

Smart Intelligent Sensor Fused Human Locator In Emergency Situation (Firefighting Robot With Human Detection)

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Abstract - Fire risks can pose significant danger to humans, especially in a hazardous situation where the presence of human beings becomes very risky. To address this problem, an intelligent firefighting robot with human detection capabilities has been developed. The purpose of the robot is to work in hazardous zones during the firefighting process. The role of the robot will be to navigate the fire hazard zone, detect any human beings present, and transmit live data to the firefighting team. Several sensors, including a flame detector, temperature detector, smoke detector, and gas detector, will help detect any fire-related hazard.

As far as detecting human beings is concerned, the robot will be equipped with a camera and an intelligent vision system based on machine learning technology that can identify the human body, even in challenging situations involving thick smoke. The robot will work in a wireless mode by transmitting live footage as well as data from the sensors to the base monitoring station. It will also activate a fire suppression system for smaller fires. For detecting humans, the use of camera technology, along with the process of machine learning, has made it possible to locate human beings despite poor visibility. This robot will function without any wired connection and send video signals as well as sensor signals through the camera to the control center.

Keywords: Firefighting Robot, Human Detection, Flame Sensor, Robotics.

1. INTRODUCTION

It should be noted that there are numerous cases where fires break out in residential houses, industrial places, and offices. These cases of fire outbreaks can cause great destruction, resulting in property damage and loss of life. It needs to be mentioned that the firefighters' lives are always endangered since they must extinguish these fires and rescue people from them. By employing the firefighting robots, the risk to human

life can be reduced in such situations. Firefighting robots can be programmed to detect fires, extinguish them, and identify humans trapped in the fire. These firefighting robots with human detection use sensors to detect fires, heat, and human presence.

2. PROBLEM STATEMENT

Fire accidents are among the key contributors to the destruction of both lives and property in industrial and domestic setups. During such accidents, firefighters face numerous challenges, mainly due to high temperatures and the presence of smoke in the environment. In addition, locating individuals affected by such event becomes quite difficult, when can lead to casualties or even fatalities. In an effort to save lives, most rescue attempts rely on human intervention, which is risky for both the victims and the firefighters. Therefore, it is necessary to develop a robotic system that can detect both the fires and humans. The Firefighting Robot with Human Detection seeks to address this challenge. In light of all these factors, there is a need to develop an intelligent system that can help locate fires and individuals without putting lives at risk. The system should to capable of operating in harsh environments, identifying humans using sensors and cameras, and extinguishing fires immediately.

3. OBJECTIVES

1. The project is going to be focused on developing an automated robot for firefighting purposes that will assist in detecting and extinguishing fires in dangerous conditions.
2. Human presence detection in dangerous zones that are affected by fire, utilizing various sensors or camera modules.
3. Elimination of any threat to people's lives, replacing firefighters with robots that will enter dangerous zones.
4. Flame detection within the zone under consideration employing either flame or temperature sensors.

5. Automatic extinguisher of fire through the utilization of a water pump or fire extinguisher placed on the robot.
6. The navigational function is performed by robot motors and sensors.
7. Real-time monitoring of the fire zone as well as human presence.
8. Designing an inexpensive solution to the problem of robot building through the employment of microcontrollers such as Arduino Uno.
9. Offering a safe way of living for individuals working in different buildings or industrial facilities.

4. EXISTING SYSTEM

TAF20 Fire Fighting Robot: The TAF20 Fire Fighting Robot from Thernite Robotics has many different sensors and cameras that help detect humans. Thermal imaging cameras and computer vision algorithms have been used to detect humans. The presence of a person in the area is detected by the robot and sends a message to the firefighters.

Currently, firefighting is a task carried out by firefighters who not only detect but also extinguish fires using fire extinguishing devices. This process is effective, but it poses some risks since firefighters can be exposed to extreme heat, toxic gases, and smoke.

