins. There is no hard and fast interface required to connect the devices to the board. Simply plug the external device into the pins of the board that are laid out on the board in the form of the header.
- The 6 analog pins are marked as A0 to A5 and come with a resolution of 10bits. These pins measure from 0 to 5V, however, they can be configured to the high range using analogReference() function and AREF pin.
- 13KB of flash memory is used to store the number of instructions in the form of code.
- Only 5 V is required to turn the board on, which can be achieved directly using USB port or external adopter, however, it can support external power source up to 12 V which can be regulated and limit to 5 V or 3.3 V based on the requirement of the project.

## Arduino Pinout

- Arduino Uno is based on AVR microcontroller called Atmega328. This controller comes with 2KB SRAM, 32KB of flash memory, 1KB of EEPROM. Arduino Board comes with 14 digital pins and 6 analog pins. ON-chip ADC is used to sample these pins. A 16 MHz frequency crystal oscillator is equipped on the board. Following figure shows the pinout of the Arduino Uno Board



## Pin Description:

There are several I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up resistors are used in the board that limits the current exceeding from the given operating conditions. However, too much increase in current makes these resistors useless and damages the device.

**LED.** Arduino Uno comes with built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON and LOW will turn it OFF.

**Vin.** It is the input voltage provided to the Arduino Board. It is different than 5 V supplied through a USB port. This pin is used to supply voltage. If a

voltage is provided through power jack, it can be accessed through this pin.

**5V.** This board comes with the ability to provide voltage regulation. 5V pin is used to provide output regulated voltage. The board is powered up using three ways i.e. USB, Vin pin of the board or DC power jack.

USB supports voltage around 5V while Vin and Power Jack support a voltage ranges between 7V to 20V. It is recommended to operate the board on 5V. It is important to note that, if a voltage is supplied through 5V or 3.3V pins, they result in bypassing the voltage regulation that can damage the board if voltage surpasses from its limit.

**GND.** These are ground pins. More than one ground pins are provided on the board which can be used as per requirement.

**Reset.** This pin is incorporated on the board which resets the program running on the board. Instead of physical reset on the board, IDE comes with a feature of resetting the board through programming.

**IOREF.** This pin is very useful for providing voltage reference to the board. A shield is used to read the voltage across this pin which then select the proper power source.

**PWM.** PWM is provided by 3, 5, 6,9,10, 11pins. These pins are configured to provide 8-bit output PWM.

**SPI.** It is known as Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) provide SPI communication with the help of SPI library.

**AREF.** It is called Analog Reference. This pin is used for providing a reference voltage to the analog inputs.

**TWI.** It is called Two-wire Interface. TWI communication is accessed through Wire Library. A4 and A5 pins are used for this purpose.

**Serial Communication.** Serial communication is carried out through two pins called Pin 0 (Rx) and Pin 1 (Tx).

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended InputVoltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Rx pin is used to receive data while Tx pin is used to transmit data.

**External Interrupts.** Pin 2 and 3 are used for providing external interrupts. An interrupt is called by providing LOW or changing value.

### Arduino Uno Technical Specifications

#### Communication and Programming:

Arduino Uno comes with an ability of interfacing with other other Arduino boards, microcontrollers and computer. The Atmega328 placed on the board provides serial communication using pins like Rx and Tx. The Atmega16U2 incorporated on the board provides a pathway for serial communication using USB com drivers. Serial monitor is provided on the IDE software which is used to send or receive text data from the board. If LEDs placed on the Rx and Tx pins will flash, they indicate the transmission of data. Arduino Uno is programmed using Arduino Software which a cross-platform application called IDE is written in Java. The AVR microcontroller Atmega328 laid out on the base comes with built-in boot loader that sets you free from using a separate burner to upload the program on the board.



#### Applications:

Arduino Uno comes with a wide range of applications. A larger number of people are using Arduino boards for developing sensors and instruments that are used in scientific research. Following are some main applications of the board.

- Embedded System
- Security and Defense System
- Digital Electronics and Robotics
- Parking Lot Counter
- Weighing Machines
- Traffic Light Count Down Timer
- Medical Instrument
- Emergency Light for Railways
- Home Automation
- Industrial Automation

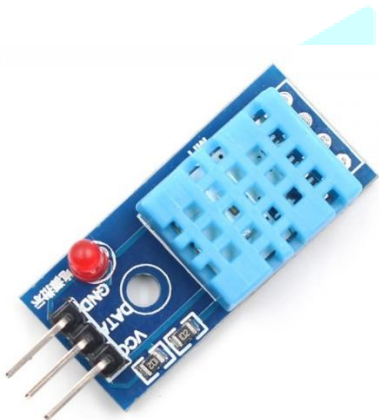
There are a lot of other microcontrollers available in the market that are more powerful and cheap as compared to Arduino board. So, why you prefer Arduino Uno?

