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# Development of Fire Fighting Robot for Fire and Motion Detection in Hill Areas by using IoT

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***Abstract*** — The fire-fighting robot is used Fire in forest/hills areas are most dangerous one and it is uncontrollable also sometimes the information passed to the Fire station is too late about the trouble in the forest. Even by using the current technology, the fire was detected and informed to the fire station. But people around that place or any persons traveling in the nearby roadways didn't get the information. By using the GSM, IOT-based Fire detection mechanism it will help to give the alert information to all. To control the fire in most dangerous and human can't enterable region, by using the fire-fighting Robot it is easy to control that kind of fire also. the main scope of this project is to Detect the fire, Control the disaster, and preserve the life of both Forests and Animals.

***Keywords:*** *Fire-Fighting Robot; Location Sharing; GSM; Temperature Detection.*

## 1. Introduction

The integration of robotics in various fields has revolutionized traditional approaches to problem-solving, particularly in firefighting. Firefighting robots, equipped with advanced sensors and communication modules, have emerged as a promising solution to combat fires efficiently and mitigate potential risks to human life. This project aims to introduce a sophisticated firefighting robot powered by Arduino microcontroller technology, featuring an array of sensors including flame, temperature, PIR (Passive Infrared), and smoke sensors, as well as a GSM module for real-time transmission of fire location data. The integration of these sensors enables the firefighting robot to detect fires accurately, assess the severity of the situation based on temperature variations, and identify the presence of individuals within the affected area using PIR technology.

The inclusion of a smoke sensor enhances the robot's ability to navigate through smoke-obscured environments, ensuring effective firefighting operations even in challenging conditions. The Arduino microcontroller technology serves as the brain of the firefighting robot, facilitating sensor data processing, decision-making, and control of the robot's movements and actions. Through a robust programming framework, the Arduino microcontroller orchestrates the robot's responses to detected fire incidents, enabling it to navigate autonomously toward the source of the fire while avoiding obstacles in its path. Furthermore, the GSM module equips the firefighting robot with the capability to transmit critical information regarding the location of the detected fire to designated authorities or emergency responders in correspondence. This feature enhances situational awareness and enables timely deployment of firefighting resources to contain and extinguish the fire effectively, minimizing property damage and ensuring the safety of occupants in the vicinity. Overall, the development of this firefighting robot represents a significant advancement in fire emergency response systems, offering enhanced efficiency, accuracy, and safety in combating fires across various environments. By leveraging Arduino microcontroller technology and advanced sensor integration, this innovative solution holds the potential to revolutionize firefighting operations and contribute to the preservation of life and property in the face of fire emergencies.

## 2. Related Work

High-temp fire-fighting robot: Ag-coated, flame sensors, 3 IR cameras, insulated interior, crawler system, dual fire extinguisher cylinders with Pan/Tilt nozzles; solenoid valve control, hose for extra fluid post-extinguisher use [1]. An Arduino-controlled fire-fighting robot rotates to detect fire, approaches slowly with temperature sensors, and extinguishes using a centrifugal pump mechanism [2]. Autonomous firefighting robots with sensor-based fire detection and water sprinkling capabilities have been developed by various researchers [3].

Blynk-controlled IoT firefighting vehicle integrates sensors, ESP32 camera, and GSM modules for fire detection, combat, water pumping adjustment, and reliable communication [4]. ESP32 Fire Fighting Robot automatically detects emergencies, alerts, rescues victims and minimizes damage by spraying water with controlled motor speed [5]. Fire-detecting robot rotates, moves forward, aligns with the center Sensor, approaches to fire, and activates the extinguisher/water pump for suppression [6]. Arduino UNO-controlled firefighting robot with obstacle and fire sensors utilizes a water tank and spray gun for extinguishing flames by pumping water [7].

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## 3. Methodology

High-temp fire-fighting robot: Ag-coated, flame sensors, 3 IR cameras, insulated interior, crawler system, dual fire extinguisher cylinders with Pan/Tilt nozzles; solenoid valve control, hose for extra fluid post-extinguisher use [1]. An Arduino-controlled fire-fighting robot rotates to detect fire, approaches slowly with temperature sensors, and extinguishes using a centrifugal pump mechanism [2]. Autonomous firefighting robots with sensor-based fire detection and water sprinkling capabilities have been developed by various researchers [3]. Blynk-controlled IoT firefighting vehicle integrates sensors, ESP32 camera, and GSM modules for fire detection, combat, water pumping adjustment, and reliable communication [4]. ESP32 Fire Fighting Robot automatically detects emergencies, alerts, rescues victims and minimizes damage by spraying water with controlled motor speed [5]. Fire-detecting robot rotates, moves forward, aligns with the center Sensor, approaches to fire, and activates the extinguisher/water pump for suppression [6]. Arduino UNO-controlled firefighting robot with obstacle and fire sensors utilizes a water tank and spray gun for extinguishing flames by pumping water [7].

