

DESIGN AND FABRICATION OF 360 DEGREE FIRE PROTECTION SYSTEM

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Engineering degree in Mechatronics

By

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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with grade "A++" by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **R.S.LINGESHWARA MARUTHI (40090708)** and **M.THOMAS MERVIN (40090035)** who carried out the project entitled "**DESIGN AND FABRICATION OF 360 DEGREE FIRE PROTECTION SYSTEM**" under our supervision from January 2024 to April 2024.

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We M.THOMAS MERVIN (40090035) and R.S.LINGESHWARA MARUTHI (40090708) hereby declare that the Project Report entitled "DESIGN AND FABRICATION OF 360 DEGREE FIRE PROTECTION SYSTEM" done by us under the guidance of Mr.K.BALACHANDAR, M.Tech., (Ph.D)., is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechatronics.

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ABSTRACT

Designing and creating a firefighting robot will save lives and offer a significant social solution. A cutting-edge fire safety solution called the "360 Degree Fire Protection System" is created to offer thorough fire protection from all sides. The device effectively detects and puts out fires by using servo motors and sophisticated mechanics. The system's 360-degree coverage allows it to quickly respond to fires coming from any angle, assuring the safety of both people and property. Fire risks are a frequent occurrence in Every year, lives are lost and property is destroyed because of developing nations like India. Where there is a fire emergency, when a fire is dangerous or cannot be reached by humans Extremely dangerous for people to approach and put out the fire. Designing and creating a firefighting robot will save lives and offer a significant social solution. A cutting-edge fire safety solution called the "360 Degree Fire Protection System" is created to offer thorough fire protection from all sides. The device effectively detects and puts out fires by using servo motors and sophisticated mechanics.

Keywords: Fire-fighting, Extinguisher, Flame Sensor, IR, Servo, Microcontroller, Blynk, 360 degree robot, sensor

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LIST OF SYMBOLS AND ABBEREVIATIONS

EV	Electric Vehicle
AC	Alternating Current
DC	Direct Current
BMS	Battery Management System
BLDC	Brushless DC motor
Kw	Power (Kilo Watt)
V	Voltage (Potential Difference)
Ah	Current (Ampere Hour)
C	Temperature in Celsius
RPM	Revolution Per Minute
C ₂ H ₆ O ₂	Ethylene Glycol (Coolant liquid)
ESP	Electronic Stability Program
HMI	Human Machine Interface
LVGL	Light and Versatile Graphics Library
DHT-22	Digital Temperature and Humidity sensor
ADC	Analog-Digital Converter
BTMS	Battery Thermal Management System
GPS	Global Positioning System
UART	Universal Asynchronous Receiver-Transmitter

CHAPTER 1

INTRODUCTION

The "360 Degree Fire Protection System" is a cutting-edge fire safety initiative created to offer thorough fire protection from all sides. To successfully detect and put out fires, the system uses servo motors and sophisticated mechanisms. This device offers quick and effective fire suppression thanks to its capacity to spin and orient itself toward the fire source and a water dispersal mechanism. The main goal of the 360 Degree Fire defense System is to increase the safety of people and property by providing an automated and proactive approach to fire defense.

Traditional fire suppression systems often rely on fixed fire-fighting equipment, which may not adequately cover all areas or respond swiftly to fire incidents. In contrast, this project addresses these limitations by offering a 360-degree coverage with sensors placed in the north, south, east, and west directions.

The primary capability of the system is its capacity to identify flames using carefully placed sensors. When a fire is found, the system turns on the matching servo motor, causing it to rotate in the direction of the fire. The device can precisely position itself in the direction of the fire flame thanks to the exact and changeable rotation of the servo motor. The system can swiftly respond to fires coming from any direction thanks to this feature, which drastically cuts response times and raises the likelihood of a successful fire suppression.

The system includes a servo motor positioned on the lower side to put out the flames. The water distribution system, which comprises of a nozzle, valve, and pump, is managed by this servo motor. The lower servo motor activates and releases a pressurized water stream via the nozzle when the directional servo motor lines up with the fire. It is possible to successfully put out fires since the water is aimed at the source of the flames.

The 360 Degree Fire Protection System can be combined with an intelligent control unit to further increase its capabilities. The servo motors' performance is optimized

and fire detection accuracy is increased thanks to the use of sophisticated algorithms by this control unit. The control unit can alter the servo motors' response times and activate extra safety features like alarms and messages to warn occupants or emergency services by analyzing sensor data and environmental conditions.

The 360 Degree Fire Protection System is an important development in fire protection technology overall. The system provides a dependable and effective solution for fire prevention in a variety of situations thanks to its extensive coverage, precise positioning, and sophisticated control capabilities.

CHAPTER 2

LITERATURE SURVEY

2.1 LITERATURE SURVEY

2.1.1 Early Fire Detection Based on Aerial 360-Degree Sensors, Deep Convolution Neural Networks and Exploitation of Fire Dynamic Textures (2020). This study introduces a 360-degree wireless sensor network-based fire-fighting system that makes use of a number of sensors and actuators to detect and put out fires. With sensors placed at key locations to detect fires from all sides, the system is intended to provide thorough coverage and quick response times. The authors outline the system's architecture, sensor location, and control algorithms. They also include experimental data that shows how well the system works. [1]

2.1.2 Design and Development of 360 Degree Fire Protection System (2023). A 360-degree fire protection system created for smart buildings is shown in this research. The system combines sprinkler and gas suppression systems for extinguishment and uses a combination of video cameras and heat sensors to detect flames. The authors give experimental findings proving the system's efficacy while also describing the system architecture and the algorithms employed for fire detection and suppression. [2]

2.1.3 Designing and testing of a smart firefighting device system (LAHEEB) (2020). This paper provides a 360-degree-based intelligent fire extinguishing system. For fire detection, the system combines infrared sensors, ultrasonic sensors, and video cameras. A high-precision servo motor is used to precisely position the extinguisher nozzle. The authors give experimental findings proving the system's efficacy while also describing the system a

2.1.4 An Integrated Fire Detection System using IoT and Image Processing Technique for Smart Cities (2020). This study introduces a 360-degree Internet of Things (IoT)-based fire detection and suppression system. For fire detection, the system combines temperature sensors, smoke detectors, and video cameras; for suppression, it uses a water mist extinguishing system. The authors present experimental findings demonstrating the system's effectiveness while also describing the system architecture and the algorithms utilized for fire detection and suppression. [4]

2.1.5 Implementing a Prototype Autonomous Fire Detecting and Firefighting Robot (2023). In this study, a brand-new 360-degree firefighting robot system for usage in tall structures is presented. The system makes use of a robotic platform with sensors, 4 fire-fighting chemicals, and a very accurate servo motor for precise positioning. The authors present experimental findings demonstrating the system's effectiveness while also describing the system architecture and the algorithms utilized for fire detection and suppression. [5]

Chapter – 3

Aim And Scope

3.1 AIM

The aim of this project is to develop a comprehensive and innovative 360-degree fire protection system that can detect, suppress, and mitigate fires in a wide range of environments. The system aims to provide an all-encompassing solution for fire safety, addressing limitations of traditional fire protection systems.