Traditional firefighting robots can also be used to detect fires and put them out. Nevertheless, most robots lack human detection capacity; thus, they cannot detect the presence of a human during a fire outbreak. Limitations of the Current Fire-fighting System:

- ✓ Risk to firefighters' lives.
- ✓ Takes more time to detect fires.
- ✓ Difficult operations in dangerous areas.
- ✓ Most robots do not have human detection capabilities.

5. LITERATURE SURVEY

1. Saritha C and B. P. Harish (2020)

In the article named "Firefighting Robot with Face Detection System," there was an explanation of robots that can detect the presence of fire as well as human beings stuck in the fire. Robots will make use of the face detection system to detect fire and other things around. The robots will use fire sensors, smoke sensors, and infrared sensors to detect fires and other things. The robot will spray water immediately after detecting the fire. As soon as the robot detects faces, the alerts will be raised.

2. Nandana R et al. (2023)

The article named "Firefighter Robot with Human Detection and Alert" explained how human beings could be detected through computer vision and sensor fusion. In the process of firefighting, the firefighters will be able to detect human beings in smoke-filled rooms. Cameras, as well as other forms of sensors like thermal imaging sensors and laser sensors, will help in the detection of humans. Alerts will be issued immediately after the detection of humans.

3. Sen Li et al. (2023)

The intelligent robot for fire extinguishing inside buildings was built using the SLAM approach in this research paper, combined with fire detection through images. It can move into areas with fire inside buildings and put out fires. The intelligent algorithm facilitates the autonomous operation of the robot in challenging environments like hot and smoky surroundings.

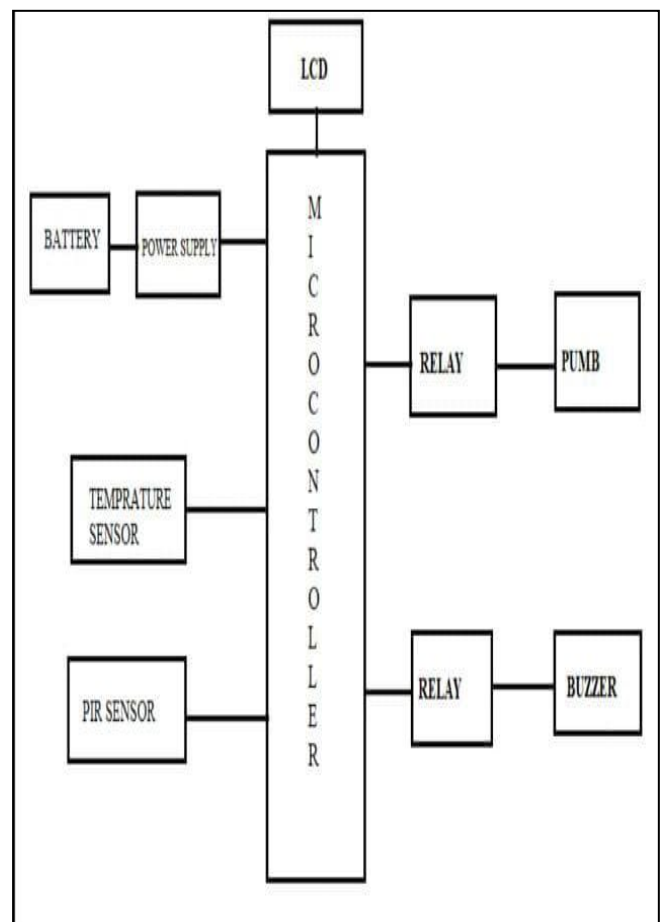
4. Weili Ding et al. (2025)

In this article, the algorithm is discussed, which helps detect and analyze the fire. In this regard, artificial intelligence techniques are applied, particularly the technique of deep learning. With the help of this algorithm, it would be ensured that the fire source is identified correctly.