### 3.1 Components Required

- Ultrasonic sensor
- Temperature sensor
- PIR sensor
- Flame sensor
- Smoke sensor
- Gear motor
- Motor drive
- GSM module
- Battery
- Water pump

### 3.2 Data -Collection

**Table 1. Sensor Data Collection**

| Sensor Name | Date | Time | Location | Measurement Type | Measurement Value |
|---|---|---|---|---|---|
| Ultra Sonic Sensor | 27/11 | 7.30 PM | 41 24.2028, 2 10.4418 | meters | 21 |
| Temperature Sensor | 27/11 | 7.30 PM | 41 24.2028, 2 10.4418 | Celsius | 26° |
| Pir Sensor | 27/11 | 7.30 PM | 41 24.2028, 2 10.4418 | CM | 10 |
| Smoke Sensor | 27/11 | 7.30 PM | 41 24.2028, 2 10.4418 | ppm | 250 |
| Flame Sensor | 27/11 | 7.30 PM | 41 24.2028, 2 10.4418 | Nano meter | 760 |

*Ultrasonic Sensor:* Use the ultrasonic sensor to detect obstacles in the robot's path, allowing it to navigate around it and reach the location of the fire. This sensor can measure the distance to an object by emitting a sound wave and measuring the time it takes for the wave to bounce back.

*Temperature Sensor:* The temperature sensor can be used to detect areas with high temperatures, indicating the presence of a fire. This sensor can be placed on the front of the robot and programmed to trigger an alarm or activate the water pump when a certain temperature threshold is reached. *Pir Sensor:* The PIR (passive infrared) sensor can be used to detect movement, allowing the robot to detect the presence of people or animals in the area. This can help prevent accidents and ensure that the robot does not cause harm while fighting the fire. *Flame Sensor:* The flame sensor can be used to detect the presence of flames and determine the location of the fire. This sensor can be placed on a servo motor, allowing it to scan the area and detect flames in different directions. *Smoke Sensor:* The smoke sensor can be used to detect the presence of smoke, which is often an early indicator of a fire. This sensor can be placed on the front of the robot and programmed to trigger an alarm or activate the water pump when smoke is detected. *Gear Motor:* The gear motor can be used to power the wheels of the robot, allowing it to move around and navigate to the location of the fire. *Motor Drive:* The motor drive can be used to control the speed and direction of the gear motor, allowing the robot to move forward, backward, and turn.

*Gsm Module:* The GSM module can be used to send alerts and notifications to emergency services or other designated recipients. This can help ensure a quick response to the fire and prevent further damage. *Battery:* The battery can be used to power all of the components of the robot. It is important to choose a battery with sufficient capacity to support the operation of the robot for an extended period. *Water Pump:* The water pump can be used to extinguish the fire by spraying water on the flames. The pump can be controlled by the temperature sensor or flame sensor, allowing it to activate only when necessary.

### 3.3 Block Diagram and Flow Chart

*3.3.1 Module – 01*

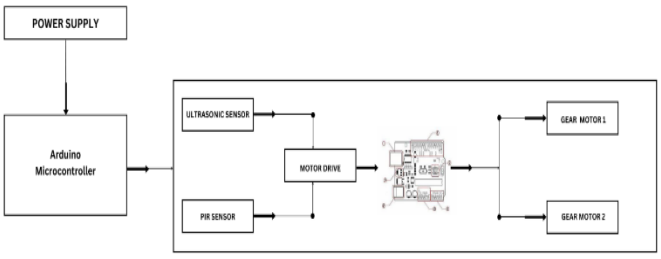


**Fig. 1: Block diagram of Animal/Human detection.**


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The power supply is connected to the Arduino microcontroller, which is programmed to control the other components in the system. The ultrasonic sensor is connected to the Arduino and used to detect obstacles in the path of the robot. When an obstacle is detected, the Arduino sends a signal to the motor drive, which controls the speed and direction of the gear motors. The PIR sensor is also connected to the Arduino and can be used to trigger certain actions when motion is detected. The block diagram Figure 1.1 represents the Animal/Human detection in the way of traveling the firefighting robot.

*Flow Chart*

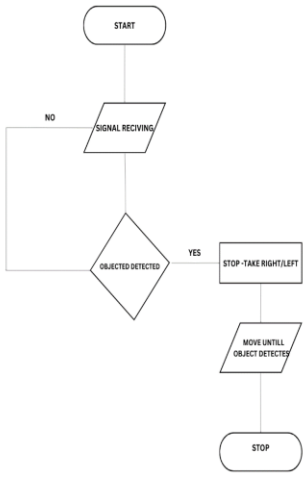


**Fig.2: Flow chart for Animal/ Human Detection**

This flowchart provides a clear and concise overview of the steps involved in creating a robot that can move around and avoid obstacles using an Arduino microcontroller, ultrasonic sensor, PIR sensor, and gear motor. It can be used as a reference for building and programming such a system. Figure1.2.

