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AUTOMATIC FIRE FIGHTING ROBOT USING IOT

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ABSTRACT

In the dynamic realm of technology, robots are playing increasingly pivotal roles, especially in high-risk scenarios. Our mission involves crafting an autonomous firefighting robot, proficient in independently detecting and suppressing indoor fires using carbon dioxide. This endeavor directly tackles the inherent dangers associated with firefighting, prioritizing human life protection and elevating the efficiency of rescue operations. Although some fire departments already employ robots, persistent challenges in size, weight, cost, and performance warrant a holistic approach.

Our approach revolves around a meticulous evaluation, highlighting five key elements crucial for the development of a pragmatic and cost-effective firefighting robot. Addressing these constraints is paramount to overcoming the persistent shortcomings observed in existing robotic solutions. The envisioned robot, born from this comprehensive strategy, aspires to not only mitigate these challenges but also to enhance the capabilities of fire departments significantly. The ultimate goal is to not only save lives but also contribute to the overall efficiency of rescue operations in emergency situations. This research initiative emphasizes the transformative potential of robotics in ensuring the safety of emergency responders and the individuals they are dedicated to protecting. By pushing the boundaries of current technology and redefining the standards for firefighting robots, we aim to revolutionize the landscape of emergency response. Through this innovative approach, our project strives to be a catalyst for positive change, fostering a future where autonomous firefighting robots stand as reliable partners in safeguarding lives and property.

Keywords: Firefighting robot, Risk, Protection, Remote Control, Heat Detection & Autonomous Navigation.

I. INTRODUCTION

A state-of-the-art fire-fighting robot, designed for effective firefighting in hazardous or hard-to-reach areas, relies on the renowned IoT capabilities of an ESP32 microcontroller. The robot allows for remote control and monitoring. Equipped with flame and smoke sensors using a multi-sensor approach, it identifies infrared radiation from flames and detects airborne smoke. Upon fire detection, the robot autonomously activates a water pump, directing a precise water stream to extinguish the fire. Mobility is achieved through DC motors with a motor driver, while a servo motor controls the water nozzle for accurate water stream direction. Governed by the ESP32 microcontroller, the robot provides precise control over its actions.

Operational flexibility is a key feature, enabling manual control through the Blynk app for remote accessibility. Alternatively, it can be programmed to follow predefined paths, showcasing adaptability in diverse fire scenarios. In summary, these fire-fighting robots represent a significant technological advance, leveraging IoT capabilities for enhanced firefighting in challenging environments, equipped with sensors and actuators for fire detection and remote control.

II. LITERATURE REVIEW

Paper No	Technology	Methodology	Experimentation	Findings
[1]	Firefighting robot, Rescue robot, Robot deployment, monitor nozzle vehicle.	The methodology likely begins with a recognition of the risks associated with firefighting and rescue missions for human responders. This	The experimentation involves deploying these robots in real-world scenarios to assess their effectiveness in firefighting and rescue	the findings in the paper highlight the potential benefits of incorporating robots in firefighting and rescue operations, the challenges faced by

		involves acknowledging the inherent dangers faced by firefighters in extinguishing fires and rescuing victims.	missions. This could include testing their ability to navigate through challenging environments, perform specific tasks, and collaborate with human responders. The passage also mentions the examination of the present status of these robots and highlights potential problems or challenges associated with their use.	traditional firefighting methods, and ongoing efforts to deploy and assess various robotic technologies.
[2]	The autonomous fire suppression robot integrates advanced technologies, featuring an Arduino UNO for control, a Ping ultrasonic sensor for flame detection, and an IoT framework for remote monitoring.	The methodology employs Automatic and Homemade modes. In Automatic mode, robots independently execute predefined commands using advanced algorithms for fire detection and suppression. Homemade mode allows manual control, offering flexibility in navigating challenges	In experiments, the robot showcased reliable performance in navigating indoor spaces, accurately identifying flames, and efficiently suppressing fires with CO2.	Findings demonstrate the robust functionality of the Arduino UNO, Ping sensor, and IoT components, presenting a promising solution for deploying life-saving robots in fire emergencies, effectively reducing risks to human life while mitigating collateral damage.
[3]	Artificial intelligence, CNN, sensors, Haar Cascade Classifier, Deep Learning Using Image AI Library	We wanted to figure out how to detect fires inside buildings. So, we put cameras in each room, pointing them towards the floor. These cameras are placed low down and face straight out, making a 90-degree angle with the floor. We focused on finding fires on the floor using a special method to recognize objects.	The experimentation involves evolving fire-fighting robots by introducing IoT, incorporating dual types of extinguishers addressing the limitations of traditional sensors through artificial intelligence, and adopting the Haar Cascade Classifier for improved object detection and recognition. The use of machine learning and deep learning	The findings highlight the importance of autonomous fire-fighting robots, the use of traditional sensors, the incorporation of IoT and dual extinguishers, limitations of traditional sensors, and the exploration of advanced techniques like machine learning using the Haar Cascade Classifier for efficient fire detection and object recognition.

