Fire Fighting Robot

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Abstract— In recent years, robotic technology has been increasingly used in hazardous environments such as firefighting. Firefighter robots with human detection and alert capabilities are an emerging application of robotics that have the potential to revolutionize firefighting and rescue operations. These robots use advanced science techniques, such as sensor fusion, to detect the presence of humans in hazardous environments and alert firefighters to their location with suppressing the fire and alerting surrounding using renewable energy. The robots are accounted with a range of sensors which provide real-time data to the robot's onboard computer system. When a fire is detected, it immediately uses water spray to suppress it and also when human is detected, the robot can use feedback to alert firefighters to their presence, allowing for faster and more efficient rescue operations using solar energy. This explores the current state of firefighter robots with human detection and alert capabilities. It also discusses the potential future applications and advancements in this field, including robotics for more autonomous firefighting that leads to reducing fatality.

Index Terms-robotics, alert, doppler sensor, solar energy

I. INTRODUCTION

Firefighter robots with human detection and alert capabilities are a fascinating example of how computer science is advancing the field of robotics. These robots use a variety of sensors and algorithms to detect the presence of humans in hazardous environments. These sensors include cameras, thermal imaging sensors, and laser range finders which work together to detect human shapes, heat signatures, and distance. The data from these sensors are processed using advanced computer vision algorithms, such as face recognition, to identify and locate humans in the robot's environment. At one point a human is detected, and the robot can use audio and visual feedback to alert firefighters to their presence. This can help save precious time and ultimately save lives. This process requires programming, machine learning, and computer vision techniques, which are all key areas of computer science. Overall, these are exciting examples of how computer science is being applied to solve real- world problems and improve public safety.

II. PROBLEM STATEMENT

To Develop and Implement Fire Fighter Robots with Human Detection and Alert using, detect fire providing surrounding alert and human presence using solar energy thereby Providing the Alert message to the system also. Alert Message to the system includes

– Analyzing and Locating the fires, Conducting Search and Alert, Monitoring the hazardous variables, and the Primary fire task is controlling and suppressing.

III. OBJECTIVES

Objectives of a firefighter robot with human detection and alert capabilities are primarily focused on enhancing the safety and efficiency of firefighting operations.

Here are some key objectives:

Objective 1 - To detect fire in the disaster-prone area– Sensor.

Objective 2 - Extinguishes fire on detection – Water Pumping Mechanisms.

Objective 3 - Human detection and alert in Fire.

IV. EXISTING SYSTEM

TAF20 Firefighting Robot: The TAF20 firefighting robot, developed by Thermite Robotics, is equipped with sensors and cameras for human detection. It uses thermal imaging cameras and computer vision algorithms to identify human presence in smoke-filled environments. When a human is detected, the robot can send alerts to the firefighting team.

Smoke Bot: Smoke Bot, developed by a European consortium, is a robotic system designed for firefighting and search and rescue operations. It utilizes a

combination of sensors, including thermal cameras and laser scanners, for human detection in smoke-filled environments. The robot can generate 3D maps and send alerts to firefighters when humans are located.

Prometheus: Prometheus is a firefighting robot developed by the Italian Institute of Technology. It utilizes a combination of sensors, including thermal cameras and gas sensors, to detect humans and fires. The robot can autonomously navigate through hazardous environments, locate humans, and send alerts to firefighters.

These are just a few examples of existing systems for firefighter robots with human detection and alert capabilities. These systems highlight the use of sensors, cameras, computer vision algorithms, and communication technologies to enable the detection of humans in firefighting scenarios and provide timely alerts to enhance the safety and effectiveness of firefighting operations.

V. LITERATURE SURVEY

In the study titled "Design and Implementation of Fire Fighting Robot with Human Detection System"[4], the authors developed a robot that can navigate through a fire- prone area and detect humans using a thermal imaging camera. The robot is equipped with an alarm system that can alert firefighters if a human is detected.

[1] The study concludes that the robot is effective in detecting humans in a fire-prone area and can be useful in assisting firefighters.

One of the recent studies on this topic [2][3] they proposed a firefighting robot that uses a combination of computer vision and machine learning algorithms to detect human presence in a burning building. The robot is equipped with a thermal camera, which is used to detect the presence of flames and smoke. Once the robot detects a human, it sends an alert to the firefighter's control center, providing them with the location and status of the human.

Another study by Park et al. (2021) [4][5] proposed a firefighting robot that can navigate complex environments and detect humans in real time. The robot is equipped with a 360-degree camera, LIDAR sensors, and a thermal camera, which are used to detect and track humans in real time. The robot also includes an emergency alert system that sends an alert to the Fire fighter's control center when it detects a human in danger.

