Advanced Fire Fighting Robot

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Abstract -

The advancements in robotics have led to a decrease in human intervention, with robots now frequently deployed for security purposes. Fire incidents have become common in daily life, often posing significant dangers that challenge firefighters in preserving human life and property. In response, firefighting robots are increasingly utilized to prevent such incidents and safeguard lives, property, and the environment.
This project aims to develop a fire-extinguishing robot characterized by its compact size, resilience, and flexibility. Leveraging a microcontroller unit (MCU) board node, the robot autonomously detects fires and employs Internet of Things (IoT) technology for project management. Through innovative design and technological integration, the challenges faced by fire fighting robots have been addressed, enhancing their effectiveness in combating fire hazards.

Keywords: *Fire Fighting Robot; Compact Size Robot; Ultrasonic Sensor; Flame Sensor; Embedded System; IOT.*

1. INTRODUCTION

Advancements in embedded design technology have led to the integration of robots into various aspects of our lives, especially in situations where human lives are at risk, such as fire fighting. These robots are equipped with gas and smoke detectors, fire extinguishing capabilities, and flame sensors, making them effective in detecting and combating fire threats. They utilize wireless sensor structures with IR sensors to navigate through challenging topographical conditions.[1]
Robotic technology has reduced human intervention in hazardous situations, with fire fighting robots now frequently employed for safety purposes. Fire incidents are common and can pose challenges for fire fighters in preserving human life and property. To address this, fire fighting robots are deployed to protect lives, property, and the environment, operating in two modes: proactive prevention and reactive response.[2]
One innovative aspect of this research is the development of a fire fighting robot that autonomously detects and extinguishes fires, using an infrared sensor gas sensor MQ6 to identify fire presence. Upon detection, the robot deploys a water pump to suppress the fire and sends a signal to an IoT server for further action. These robots can be deployed in various locations to effectively combat fire hazards where human intervention may be limited.

2. Body of Paper

LITERATURE SURVEY

1. **"Implementation of an Intelligent Fire Fighting Robot using NodeMCU":** This project, authored by an unspecified individual or team, introduces an intelligent firefighting robot equipped with a flame sensor, temperature sensor, and water pump. The robot is capable of autonomously detecting and extinguishing fires.
2. **"An Automated Fire Fighting Robot Using the NodeMCU and Android Device" (2019) by S. S. Gupta and M. B. Kurhade:** Gupta and Kurhade detail the design and development of an automated firefighting robot utilizing the NodeMCU and Bluetooth technology. The robot features a flame sensor, temperature sensor, and water pump, and it can be operated remotely through an Android app.
3. **"Development of a Fire Fighting Robot Using the Internet of Things and NodeMCU" (2019) by V. K. Gupta and A. R. Pathak:** Gupta and Pathak discuss the development and design of a firefighting robot incorporating NodeMCU and IoT technology. The robot includes a flame sensor, temperature sensor, and water pump, with a web interface for remote operation.
4. **"Design and Development of a Fire Fighting Robot Using NodeMCU and Internet" (2020) by A. K. Mishra and S. K. Sahoo:** Mishra and Sahoo present the design and development of a firefighting robot utilizing NodeMCU and IoT technology. The robot features a flame sensor, temperature sensor, and water pump, along with a web interface for remote operation.

2.1 PROPOSED SYSTEM

To address shortcomings in the current firefighting system, the project implements both automatic and manual controls. In

manual mode, firefighters outside can assess the situation within the structure, while in automatic mode, low-priority issues are handled by the robot itself, alleviating stress on fire fighters. The suggested model employs an ultrasonic sensor to detect fire and sends the robot to the fire site. Upon detection, the robot autonomously operates a fire extinguisher via wireless communication to extinguish the fire. Additionally, the robot serves as an extra set of eyes for firefighters, aiding in situational analysis.[3] The design includes IR and flame sensors, motors, and a motor driver for robot adjustments. Upon detecting fire, the robot communicates with the microcontroller (Node MCU) and moves towards the flames to extinguish them autonomously.

2.2 METHODOLGY

The Firefighting Robot Project comprises a systematic approach to create an autonomous firefighting robot with the capability to detect and suppress fires in hazardous environments. The key components in this block diagram include sensors for fire, smoke, and obstacle detection, a microcontroller (Node-MCU 8266) for data processing and control, communication modules like Bluetooth HC-05 and a GSM module for remote operation and real-time alerting, and actuators in the form of a DC motor for movement and a 5V water pump for fire suppression. The sensors continuously monitor the robot's surroundings, feeding data to the microcontroller, which processes the information and makes informed decisions. The robot can autonomously move toward fire sources, suppress fires using the water pump, and navigate around obstacles using the ultrasonic sensor.[4] Additionally, the GSM module ensures real-time alerting, allowing the robot to promptly inform relevant personnel or authorities when fires are detected.[5] This integrated methodology is designed to enhance safety, speed, and efficiency in firefighting operations, ultimately offering a comprehensive solution to address the multifaceted challenges posed by fire emergencies, while minimizing risks to human responders and property damage.