			techniques aims to enhance the robot's ability to detect fires at a wider range and operate more efficiently in complex environments.	
[4]	This project utilizes various sensors, including Proximity Infrared Sensor (PIR), flame sensor, ultrasonic sensor, and MQ2 (LPG) sensor. Actuators such as motors and a buzzer enable the robot to respond to detected fire incidents.	The methodology involves employing a firefighting robot equipped with multiple sensors to detect fire incidents. The Proximity Infrared Sensor, flame sensor, ultrasonic sensor, and MQ2 (LPG) sensor collectively contribute to accurate fire detection. Upon detection, the robot utilizes actuators, specifically motors, to move towards the source of the fire. The buzzer serves as an alert mechanism, notifying surrounding individuals about the potential danger.	Controlled experiments were conducted to evaluate the performance of the firefighting robot in different fire scenarios. The sensors, including PIR, flame sensor, ultrasonic sensor, and MQ2, were tested for their responsiveness and accuracy in detecting fire and smoke. The actuators, motors, and buzzer were assessed for their effectiveness in navigating towards the fire and alerting nearby individuals.	The findings highlight the potential of this technology to reduce the risk of injury and property damage during fire accidents, emphasizing its role in autonomous and timely fire rescue operations in residential and community settings.
[5]	IOT, Cloud computing, sensors, UBIDOTS, ARDUINO IDE	the methodology of the paper involves setting the context by discussing the dangers of fire, identifying challenges faced by firefighters, introducing the role of robotics in fire safety, and outlining the focus of the paper, which is the advancement of firefighting through the use of robots.	The experimentation starts with an acknowledgment of the challenges posed by fire situations, including the risks to human life and property. The experimentation involves recognizing the potential of robotics to address challenges in firefighting.	the findings highlight the dual nature of fire, the challenges faced by firefighters, the increasing commonness of fire accidents, and the role of robotics in mitigating risks and advancing firefighting capabilities.

The survey explores the role of robots in high-risk scenarios, emphasizing an autonomous firefighting robot mission prioritizing human life. It assesses challenges in size, weight, cost, and performance, proposing a comprehensive approach to revolutionize emergency response through transformative robotics, focusing on five key elements for a pragmatic and cost-effective solution.

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III. METHODOLOGY

Major Constraints:

Our goal is to create an autonomous firefighting robot addressing key constraints: size, weight, cost, and operational efficiency. Current robotic systems fall short in meeting optimal standards due to these factors. Our approach involves evaluating and enhancing these elements to develop a pragmatic and cost-effective solution, ultimately contributing to safer and more efficient rescue operations[1].

Methodology of Problem Solving:

To construct an autonomous firefighting robot, gather hardware components including an ESP32 microcontroller, flame and smoke sensors, DC motors, motor driver, water pump, servo motor, and Blynk app. Design and assemble the robot chassis, mounting hardware components as per a schematic diagram. Install Arduino IDE, write code for sensor and motor control, and create a Blynk app for remote control. Test sensors, motors, water pump, and app functionality. Deploy the robot in a safe setting, monitoring its performance and making necessary adjustments[3]. Utilize flame and smoke sensors to trigger water pump and alarm respectively. Employ DC motors and motor driver for robot movement, while the water pump and servo motor extinguish fire by directing the water nozzle toward the detected flame.

System Architecture:

The System Architecture is shown in below figure 1.