6. PROPOSED SYSTEM

The robot to be developed would be a firefighting robot. This robot will have the following functionalities through the Artificial Intelligence Platform:

- *Mobility through regions affected by fire.
- *Detection of fire based on flames, smoke, temperature, and gas sensors.
- *Detection of the existence of trapped humans in the fire using artificial intelligence.
- *Transfer of videos and data via wireless communication.
- *Implementation of fire extinguishing equipment.
- *Remote rescue missions.



The major components of the proposed design:

- ✓ Microcontroller(Arduino, ESP32, Raspberry Pi).
- ✓ Flame sensor.
- ✓ Temperature sensor.
- ✓ Smoke sensor.
- ✓ Gas sensor.
- ✓ Camera sensor.
- ✓ Human presence AI sensor.
- ✓ Wireless communication.
- ✓ Fire extinguishing equipment (water pump).
- ✓ Wheeled motors.

7. TOOLS & METHODOLOGY

HARDWARE COMPONENTS:

1. Microcontroller(Arduino/Raspberry Pi) - The brain of the robot that processes data obtained from sensors.
2. Flame sensor- Helps in determining the location of the fire.
3. PIR sensor/IR sensor-Detects the presence of movement or a heat source in the human body.
4. Motor driver(L298N)-Controls the operation of the DC motor.
5. DC motor with wheel-Moves the robot.
6. Water Pump-Sprays water on the fire to put out the fire.
7. Power Supply/Battery-Power for the robot.
8. Ultrasonic Sensor-Detects any obstacles in front of the robot.
9. Camera Module(Optional)-Human Identification.

SOFTWARE COMPONENTS:

10. Arduino IDE-Programs Microcontroller.
11. Embedded C/Python-Program Control.
12. OpenCV-Human Detection through Image Processing.

8. PROPOSED METHODOLOGY

STEP 1: FIRE DETECTION

There is also one other extremely important task that needs to be done when using a firefighting robot, and that is detecting fire.



This robot must be able to sense the fire, travel to the area where the fire is located, extinguish the fire, and search for any individuals who may be in danger due to the fire. This can be accomplished by means of sensors and intelligent algorithms.

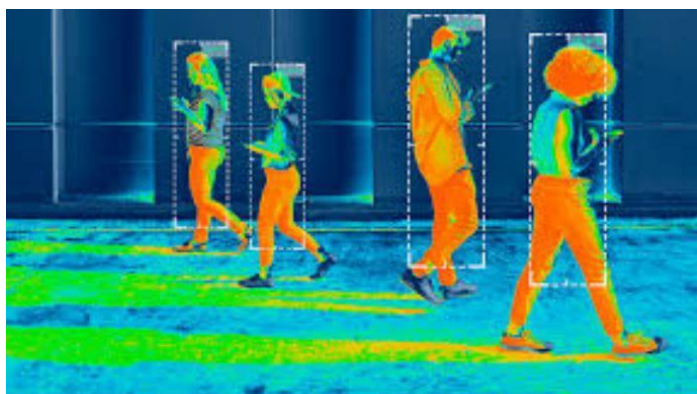
STEP 2: NAVIGATION

The robot possesses the capability to perform the task of navigation, which is performed with the help of the DC motors driven by the motor driver.



The process of navigating the firefighting robot can be explained as the ability of the robot to travel from one location to another in such a manner that it reaches the location where the fire is occurring. To do so, it becomes necessary for the robot to control the DC motors. It is achieved by connecting the DC motors to the wheels of the robot, and this is facilitated by the microcontroller. Additionally, other sensors, including flame, smoke, and temperature sensors, will help to easily detect the location of the fire source. When searching for the locations of trapped humans, the robot requires a camera system along with its artificial intelligence software.

Step 3: Human Detection Using AI



The camera captures live video clips. The deep learning algorithm analyses frames to check the presence of any human being in them. Even in low-visibility situations, the use of an AI-based system can work successfully. AI-based human detection forms a very important part of the operation of an arecue robotthat operates in firefighting activities. Through this, the arecue robotis able to identify humans stuck inside a fire breakout and rescue operations are conducted. The camera is attached to the are rescue robot and captures live videos.