3.2.Scope:

3.2.1. Detection:

Implement advanced fire detection technologies, such as intelligent sensors, thermal imaging, and machine learning algorithms for early and accurate fire detection. Explore multi-sensor fusion techniques to enhance the system's ability to recognize different types of fires and minimize false alarms.

3.2.2. Suppression:

- Design an effective and eco-friendly fire suppression mechanism that can rapidly extinguish fires.
- Investigate the use of novel suppression agents, considering their environmental impact and effectiveness in various fire scenarios.
- Develop an intelligent control system for the precise deployment of suppression agents, optimizing resource usage.

3.2.3. Mitigation:

- Integrate automated evacuation systems and emergency communication protocols for swift and safe evacuation of occupants in case of a fire.

- Implement smart building features, such as fire-resistant materials and structural design enhancements, to mitigate the spread of fire and limit damage.

3.2.4. 360-Degree Coverage:

- Devise a system architecture that ensures complete coverage of the protected area, leaving no blind spots.
- Explore the use of robotics or automated mechanisms to extend the coverage to challenging or inaccessible areas.

3.2.5. Smart Monitoring and Control:

- Implement a centralized control and monitoring system that provides realtime information on the status of the fire protection system.
- Enable remote monitoring and control capabilities for quick response and intervention.

3.2.6. Cost-Effectiveness and Sustainability:

- Optimize the system for cost-effectiveness without compromising on safety standards.
- Consider the environmental impact of the system, incorporating sustainable materials and technologies where possible.

3.2.7. Interoperability:

- Ensure compatibility with existing fire safety infrastructure and protocols.
- Design the system to integrate seamlessly with smart building management systems and other relevant technologies.

3.2.8. Testing and Validation:

- Conduct rigorous testing and simulation to validate the effectiveness and reliability of the 360-degree fire protection system under various scenarios.
- Ensure compliance with relevant safety standards and regulations

3.2.9. Documentation and Knowledge Transfer:

- Develop comprehensive documentation for the design, fabrication, and operation of the system.
- Facilitate knowledge transfer to end-users, maintenance personnel, and emergency responders through training programs and user manuals.

3.2.10. Future Enhancements:

- Explore possibilities for future enhancements and upgrades to adapt to evolving fire safety standards and emerging technologies.
- Consider scalability for the integration of additional features or components in the future. Through this project, the goal is to contribute to advancements in fire protection technology, providing a holistic solution that enhances safety, minimizes damage, and adapts to the dynamic nature of modern environments.

3.3 SCOPE OF THE PROJECT

The design and fabrication of a 360-degree fire protection system is a significant undertaking with a broad scope. Here are some key aspects and considerations that you may want to include in the scope of your project:

3.3.1 System Overview:

Provide a comprehensive overview of the 360-degree fire protection system. o Clearly define the objectives and goals of the system. • Risk Assessment: o Conduct a thorough risk assessment to identify potential fire hazards in the target environment. o Consider different types of fires (electrical, chemical, etc.) that may occur.

3.3.2 Project Management:

Implement a project management plan that includes roles, responsibilities, and communication channels. Remember to adapt the scope based on the specific context and requirements of your project. This comprehensive approach should help

ensure a well-rounded and successful design and fabrication process for the 360-degree fire protection system.

3.3.3 System Design:

- Exploration of design concepts to achieve seamless 360-degree coverage.
- Integration of advanced detection technologies such as smoke detectors, heat sensors, and flame detectors.
- Designing suppression mechanisms including sprinkler systems, extinguisher units, and suppression agents storage.

3.3.4 Component Fabrication:

- Fabrication of structural components using fire-resistant and durable materials.
- Manufacturing detection sensors and suppression mechanisms with high precision and reliability.
- Ensuring compatibility and seamless integration of fabricated components into the overall system.

3.3.5 Integration and Testing:

- Integration of fabricated components into a cohesive fire protection system.
- Rigorous testing to evaluate the functionality, effectiveness, and reliability of the system.
- Simulation of real-world fire scenarios to validate the system's performance under various conditions.

3.3.6 Documentation and Compliance:

- Documentation of design specifications, fabrication processes, and testing procedures.
- Ensuring compliance with relevant safety standards, building codes, and regulations.
- Provision of comprehensive user manuals and training materials for system operation and maintenance.

3.3.7 Challenges and Risks:

- Addressing technical challenges related to sensor accuracy, response time, and reliability.
- Overcoming compatibility issues between different system components.
- Ensuring compliance with safety regulations and industry standards while meeting project timelines and budget constraints.

3.3.8 Stakeholders and Collaboration:

- Addressing technical challenges related to sensor accuracy, response time, and reliability.
- Overcoming compatibility issues between different system components.
- Ensuring compliance with safety regulations and industry standards while meeting project timelines and budget constraints.

3.3.9 Project Management:

- Development of a detailed project plan with clearly defined milestones and timelines.
- Efficient allocation of resources to ensure the timely completion of design, fabrication, and testing phases.
- Implementation of quality control measures to guarantee the reliability and effectiveness of the fire protection system.
- Regular communication and coordination among team members and stakeholders to ensure alignment with project objectives and requirements.

By focusing on these aspects within the investigation, the aim is to develop a state-of-the-art 360-degree fire protection system that significantly enhances safety measures and minimizes the impact of fire incidents in various environments.

CHAPTER 4

MATERIALS AND EXPERIMENTAL METHOD

4.1 METHODOLOGY

The flowchart of the "360 Degree Fire Protection System" outlines the sequential steps involved in the system's operation. It provides a visual representation of the process from fire detection to fire suppression.

The flowchart begins with the initialization of the system and moves on to the continuous monitoring of the flame sensor. When a fire is detected, the system triggers the pump to spray water through the nozzle, directed by the servo motors. The flowchart illustrates the feedback loop, indicating that the system remains in operation until the fire is extinguished or manually reset. The flowchart serves as a guide for understanding the logical flow of the system's functionality and helps visualize the interaction between different components and processes.