1. **Flame Sensors**: These sensors detect the presence of fire and provide input to the firefighting robot. They are crucial for identifying fire hazards.
2. **Node-MCU**: This development board serves as the central control unit, linking and coordinating the various components of the robot. It facilitates communication between different parts of the system.
3. **L293D Motor Driver**: The motor driver is responsible for controlling the movement of the robot. It can drive two DC motors simultaneously, enabling the robot to move in different directions. In this case, it controls the left DC motor and the right DC motor.
4. **Servo Motors**: Servo motors are used for precise control of mechanisms such as robotic arms or sensors. They may be employed in the firefighting robot for tasks such as directing the flame sensors or controlling other mechanisms.
5. **Submersible Water Pump**: This pump is essential for supplying water to the firefighting system. It is used to extinguish fires by spraying water onto the affected area.
6. **Motors**: These motors are likely part of the locomotion system of the robot. They drive the wheels, allowing the robot to move in different directions.
7. **Rubber Wheels**: Rubber wheels provide traction and stability to the robot, enabling it to navigate various terrains effectively.

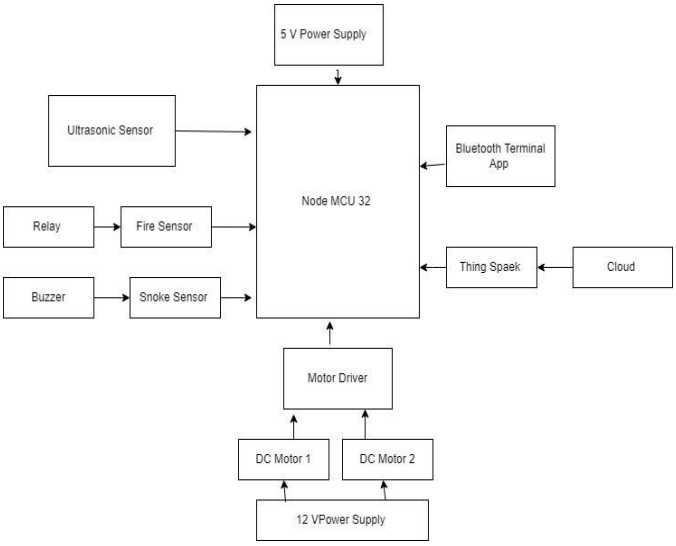

Fig -1: Block Diagram

The development of the firefighting robot follows a structured methodology encompassing design, development, integration, and testing phases.[6] Initially, a comprehensive requirement analysis was conducted through consultations with firefighters and safety experts to identify essential functionalities such as fire detection, autonomous navigation, and fire suppression capabilities.[7] A thorough literature review provided insights into current technologies and methodologies, guiding the selection of advanced sensors and control systems. Conceptual designs were generated, and components like flame, gas, IR, and temperature-humidity sensors were selected for integration. Prototypes were developed using off-the-shelf components, and preliminary tests ensured functionality.[8] The sensors were then integrated and calibrated for accurate detection. The control system, based on Node-MCU, was programmed to process sensor data and control movements, with algorithms implemented for noise filtering and data mapping. Suitable actuators were chosen for movement and fire suppression, and mechanical linkages were designed. Safety features, including obstacle detection and emergency stop mechanisms, were integrated. An intuitive user interface was developed to configure settings and provide real-time feedback.[9] Extensive testing and evaluation were conducted

to assess performance and usability, followed by iterative refinements based on feedback. Finally, comprehensive documentation was prepared, and the robot was readied for deployment, ensuring compliance with safety standards and certifications. This structured approach ensures the robot is a robust, reliable, and effective tool for enhancing firefighting operations and safety.[10]

