Aether Watch: Self Navigating Fire Supression Robot With Lifeline Responder: Autonomous Human Locator And Extrication

Dharshini R[1], Jothika S[2], Karthika E[3], Mijaisha V S[4]
[1, 2, 3, 4] Dept of Computer Science and Engineering
[1, 2, 3, 4] AVS Engineering college, Anna University, Salem, India.

Abstract- *This project presents an autonomous fire suppression robot integrated with a Lifeline responder system to locate and assist trapped humans in fire emergencies. The system employs an ATmega8 microcontroller for navigation, ESP32-CAM for real-time visual feedback, fire sensors for detection, and IoT for remote monitoring and control. The robot navigates through hazardous zones, identifies fire locations, extinguishes flames, and assists in human detection and rescue operations.*

Fire emergencies pose a significant threat to human life and infrastructure, often requiring rapid response to locate trapped individuals and suppress fires. This project proposes a Self-Navigating Fire Suppression Robot with Lifeline Responder, which integrates motion and voice sensors, IoT-based camera streaming, real-time monitoring, motorized mobility, and an automated fire-spraying mechanism. The robot autonomously navigates fire-affected areas, detects human presence, and provides a lifeline for rescue operations. Equipped with AI-based object detection and IoT connectivity, the system ensures remote monitoring and fire control while assisting emergency responders in real time.

Keywords- Fire suppression, Atmega8, ESP32-cam, Autonomous robot, Real time monitoring, Water spraying, Human detection, rescue system.

I. INTRODUCTION

Aether watch is self-navigating fire suppression robot equipped with integrated life-saving capabilities. Designed for high-risk environments, it not only an autonomously detects and extinguishes fire but also includes the lifeline responder system – a specialized module for locating and safely extracting trapped individuals. Combining real-time navigation, fire detection and suppression, real time streaming and life line responder Aether watch represents a cutting-edge solution for enhancing safety and efficiency in emergency response scenarios.

II. LITERATURE SURVEY

2.1. Autonomous Fire-Fighting Robots

Autonomous robots for fire suppression have been a prominent area of research due to their potential to replace or assist human firefighters in hazardous conditions.

"Design and Development of a Fire Fighting Robot" – IEEE (2016)

This paper outlines the design of a robot capable of detecting and extinguishing fires using IR sensors and a water tank-based suppression system. Navigation is achieved using line-following methods, which limits flexibility in dynamic environments.

"Autonomous Fire Detection Robot with Wireless Surveillance" – IJERT (2018)

Highlights integration of sensors (IR, flame) and wireless video surveillance to detect fires and report back to base stations. However, lacks advanced path planning and autonomous navigation in cluttered environments.

2.2. Navigation and Obstacle Avoidance

Efficient and safe navigation in unpredictable, smoke-filled environments is critical.

"Simultaneous Localization and Mapping (SLAM) for Mobile Robots" – Robotics and Autonomous Systems (2019)

Discusses the application of SLAM techniques in enabling robots to map unknown environments in real-time, which is crucial for indoor fire-fighting tasks.

"ROS-Based Autonomous Navigation for Rescue Robots" – IEEE (2020)

Explores how ROS (Robot Operating System) and LiDAR sensors are used to implement obstacle avoidance and efficient path planning in real-time.

2.3. Human Detection and Tracking in Rescue Operations

One of the key features of the Aether Watch is its ability to locate trapped individuals during fire events.

"Deep Learning-Based Human Detection for Search and Rescue Robots" – Sensors Journal (2021)

Utilizes CNNs and thermal imaging to identify human presence in low-visibility environments. Proves effective where normal vision fails due to smoke and fire.

"Thermal and IR Sensing for Victim Detection in Rescue Robotics" – Elsevier (2017)

Explores fusion of thermal cameras and PIR sensors to improve accuracy in detecting humans through heat signatures, even when partially obstructed.

4. Fire Suppression Systems

Fire extinguishing mechanisms are central to robots like Aether Watch.

"Automatic Fire Extinguisher Robot Using Flame Sensor" – IJSER (2016)

Discusses using flame sensors for fire detection and a pump motor for extinguishing. The system is semi-automatic and lacks intelligence in targeting fire zones effectively.

"High Pressure Water Mist Systems for Fire Suppression in Robotics" – Fire Safety Journal (2020)

Advanced suppression using water mist and dry chemical agents to target high-temperature zones with minimal collateral damage.