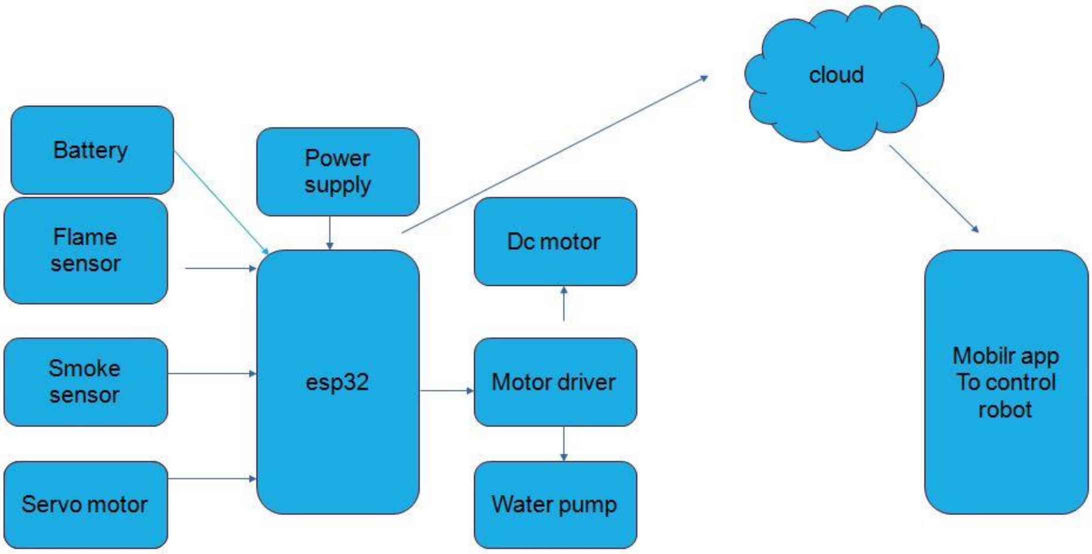

Figure 1: System Architecture

Methodologies/Algorithm:

Hardware Tools:

Components Name	Components	Description
ESP32 Microcontroller	 Figure 2	The ESP32 is a low-cost, low-power system-on-a-chip (SoC) microcontroller with integrated Wi-Fi and Bluetooth. It is based on the Xtensa LX6 dual-core processor and has a clock speed of up to 240 MHz. The ESP32 also has 4 MB of flash memory and 520 KB of SRAM[4]. The ESP32 development module is shown in figure 2.

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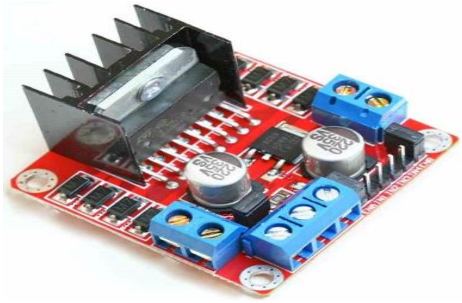
L298 Driver Module	 Figure 3	The L298N Motor Driver Module is provided with high voltage Dual HBridge circuit. Its input of 12V and its output is 5V. Here we used this module to run the motors of robot[4]. The L298 Driver module is shown in figure 3.
DC Motor	 Figure 4	Motors are used to move the robot chassis. The movement in robot required to detect and extinguish the flame[5]. The DC motor is shown in figure 4.
Buzzer	 Figure 5	The buzzer consists of an external housing with two pins to connect it to the power supply and to the ground. We used buzzer in our project as a alert when flame is detected[4]. The buzzer is shown in figure 5.
Ultrasonic sensor	 Figure 6	Ultrasonic sensor is a type of proximity sensor which measures the distance from the target object. The sensor first emits a short Ultrasonic Pulse (sound waves) and waits for the echo[2]. When echo is retuned, the sensor detects the target by measuring the time delay between transmitted pulse and the return echo. Then sensor calculates the distance between sensor and the target object. Formula used: Distance = (Time x Speed of Sound) / 2[4] f. The ultrasonic sensor module is shown in figure 6.

Flame Sensor	 Figure 7	Flame sensor is used to detect the flame. Here, we used two Flame sensors. Instead we can use multiple sensors to increase the range and directions. It consists of 4 pins: Vcc, Gnd, digital and analog pin[3]. It has a wavelength of 700nm to 1100nm. It detects the flame at 60 degrees range[5]. The flame sensor module is shown in figure 7.

Software Interface Description:

- Operating system: Windows 7 and above.
- Coding Language: c, c++ .

IV. MODELING AND ANALYSIS

Experimentation Platform :

The Flow Chart of the Experimentation setup is shown in below Figure 8,

Step 1: Hardware

Gather the necessary hardware components: ESP32 microcontroller, flame sensor, smoke sensor, DC motors, motor driver, water pump, servo motor, and Blynk app.

Design and build the robot chassis.

Mount the hardware components on the chassis.