Actually, Arduino comes with a big community that is developing and sharing the knowledge with a wide range of audience. Quick support is available pertaining to technical aspects of any electronic project. When you decide Arduino board over other controllers, you don't need to arrange extra peripherals and devices as most of the functions are readily available on the board that makes your project economical in nature and free from a lot of technical expertise.



## DHT11SENSOR(TEMPERATURE/HUMIDITY)

*The DHT11 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds.*



### Typical Application:

Note: 3Pin – Null; MCU = Micro-computer Unite or single chip Computer

When the connecting cable is shorter than 20 metres, a 5K pull-up resistor is recommended;

When the connecting cable is longer than 20 metres, choose an appropriate pull-up resistor as Needed.

### LCD:

LCD (Liquid Crystal Display) is the innovation utilized in scratch pad shows and other littler PCs. Like innovation for light-producing diode (LED) and gas-plasma, LCDs permit presentations to be a lot more slender than innovation for cathode beam tube (CRT). LCDs expend considerably less power than LED shows and gas shows since they work as

opposed to emanating it on the guideline of blocking light.

A LCD is either made with a uninvolved lattice or a showcase network for dynamic framework show. Likewise alluded to as a meager film transistor (TFT) show is the dynamic framework LCD. The uninvolved LCD lattice has a matrix of conductors at every crossing point of the network with pixels. Two conductors on the lattice send a current to control the light for any pixel. A functioning framework has a transistor situated at every pixel crossing point, requiring less current to control the luminance of a pixel.

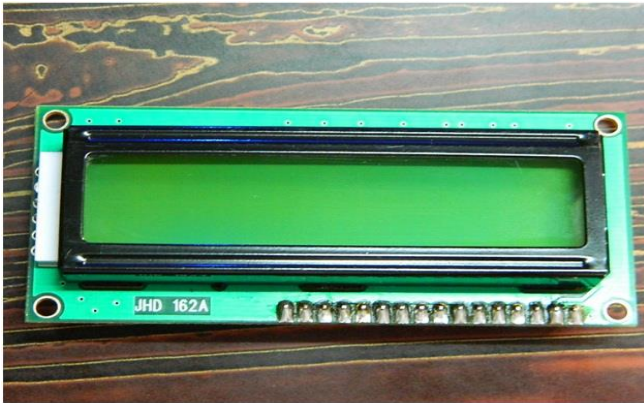
Some aloof network LCD's have double filtering, which implies they examine the matrix twice with current in the meantime as the first innovation took one sweep. Dynamic lattice, be that as it may, is as yet a higher innovation.

A 16x2 LCD show is an essential module that is generally utilized in various gadgets and circuits. These modules more than seven sections and other multi fragment LEDs are liked. The reasons being: LCDs are affordable; effectively programmable; have no restriction of showing exceptional and even custom characters (not at all like in seven fragments), movements, etc.

A 16x2 LCD implies 16 characters can be shown per line and 2 such lines exist. Each character is shown in a lattice of 5x7 pixels in this LCD. There are two registers in this LCD, in particular Command and Data. The directions given to the LCD are put away by the order register.

An order is a direction given to LCD to play out a predefined assignment, for example, introducing it, clearing its screen, setting the situation of the cursor, controlling presentation, and so forth. The information register will store the information that

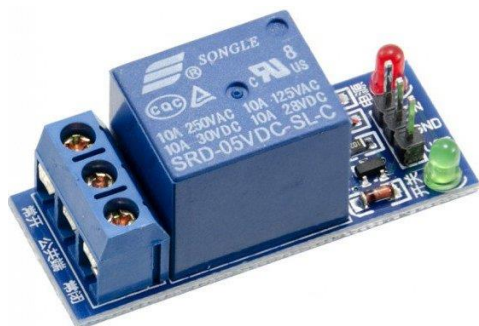
will be shown on the LCD. The information is the character's ASCII incentive to show on the LCD.



## RELAY

Relay is an electromagnetic switch that is used to turn on and turn off a circuit by a low power signal, or where several circuits must be controlled by one signal.

