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Autonomous Fire Fighting Robot using IOT

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Abstract

This paper presents the design and development of an autonomous firefighting robot with the purpose of providing a fast and accurate response to fire hazards. The robot has fire detection sensors, motor drivers, a water pump, and a rechargeable battery. The controlled response of the robot when fires are detected from the three directions is that it walks in closer direction to the source of the fire, activates water pump to extinguish the fire and sends SMS alert to emergency services. So the system is an autonomous approach to fire hazards, which reduces the need to use manual human-based firefighting methods, as well as makes rapid response and notification possible. This paper provides an overview of the robot's design and hardware and software parts, as well as provides the advantages and limitations of the system.

Keywords — Autonomous Firefighting Robot, Fire Detection Sensors, Water Pump, SMS Alert, Emergency Response, Robotics, Fire Safety, Autonomous Systems.

I. INTRODUCTION

Fig.1: Fire accidents in Environment

Automation as a tool for dangerous industries has become increasingly relevant in recent decades. Firefighting is one of the most dangerous jobs humans can undertake - especially in large industries such as coal mines, chemical plants, and forest fires. Firefighting techniques based on human intervention have been found in many cases to be delayed, hazardous, and potentially inefficient in some cases. In order to overcome these challenges, autonomous firefighting robots have become an excellent research field. They are designed to provide faster, safer, and more reliable methods for detecting and putting out fires. While firefighting is a very complex and dynamic process, it requires fast decision-making, well-coordinated operations, and good communication. Human firefighters face a number of challenges in firefighting from hazardous environments, limited visibility and physical fatigue to many other complexities, including the number of stakeholders involved in a firefighting deployment ranging from firefighters to emergency responders and incident commanders. The use of autonomous firefighting robots can provide real-time information, and enhanced situational awareness and allow better decision-making in firefighting. Autonomous firefighting robots have the potential to significantly change the way fires are battled, especially in hazardous environments. The ability to operate in places that would be out of the reach of human firefighters will decrease the risk of injury or death. The ability to respond quickly to a fire will also reduce the amount of damage it causes. The robot could also provide real-time information about a fire based on location, size, autonomous firefighting robots require substantial progress in

various key areas, such as robotics, artificial intelligence, computer vision, and sensor systems. Researchers have made significant progress in each of these areas, and new autonomous firefighting robots have been developed. There are still several challenges to be overcome, including developing more effective fire detection and suppression systems, improving the autonomy of the robot in search and rescue operations, and ensuring the safety and reliability of the firefighting robot.

An autonomous firefighting robot will overcome the limitations of traditional firefighting methods. The proposed robot combines advanced technologies, including a fire detection sensor, autonomous navigation system, water pumping system, and real-time monitoring and notification system. The robot will be able to detect fires quickly and accurately, navigate through adverse environments, and effectively suppress fires.

II. LITERATURE REVIEW

Deore Jagruti et al [1] aims to present an innovative solution for efficient fire detection and extinguishing. Utilizing Arduino Uno, flame sensors, water tanks, and servo motors, this robot automatically detects fires and sprays water to extinguish them. Research highlights the effectiveness of such systems in reducing risks to human life and improving firefighting efficiency. Studies have explored various sensor technologies, navigation algorithms, and control systems for firefighting robots. The literature survey underscores the potential of Arduino-based solutions in developing compact, automated, and effective fire-fighting technologies.

Kondeti el al [2] introduced a design methodology and the practical realization of an affordable autonomous robot prototype. This robot can detect the presence of fire in its environment and take appropriate actions to extinguish it. Equipped with a mounted camera, the prototype continuously captures video footage of its surroundings, which is utilized for fire detection within its vicinity. To detect fire, an image processing algorithm was devised and tested using a database created by the authors. The robot's performance and accuracy were evaluated in various locations, and the success rate of fire detection and heading angle measurement was measured to assess its effectiveness.