STEP 4: DATA TRANSMISSION

The data obtained from the video sensors would be sent to the monitoring system outside. The rescue team would be informed about the data being transmitted. Data transfer from one system to another is known as data transmission. For the purpose of firefighting robot, data transmission assumes a lot of importance since it plays an important role in transferring significant information regarding fire, human beings, and robots.



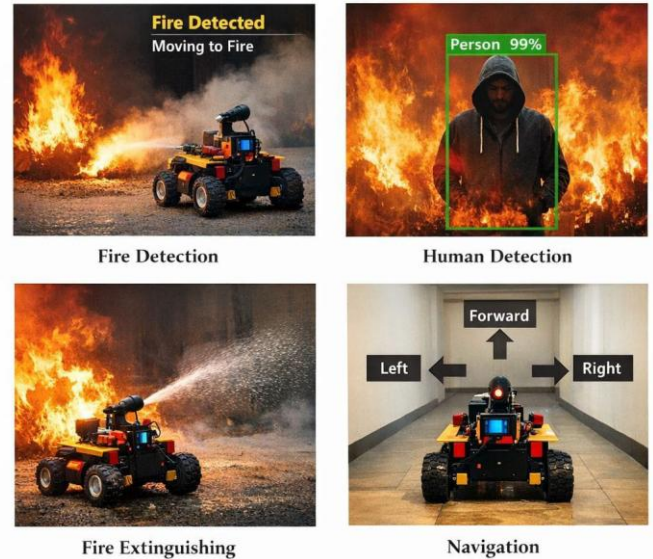
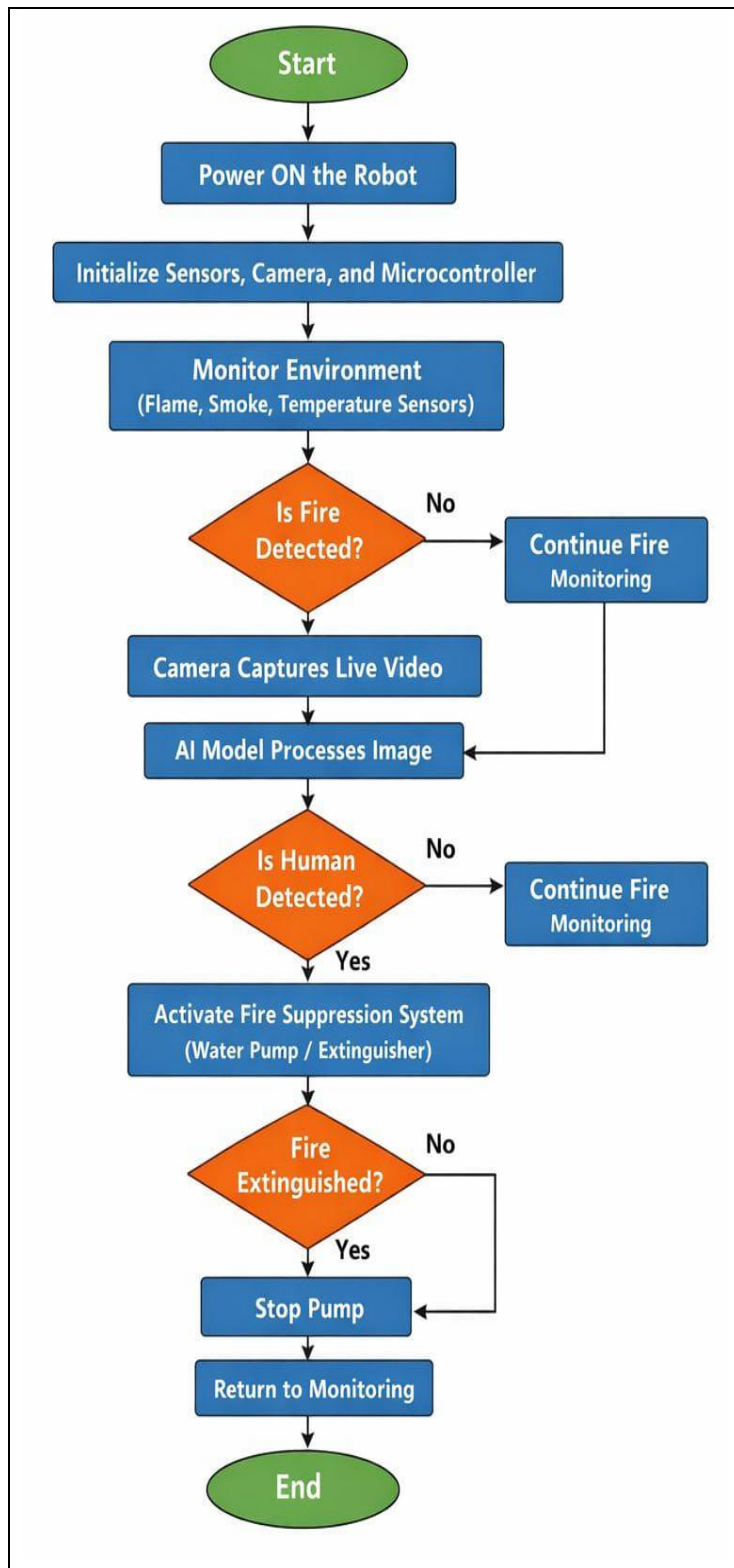
The first step is that the robot uses its sensors, such as the flame sensor, temperature sensor, smoke sensors, and even a camera module, to detect the presence of any humans. The second step is that data transmission occurs in a wireless manner, using approaches such as Wi-Fi, Bluetooth, and RF modules. Data analysis then takes place using microcontroller units such as Arduino, ESP32, and Raspberry Pi; in turn, information is sent instantly regarding the location of the fire, temperature, and presence of any humans. Video transmission is also possible since it involves the camera module.