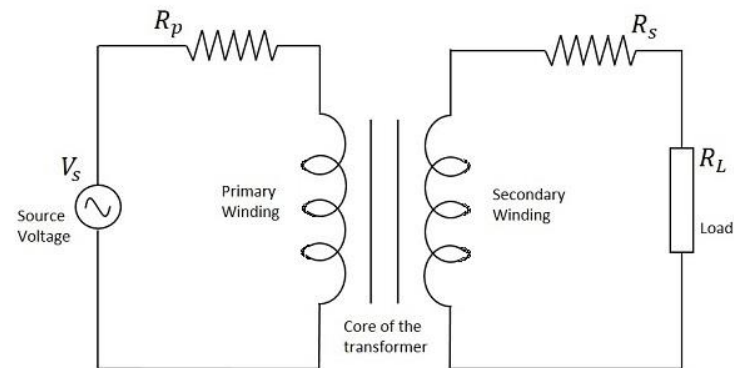
Most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.



## Transformer:

A transformer is a static electrical gadget that exchanges control between at least two circuits. A fluctuating current creates a changing attractive motion in one transformer curl, which thus actuates a differing electromotive power over a second loop twisted around a similar center.

Without a metallic association between the two circuits, electrical vitality can be exchanged between the two loops. The enlistment law of Faraday found in 1831 portrayed the impact of prompted voltage in any curl because of the changing attractive flux surrounded by the coil.



**Circuit of transformer**

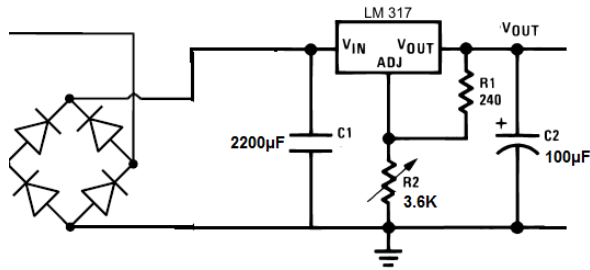


**Transformer**

## Power supply

A power is a than 14 A power supply is a component that provides at least one electrical charge with power. It typically converts one type of electrical power to another, but it can also convert a different Energy form in electrical energy, such as solar, mechanical, or chemical.

A power supply provides electrical power to components. Usually, the term refers to devices built into the powered component. Computer power supplies, for example, convert AC current to DC current and are generally located along with at least one fan at the back of the computer case.

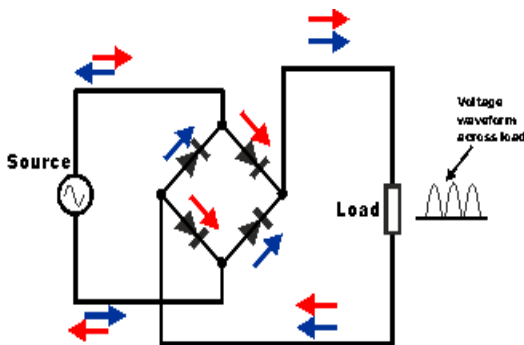


Some basic components used in the supply of power:

**RECTIFIER**

**rectifier** is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as *rectification*, since it "straightens" the direction of current.

Rectifiers have many uses, but are often found to serve as components of DC power supplies and direct power transmission systems with high voltage. Rectification can be used in roles other than direct current generation for use as a power source.



**Circuit of rectifier**



**Rectifier**

**Capacitors:**

Capacitors are used to attain from the connector the immaculate and smoothest DC voltage in which the rectifier is used to obtain throbbing DC voltage which is used as part of the light of the present identity. Capacitors are used to acquire square DC from the current AC experience of the current channels so that they can be used as a touch of parallel yield.

