

360° Fire Protection System

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Abstract—Fires have the potential to threaten life, property, equipment and the environment. Traditional fire extinguishing methods may need human assistance and this can be risky in dangerous situations. In this paper, an autonomous fire-fighting robot with the help of an ESP32 microcontroller is presented to create a 360° Fire Protection System. The proposed system is a combination of 3 fire sensors, DC motors, motor driver, relay module, water pump and water sprayer controlled by a servo motor. Fire sensors are installed to detect fire in various directions and give an idea of the direction of the fire, based on its location. The ESP32 receives data from the sensor, and it sends instructions to the robot motor to move it to the location of the fire. The water pump is operated by a relay and the servo motor controls the direction of the sprayer to give a larger fire-suppression area. The idea behind the system is to minimize the involvement of humans and enhance the fire incident response. It is modular and low cost, and can be used in the house, laboratory, warehouse, industrial zone and other places with fire hazard. The system proposed can be the basis for further development of smart fire detection, monitoring, and autonomous protection from fire.

I. INTRODUCTION

Fire can result in massive loss of life, property, equipment and the environment. Early detection and immediate suppression is key to minimizing fire effects. Traditional fire-fighting methods are mainly based on human being's action or fixed fire protection equipment. Often in high-risk situations, it is possible that walking directly into the fire could put the people at risk of exposure to heat, smoke and other dangers. With the advances of embedded systems and robotic technologies, automated fire-detection and suppression systems can be developed. Actuators can be controlled in real-time by microcontrollers based on the input received from the sensors. Mobile robots may be employed to go into hazardous regions and undertake fire fighting tasks without the need for

continuous human control. The proposed Fire Protection System is a 360-degree autonomous robot that is capable of fire-fighting using an ESP32 microcontroller, three fire sensors, DC motors, relay module, water pump, and servo motor. The 3 fire sensors are placed to cover different directions in order to help determine the direction a fire is coming from, to a certain extent. The ESP32 reads the sensor readings and drives the robot in the direction of the fire based on the sensor data. Once the fire is detected, the robot will head towards the fire. The relay module is used to turn on the water pump, and the servo motor turns the water sprayer in different directions. This also offers greater fire protection than with a fixed nozzle. The system aims to lessen the need for direct human intervention in the event of a fire.

II. LITERATURE SURVEY

A variety of fire detection and fire fighting systems have been designed that involve sensors, microcontrollers, wireless communication and robotic platforms. Sensor-based systems can be used to detect the fire in

early stages and robotic systems can assist in controlling the fire in hazardous environments.

In the above research, Arduino UNO, temperature sensor, smoke sensor, GPS and IoT were used for forest fire detection and animal health monitoring for environmental monitoring. While these can be used for realtime detection, sensor-based detection has to rely on sensor placement and coverage.

The other research project designed a fire-detection and extinguishing robot system based on the PIC16F877A microcontroller, fire sensors, RF module, water pump and robot platform. The system was capable of detecting fire and proceed towards the fire area, but the range of the sensing was limited. This

means that there is a need for better fire localization and more fire detection.

Also, there have been some studies on deep-learning based fire-detection system, such as CNN and image processing, etc. Video systems are capable of detecting fire, but may be complicated and require a lot of computational power. They typically are not designed to do automatic physical suppression but are designed to detect the fire and warn people.

To overcome these drawbacks, the proposed system involves a multi-directional fire sensing, autonomous robot motion and water-based suppression. The ESP32 drives the movement, pump and servo sprayer, three fire sensors are used to enhance the directionality of the fire detection.

III. EXISTING SYSTEM

The typical fire-protecting systems are based on detecting smoke, heat or flame. Fixed fire alarms will warn but don't necessarily automatically extinguish the fire or move towards it. Currently, fire-fighting robotic systems with only one fire sensor or small sensing area are available. In such systems, it may be hard to accurately determine the direction of a flame. The water nozzle may also not be able to move from place to place and direct water to fire location in various directions. The current method has some drawbacks, such as: Relying on people to come into hazardous situations. Poor direction of fire detection. Limited coverage with 1 sensor/fixed nozzle. Challenge to accurately determine the location of fire. Restricted automatic suppression and automatic movement facilities. These restrictions mean that a system incorporating automatic water suppression, direction of movement and fire detection into one robotic platform is needed.