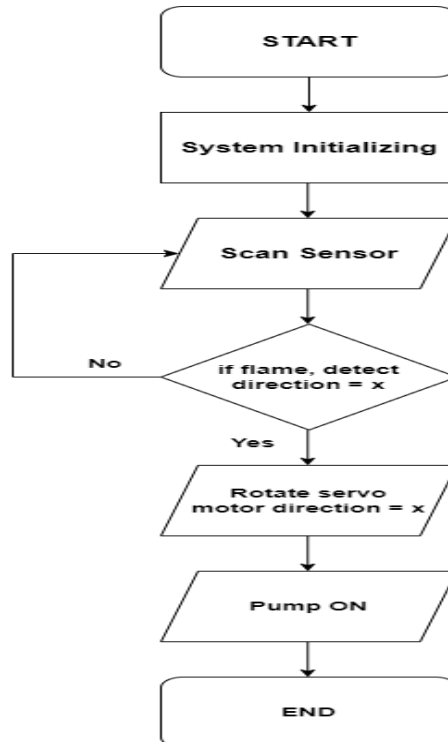


Fig - 4.1 METHODOLOGY

4.1.1 Block Diagram

The "360 Degree Fire Protection System" block diagram offers a high-level breakdown of the system's architecture and the linkages between its key elements. It provides a visual representation of the functional building pieces and their connections inside the system. The flame sensor, Arduino Nano microcontroller, power supply, voltage regulator, LCD display, buzzer, main servo motor, pump servo motor, relay, and pump are frequently included in block diagrams as shown in Fig.2

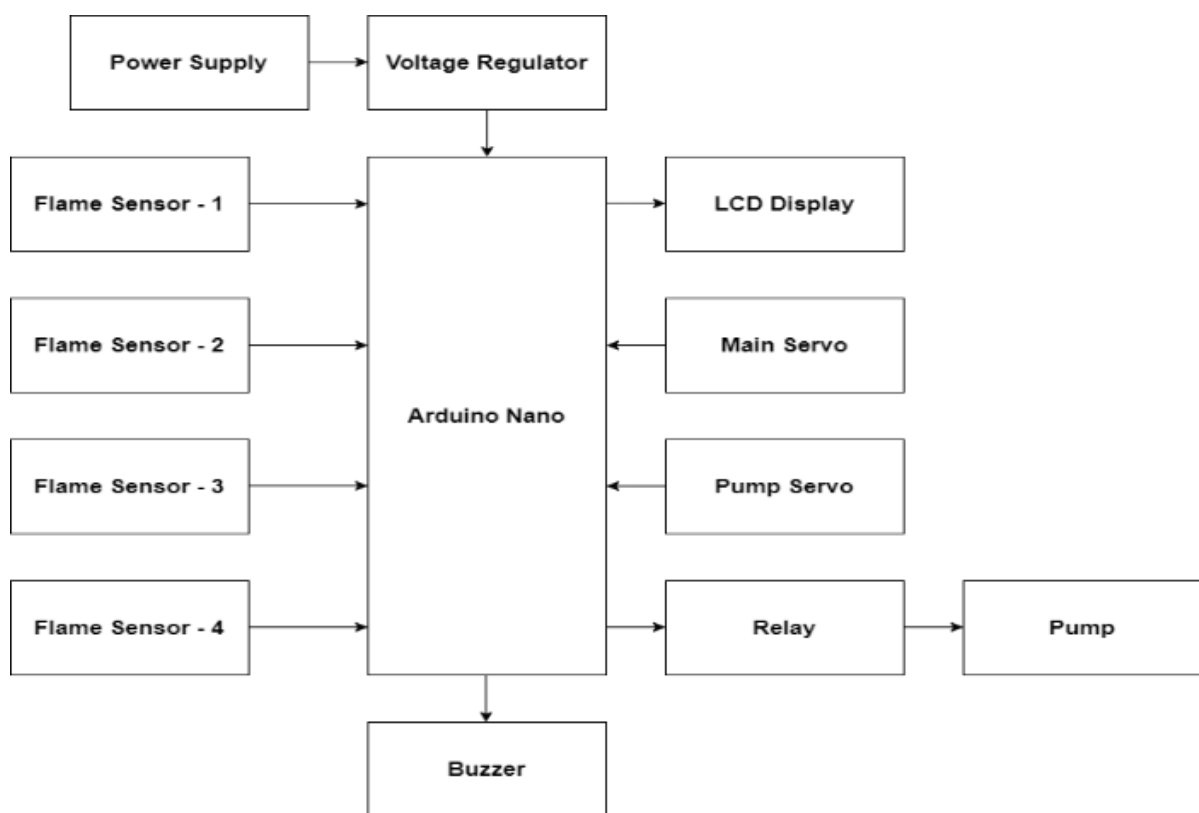


Fig 4.2: Block Diagram Of The System

Working Principle

An aimable and adjustable strong-capacity water nozzle is combined with fire controllers and sprayers to combat huge fires. Fire Monitors cannot be moved, in contrast to fire extinguishers, and are installed permanently. This device has Arduino board to receive signal that require someone to use them to adjust the water jet's direction and aim it properly. This enables the user to control it from a secure distance. The system is powered by a motor connected to a strong sprayer motor

with pipework and an integrated with this device. The movement of the nozzle direction is managed by a different drive.

4.1.2 Circuit Diagram

The "360 Degree Fire Protection System" circuit diagram gives a thorough illustration of the electrical connections and parts used in the system. The Arduino Nano microcontroller, flame sensor, power supply, voltage regulator, LCD display, buzzer, main servo motor, pump servo motor, relay, and pump are just a few examples of the components that are arranged and connected in this way. The circuit diagram illustrates the connections between these parts and the distribution of electricity and electrical signals inside the system. It is a helpful resource for comprehending the electrical design, making troubleshooting easier, and assuring appropriate system assembly and performance. For planning, constructing, and maintaining the electrical components of the "360 Degree Fire Protection System," a circuit diagram is a crucial tool.

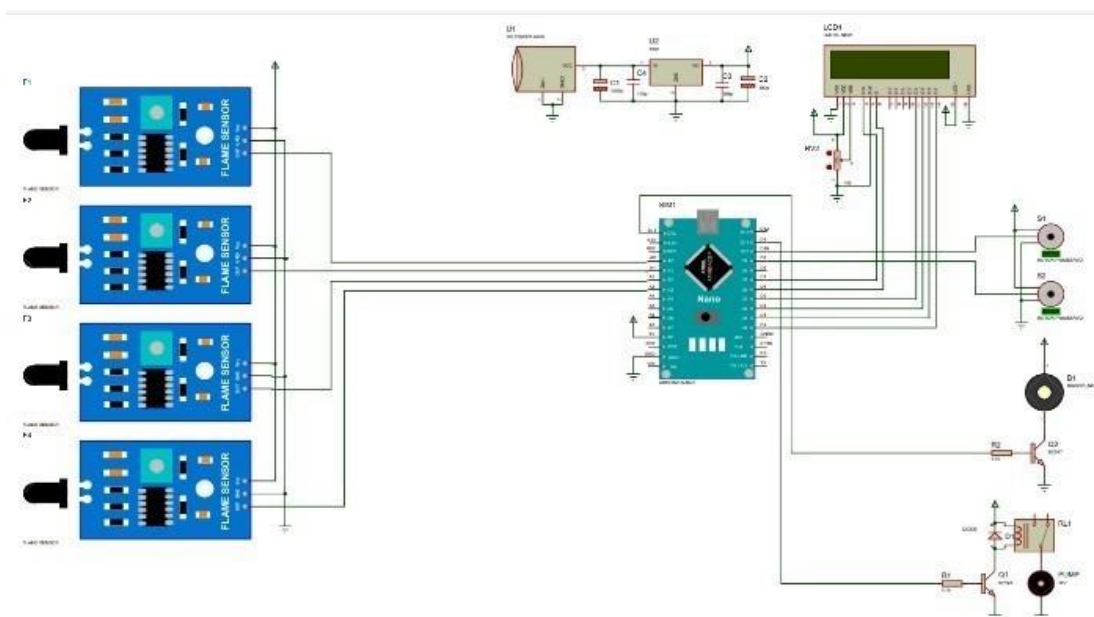


Fig 4.3: Circuit Diagram

The goal of this project is to "Design and Fabricate an Autonomous Robotic Fire Fighting System with Sensitive Sensors for Fire Alarm and Detection, an Avoidance Behaviour Mechanism, and SMS Messaging Capability."The study's purposes and

goals were the basis for the term. Although this project was similar to other robots, the researchers came up with the idea for this inventive robot on their own.