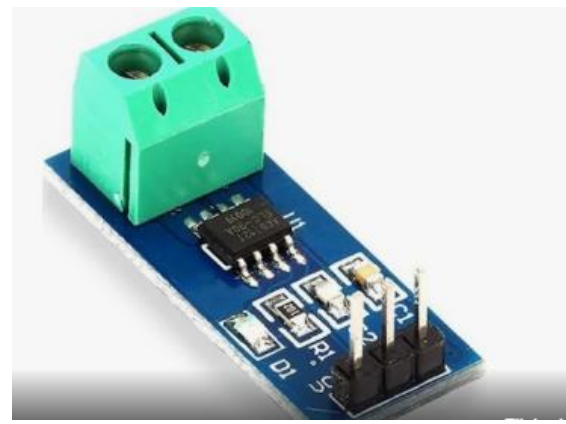
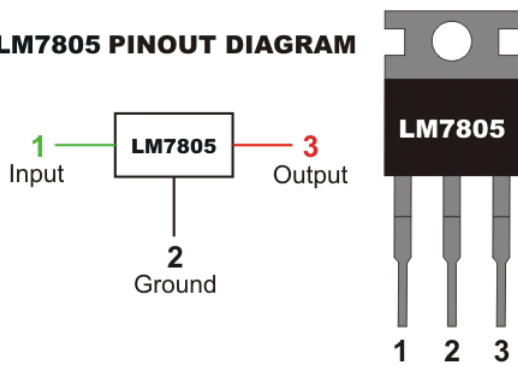
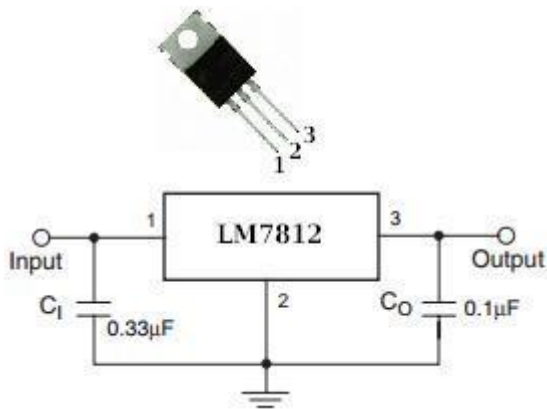


**Capacitor**

**Voltage regulators:**

The 78XX voltage controller is mainly used for voltage controllers as a whole. The XX speaks to the voltage delivered to the specific gadget by the voltage controller as the yield. 7805 will supply and control 5v yield voltage and 12v yield voltage will be created by 7812.

The voltage controllers are that their yield voltage as information requires no less than 2 volts. For example, 7805 as sources of information will require no less than 7V, and 7812, no lesvolts. This voltage is called Dropout Voltage, which should be given to voltage controllers.

**LM7805 PINOUT DIAGRAM****Voltage sensor:****7805 voltage regulator with pinout****7812 voltage regulator with pinout****Current sensor:**

The ACS712 is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and an integrated low-resistance current conductor. Technical terms aside, it's simply put forth as a current sensor that uses its conductor to calculate and measure the amount of current applied.

For current sensors that work by direct sensing, ohm's law is being applied to measure the drop in voltage when flowing current is detected.

Current flows through the onboard hall sensor circuit in its IC.

The hall effect sensor detects the incoming current through its magnetic field generation.

Once detected, the hall effect sensor generates a voltage proportional to its magnetic field that's then used to measure the amount of current.



A voltage sensor is a device that measures the voltage of an electrical circuit. Voltage sensors are used in many applications, including monitoring and controlling equipment and machinery.

Voltage sensors are used in various industries, including the automotive, manufacturing, maintenance, and medical fields.

In the maintenance industry, voltage sensors are used to monitor the voltage of assets and equipment. For example, if the sensor is wireless, it can be placed anywhere on an asset. The data can be relayed back to a CMMS (for example), where a maintenance manager can make adjustments based on their preventive maintenance plan. Below are some examples of voltage sensors in maintenance:

**Power failure detection:** the process of detecting a power failure so that the system can safely switch to an alternate power source.

**Load sensing:** a method of measuring the load on a motor and adjusting its speed accordingly.

**Safety switching:** refers to a device that shuts off power in case of an overload or fault condition to prevent equipment damage.

**Motor overload control:** a technique for preventing motor damage due to overloading by using thermal sensors, pressure sensors, current sensors, or other methods to detect the condition of the motor and avoid damage.

**Temperature control:** refers to controlling



temperature by regulating airflow or adding insulation around machinery components

### **IR sensor:**

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

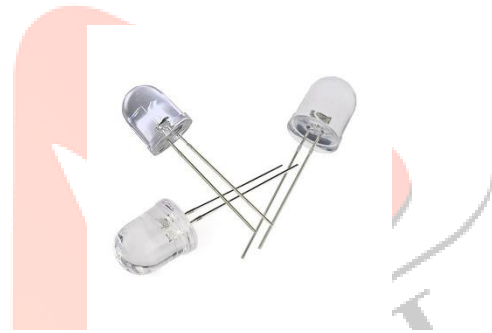
The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED's of specific wavelength used as infrared sources.