Design and Development of a Firefighting Robot with Human Detection and Alert System Using Deep Learning Techniques in this study[6][7], While extinguishing the fire, firefighters find it difficult to reach the specified areas due to confined space.. In urban cities and industrial areas, there are firefighters ready in case of emergencies. This can lead to a shortage of manpower. Thus, the firefighting robot can act as support for firefighters and will also reduce the risk to their life.

Firefighting Robot with Human Detection and Alert System Using Machine Learning Algorithms. In this study [8][9] they proposed firefighting robot has high accuracy in extinguishing fire belonging to class E type and as of now, it can only be used in the household to extinguish fires caused due to electric appliances.

VI. PROPOSED SYSTEM

Senses fire, smoke, temperature, air quality, human presence, type of fire by using flame, smoke, gas, Doppler radar, air quality sensors Sends alerts (text) using GSM & location using GPS to the first response team. If fire is detected, a water pump mechanism is operated at the site and data is stored about the type of fire, human presence, etc. including location. Images, videos & data is stored for future use in SD card and also alert surrounding using solar energy.

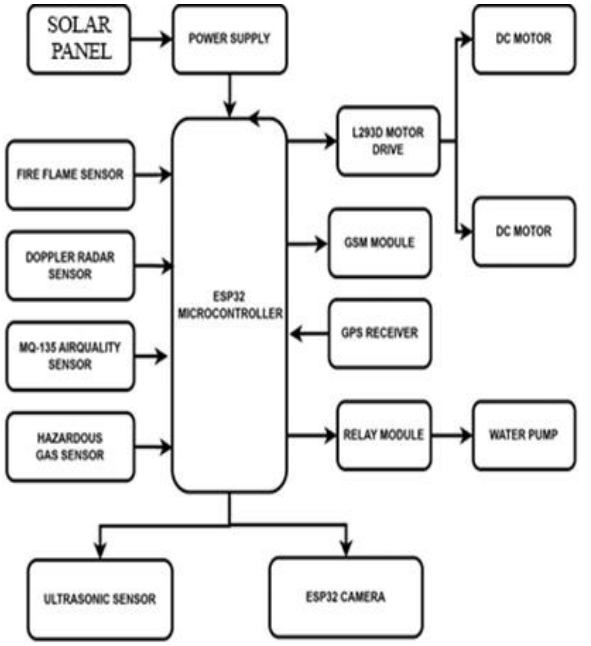

Fig 1

TOOLS AND METHODOLOGY

HARDWARE REQUIREMENTS

ESP 32 Microcontroller, IR Flame Sensor, Ultrasonic Sensor, Temperature Sensor, L293D Driver Module, DC Water Pump, Bluetooth Module, Servo Motors, BO Motors, GPS Module, GPS Module, ESP32 camera module, Doppler radar, AQI sensor, Gas sensor module, 12V Siren, Exhaust Fan.

SOFTWARE REQUIREMENTS

We are using a web server with 'IotWebServer.com' to use with a remote connection.

'IotWebServer.com' is an initiative to help the upcoming programmers with the IoT cloud support. It is focused on providing the most efficient and simple cloud backend for IoT based projects.

VII. PROPOSED METHODOLOGY

DC MOTOR: Here we are using four motors, each motor having two wires (red and black). The two red wires on the left side are twisted together to form one red wire wise the black wire on the left side is twisted. Similarly, we are doing the same thing on the right side. The Four wheels are connected to the Shaft.

Fig 2

ESP32: The ESP32 operates on 3.3V and can be programmed with ESP-IDF or with Arduino IDE. The Arduino operates at 5V and is known for its easy-to- use Arduino IDE and strong community support. So to conclude, if you have prior experience with programming and your project really requires some heavy processing with IoT capabilities, then ESP32 can be preferred over Arduino.

