

AUTOMATIC FIRE EXTINGUISHING SYSTEM

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ABSTRACT: Fire accidents in public places such as malls, offices, and hospitals pose serious threats to life and property. Conventional fire safety systems often result in delayed response and excessive water usage. To address these issues, this project presents an IoT-Based Smart Fire Extinguishing System using Node MCU. The system uses sensors to detect fire or abnormal temperature conditions and enables real-time decision-making through the Node MCU microcontroller. Upon detection, a relay activates the water pump while a servo motor directs water only toward the affected area, reducing unnecessary water wastage. The integration of IoT technology improves monitoring and ensures quick response during emergencies. The developed prototype demonstrates efficient fire detection, rapid suppression, and reliable operation, making it suitable for public and commercial environments as a cost-effective and automated fire safety solution.

Keywords: ESP8266, Node MCU, IoT.

I. INTRODUCTION

Fire safety is one of the most important concerns in modern buildings and public environments, for extra protection against fire, however, in addition to smoke alarms, installation of fire sprinklers is recommended. It is reported that the risk of dying and property loss decreases by about 80% and 71%, respectively [12], when sprinklers are installed where even a small fire can lead to serious damage if not controlled in time. The increasing use of electrical equipment, combustible materials, and enclosed indoor spaces has made fire accidents more frequent and hazardous. Our project could be an advisable choice to combat large fire due to its efficiency [11] To address this issue, this project presents a Smart Fire Extinguishing System using Node MCU [6], designed for automatic fire detection and localized fire suppression. The proposed system is a low-cost automated fire safety prototype that detects fire using two IR flame sensors [9] and suppresses it using a 12V DC water pump [7]. A Node MCU microcontroller acts as the central control unit, continuously monitoring the sensor inputs and processing fire detection signals. When a flame is detected, the Node MCU identifies the direction of the fire and controls a 180-degree servo motor [7] to rotate the nozzle toward the affected area. The water pump is then activated to spray water only at the fire source, ensuring targeted extinguishing and reduced water wastage. The system is powered using a 220V AC to 12V DC transformer, bridge rectifier [4], voltage regulator, and regulated power supply for stable operation. The project also demonstrates the practical implementation of embedded systems and automation in fire safety applications. Compared to conventional sprinkler systems, the proposed system provides faster response, improved efficiency, and better water management by focusing only on the affected area. The compact design, low power consumption, and simple circuitry make the system easy to install and maintain in indoor environments such as offices, classrooms, laboratories, hospitals, shops, and small commercial spaces. In addition, the built-in IoT capability of the Node MCU offers future scope for remote monitoring, smart alerts, and integration with smart building systems.

II. DESCRIPTION

Fire accidents are one of the major hazards in residential, commercial, and industrial environments. In places such as offices, hospitals, shopping malls, laboratories, and schools, even a small fire can spread rapidly and cause serious damage to life and property. Traditional fire safety systems mainly rely on manual operation or centralized sprinkler systems, which often result in delayed response and excessive water wastage. To overcome these limitations, this project presents a Smart Fire Extinguishing System using Node MCU for automatic fire detection and localized fire suppression. In other words, the amount of CO present in the detected smoke is a determining factor for fire detection, fire extinguishing system activation, and subsequent notification calls. Various other algorithms for similar kind of sensor integration for fire detection are available in the literature [13-14]. The system uses two IR flame sensors to detect the presence and direction of fire. A Node MCU ESP8266 microcontroller acts as the central control unit, continuously monitoring sensor inputs and processing the signals in real time. When a flame is detected, the Node MCU controls a

180-degree servo motor to rotate the water nozzle toward the affected area. A relay module then activates the 12V DC water pump, which sprays water directly onto the fire source for effective suppression. The system operates using a regulated 12V DC power supply obtained from a 220V AC source through a transformer, bridge rectifier, and voltage regulator. The targeted water spraying mechanism reduces unnecessary water wastage and improves extinguishing efficiency compared to conventional systems. The compact design, low cost, low power consumption, and IoT capability of the Node MCU make the system suitable for modern indoor fire safety applications.

BLOCK DIAGRAM

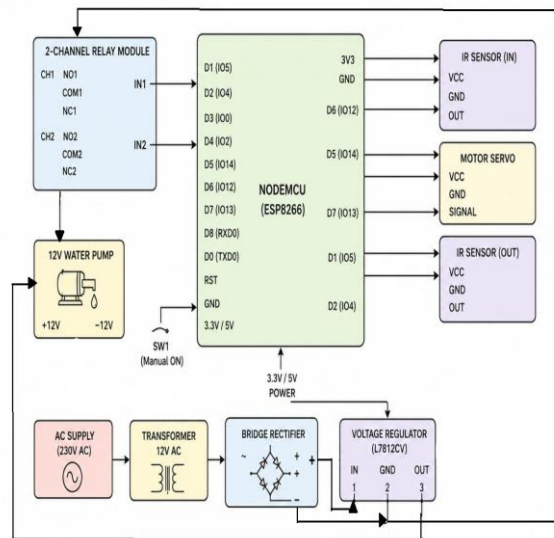


Fig 1 Block Diagram

IR Sensor

This unit integrates dual IR flame sensors for infrared radiation detection and heat source localization. These sensors work collaboratively to provide directional feedback, ensuring early and accurate fire detection.