IV. PROBLEM STATEMENT

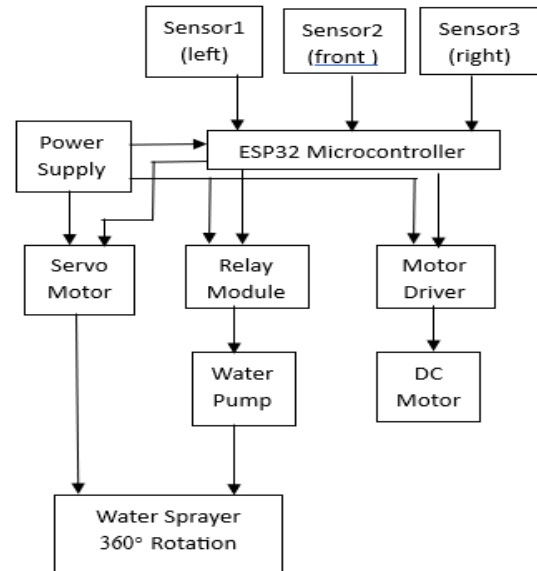
Traditional firefighting techniques may involve human use, putting those in a risky environment in danger. Current fire detection and alarm systems based on sensors might not be able to automatically approach the fire and have only limited directional coverage. Apart from that, a fixed mechanism for water-spraying is not very effective in directing water in various directions towards the fire location. Thus, a low cost autonomous fire-protection system which is able to

detect the fire from any directions, localize an approximate location of the fire, approach to the fire region and automatically suppress fire with a directional water sprayer is in need.

V. OBJECTIVES

- To automatically sense fire using a set of flame sensors.
- To determine the direction in which fire is detected.
- To autonomously drive the robot towards the fire.
- To start up the water pump and put out the fire.
- To increase the spread of the water spray by a servo controlled water sprayer

BLOCK DIAGRAM



VI. PROPOSED SYSTEM

The proposed system is an autonomous fire-fighting robot which is able to detect and extinguish fire with minimum human intervention. Mainly controlled by an ESP32 microcontroller. The three fire sensors are set in different directions to be able to sense the environment and determine the direction of the fire. The signals from the sensor are sent to the ESP32 from where it decides the necessary movement of the robot. Forward, backward, left and right movements are given by the motors connected to a Motor Driver. Once the robot has arrived at the desired location, the ESP32 will turn on the relay module and the water pump will

turn on. The water pump is used to pump water from the tank to the sprayer. The water is directed towards various fire sites with a servo motor-controlled angular movement of the sprayer. The multi-directional sensing, autonomous movement and servo controlled spraying is designed to offer comprehensive coverage of fire-protection.

A. Working Principle All three of the fire sensors are constantly checking the environment. If a flame is detected, the sensor signals will be sent to the ESP32. The ESP32 is able to detect the approximate

direction of the fire. The robot is driven by the motor driver to move towards the detected fire using the DC motors. The relay module is used to turn on the water pump. Servo motor turns the sprayer towards fire. The nozzle will be used to suppress the flames with water. Once the fire has been controlled, the pump is turned off and the system maintains its monitoring operation.

VII. ADVANTAGE

- Automatic fire detection with a number of flame sensors.
- 360° fire coverage via the servo controlled water sprayer.
- Fast response – System automatically detects the fire and moves towards it.
- Minimizes the risk to humans by enabling passive fire detection and extinguishing without the need for people to be present.
- It is also implemented with low cost sensors, motors and water pump, using ESP32 microcontroller.
- Directional fire detection can be used to determine an approximate position of the flame.
- The automatic water control is achieved by the relay and pump. Works in a variety of settings including homes, laboratories, warehouses and industries.
- The robot is portable and compact, can be pushed to the position of the fire source.
- Future additions to the system, including IoT monitoring, cameras and temperature sensors.

VIII. EXPECTED OUTCOME

The proposed system will be expected to: Detect fire from a number of directions with three fire sensors. Establish an approximate direction of the detected flame. Automatically move the robot towards the fire location. Turn on the water pump with the relay. Use the servo motor for rotation of the sprayer. Offer greater directionality of fire suppression. Minimize the need for close hand operations. Facilitate, low cost and modular implementation. The actual accuracy of detection, response time, performance of movement and effectiveness of fire-extinguishing must be tested in an experimental way. The first PPT outlines the testing to be conducted on individual sensors, movement of the robot, activation of the pumps and operation of the sprayer; however, there are no reported results from the testing.

IX. APPLICATIONS

The proposed system can be used in:

- Homes – To locate and put out low intensity fires.
- Industries: For monitoring and responding to fire, in hazardous areas.
- Laboratories: To minimise the need of individuals to go near fire prone equipment.
- Fire Protection: To help the detection and suppression of fire in the storage areas (warehouses).
- The "Rewards on Educational Institutions" is a prize for the demonstration of technology for automatic fire protection.
- Other Fire Prone Environments: Autonomous Fire Detection & suppression can reduce Human Risk.

X. CONCLUSION

The paper introduces a Fire Protection System which is 360° around a fire-fighting robot working autonomously based on the ESP32 microcontroller. Three fire sensors, DC motors, motor driver, relay module, water pump and a servo-controlled water sprayer are used in the system. The dots containing the fire sensors will detect the fire in multiple directions, and the ESP32 will evaluate the signals from the fire sensors and manage the robot motion and fire

suppression operations. The design for the proposed system is aimed at augmenting the fire-responsiveness capability of the system, which will include automatic detection, autonomous movement, and direction spray of water. Its modular and low cost design allows it to be easily expanded for use in fire-protection. Future features could be IoT monitoring, camera based fire detection, temperature sensor, GPS and remote control. The additions might enhance the system's monitoring capability and reliability.

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