Wire the components together according to a schematic diagram.

Step 2: Software

Install the Arduino IDE software on your computer.

Write the Arduino code to control the robot's sensors, motors, and water pump.

Create a Blynk app to control the robot.

Step 3: Testing

Test the robot's sensors to ensure they are working properly.

Test the robot's motors to ensure they are moving in the correct direction.

Test the robot's water pump to ensure it is working properly.

Test the Blynk app to ensure it can control the robot.

Step 4: Deployment

Deploy the robot in a safe environment.

Monitor the robot's performance.

Make any necessary adjustments to the robot's design or software.

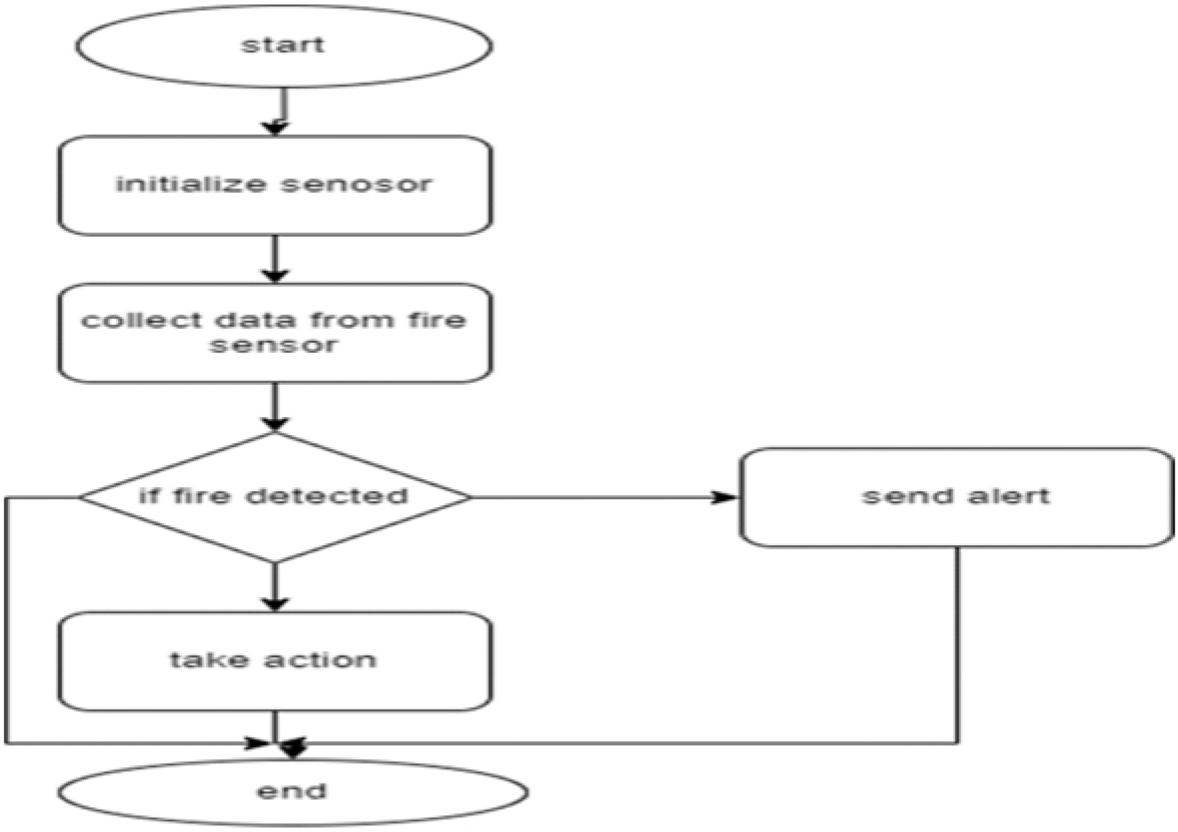


Figure 8: Flow Diagram

V. CONCLUSION

In conclusion, the firefighting robot project successfully addresses the critical need for enhanced firefighting capabilities. Through rigorous development, testing, and implementation, the robot exhibits commendable efficiency in navigating hazardous environments, detecting fires, and executing firefighting tasks. The integration of advanced sensors, robust communication systems, and reliable autonomy ensures the robot's effectiveness. Despite challenges, continuous improvements and adherence to safety standards contribute to its overall success. This innovative solution stands poised to significantly enhance firefighting operations, offering a promising avenue for increased safety and efficiency in combating fires.

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