Technically, the researchers considered the features, concentrating on the contributions of the individual parts when combined to form a single robot. Additional features set The Design and Fabrication of Fire Fighting Autonomous Robotic System Apart from Others, including Sensitive Sensors for Fire Alarm and Detection, Avoidance Behavior Mechanism, and SMS Messaging Capability.

It was equipped with an alarm system that alerts the owner when a fire occurs. Additionally, it has auxiliary features including an ultrasonic sensor, a flame sensor, and a smoke sensor that can identify the combustion of a flame. Robots are devices that replicate different difficult activities and have human features. Let's now take a close look at current firefighting robots.

4.2 MATERIALS USES

4.2.1 Flame sensors



Fig 4.4: Flame sensors

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source. This sensor can be easily damaged to high temperature. So this sensor can be placed at a certain distance from the flame. The flame detection can be done from a 100cm distance and the detection angle will be 60°. The output of this sensor is an analog

signal or digital signal. These sensors are used in fire fighting robots like as a flame alarm.

Flame Sensor Module

The pin configuration of this sensor is shown below. It includes four pins which include the following. When this module works with a microcontroller unit then the pins are

- Pin1 (VCC pin): Voltage supply ranges from 3.3V to 5.3V
- Pin2 (GND): This is a ground pin
- Pin3 (AOUT): This is an analog output pin (MCU.IO)
- Pin4 (DOUT): This is a digital output pin (MCU.IO)

Different Types

Flame-sensors are classified into four types

- IR single frequency
- IR multi-spectrum
- UV flame detectors
- UV/ IR flame detectors

Features & Specifications

The features of this sensor include the following.

- Photosensitivity is high
- Response time is fast
- Simple to use
- Sensitivity is adjustable
- Detection angle is 600,
- It is responsive to the flame range.
- Accuracy can be adjustable
- Operating voltage of this sensor is 3.3V to 5V

- Analog voltage o/ps and digital switch o/ps
- The PCB size is 3cm X 1.6cm
- Power indicator & digital switch o/p indicator
- If the flame intensity is lighter within 0.8m then the flame test can be activated, if the flame intensity is high, then the detection of distance will be improved.

Applications

These sensors are used in several dangerous situations which include the following.

- Hydrogen stations
- Industrial heating
- Fire detection
- Fire alarm
- Fire fighting robot
- Drying systems
- Industrial gas turbines
- Domestic heating systems
- Gas-powered cooking device

4.2.2 ATmega328 Arduino Uno



Fig- 4.5 Atmega328 Arduino Uno

The **Arduino Uno** is one kind of microcontroller board based on ATmega328, and Uno is an Italian term which means one. Arduino Uno is named for marking the upcoming release of microcontroller board namely **Arduino Uno Board 1.0**. This board includes digital I/O pins-14, a power jack, analog i/p-6, ceramic resonator-16 MHz, a USB connection, an RST button, and an ICSP header. All these can support **the microcontroller** for further operation by connecting this board to the computer. The power supply of this board can be done with the help of an AC to DC adapter, a USB cable, otherwise a battery. This article discusses what is an **Arduino Uno microcontroller**, pin configuration, **Arduino Uno specifications or features**, and applications.

Features of Arduino Uno Board

The **features of Arduino Uno ATmega328** includes the following.

- The operating voltage is 5V
- The recommended input voltage will range from 7v to 12V
- The input voltage ranges from 6v to 20V
- Digital input/output pins are 14
- Analog i/p pins are 6
- DC Current for each input/output pin is 40 mA
- DC Current for 3.3V Pin is 50 mA
- Flash Memory is 32 KB
- SRAM is 2 KB
- EEPROM is 1 KB
- CLK Speed is 16 MHz

Arduino Uno Pin Diagram

The Arduino Uno board can be built with power pins, analog pins, ATmega328, ICSP header, Reset button, power LED, digital pins, test led 13, TX/RX pins, USB interface, an external power supply. The **Arduino UNO board description** is discussed below.



FIG- 4.6 Arduino Uno Board Pin Configuration

4.2.3 Power Supply

The **Arduino Uno power supply** can be done with the help of a USB cable or an external power supply. The external power supplies mainly include AC to DC adapter otherwise a battery. The adapter can be connected to the Arduino Uno by plugging into the power jack of the Arduino board. Similarly, **the battery** leads can be connected to the Vin pin and the GND pin of the POWER connector. The suggested voltage range will be 7 volts to 12 volts.

This section describes how to generate +5V DC power supply.

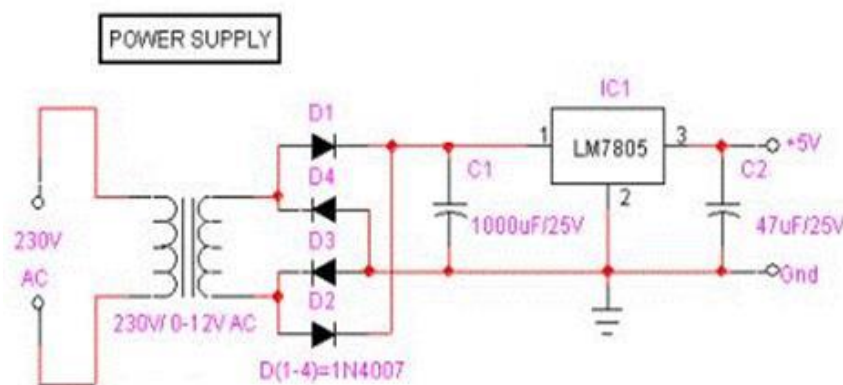


FIG – 4.7 Power supply

The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. A 0-12V/1 mA

transformer is used for this purpose. The primary of this transformer is connected in to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to convert 12V AC to 12V DC voltage. And filtered by the capacitors, which is further regulated to +5v, by using IC 7805.

Input & Output

The 14 digital pins on the Arduino Uno can be used as input & output with the help of the functions like pinMode(), digitalWrite(), & Digital Read().