III. METHODOLOGY

3.1. Problem Definition

In fire emergency scenarios, human rescuers face severe risks due to extreme heat, poor visibility, structural instability, and time constraints. Current fire suppression systems and rescue operations often lack autonomy and precision in locating and extracting trapped victims. The need arises for an autonomous system capable of navigating hazardous environments, extinguishing fires, and efficiently locating and assisting human victims without endangering rescuers.

3.2. Planning and designing the robot

3.2.1.Navigation & Obstacle Avoidance (Ultrasonic + ATmega8)

The Navigation and Obstacle Avoidance Module is a core component of the Aether Watch robot, responsible for autonomously guiding the robot through dynamic, debris-filled, and low-visibility environments such as burning buildings, industrial sites, or collapsed structures.

LIDAR (Light Detection and Ranging): Captures detailed 3D point clouds to detect structural layouts and obstacles.

Infrared (IR) Cameras: Penetrate smoke and low-light conditions to detect heat-emitting hazards and human signatures.

Ultrasonic Sensors: Provide short-range obstacle detection for real-time proximity alerts.

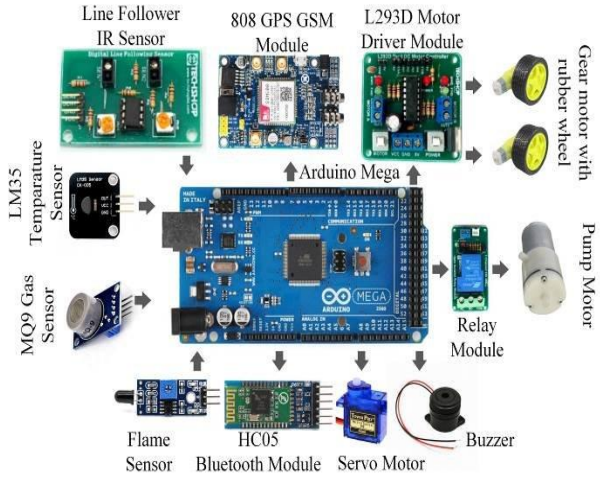


Fig-1: Robot's Parts

3.2.2.Fire Detection System (Flame/Smoke Sensors)

This module ensures that the robot can quickly respond to fire outbreaks in a targeted and efficient manner, reducing damage and increasing operational effectiveness.
Flame Sensors

Type: UV and IR-based flame sensors.
Function: Detect light emitted by flames in specific wavelengths (commonly 760 nm – 1100 nm).

Working: The sensor captures rapid flickering patterns unique to flames and differentiates them from ambient light.
Thermal Imaging Camera
Type: Long-wave infrared (LWIR) camera.
Function: Captures temperature gradients in the environment.
Working: It creates a thermal map of the area, highlighting hot spots and fire intensity zones. The robot uses this data to aim its fire suppression nozzle precisely.

3.2.3. FireSuppression Mechanism (Water/CO2 Pump)

The Fire Suppression Module (FSM) of the Aether Watch robot is designed to autonomously detect,analyze and extinguish fire outbreaks in hazardous environments where human access is limited or unsafe.
Water Mist: For general-purpose cooling and smothering.
The nozzle adjusts spray pressure and pattern (stream, mist, fog) depending on fire intensity and environment.
Post-suppression, sensors continuously monitor the area for:
Residual heat, Smoke recurrence, Re-ignition signs
If needed, the module re-engages with additional suppression or alerts for human intervention.
The fire detection system within the Aether Watch robot serves as the first and most critical step in identifying and responding to fire hazards in real-time.

3.2.4. HumanDetection System (ESP32-CAM + Motion and voice sensors)

The Navigation and Obstacle Avoidance Module is a core component of the Aether Watch robot, responsible for autonomouslyguiding the robot through dynamic, debris-filled, and low-visibility environments such as burning buildings, industrial sites, or collapsed structures.