The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibers. Optical components are used to focus the infrared radiation or to limit the spectral response

### **Light Emitting Diodes (LEDs)**

The Light emitting diode is a two-lead semiconductor light source. In 1962, Nick Holonyak has come up with an idea of light



emitting diode, and he was working for the general electric company. The LED is a special type of diode and they have similar electrical characteristics of a PN junction diode. Hence the LED allows the flow of current in the forward direction and blocks the current in the reverse direction. The LED occupies the small area which is less than the  $1 \text{ mm}^2$ . [The applications of LEDs](#) used to make various electrical and electronic projects. In this article, we will discuss the working principle of the LED and its applications.

### **Buzzer:**

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of

user input such as a mouse click or keystroke. Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination, can complete a simple circuit design, to "plug and play."



### Buzzer Features and Specifications

- Breadboard and Perf board friendly Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package

A **buzzer** is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to

the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customized with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

### MQ2 sensor:

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. Gas sensors are very important part of such systems. Small like a nose, gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at gaseous state.

Gas sensors are available in wide specifications depending on the sensitivity levels, type of gas to be sensed, physical dimensions and numerous other factors. This Insight covers a methane gas sensor that can sense gases such as ammonia which might get produced from methane. When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current.





The **gas sensor module** consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it, the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it.

#### Image Showing Various Parts of a Gas Sensor

Image 01 shows externals of a standard gas sensor module: a steel mesh, copper clamping ring and connecting leads. The top part is a stainless steel mesh which takes care of the following:

1. Filtering out the suspended particles so that only gaseous elements are able to pass to insides of the sensor.
2. Protecting the insides of the sensor.
3. Exhibits an anti-explosion network that keeps the sensor module intact at high temperatures and gas pressures.

#### Node MCU:

The ESP8266 NodeMCU CP2102 board has ESP8266 which is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application-specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including the front-end module, is designed to occupy minimal PCB area.

The ESP8266 NodeMCU development board – a true plug-and-play solution for inexpensive projects using WiFi. The module arrives pre-flashed with NodeMCU firmware so they're ready to go – just install your USB driver (below). ESP-12 Lua Nodemcu WIFI Dev Board Internet Of Things board contains a full ESP8266 WiFi module with all the GPIO broken out, a full USB-serial interface, and a power supply all on the one breadboard-friendly package.

This board is pre-flashed with NodeMCU – a Lua-based firmware for the ESP8266 which allows easy control via a neat scripting language – Lua – so you're ready to go in just a few minutes.

The ESP-12 Lua NodeMCU WIFI Dev Board Internet Of Things with ESP8266 is an all-in-one microcontroller + WiFi platform that is very easy to use to create projects with WiFi and IoT (Internet of Things) applications.

The board is based on the highly popular ESP8266 WiFi Module chip with the ESP-12 SMD footprint. This WiFi development board already embeds in its board all the necessary components for the ESP8266 (ESP-12E) to program and upload code. It has a built-in USB to serial chip upload codes, 3.3V regulator, and logic level converter circuit so

you can immediately upload codes and connect your circuits.

Features:

Open-source, Interactive, Programmable, Low cost, Simple, Smart, WI-FI enabled

Arduino-like hardware IO

Integrated TR switch, balun, LNA, power amplifier and matching network

Integrated PLL, regulators, DCXO and power management units

Onboard USB to serial chip to easily program and upload codes from the Arduino IDE

Embeds logic level converter circuits

Has onboard 3.3V regulator to ensure enough power to function as your go-to WiFi chip!

Easy access to the GPIO pins for easy prototyping

ESP-12E Processor

Easy to use breadboard friendly form factor



writing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this software that is an open source and is readily available to install and start compiling the code on the go.

### Introduction to Arduino IDE:

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, and Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

## SOFTWARE REQUIREMENTS

### Arduino IDE:

**Arduino IDE** where IDE stands for Integrated Development Environment – An official software introduced by Arduino.cc, that is mainly used for