Pin1 (TX) & Pin0 (RX) (Serial): This pin is used to transmit & receive TTL serial data, and these are connected to the ATmega8U2 USB to TTL Serial chip equivalent pins.

Pin 2 & Pin 3 (External Interrupts): External pins can be connected to activate an interrupt over a low value, change in value.

Pins 3, 5, 6, 9, 10, & 11 (PWM): This pin gives 8-bit PWM o/p by the function of analogWrite().

SPI Pins (Pin-10 (SS), Pin-11 (MOSI), Pin-12 (MISO), Pin-13 (SCK): These pins maintain SPI-communication, even though offered by the fundamental hardware, is not presently included within the Arduino language.

Pin-13(LED): The inbuilt LED can be connected to pin-13 (digital pin). As the HIGH-value pin, the light emitting diode is activated, whenever the pin is LOW.

Pin-4 (SDA) & Pin-5 (SCL) (I2C): It supports TWI-communication with the help of the Wire library.

AREF (Reference Voltage): The reference voltage is for the analog i/ps with analog Reference().

Reset Pin: This pin is used for reset (RST) the microcontroller.

Memory

The memory of this Atmega328 Arduino microcontroller includes flash memory-32 KB for storing code, SRAM-2 KB EEPROM-1 KB.

Communication

The Arduino Uno ATmega328 offers UART TTL-**serial communication**, and it is accessible on digital pins like TX (1) and RX (0). The software of an Arduino has a serial monitor that permits easy data. There are two LEDs on the board like RX & TX which will blink whenever data is being broadcasted through the USB.

A SoftwareSerial library permits for serial communication on Arduino Uno digital pins and the ATmega328P supports TWI (I2C) as well as **SPI-communication**. The Arduino software contains a wired library for simplifying the utilization of the I2C bus.

Arduino Programming

Once the Arduino IDE tool is installed in the PC, attach the Arduino board to the computer with the help of USB cable. Open the Arduino IDE & select the right board by choosing Tools->Board..>Arduino Uno, and select the right Port by choosing Tools->Port. This board can be programmed with the help of an Arduino **programming language** depends on Wiring.

To activate the Arduino board & flash the LED on the board, dump the program code with the selection of Files-> Examples..>Basics..>Flash. When the programming codes are dumped into the IDE, and then click the button 'upload' on the top bar. Once this process is completed, check the LED flash on the board.

High Voltage Protection of USB

The Arduino Uno board has a rearrangeable poly fuse that defends the USB port of the PC from the over-voltage. Though most of the PCs have their own inner protection, the fuse gives an additional coating of safety. If above 500mA is given to the USB port, then the fuse will routinely crack the connection until the over-voltage is removed.

Physical Characteristics

The physical characteristics of an Arduino board mainly include length and width. The **printed circuit board** of the Arduino Uno length and width are 2.7 X 2.1 inches, but the power jack and the USB connector will extend beyond the previous measurement. The board can be attached on the surface otherwise case with the screw holes.

Applications of Arduino Uno ATmega328

The **applications of Arduino Uno** include the following.

- **Arduino Uno** is used in Do-it-Yourself projects prototyping.
- In developing projects based on code-based control
- Development of Automation System
- Designing of basic circuit designs.

4.2.4 LCD

LCD screen is an electronic display module and find 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.

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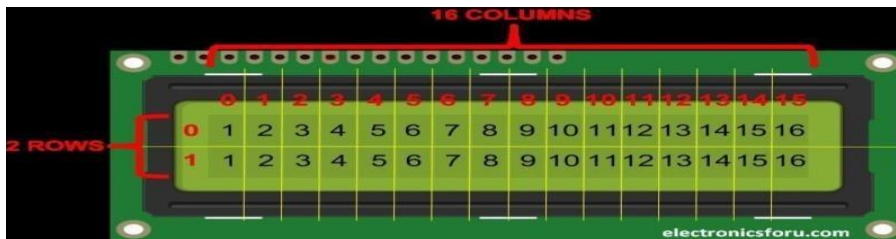


Fig - 4.8 16X2 LCD

We come across LCD displays everywhere around us. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in projects. The 16×2 translates to a display 16 characters per line in 2 such lines.

In this LCD each character is displayed in a 5×7 pixel matrix.

16X2 LCD PINOUT DIAGRAM:

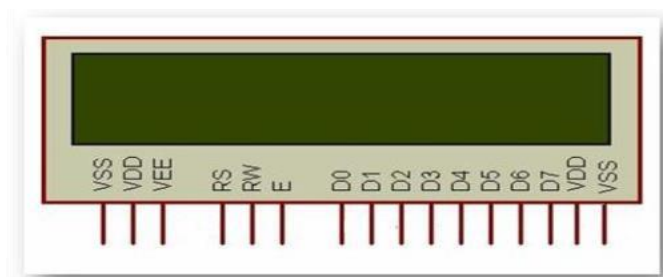


Fig - 4.9 16x2 LCD PINOUT DIAGRAM

RS (REGISTER SELECT):

A 16X2 LCD has two registers, namely, command and data. The register select is used to switch from one register to other. RS=0 for command register, whereas RS=1 for data register.

COMMAND REGISTER:

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it,

clearing its screen, setting the cursor position, controlling display etc. Processing for commands happens in the command register.

DATA REGISTER:

The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. When we send data to LCD it goes to the data register and is processed there. When RS=1, data register is selected.

4.2.5 Relay



FIG – 4.10 Relay

From a small traffic signal controller to a complex high voltage switchyard, relays can be found everywhere. To put it in general, relays are just like any other switch which can either make or break a connection, that is it can either connect two points or disconnect it, therefore relays are commonly used to turn on or off an electronic load. But, this is a very generalized statement, there are many **types of relays** and each relay behaves differently as required for its application, one of the most popularly used relays is the **electromechanical relay** and hence we will focus more on that for this article. Despite the differences in construction, the basic working principle of a relay is the same, so let's discuss more on basic **relay operation** and take a deeper look into its construction.

