JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

FIRE COMBAT SYSTEMUSING ARDUINO

Kiran Kumar G R[1], Nayana N G[2], Ravikumar V B[3], Ganesh N[4], Karthik K C[5]
[1]Assistant Professor, Department of Electrical and Electronics Engineering, PES Institute of Technology and Management, Shivamogga, Karnataka, India.
[2345]Undergraduate Students, Department of Electrical and Electronics Engineering, PES Institute of Technology and Management, Shivamogga, Karnataka, India.

Abstract: In recent years, robotics has emerged as a significant field of interest for many, driven by the growing human population and rapid technological advancements. These developments have also led to an increase in fire-related accidents and associated risks. The unpredictable nature of fire incidents, combined with human physical limitations, makes fire extinguishing a challenging and high-risk task that often endangers lives. Robotics offers a promising solution to safeguard both human lives and the environment. This paper presents a fire-extinguishing robot designed to mitigate the limitations and risks faced by humans during firefighting operations. The proposed model can autonomously navigate fire-prone areas, detect fires, and extinguish them before they escalate. Equipped with advanced sensors, the robot can efficiently scan a building while continuously monitoring for fire hazards. It can be remotely operated from any location using a mobile device or laptop. Additionally, leveraging the Internet of Things (IoT) and machine communication technologies, the robot provides real-time alerts and updates about the situation. The proposed system is particularly useful in firefighting scenarios where the entry of human responders into fire-affected areas is either highly dangerous or impractical. This innovative approach ensures greater efficiency and safety in fire mitigation efforts.

Index Terms -Robotics, Fire extinguishing, Fire accidents, Human safety, Internet of Things (IoT).

I. INTRODUCTION

The increasing human population and rapid urbanization have led to a rise in fire accidents across various environments, including homes, schools, offices, industries, and factories. These incidents, often caused by diverse factors, pose significant risks to human safety and require efficient strategies for mitigation. The initial moments following the outbreak of a fire are critical for controlling it and preventing its escalation. However, the hazardous and suffocating environment during fire incidents often challenges human responders due to physical limitations and safety concerns.

To address these challenges, this paper presents a wireless, manually controlled fire combat system that can be operated remotely using a smart device. The proposed system integrates advanced sensors to continuously monitor critical parameters such as flame detection, temperature, humidity, human casualties, and the proximity of obstacles. Once a fire is detected, it utilizes a DC fan to extinguish the flames effectively. A webcam is mounted on the system to provide a real-time, comprehensive view of the surroundings, ensuring that the robot can prioritize areas requiring immediate attention. This feature reduces response time and enhances fire fighting efficiency.

Unlike traditional systems that rely solely on sensors, the proposed model incorporates redundancy to ensure reliability. Even in cases where sensors fail due to adverse environmental conditions or faulty readings, the robot can continue its operation using the webcam. Additionally, the system is programmed to avoid entering dangerous fire zones, ensuring its safety while addressing fire incidents effectively. This innovative approach offers a reliable and efficient solution for mitigating fire accidents, particularly in scenarios where human intervention is challenging or dangerous.

II. LITARATURE SURVEY

The feasibility of deploying fire-fighting robots to address hazardous situations beyond human capabilities has been explored extensively in previous research [1]. However, this paper focuses on designing a manually controlled fire-extinguishing robot, as earlier studies suggest that autonomous Fire Combat System often yield less efficient results compared to those operated by users [2]. Many autonomous systems take considerable time to process and scan the environment for fire, failing to prioritize critical areas. This delay can allow fires to spread uncontrollably, resulting in significant loss of life and property [3], [4].

Additionally, some fire-fighting robots are designed to function in restricted environments, limiting their applicability in dynamic, real-world scenarios [5]. Relying entirely on sensor readings in fire-prone environments may prove ineffective, as adverse conditions can disrupt sensor functionality and produce inaccurate data, rendering the robot unable to perform its tasks [6]. Furthermore, streaming real-time video feeds over cloud platforms often introduces undesirable latency, which is unsuitable for time-sensitive applications like firefighting [7].

To address these inefficiencies, the proposed robot integrates features to enhance performance and reliability. By giving users complete control over the robot's movement, they can prioritize vulnerable areas for firefighting, ensuring a more effective response. Alongside multiple sensors, the robot is equipped with a mounted webcam, enabling users to visually monitor the environment and confirm the robot's surroundings even if sensors produce faulty readings, and vice versa.

Traditional wireless systems that rely on Arduino and Wi-Fi dongles are limited by operational delays as the distance between the robot and controller increases, making them impractical in remote firefighting scenarios. To overcome this limitation, the proposed robot leverages the Weaved IoT platform, which relies solely on a stable internet connection. This platform minimizes operational latency and allows seamless remote interaction between the user and the robot, regardless of the distance [8]. Weaved's IoT capabilities, such as automatic Port Forwarding, simplify remote access and enhance the system's usability, eliminating the need for complex manual configurations.