2.3 Program Flow

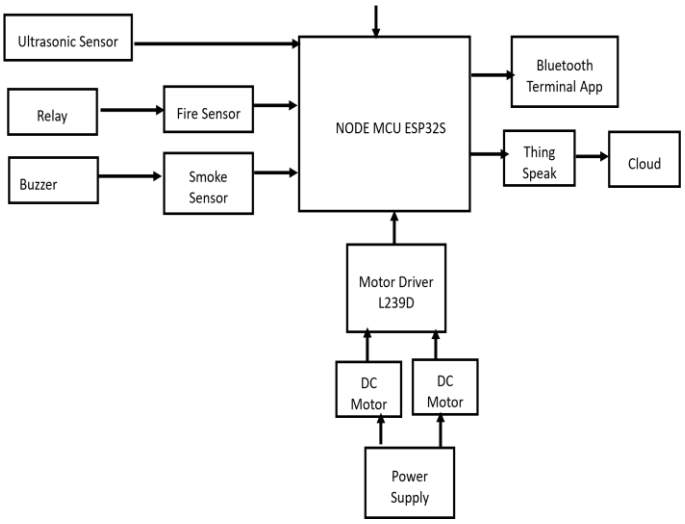

Fig -2: Program Flow

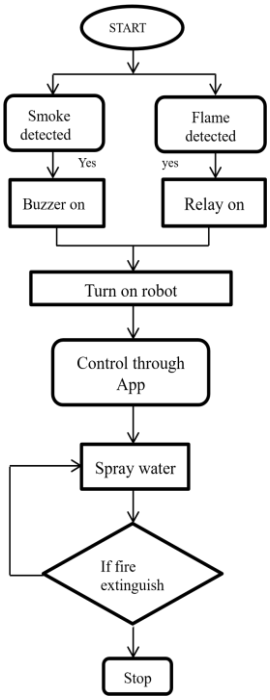

Fig -3: Flow chart

The flow starts by initializing the ports of components. First the power supply should be on to the circuit and three sensors are there one on middle and remaining two on right and left side of chassis whenever the fire is occurred the respective value is read by the sensors when fire is occurred the voltage becomes zero and chassis is moved to the respective and put off fire whenever there is no fire then there is no input is occurred occurred voltage is more than 0 volts and the initial condition is move to other direction

3. CONCLUSIONS

The Automated Fire Fighting Robot utilizing Node MCU is an innovative project demonstrating the potential of technology in improving firefighting effectiveness and safety. It offers a safer environment for firefighters and reduces firefighting risks. To further enhance the robot's capabilities, advanced sensors and actuators can be integrated. This project showcases the feasibility of creating an automated firefighting robot capable of timely and efficient fire detection and response. The utilization of Node MCU, an open-source microcontroller, ensures cost-effectiveness and accessibility for a broad user base.

4.Result and discussion

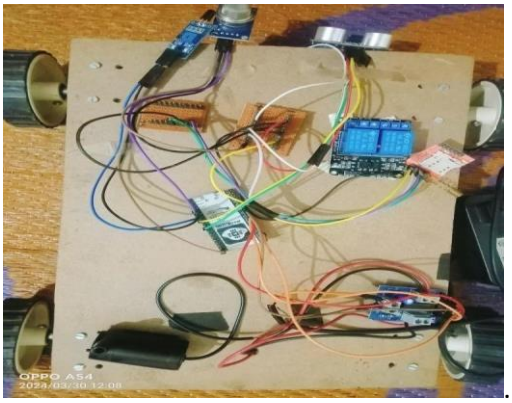

Fig. 1 Output

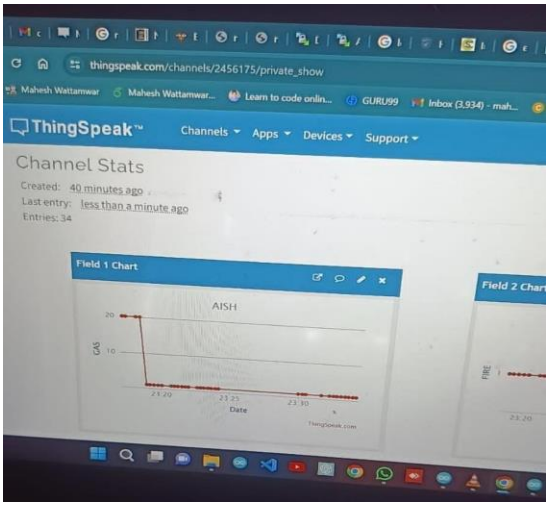

Fig. 2 ThingSpeak Output

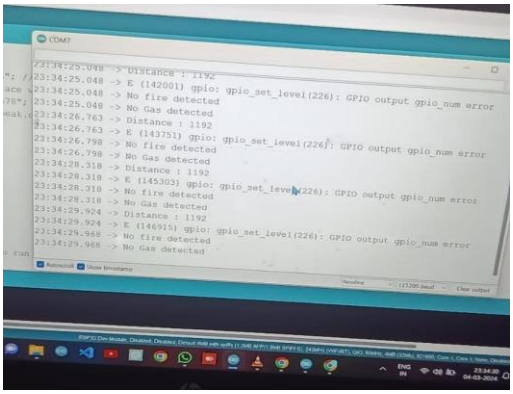

Fig. 3 Serial Monitor Output

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