*3.3.2 Module – 02*

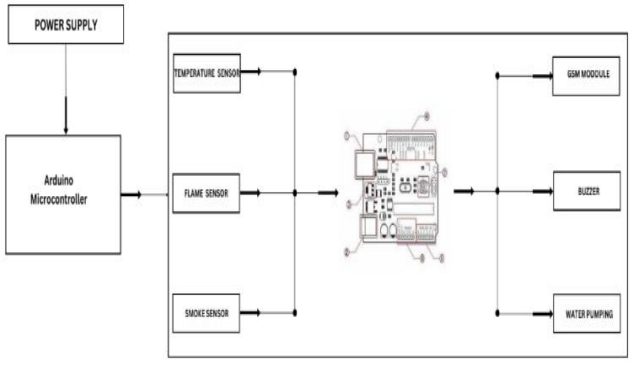


**Fig.3: Block diagram of Detecting the Fire/ Temperature/ Smoke**

This block diagram illustrates the components and connections of a system that can be used for fire detection and suppression, temperature control, or environmental monitoring. The specific actions and behaviors of the system can be customized by modifying the program that runs on the Arduino microcontroller. Figure: 2.1 Detecting the fire surrounding areas.

*Flow Chart*

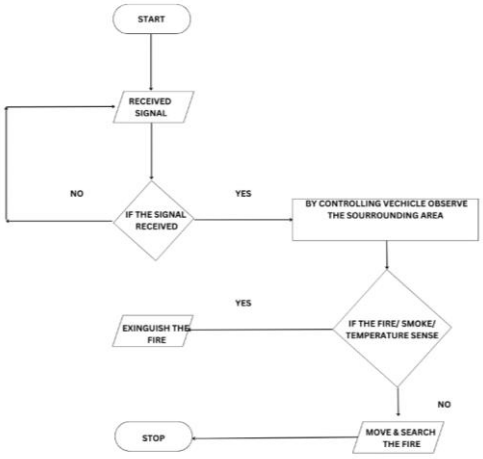


**Fig.4: Flowchart of sensing the fire, temperature, and smoke in surrounding areas.**

A system that uses an Arduino microcontroller, ultrasonic sensor, PIR sensor, and gear motor can be used to create a robot that can move around and avoid obstacles. The program initializes the components and sets the initial speed and direction of the gear motors to 0. It then enters a loop that runs continuously, allowing it to repeatedly check for obstacles and motion. The ultrasonic sensor is used to detect obstacles, and the program calculates the distance to the obstacle and adjusts the speed and direction of the gear motors accordingly. The PIR sensor is used to detect motion, and the program triggers a specific action when motion is detected. The program waits for a short period before repeating the loop, allowing it to check for obstacles and motion continuously. This system can be used for a variety of applications, such as security, surveillance, or autonomous navigation. Figure 2.2 Flowchart of sensing the fire, temperature, and smoke in surrounding areas.

## 4. System Overview

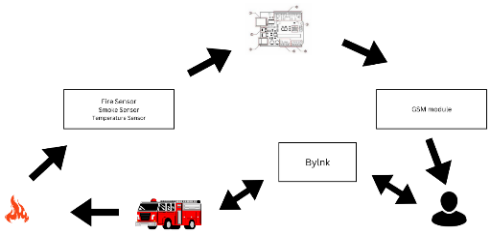


**Fig.5: System Overview**


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The system you need is a fire-fighting robot that utilizes the given components to detect and extinguish fires. The main controller of the system is an Arduino board, which is responsible for processing sensor data and controlling the system's actuators. The ultrasonic sensor is used to detect obstacles in the robot's path and avoid them. The temperature sensor measures the temperature of the environment, and when combined with the PIR sensor, can detect the presence of humans and determine if they are in danger due to high temperatures. The flame sensor is used to detect the presence of flames, and when triggered, activates the water pump and gear motor to extinguish the fire. The smoke sensor serves as a backup to the flame sensor, detecting smoke and also triggering the fire-extinguishing mechanism the GSM module allows the system to send and receive SMS messages, enabling remote control and monitoring of the system. The battery powers the entire system, and its capacity must be sufficient to support the operation of all components for an extended period the system is designed to detect and extinguish fires using various sensors and actuators, and it can be remotely monitored and controlled using the GSM module. The ultrasonic sensor and PIR sensor help the robot navigate and detect human presence, while the temperature sensor and smoke sensor provide additional safety measures. The water pump and gear motor are responsible for extinguishing the fire, and the battery powers the entire system.