Step 5: Fire Suppression



During a small fire incident, the water pump will be activated by the robot. Fire suppression means the process of controlling and extinguishing a fire using a fire suppression system. As for the firefighting robot, fire suppression can only be done after detecting the fire and moving towards its source. The parts that make up a firefighting robot include the water tank, the water pump and the nozzle. Once fire is detected, there will be a command sent from the microcontroller that activates the water pump.

9. FLOW CHART



Fire-Fighting Robot with Human Detection Using AI Technology. Tests were conducted in laboratory settings. The sensor used in detecting the presence of fire was mounted on the fire detection robot, which then helped in detecting the presence of fire and conveying the message to the controller.

The firefighting robot moved to the location where there was fire using the DC motors, which were powered by the motor driver. Further, human detection using AI technology proved to be effective in detecting the presence of human beings in live feeds from deep learning algorithms. Once human beings were detected, the robot issued an alarm and identified the trapped humans.

11. FUTURE SCOPE

There is no doubt that the future scope of this robot is very promising because of the continuous development of new technology. Within the next few years, the robot can become capable of using artificial intelligence to make proper judgments when dealing with emergencies, including assessing the intensity of the fire and deciding on the best ways to extinguish it. Human detection abilities can be enhanced further by the use of infrared imaging and algorithms, thereby enabling the robot to detect any human beings in the midst of the thick smoke and darkness. Self-navigability may also be another area where the robot can become more advanced, making it possible for it to move around even in unknown and complicated environments. Another possibility for the future development of the robot involves connecting it with IOT technology to allow instant communication of data to the rescue team. Some other components that could be added to the robot are drones, better firefighting skills, and communication abilities between victims and the robot.

12. CONCLUSION

Application of the Fire Fighter Robot with Artificial Intelligence Technology for Human Detection is regarded as one of the best ways to address any kind of issue that could arise during the present firefighting process. Due to the presence of several environmental sensors with the help of artificial intelligence technology, the robot can detect threats as well as humans that could exist in case of poor visibility.

10. RESULT & DISCUSSION

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