*Fire Extinguishing Robot based on Arduino UNO*

Sajja Reneesha

*Electronics and Communication Engineering*

*New Horizon College of Engineering*

Bengaluru, India

reneeshasajja@gmail.com

Sneha S

*Electronics and Communication Engineering*

*New Horizon College of Engineering*

Bengaluru, India

snehashiva935358@gmail.com

Ishita Deb

*Electronics and Communication Engineering*

*New Horizon College of Engineering*

Bengaluru, India

ishitadeb.nhce@newhorizonindia.edu

***Abstract*** **Several accidents involving fire have occurred. worldwide that have killed thousands of people, animals, and other living creatures.** **Robots could possibly replace the role of humans in the firefighting process thanks to technological advances, particularly in robotics. In this paper, we developed a robot that can use fire sensors to identify a fire and extinguish the fire using water with the goal that would save everyone's life. With the help of an Arduino, this robot is controlled, and a motor driver is used so as to move the robot from place to place.** **A small DC submersible pump that can eject water is used so that it can extinguish the fire. The servo motor allows the pipe that is linked to the pump to be moved in a specific direction of the fire and extinguish it. As a result, firefighters would be more successful and wouldn't have to take the risk of putting people's lives in danger.**

***Keywords Extinguish fire, fire sensors, Arduino, Motor Driver, DC submersible pump, servo motor***

# Introduction

In the exothermic combustion process, which emits light, heat, and various reaction materials, a process known as "rapid oxidation" of a substance is referred to as fire. The component present in the fire which emits radiant burning gases was a flame. Accidents involving fire are uncommon. Plenty of things have been physically damaged as an outcome of fire occurrences. However, when they occur, they result in a great deal of chaos, destruction, and occasionally death. A person's slight recklessness manifests as fire, which would be disastrous. Due to smoke, extreme temperatures, explosive chemicals, and poisonous gases, fighting a fire would be extremely dangerous for the firefighters. In order to put out such a fire, firefighting robots could replace the role of humans, thereby saving thousands of lives.

In the history, there were two innovative streams that have contributed to the development of robotic devices and technologies one is ‘Ancient automation and watchmaking’ and the other is ‘Improvements and developments in industrial machinery’. These two lines will be further illustrated by the brief explanation of several of these technologies. These machines were and are more adaptable in terms of their capacity to modify programmes. When CNC machines took on the role of NC machines, programming became more complicated, and the trajectories were then calculated by the machine's computer.[1]

Robotics solutions are being utilized in an increasing wide range of industries and applications as robots manufacturers continue to introduce breakthroughs in the areas of capabilities, affordability, and form factor. Due to advancements in processing speed and Ai applications, we can now utilize robots in a number of ways to carry out essential tasks. Several studies have demonstrated the potential benefits of robots in the fields of medicine [2], rehabilitation [3–7], rescue activities [8–9], and industries [10]. While there are many variety of uses for robotics currently giving instructions, shelf stacking, welding metal in hazardous situations, and much more.

The autonomous mobile robots and autonomous guided vehicles are two categories for the mobile robots. An AMR and an AGV differ primarily because an AMR uses free navigation using lasers, while an AGV is located using fixed elements such as magnetic tapes, magnets, beacons, etc. Therefore, they need a predictable route in order to be effective.[11]