## 5. System Architecture

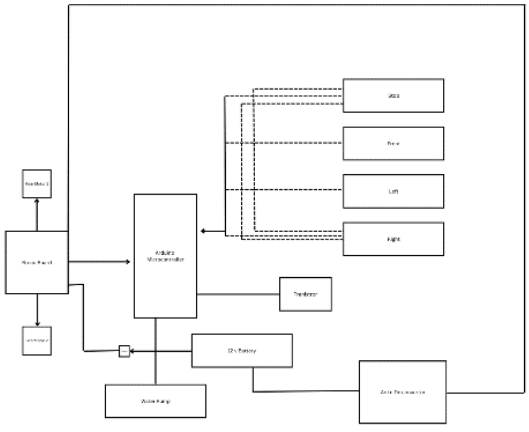

**Fig.6: System Architecture**

Navigation and Obstacle Avoidance: The ultrasonic sensor works in tandem with the PIR sensor to ensure safe navigation while avoiding obstacles and humans. *Fire Detection:* The flame and smoke sensors are crucial for identifying the presence of a fire. The temperature sensor complements these by indicating the fire's severity. *Extinguishing:* Once a fire is detected, the water pump activates, using the gear motor to pump water through a nozzle or spray mechanism. The motor drive controls the speed and direction of the pump, ensuring efficient water delivery. *Communication and Alerts:* The GSM module sends alerts to fire stations or emergency services when a fire is detected, providing them with the location and severity of the fire. *Power Supply:* The battery supplies power to all components, including the motor drive, sensors, GSM module, and water pump. The choice of battery will affect the robot's mobility and operational time.

## 6. Result and Discussion

The integration of components into a fire-fighting robot, such as a Global System for Mobile (GSM) module, enables the robot to autonomously detect fires, navigate safely around obstacles, and extinguish fires using water. The GSM module allows for immediate alerts to fire stations, potentially saving lives and property. The robot's ability to detect smoke and flames, combined with temperature readings, enables it to assess the severity of a fire and tailor its extinguishing efforts accordingly. The system's effectiveness relies heavily on the accuracy and reliability of its sensors, the efficiency of its motor drive, and the power capacity of its battery. Additionally, the water pump's performance is crucial for the robot's ability to effectively extinguish fires. In summary, the integration of these hardware components into a fire-fighting robot creates a sophisticated system capable of autonomously detecting fires, navigating safely around obstacles, and extinguishing fires using water. The use of a GSM module for communication allows for immediate alerts to fire stations, potentially saving lives and property. The robot's ability to detect smoke and flames, combined with temperature readings, enables it to assess the severity of a fire and tailor its extinguishing efforts accordingly. The system's effectiveness relies heavily on the accuracy and reliability of its sensors, the efficiency of its motor drive, and the power capacity of its battery. Additionally, the water pump's performance is crucial for the robot's ability to effectively extinguish fires. In conclusion, the integration of these hardware components into a fire-fighting robot represents a significant advancement in fire safety and response technology, offering a proactive approach to fire detection and extinguishment.

## 7. Conclusion

The development of a fire-fighting robot using the specified hardware components represents a significant advancement in fire safety and response technology. Such a system can autonomously detect fires, navigate safely, extinguish fires efficiently, and communicate with external systems in real time. The integration of these components into a cohesive system could significantly improve fire-fighting capabilities, potentially saving lives and reducing property damage in emergencies.


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## References

[1] Alhaza T, Alsadoon A, Alhusinan Z, Jarwali M, Alsaif K - New Concept For Indoor Fire Fighting Robot – 2018
[2] Tawfiqur Rakib, M. A. Rashid Sarkar- Design And Fabrication Of An Autonomous Fire Fighting Robot With Multisensor Fire Detection Using Pid Controller- 2018
[3] Dr. Ramkumar Prabhu, P. Deva- Development Of Fire Monitoring And Extinguishing Robot Using Iot - 2020
[4] Rajeshwarrao Arabelli, T. Bernatin- Self-Directed Fire Fighting Robot Using Internet Of Things And Machine Learning-2020
[5] K. Shamili Devi, K. Akhileswar, Ch. Vinayaka, M. Karthik, Y. K. Viswanadham- Fire Fighting Robot-2020
[6] S Kirubakaran, S P Rithanyaa, S P Thanavarsheni, E Vigneshkumar- Arduino Based Firefighting Robot-2021
[7] A R M Raafeek, N Satheeskanth, J Joy Mathavan, A Kunaraj- Iot Based Guided Fire Fighting Vehicle-2022.


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