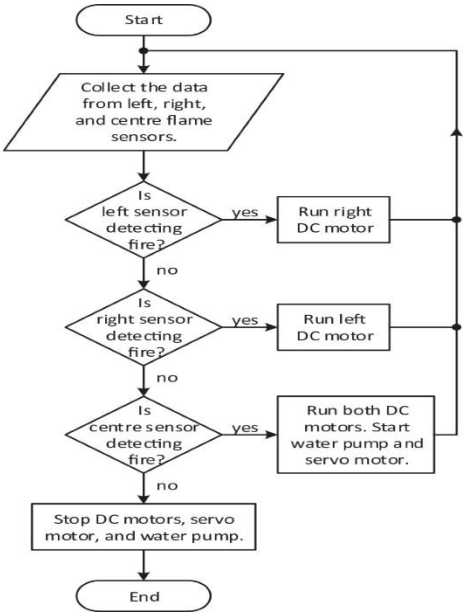


Fig-2: Data flow Diagram

4. WORKING

The workflow of the Aether Watch robot follows a structured approach, incorporating multiple modules for autonomous navigation, fire suppression, human detection, and extrication. The process can be broken down into several key stages: Activation, Fire Detection, Navigation, Fire Suppression, Human Search and Rescue, and Completion.

4.1.Self-Navigating Fire Suppression:

Autonomous Navigation: The robot is designed to move through an environment (likely a building or complex) without direct human control. This would involve:

Mapping and Localization: It would likely build or have a pre-existing map of the area. Using sensors like LiDAR, cameras, and potentially inertial measurement units (IMUs), it can determine its own position within this map.

Obstacle Avoidance: Real-time sensor data allows it to detect and navigate around obstacles like walls, furniture, and debris.

Path Planning: Algorithms would enable it to calculate efficient routes to potential fire locations or areas needing inspection.

Fire Detection: The robot would be equipped with sensors capable of detecting fire, such as:

Smoke Detectors: To sense the presence of smoke particles.

Heat Sensors (Thermocouples, Infrared Cameras): To identify areas of elevated temperature.

Flame Detectors (UV/IR): To directly detect the light emitted by flames.

4.2. Fire Suppression System:

Once a fire is detected, the robot would activate its onboard suppression system. This could involve:

Extinguishing Agent Delivery:Carrying and deploying water, foam, or a dry chemical agent through a nozzle or other delivery mechanism.

Targeted Application: Utilizing its navigation and sensor data to precisely direct the extinguishing agent at the source of the fire.

4.3. Lifeline Responder:

Autonomous Human Locator & Extrication:

Human Detection: In emergency scenarios, the robot would be able to autonomously search for and locate individuals. This could involve:

Motion detection: The motion can be detected with the help of PIR motion sensor. This helps in identifying the trapped individuals.

Audio Detection: Potentially listening for distress calls or other human sounds with the help of voice sensors.

4.4. Human Localization:

Once a person is detected, the robot would determine their precise location and potentially create a map or communicate this information to human responders and rescue team.

4.5. Communication:

The robot would likely have communication capabilities to relay information (fire status, human locations, environmental data) to a central control station or human first responders.

V. RESULTS

The results of this project can be as follows:

- Fully autonomous robot that detects and suppresses fire with water pump.
- Fire sensors detect and guide towards flame sources.
- Uses ESP32-CAM for live video streaming and image-based human detection.
- IOT integration allows remote access, notifications, and real-time control.
- Human detection assists in immediate rescue responses.
- It has obstacle avoidance system, Fire-detection suppression control system, Human detection & lifeline responder, IOT based real time monitoring and tracking.
- Thus minimizes the loss of life. Saves trapped individuals and Fireman.

Fig – 3: Camera module,fire suppression

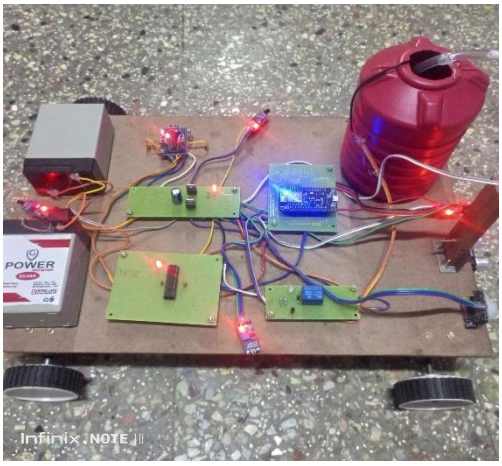
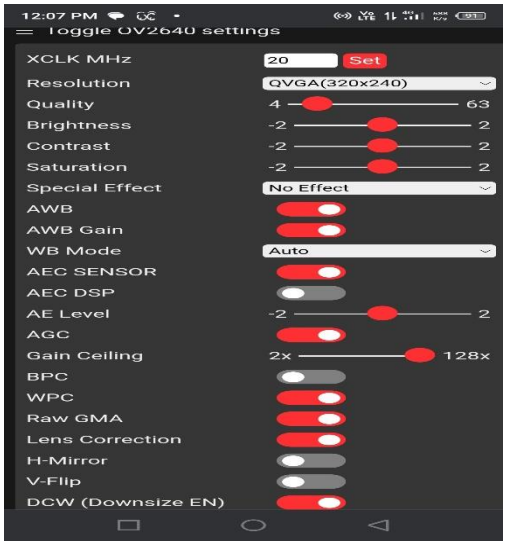