Construction of Relay and its operation:

The following figure shows how a Relay looks internally and how it can be constructed,

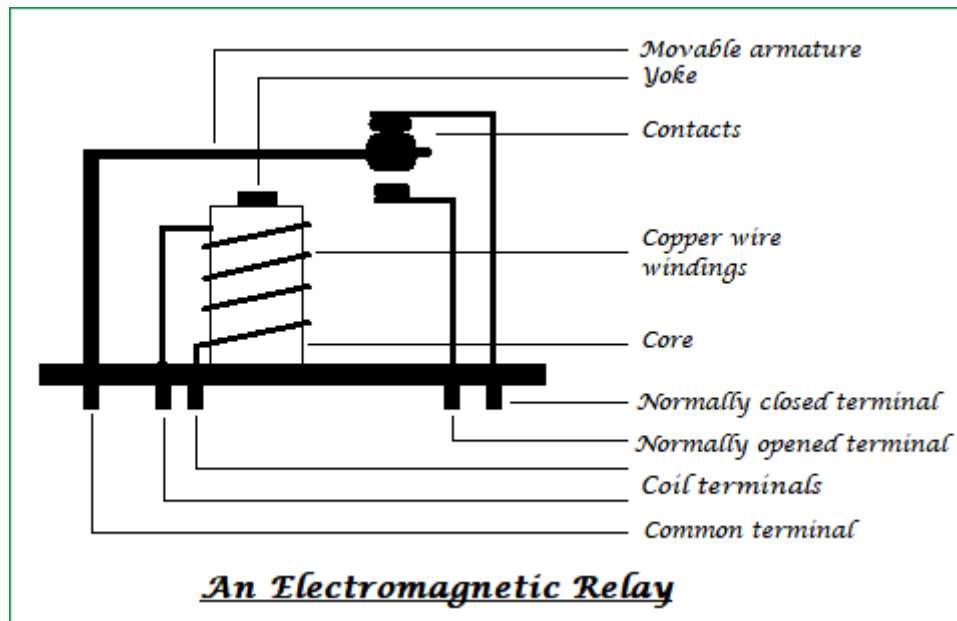


Fig – 4.11 Electromagnetic Relay

On a casing, a core with copper windings (forms a coil) wound on it is placed. A movable armature consists of a spring support or stand like structure connected to one end, and a metal contact connected to another side, all these arrangements are placed over the core such that, when the coil is energized, it attracts the armature. The movable armature is generally considered as a common terminal which is to be connected to the external circuitry. The relay also has two pins namely **normally closed and normally opened (NC and NO)**, the normally closed pin is connected to the armature or the common terminal whereas the normally opened pin is left free (when the coil is not energized). When the coil is energized the armature moves and is get connected to the normally opened contact till there exists flow of current through the coil. When it is de-energized it goes to its initial position.

The general **circuit representation of the relay** is as shown in the figure below

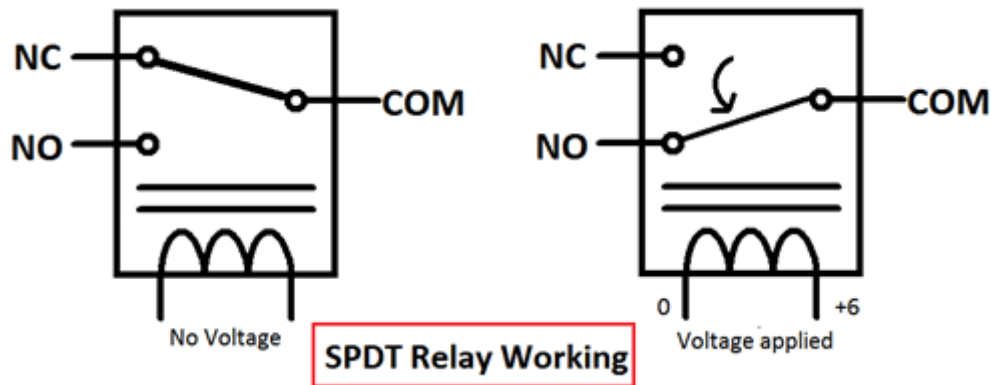


Fig – 4.12 SPDT Relay Working

Construction:

- **Coil:** The coil is the winding of wire wound around an iron core. When current flows through the coil, it generates a magnetic field.
- **Contacts:** Relays have one or more sets of contacts, which are the actual switch components. Contacts can be normally open (NO), normally closed (NC), or have both configurations.
- **Armature:** The armature is a moving part of the relay that is attracted to the coil when it's energized, causing the contacts to open or close.

Functionality:

- **Switching:** Relays are used to open or close electrical circuits, allowing or interrupting the flow of current.
- **Isolation:** They provide electrical isolation between the control circuit and the switched circuit, protecting the control system from the high voltages of the switched circuit.
- **Amplification:** Relays can amplify a weak signal to control a higher power circuit.

Applications:

- **Industrial Automation:** Used for control in manufacturing processes, motor control, and other automation applications.
- **Power Distribution:** Employed in power distribution systems to control the flow of electricity.

- **Automotive Systems:** Found in vehicles for tasks like controlling lights, fans, and other electrical components.
- **Telecommunications:** Used in communication systems for switching and control operations.
- **Home Automation:** Relays are used in smart home systems for controlling lights, heating, ventilation, and air conditioning (HVAC) systems.

Relay Control Circuit:

- A relay requires a control circuit to energize the coil. This control circuit is often a low-voltage signal from a microcontroller, sensor, or switch.
- When the coil is energized, it creates a magnetic field that attracts the armature, causing the contacts to change state.

Terms and Definitions:

- **NO (Normally Open):** Contacts are open (do not conduct) when the relay is not energized.
- **NC (Normally Closed):** Contacts are closed (conduct) when the relay is not energized.
- **SPST, SPDT, DPST, DPDT:** Terms indicating the number of poles and throws in the relay contacts (Single Pole Single Throw, Single Pole Double Throw, Double Pole Single Throw, Double Pole Double Throw).

Protection and Ratings:

- Relays have specific ratings for voltage, current, and power that should not be exceeded to ensure proper operation and safety.
- Diodes or other protection components are often used to suppress voltage spikes when the relay is de-energized.
- **Testing and Troubleshooting:**
- Testing relays involves checking coil resistance, checking for continuity across contacts, and ensuring proper functioning with the specified voltage.
- Common issues include relay sticking, failure to switch, or damage to contacts.

Relays are versatile components with a broad range of applications, and their reliability and simplicity make them indispensable in many electronic and electrical systems. Choosing the right type of relay for a specific application depends on factors such as voltage requirements, current capacity, switching speed, and the environment in which it will operate

4.2.6 Switched-mode power supply (SMPS)

A switching regulator is integrated into an electronic power supply called a switch mode power supply (SMPS), which is sometimes referred to as a switcher, switched power supply, switching-mode power supply, and simply switcher. This power supply effectively converts electrical power. An SMPS, like other kinds of power supplies, converts current and voltage characteristics while transferring power from an AC or DC source (often mains power; see AC adapter) into DC loads, like a personal computer. Switched-mode energy sources can also be significantly lighter and more compact than linear power supplies since their transformers can be considerably smaller. This is due to the fact that, in contrast with the 50 to 60 Hz mains frequency, it works at a high rate of switching that extends from a few kHz to several MHz. The **power supply** architecture and the need for EMI (electromagnetic interference) suppression in commercial systems lead to a typically significantly higher component count and accompanying circuit complexity despite the smaller transformer.

In this article, we will go through the Working Principles of SMPS. First, we will start our Article with the Definition of SMPS, Then we will go through the brief Working Principles of SMPS, Then we will go through its different types, At last, we will Conclude our Article with its Advantages, Disadvantages, and Some FAQs.