The paper by Sathe el al [3] aims to combat fires efficiently, leveraging advanced technologies. Research highlights the significance of firefighting robots in reducing risks and improving response times. Existing literature reveals various fire detection methods, including flame sensors, smoke detectors, and heat sensors. Navigation systems utilizing GPS, wireless communication, and sensors enable effective robot movement. Water spraying and extinguishing systems, such as foam-based and water mist-based systems, have been explored. Arduino-based implementations demonstrate the potential for compact and efficient firefighting robot designs. Challenges in firefighting robot development include sensor accuracy, navigation, and communication.

III. SYSTEM OVERVIEW

The design and development of an autonomous Firefighting robot is described. The robot has the following features: fire detection sensors, motor drivers, a water pump, and a rechargeable battery. These features provide the ability to detect fires, locate the fire source, and extinguish it. When detecting a fire, the robot automatically moves closer to the source (using its motor drivers to drive itself forward), then activates its water pump to discharge a controlled stream of water to extinguish the fire. This is a precisely coordinated response to reduce the damage suffered by the fire and prevent it from spreading. The robot also has an SMS alert system; that alerts emergency services with important information about where and how large the fire is. This rapid response and notification mechanism allows emergency services to respond swiftly and efficiently and thus save lives and property.

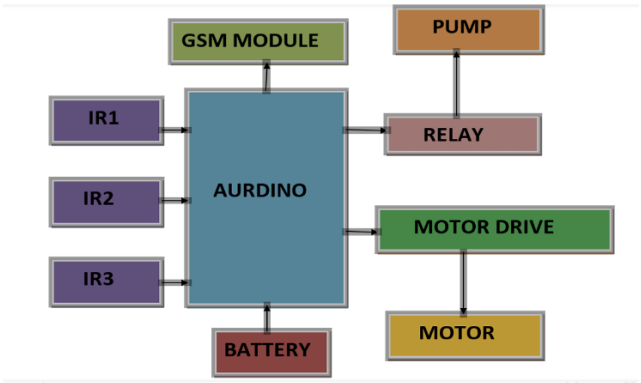

Fig: Block diagram of autonomous fire fighting robot

The autonomous firefighting robot can perform several benefits over traditional manual firefighting techniques, i. e. it can respond to fires more quickly and accurately and thus reduce the risk of damage to and injury to human firefighters. It can also operate in hazardous environments that reduce the risk of injury to human firefighters. Description of the Design, Hardware, and Software Parts of the Autonomous Firefighting Robot. The paper presents a complete description of the robot, describes the hardware components and software components, explains its benefits and disadvantages, discusses potential applications, and suggests future directions for this project.

IV. METHODOLOGY

Firefighting robots are increasingly becoming an essential device in the battle against hazardous fires. The new devices have been made to bridge the gap where humans can no longer tread safely, allowing firefighters to operate with increased safety yet still be capable of fighting fires efficiently. Fire robots can penetrate hazardous ground and help in putting out fires. This essay will look at the studies on firefighting robots as they focus on the

technological details of their functioning and the benefits that they can bring to firefighting efficiency and safety.

Mainly, firefighting robots come installed with a combination of sensors and actuators that help them sense and respond to instances of fire. Of these, sensors like temperature are especially crucial in that they help the robot not only detect that there is fire but also to determine the scale of the fire. Actuators are those that help the robot navigate its surroundings as well as suppress fire, typical components being pumps, motors, and valves.

Also, they are fitted with a fire extinguishing system, which is normally made up of separate containers for different extinguishing agents and a nozzle or other delivery mechanism. Some of the most common extinguishing agents employed by fire robots include water, foam, dry chemicals, wet chemicals, and carbon dioxide. The intelligence of the firefighting robot is an Arduino Uno Board serving as its CPU. If a flame sensor detects that there is a fire, it will trigger the motor driver, and the DC motors will turn on, allowing the robot to move toward the fire.