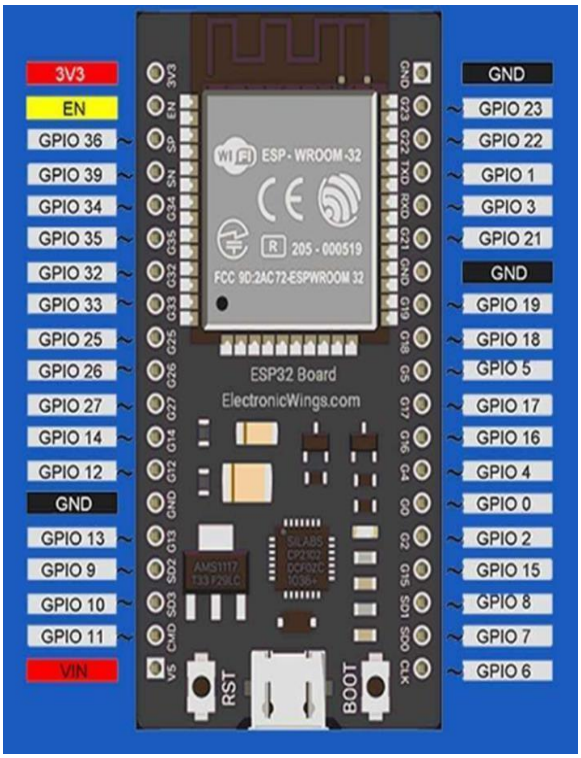

Fig 3

L298 DRIVER AND ARDUINO MODULE: The joined positive (red) wire from the left side of the motor is connected to out1. The negative (black) from the left side of the motor is connected to out2. The positive wire from the right side of the motor is connected to out3. The positive wire from the right side of the motor is connected to out4. The four input pins of the 298 Driver module are connected to the 2nd,3rd,4th, and 5th pins in the Arduino respectively. It has 4 output pins named OUT1, OUT2, OUT3, OUT4 and 4 input pins named IN1, IN2, IN3, IN4.

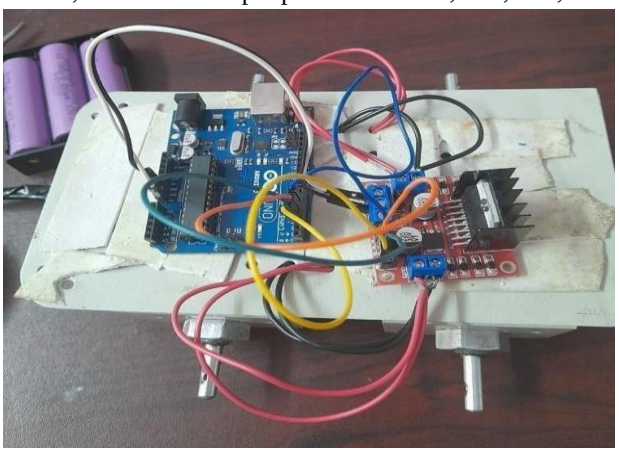

Fig 4

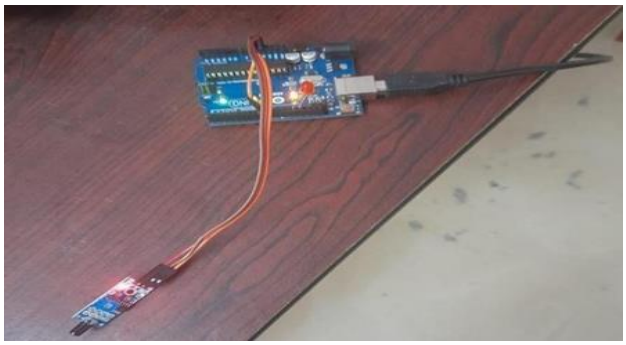

Fig 5

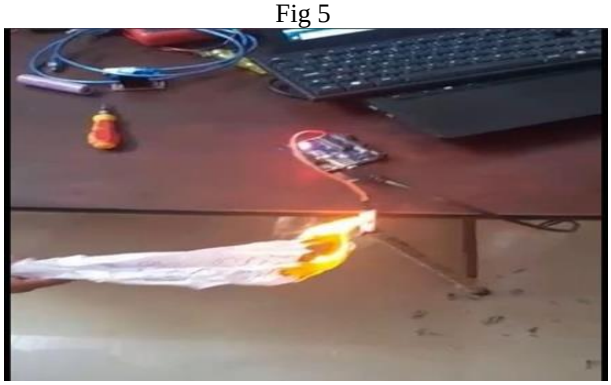

Fig 6

VIII. OUR SYSTEM DIFFERS BY

- *SOLAR* charged device.
- Not only detects fire but notifies the accurate *location of fire & its type.*
- Can withstand *high temperatures.*
- Data about *air quality.*
- *Smoke dissipater* for better navigation in smoke filled environment.
- Accurate *location of life presence*
- Cover full *360 degree.*
- *Alerts* about fire

IX. RESULT

The robot is equipped with all the components that are required for performing different functions such as Movement, obstacle and flame detection, manual control, and fire extinguishing. The robot is turned on, we are required to connect with the Android app via Bluetooth module, then we can decide whether to control the robot manually or automatically.

X. FUTURE SCOPE

The Firefighter Robot with Human Detection and Alert will become increasingly autonomous and will be able to navigate dangerous environments, detect and analyze fires while alerting surrounding and take action to extinguish them by using solar power. The Future of this project indicates holding the camera module with the robot to efficiently detect obstacles, humans, and fire.

XI. CONCLUSION

We are trying the development of advanced firefighter robot with human detection and alert using solar energy. The robot detects temperature, smoke, and flame at the site where the robot exists. This robot can move wirelessly. The robot is helping the area where natural calamities and bomb explosions where occurred. If the fire is detected with the help of sensors, MCU operates the water pump mechanism through a relay circuit. One of the important added features of our work is the human detection and alerting function.

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