## How to install Arduino IDE:

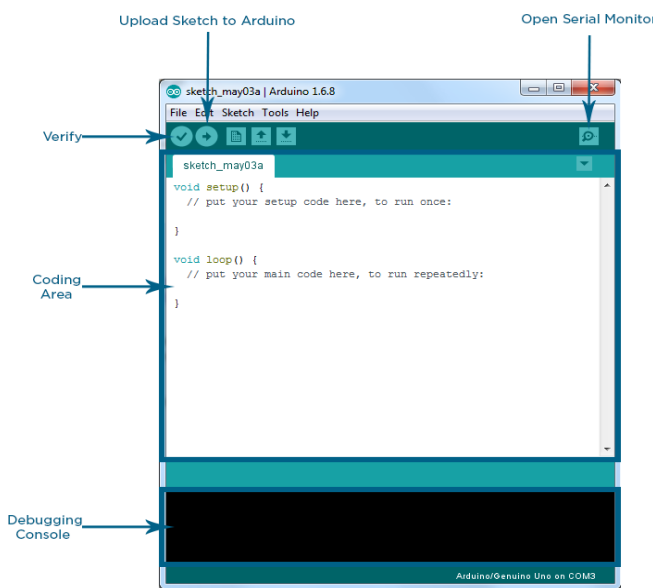
You can download the Software from [Arduino](#) main website. As I said earlier, the software is available for common operating systems like Linux, Windows, and MAX, so make sure you are downloading the correct software version that is easily compatible with your operating system.

- If you aim to download Windows app version, make sure you have Windows 8.1 or Windows 10, as app version is not compatible with Windows 7 or older version of this operating system.

The IDE environment is mainly distributed into three sections

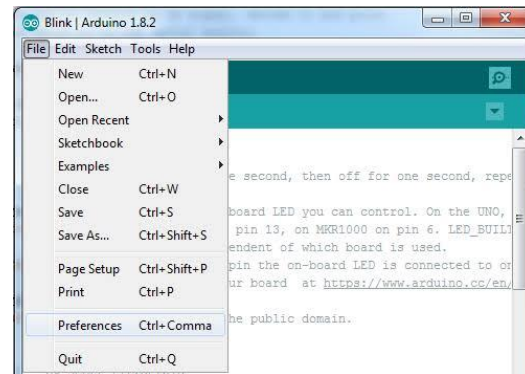
- 1. Menu Bar
- 2. Text Editor
- 3. Output Pane

As you download and open the IDE software, it will appear like an image below.



The bar appearing on the top is called **Menu Bar** that comes with five different options as follow

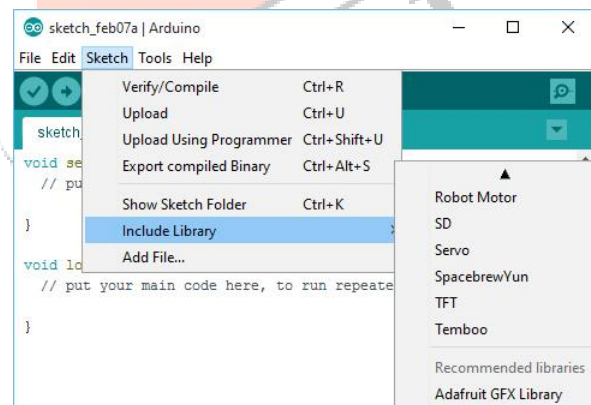
- **File** – You can open a new window for writing the code or open an existing one. Following table shows the number of further subdivisions the file option is categorized into.



As you go to the preference section and check the compilation section, the Output Pane will show the code compilation as you click the upload button.

## Libraries:

Libraries are very useful for adding the extra functionality into the Arduino Module. There is a list of libraries you can add by clicking the Sketch button in the menu bar and going to Include Library.



As you click the Include Library and Add the respective library it will on the top of the sketch with a #include sign. Suppose, I Include the EEPROM library, it will appear on the text editor as

```
#include <EEPROM.h>
```

Most of the libraries are preinstalled and come with the Arduino software. However, you can also download them from the external sources.

## CONCLUSION

In conclusion, the proposed system for "Smart Monitoring and Protection of Industrial Equipment using IoT" presents a robust solution to address the challenges associated with industrial equipment monitoring. By integrating IoT technologies, including Arduino controllers, current and voltage sensors, and environmental sensors, the system provides a comprehensive and real-time view of crucial parameters. The incorporation of NodeMCU facilitates the seamless connection to online IoT platforms, enabling remote monitoring and centralized control. This not only enhances the efficiency of industrial operations but also contributes to preventive maintenance strategies by detecting anomalies and potential faults before they escalate.

The project's significance lies in its ability to bring about a paradigm shift in industrial management, promoting a proactive approach to equipment maintenance and ensuring the longevity of machinery. The online monitoring capabilities offered by the proposed system empower industry professionals with timely insights, allowing them to make informed decisions, optimize resource utilization, and prevent unplanned downtime. As industries increasingly embrace IoT solutions for operational excellence, the Smart Monitoring and Protection system stands as a testament to the transformative potential of integrating smart technologies into traditional industrial frameworks

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