Fig -4: Top view of Aether watch



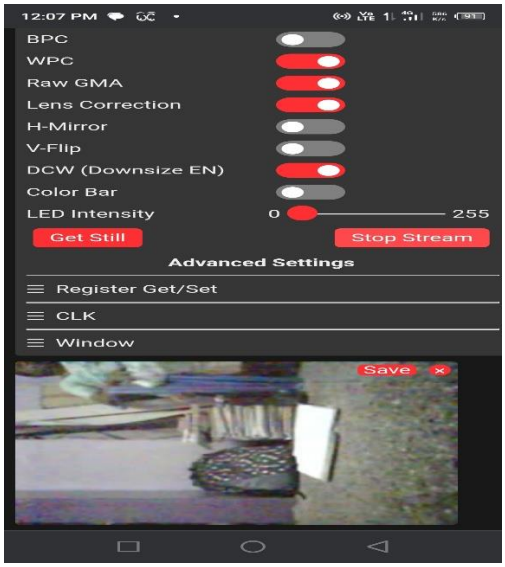


Fig-5: Live streaming from Camera

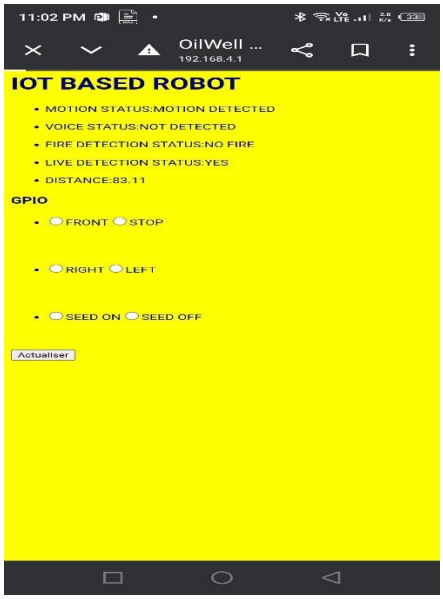


Fig-6: Data shown in web page, Live status of motion, fire and voice sensors

VI. FUTURE SCOPE

Thermal imaging camera integration.
Advanced ML-based human recognition.
GPS for outdoor navigation.
Autonomous exit routing for survivors.
Drone version of the robot for high-rise buildings.

VII. CONCLUSION

This project demonstrates a significant leap in fire emergency response using robotics and IoT. The self-navigating responder effectively combines fire detection, suppression and human rescue capabilities in one autonomous platform. With its real-time monitoring,human detection and remote-control features, it provides a practical and reliable solution for enhancing safety and efficiency during fire emergencies.

Future, enhancements may include Thermal imaging camera integration, Advanced ML-based human recognition, GPS for outdoor navigation, Autonomous exit routing for survivors, Drone version of the robot for high-rise buildings.

REFERENCES

[1] Hosamani, B. K., Kokale, A. R., Shikalgar, S. D., Sawant, D. D., & Ghorpade, A. D. (2024). A Review Paper on Automatic Fire Fighting Robot Using Arduino. International Journal of Research Publication and Reviews, 5(1), 5670-5674.
[2] Akinloye, B. O. (2023). Development of a Dual-Mode Fire Fighting Robot. FUPRE Journal of Scientific and Industrial Research (FJSIR), 7(1), 23-30.
[3] Azeta, J., & Oche, M. (2023). Implementing a Prototype Autonomous Fire Detecting and Firefighting Robot. International Journal of Advanced Research in Computer and Communication Engineering, 12(4), 45-52.
[4] Sathe, J., Raut, V., Peddapelli, R., &Waghchaure, J. (2023). Design and Development of Fire Fighting Robot. International Research Journal of Engineering and Technology (IRJET), 10(5), 1753-1757 ESP32-CAM Official Docs.
[5] Design and Development of Fire Fighting Robot. International Research Journal of Engineering and Technology (IRJET), 10(5), 1753-1757 ESP32-CAM Official Docs.