TABLE I. LITERATURE REVIEW

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| --- | --- | --- |
| **Ref.no** | **HIGHLIGHT** | **CONCLUSION** |
| [12] | This paper is based on the theory of binocular vision. The enhanced algorithm is examined using MATLAB and ROS. | An intelligent FFR with an original design and an improved global path planning algorithm are given. |
| [13] | This paper offers a smart robot that recognises and classifies flames using deep learning. They combined the use of ImageNet and AlexNet to detect fire in order to identify the fire. | The accuracy of this paper's fire detection system was 98.25%, while the accuracy of its fire categorization system was about 92%. |
| [14] | The approach in this research is broken down into three sections. The hardware description comes first, then the hardware schematics, and ultimately the programming design. | In this article, the QRob has the capacity to avoid running into any nearby objects or obstacles. One location where the QRob robot can be employed is a tiny entry or fits due to its compact structure. |
| [15] | When the bot detects fire, its location is established using the Google API, and waypoints can be recorded using the mission planner and GPS module. The bot will travel utilising computer vision technologies. | We can draw the conclusion that in this paper, as soon as the robot arrives at the desired location, the fire and heat sensors will Identify the fire and use water to extinguish it. using a nozzle that can rotate roughly 180 degrees. |
| [16] | This study discovered that objects with similar colour features can interfere with flame detection. The moving object in the video stream is found using the improved background subtraction method. Finally, the flame colour features are examined using the RGB and LMS colour models. | The flame detection experiment finally shows the algorithm's excellent environmental adaption, which enables real-time flame recognition and successfully reduces interference from stationary objects with comparable colours and instantaneous light. |
| [17] | The mathematical model of the robot's movements is examined in this work. Using ADAMS, the kinematics simulation is run. | The firefighting robot created in this project uses a four-track and four-drive flexible crawler construction for walking, which has a strong ability to overcome obstacles. |
| [18] | The proposed fire-fighting robot can climb the stairs and, can withstand temperatures of up to 700o C for around 60 minutes. It is set up to give gas masks and oxygen bottles to the people who are confined. | This work proposes and develops a fire fighting robot that has the ability to speak with trapped and hurt people, and relay audio and video data to the control unit outlining the fire situation inside. |
| [19] | In hazardous buildings where GPS signals are not available inside, the developed robotic system can locate civilians inside and calculate the fastest and safest approach to reach them. | The Lego EV3 platform has been used to implement the prototype system, together with the C# programming language for the application running on the firefighter PC. |
| [20] | By integrating thermal camera, it improves the device's accuracy and precision while detecting flames and victims nearby. MATLAB/Simulink is used for system development. | In the incident region, electric and metal fires can all be quickly and effectively put out by LAHEEB without spreading. |
| [21] | Microcontrollers, wireless transceiver modules, jet spray, DC motors, and buzzers are interfaced to microcontroller as major controlling components of system. All four directions can be covered by spray. | In darker environments, fire sensors perform better. This robot's design can combat massive fires with greater reserve capacity, and an enhanced sensing unit can even provide early fire detection in all situations. |

In this research, multi-sensor fusion is used to build an intelligent fire-fighting robot. The robot can efficiently aggregate information from the operating environment and make judgements based on multi-sensor fusion. It also includes self-inspection and firefighting capabilities. An upgraded path-planning mechanism is designed to overcome some of the drawbacks of the ant-colony optimisation method, such as its simple inclination to arrive at local optimal solutions, slow convergence speed, and poor global searching capacity. To measure the upgraded ACO's relevance and efficacy, a comprehensive standard method is established. [12]

The risk to firefighters' lives can be reduced by using the firefighting robot as an auxiliary assistance. An intelligent robot that employs deep learning to identify and categorise flames as well as put them out in accordance with their class. The suggested firefighting robot is less costly, more self-sufficient, and requires less maintenance. [13]

The organised robot is intended to work independently or under remote control. Such robots provide safer to detect fire and rescue of trapped humans without putting firefighters at danger. The DC motor will come to a complete halt 40 cm distant if the flame sensor senses a fire. The operator will extinguish the fire from a safe distance using the remote control. The operator can also monitor the QRob via a smartphone-connected camera. [14]

The introduction of an autonomous fire-fighting robot aims to prevent these dangerous behaviours. When the bot receives data regarding the fire, it will activate. Once the precise spot has been determined using the Google API, waypoints can be marked in the mission planner using the GPS module. Through the use of computer vision technology, the bot will come at the location on its own. [15]

It's been observed that items with comparable colour features can quickly obstruct flame detection, which is based on colour feature analysis. To reduce the interference of static objects, an approach integrating continuous moving recognition of objects and colour feature analysis used for flame detection.[16].