Condensing the methodology into three stages:

1. Development of model
    a. Design and develop the robot platform and include sensors.
    b. Incorporate AI-based algorithms for fire detection and navigation.
2. Testing and Validation
    a. Conduct simulations and field testing.
    b. Test the fire detection and fire extinguishing functionality.
3. Deployment and Maintenance
    a. Deploy the robot in the specified environment.
    b. Monitor its performance and accordingly update the software.
    c. Regular maintenance checks are to be performed.

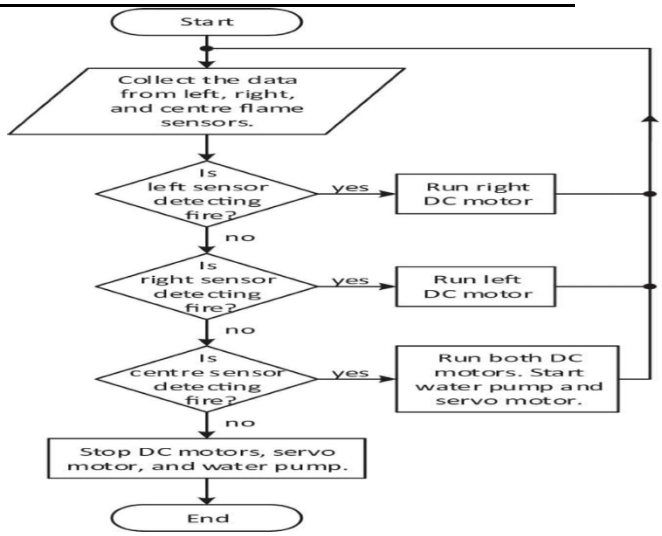

Fig.4: Output of model evaluation

V. RESULT ANALYSIS

The autonomous firefighting robot was able to recognize the risks of the fire quickly and accurately, thus traveling towards the fire initiation zone, controlling the current flow of the fire, and sending SMS notifications to emergency services. The robot had the ability to recognize fire threats from three sides of the scene and thereby react accordingly; thus, the robot can be considered reliable and efficient. In addition, by reducing the need for manual human firefighting, the robot avoids harming the human firefighters, i. e. it provides a faster response time to the fire. The advantages of the system, such as its autonomous function and rapid notification capacity, have made it a valuable tool in the firefighting environment. However, it is also noted that the system has its limitations, since it identify areas where further research is needed to enhance the system. Thus, autonomous firefighting robot is an area where further studies are required.

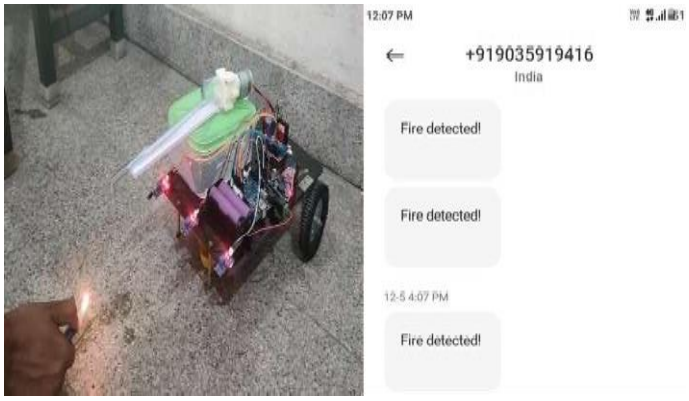

Fig 5. Outcome of the proposed methodology

VI. CONCLUSION

The fire fighting robot developed in this project is a robust, self-governing system. Its already mentioned potential advantage over traditional firefighting is the use of fire detection sensors for movement and a relay-controlled water pump the robot can detect and deploy to firefighting in various environments: challenges (such as limited sensor range)and environmental interference. The robot is certainly an important step forward in robotic firefighting. hnology. Further improvements may address improved sensor performance, better battery life, and improvement of the robot's maneuverability in dynamic fire conditions

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PROFILE DETAILS

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