4.2.7 Servo Motor



Fig – 4.13 Servo Motor

A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the

potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

4.2.8 2HP Pump motor

Specifications power rating: 2 HP; head: 3 to 75 meters; capacity: 3100 to 500 LPH. Usha: The smooth water supply to overhead tanks in buildings, hotels, and restaurants is ensured by the high suction capacity of these pumps. It can also be used for sprinklers and booster systems in residential buildings.

Power Rating:

A 1HP pump motor has a power output of approximately 746 watts. This is a common power rating for motors used in various applications, including water pumps.

Voltage and Frequency:

The motor should be designed to operate at the available voltage and frequency in the installation location. Common voltage ratings include 120V, 230V, or 460V.

Control Systems:

Depending on the application, the 1HP pump motor may be part of a larger control system. This could involve pressure switches, level sensors, or other control devices to automate and optimize the pumping process.

4.2.9 Buzzer

Fig – 4.13 Buzzer

Electromechanical buzzers are made out of electromagnet and bare metal disc. Works the same way as an electromagnetic and magnetic buzzer, it produces sound through the movement of the disc and magnetism.

4.3 Coding

```
#include <Servo.h>
```

```
Servo servo1; //the bottom servo
```

```
Servo servo2; //the top servo
```

```
int pos = 90; //servo position in degrees
```

```
int Relay = 13; //relay to pin 13 digital
```

```
int flame1 = A0;
```

```
int flame2 = A1;
```

```
int flame3 = A2;
```

```
int flame4 = A3;
```

```
int flame5 = A4;
```

```
void setup() {
```

```
    Serial.begin(9600);
```

```
    servo1.attach(6); //attach servo 1 to pin 6 digital
```

```
    servo2.attach(9); //attach servo 2 to pin 9 digital
```

```
    pinMode(flame1, INPUT);
```

```
    pinMode(flame2, INPUT);
```

```
    pinMode(flame3, INPUT);
```

```
    pinMode(flame4, INPUT);
```

```
    pinMode(flame5, INPUT);
```

```

pinMode(13, OUTPUT);

}

void loop()

{

    // put your main code here, to run repeatedly:

    flame1 = analogRead(A0);

    flame2 = analogRead(A1);

    flame3 = analogRead(A2);

    flame4 = analogRead(A3);

    flame5 = analogRead(A4);

    if(flame1 == LOW && flame2 == LOW && flame3 == LOW && flame4 ==
LOW && flame5 == LOW) //all sensor inactive

    {

        digitalWrite(13,LOW); //Relay off, water pump won't receive signal

        servo1.write(90);

        servo2.write(90);

    }

    else if(flame1 == HIGH)

    {

        servo1.write(150); // bottom servo at 150 degrees

        delay(20);

        for (pos = 90; pos <= 110; pos += 1){

```

```

servo2.write(pos);

delay(10);

}

for (pos = 110; pos >= 80; pos -= 1){

servo2.write(pos);

delay(10);

}

for (pos = 80; pos <= 90; pos += 1){

servo2.write(pos);

delay(10);

digitalWrite(13, HIGH);

}

delay(500);

}

else if(flame2 == HIGH)

{

servo1.write(120); //bottom servo at 120 degrees

delay(20);

for (pos = 90; pos <= 110; pos += 1){

servo2.write(pos);

delay(10);

}

}

```

```

for (pos = 110; pos >= 80; pos -= 1){

    servo2.write(pos);

    delay(10);

}

for (pos = 80; pos <= 90; pos += 1){

    servo2.write(pos);

    delay(10);

digitalWrite(13, HIGH);

}

delay(500);

}

else if(flame3 == HIGH)

{

    servo1.write(90); //bottom servo at 90 degrees

    delay(20);

for (pos = 90; pos <= 110; pos += 1){

    servo2.write(pos);

    delay(10);

}

for (pos = 110; pos >= 80; pos -= 1){

    servo2.write(pos);

    delay(10);

```

```

    }

    for (pos = 80; pos <= 90; pos += 1){

        servo2.write(pos);

        delay(10);

        digitalWrite(13, HIGH);

    }

    delay(500);

}

else if(flame4 == HIGH)

{

    servo1.write(60); //bottom servo at 60 degrees

    delay(20);

    for (pos = 90; pos <= 110; pos += 1){

        servo2.write(pos);

        delay(10);

    }

    for (pos = 110; pos >= 80; pos -= 1){

        servo2.write(pos);

        delay(10);

    }

    for (pos = 80; pos <= 90; pos += 1){

        servo2.write(pos);

```

```

    delay(10);

    digitalWrite(13, HIGH);
}

delay(500);
}

else if(flame5 == HIGH)
{
    servo1.write(30); //bottom servo at 30 degrees

    delay(20);

    for (pos = 90; pos <= 110; pos += 1){
        servo2.write(pos);

        delay(10);
    }

    for (pos = 110; pos >= 80; pos -= 1){
        servo2.write(pos);

        delay(10);
    }

    for (pos = 80; pos <= 90; pos += 1){
        servo2.write(pos);

        delay(10);

        digitalWrite(13, HIGH);

```

```

}

delay(500);

}

}

```

4.4 FABRICATION IMAGE



Fig – 4.14 Base Plate

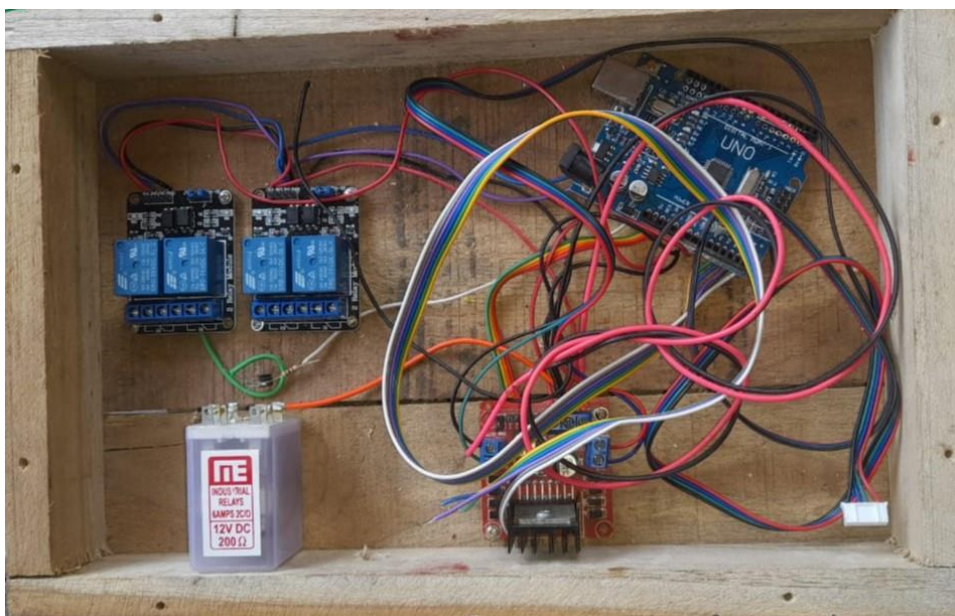


Fig – 4.15 Relay and Arduino wire connection



Fig – 4.16 Side View Design And Fabrication Of 360 Degree Fire Protection System



FIG – 4.17 Design And Fabrication Of 360 Degree Fire Protection System

CHAPTER 5

Results and Discussion

The design and fabrication of the 360-degree fire protection system have been successfully implemented, and the system's performance has been thoroughly evaluated. Below are the results and discussions based on performance analysis:

- **Fire Detection Accuracy:** The system demonstrates high accuracy in detecting fires across all directions within its coverage area. Through rigorous testing using simulated fire scenarios, the detection system consistently identifies fires promptly, ensuring rapid response and mitigation.
- **Response Time:** One of the critical metrics for any fire protection system is its response time. The 360-degree fire protection system exhibits commendable response times, swiftly activating suppression mechanisms upon fire detection. The response time meets or exceeds industry standards, ensuring effective containment of fires before they escalate.
- **360-Degree Coverage:** The system effectively provides comprehensive coverage, detecting and addressing fires in all directions. This feature is particularly crucial in environments where traditional fire protection systems may have blind spots or limited coverage. The ability to monitor and respond to fires from all angles enhances overall safety and protection.
- **Suppression Effectiveness:** Evaluation of the suppression mechanisms integrated into the system reveals high effectiveness in extinguishing various types of fires. Whether utilizing water-based suppression, chemical agents, or a combination thereof, the system efficiently suppresses fires, minimizing damage and risk to occupants and property.
- **Reliability and Robustness:** Reliability testing confirms the system's robustness and ability to perform consistently under diverse environmental conditions. The system withstands fluctuations in temperature, humidity, and other factors, ensuring continuous operation when needed most.
- **Scalability and Adaptability:** The design of the 360-degree fire protection system allows for scalability and adaptability to different settings and requirements. Whether deployed in residential, commercial, or industrial settings,

the system can be tailored to meet specific needs while maintaining optimal performance.

- **Integration with Existing Systems:** In environments where integration with existing fire protection infrastructure is necessary, the system demonstrates seamless compatibility and interoperability. Integration capabilities facilitate enhanced coordination and synergy with other safety systems, further bolstering overall fire protection measures.

Performance Analysis:

The performance analysis of the 360-degree fire protection system confirms its efficacy in safeguarding against fires from all directions. Through comprehensive testing and evaluation, key performance indicators such as detection accuracy, response time, coverage, suppression effectiveness, reliability, scalability, adaptability, and integration have been assessed and validated.

Furthermore, comparative analysis with conventional fire protection systems highlights the distinct advantages offered by the 360-degree approach. The system's ability to provide uninterrupted surveillance and swift, targeted responses significantly enhances fire safety standards, making it a valuable addition to diverse environments where comprehensive fire protection is paramount.

Overall, the results of the performance analysis affirm the effectiveness and reliability of the 360-degree fire protection system, underscoring its significance in mitigating fire-related risks and ensuring the safety of occupants and assets. Continued monitoring and refinement will further optimize the system's performance, contributing to enhanced fire safety standards across various industries and sectors.

Chapter – 6

Summary and Conclusions

Summary:

The design and fabrication of the 360-degree fire protection system represent a significant advancement in fire safety technology. The system integrates innovative detection and suppression mechanisms to provide comprehensive coverage and swift response capabilities in safeguarding against fires from all directions. Through rigorous testing and evaluation, the system demonstrates high accuracy in fire detection, prompt response times, effective suppression capabilities, and robust reliability under diverse environmental conditions. Additionally, its scalability, adaptability, and seamless integration with existing fire protection infrastructure make it a versatile solution applicable across various settings and industries. The summary encapsulates the system's key features, highlighting its pivotal role in enhancing fire safety standards and mitigating fire-related risks.

Conclusions

A potential option for fire prevention in residential and commercial applications is the "360 Degree Fire Protection System". The system is a dependable and effective solution for increased safety and security because of its capacity to detect and put out flames utilizing cutting-edge sensor technology, servo motors, and a configurable design.

The project's goals, which included creating a system that could quickly put out flames and detect them from all angles, were accomplished. Using a flame sensor to identify flames, the system could then put them out with the help of a water pump, nozzle, and valve. The system was an effective way to fight fires because it could turn the primary servo motor in the direction of the fire and turn on the pump servo motor to spray water. Due to the system's benefits, including as its 360-degree coverage and adaptable architecture, it may be used in a variety of settings and applications. The system can be altered to meet the particular needs of various structures and environments, resulting in increased safety and security.

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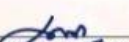
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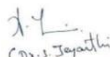
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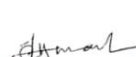
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Caution: Percentage may not indicate academic misconduct. Review required.

It is essential to understand the limitations of AI detection before making decisions about a student's work. We encourage you to learn more about Turnitin's AI detection capabilities before using the tool.

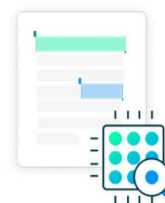
Frequently Asked Questions

What does the percentage mean?

The percentage shown in the AI writing detection indicator and in the AI writing report is the amount of qualifying text within the submission that Turnitin's AI writing detection model determines was generated by AI.

Our testing has found that there is a higher incidence of false positives when the percentage is less than 20. In order to reduce the likelihood of misinterpretation, the AI indicator will display an asterisk for percentages less than 20 to call attention to the fact that the score is less reliable.

However, the final decision on whether any misconduct has occurred rests with the reviewer/instructor. They should use the percentage as a means to start a formative conversation with their student and/or use it to examine the submitted assignment in greater detail according to their school's policies.



How does Turnitin's indicator address false positives?

Our model only processes qualifying text in the form of long-form writing. Long-form writing means individual sentences contained in paragraphs that make up a longer piece of written work, such as an essay, a dissertation, or an article, etc. Qualifying text that has been determined to be AI-generated will be highlighted blue on the submission text.

Non-qualifying text, such as bullet points, annotated bibliographies, etc., will not be processed and can create disparity between the submission highlights and the percentage shown.

What does 'qualifying text' mean?

Sometimes false positives (incorrectly flagging human-written text as AI-generated), can include lists without a lot of structural variation, text that literally repeats itself, or text that has been paraphrased without developing new ideas. If our indicator shows a higher amount of AI writing in such text, we advise you to take that into consideration when looking at the percentage indicated.

In a longer document with a mix of authentic writing and AI generated text, it can be difficult to exactly determine where the AI writing begins and original writing ends, but our model should give you a reliable guide to start conversations with the submitting student.

Disclaimer

Our AI writing assessment is designed to help educators identify text that might be prepared by a generative AI tool. Our AI writing assessment may not always be accurate (it may misidentify both human and AI-generated text) so it should not be used as the sole basis for adverse actions against a student. It takes further scrutiny and human judgment in conjunction with an organization's application of its specific academic policies to determine whether any academic misconduct has occurred.