The vehicle body contains a different sensor data, and it is capable of sending both sensor data from the vehicle and information about its surroundings to the receiver for remote control and decision-making via transparent and picture transmission systems. [17]

A remotely controlled indoor tracked firefighting robot features a good thermal insulation system to keep the interior temperatures of the electrical equipment within acceptable limits. It can climb stairs, engage with injured and trapped fire victims, and send speech and video data to the control unit. [18]

The major goal of this effort was to develop and test a robotic prototype system that could assist firefighters in carrying out their duties, such as calculating the shortest distance between two locations. The Lego EV3 platform has been used to implement the prototype system, together with the C# programming language for the application running on the firefighter PC. [19]

All sensors, as well as a pump and servo motors, are connected to an Arduino DUE board to control the device's movement in 360° and 90° up and down. In the flame detection test, the seven integrated flame sensors in the LAHEEB gadget are used to detect the entire range in a room. The test is performed by comparing the seven sensors, with the highest value used to move the servo to the location of the flame and centre of the fire source. [20]

The Fire Fighting Robot is made using components that are easily accessible locally, and its performance during obstacle detection tests and fire sensing tests is evaluated to determine how well it performs in various scenarios. With more reserve capacity and an enhanced sensing unit, this robot's design can even detect fire earlier in all situations. It can also fight against major fires. [21]

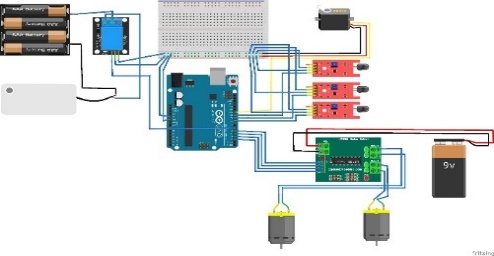
# PROPOSED SYSTEM

## Block Diagram

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A fire sensor module handled by the Arduino main board is used to detect fire in this project. The fire sensors are used to sense the fire in the surrounding environment. It works better in darker places. These sensors include an infrared receiver (photodiode) for fire detection. The sensor will detect the smallest amount of infrared light emitted by a fire. When the fire sensor detects a fire, it travels in the direction of the fire using motor driver L293D. Two DC motors are attached to the motor driver and can help it travel from one location to another. When the robot approaches the fire, it will use the water pump to shower water on it to extinguish it. The water pump is linked to the relay module. To deliver electricity to the pump, the controller can activate a pump relay, which acts as a switch.

## Circuit Diagram



DETECTS FIRE

YES

MOVE TOWARDS THE DIRECTION OF FIRE

A fire sensor that is managed by the Arduino main board is utilised to search for fire in this project. For fire detection, these sensors have an infrared receiver. (photodiode). The sensor will pick up on the minimal infrared light that a fire releases. Then, to monitor voltage change, we use an Op-Amp across the IR the receiver, to ensure that if there is fire, the pin that outputs (DO) will be 0V (LOW), otherwise it will be 5V (HIGH).

WATER PUMP ON

END

We set three sensors on the robot in three different orientations to detect the direction of the fire. The L293D module allows us to drive our motors closer to the fire based on its direction. We should use water to extinguish a fire. To direct the flow of water, we must use a tiny container to transport the water., a 5V pump is placed inside the container, The entire container is put on top of a servo motor, which controls the direction in which the water is sprayed. The relay module is attached to the water pump. To deliver electricity to the pump, the controller can activate a pump relay, which serves as a switch.

Since many pumps require between 110 and 220V AC and the controller only outputs 24V AC power. The pump relay turns on the pump and serves as a setup transformer for additional power.

## Flow Chart

START

INITIALIZE THE PINS

MOTOR DRIVER

FIRE SENSOR

NO

Our robot is advantageous in many ways such as It has the ability to properly sense with improved flexibility, as well as discern the precise direction of the fire source. It minimizes human effort. It is also trustworthy and affordable. It is not susceptible to the elements. It can analyze and locate flames, conduct search and rescue, monitor hazardous variables, and perform the core task of control of fires and suppression.

It has a variety of uses, including that it can be employed in surveillance and rescue missions in disaster areas and also to put out fires in areas where there is a significant risk of explosion. It can also be used to put out home fires and is appropriate for server rooms.

# CONCLUSION

The design's principles make it possible to upgrade our robot into a more durable system that can put out real flames in residential or business environments. The creation of a completely autonomous robot is the fundamental prerequisite for this project. This means that after the user turns on the robot, it moves around, looks for the fire, and puts it out entirely on its own, without the user's help or input. This project depicts the design and construction of a fire-fighting robot that moves towards the fire and pumps out water to extinguish it. The system may be helpful in supporting fire fighters and containing an outbreak. It was created a system that could detect a fire and then extinguish it with a water pump. It was successful to conduct research on various components and their interfacing procedures.

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