ESP8266 (Node MCU)

This module continuously reads sensor data. A sophisticated threshold algorithm is applied, where a single sensor trigger initiates a "possible fire" state, but fire validation only occurs when two or more sensors confirm the event, significantly reducing false alarms.

The Node MCU (*Node Micro Controller Unit*) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds

Servo Motor

Upon fire confirmation, the microcontroller sends PWM signals to a servo motor. This motor manipulates the PVC water turret, enabling horizontal targeting of the fire source, optimizing water usage and suppression effectiveness.

12 Volt DC Pump

Activated by a dual-channel relay module, the high-pressure 12V DC water pump engages to release water. This allows for a concentrated stream of water to be directed specifically at the flame, providing rapid and efficient fire suppression without widespread water damage.

Transformer

A transformer converts the standard 220 V AC mains supply into a regulated 12 V DC power supply required for proper system operation. This controlled voltage conversion protects the water pump and other electronic components from electrical damage, overheating, voltage fluctuations, and unstable power conditions during continuous firefighting system operation.

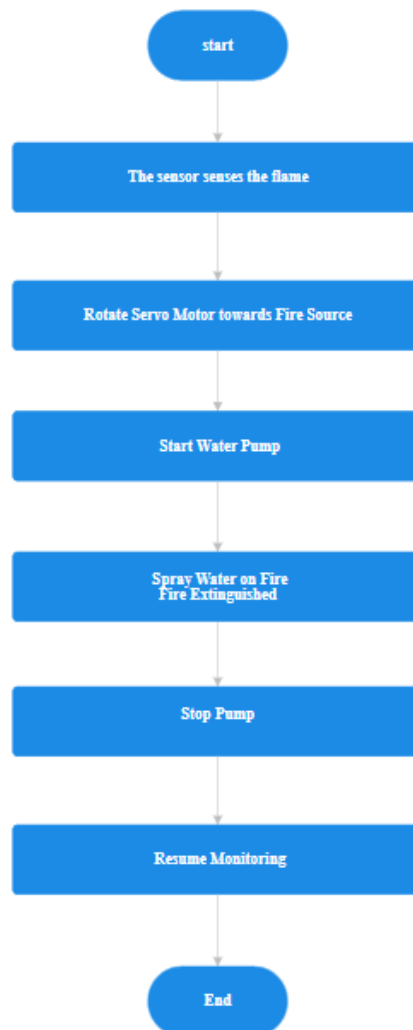
Voltage Regulator

The transformer output may experience fluctuations and pulsating voltage during operation under varying electrical load conditions.

Rectifier

A single-phase full-wave diode rectifier is used to convert the 12V AC output from the step-down transformer into 12V pulsating DC. The rectifier uses a bridge configuration of four diodes, allowing both half cycles of the AC waveform to be utilized, resulting in higher efficiency and reduced ripple. The pulsating DC output is then filtered and regulated to provide a stable DC supply for the Node MCU, sensors, relay module, servo motor, and water pump.

III. FLOW CHART



IV. CONCLUSION

The Smart Fire Extinguishing System using Node MCU successfully demonstrates an intelligent, automated, and water-efficient approach to modern fire safety. The system detects fire using IR flame sensors and automatically responds through the Node MCU microcontroller, which controls the servo motor and water pump for targeted fire suppression. By spraying water only at the affected area, the system reduces unnecessary water wastage and improves extinguishing efficiency compared to conventional methods. The project proves the effective use of embedded systems and automation in enhancing fire safety

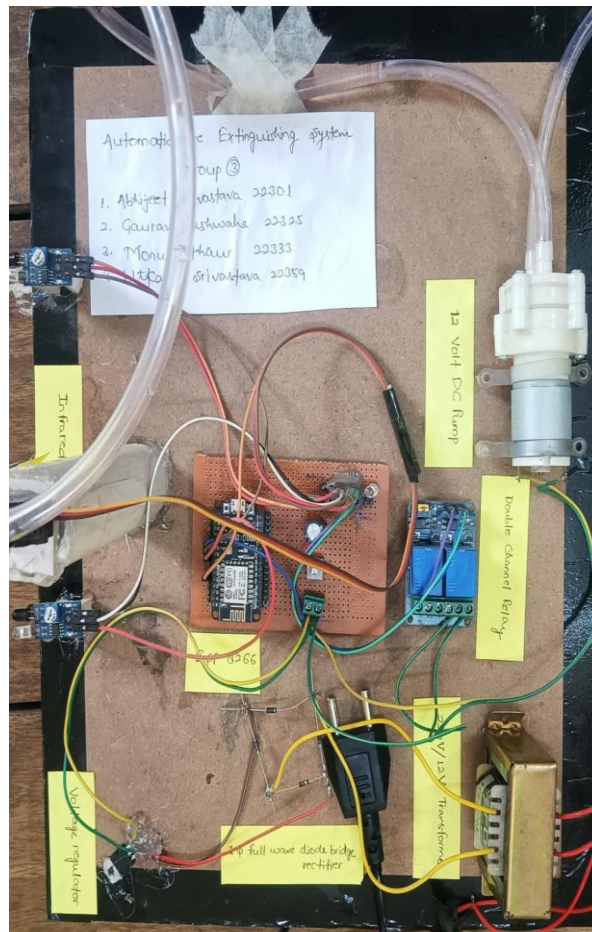


Fig 2 Final Prototype

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