III. PROBLEM STATEMENT

Fire accidents are among the most devastating disasters, causing significant loss of life, property, and environmental damage. Traditional firefighting methods often expose human firefighters to hazard environments, including high temperatures, toxic smoke, and unstable structures, putting their lives at considerable risk. Additionally, in large-scale fires, such as industrial plant incidents, forest fires, or chemical spills, the scale and complexity of operations can overwhelm human capabilities, delaying response times and increasing potential damage.

Modern urbanization, industrialization, and climate change have exacerbated the frequency and severity of fire outbreaks. The inability to access certain areas, such as narrow urban streets, high-rise buildings, or dense forests, further complicates firefighting efforts. Furthermore, identifying the fire source, extinguishing it effectively, and rescuing individuals in danger require precise and timely actions, which may not always be achievable with human intervention alone.

To address these challenges, the development of Fire Combat System presents a transformative solution. This autonomous or semi-autonomous robot, equipped with advanced sensors, thermal cameras, and AI-based navigation systems, can detect fire sources, map the affected area, and operate in hazardous conditions without risking human lives. The System can be designed to navigate through confined spaces, climb stairs, and adapt to various terrains, enabling it to reach areas inaccessible to humans.

Incorporating real-time data analytics and wireless communication systems, the robot can relay critical information to command centers, facilitating coordinated firefighting efforts. It can also carry fire suppression tools, such as water jets, foam sprayers, or extinguishers, and deploy them with precision. Additionally, with integrated rescue mechanisms, the robot can locate and assist trapped individuals, ensuring faster evacuation and medical aid.

By leveraging cutting-edge robotics and AI technologies, the Fire Combat System can revolutionize firefighting operations, enhancing efficiency, safety, and effectiveness in combating fire emergencies. This innovation not only reduces the risk to human firefighters but also ensures quicker, more comprehensive responses to save lives and protect valuable assets.

IV. OBJECTIVES

The main objective of this Fire Combat System as follows:

- To design and model the prototype.
- To safe guard the human life and property from fire.
- To reduce the amount of human effort required in completing the task.

IV. METHODOLOGY

This chapter describes about the proposed system and its function for the problem identified after literature survey, which are represented in block diagram and also describes the working of proposed model.

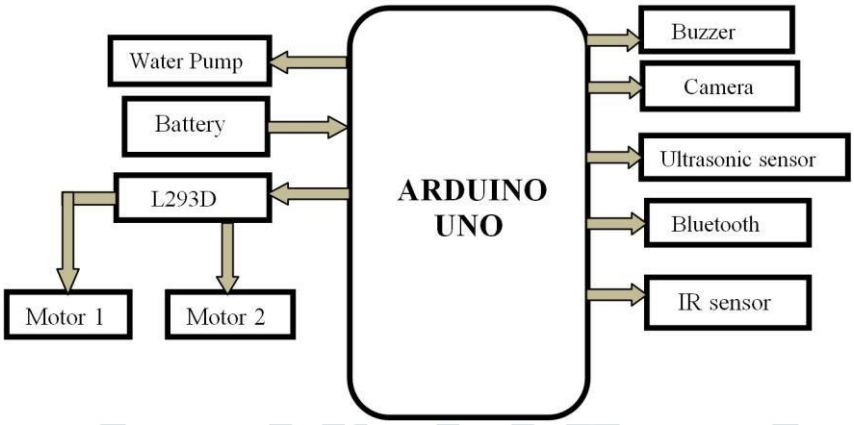

Fig. 1: Block Diagram of Fire Combat System Using Arduino

V. RESULT

The Fire Combat System is designed to minimize human risk and automate fire detection and extinguishing processes without requiring direct human intervention. Using IR flame sensors connected to the Arduino Uno, the robot accurately detects fire and activates the motor drive, which controls its movement towards the detected location. Once the fire source is reached, the pumping mechanism extinguishes the fire effectively.

Fig.2. Fire Combat System Using Arduino model

This system is particularly beneficial in industrial environments where fire accidents require continuous monitoring and rapid response. Delays in detection and action can lead to irreparable losses. The Fire Combat System addresses this challenge by continuously scanning the surroundings, ensuring timely detection and intervention to extinguish fires efficiently. This result demonstrates that the robot is reliable for real-time fire monitoring and mitigation, making it a valuable tool in reducing fire-related damages and safeguarding lives and property.

V I. CONCLUTIONS

This paper presents the design and implementation of an advanced Fire Combat System using Arduino, combining technology and emergency response to enhance fire management capabilities. The proposed system integrates advanced sensors, autonomous navigation, and real-time communication features to address the critical challenges of fire detection, safe operation in hazardous environments, and efficient fire suppression. By leveraging these capabilities, the system significantly reduces risks to human firefighters, improves response times, and protects lives and property. The inclusion of a manually controlled mechanism allows users to prioritize critical areas, ensuring rapid intervention where it is most needed. As Fire Combat System like this continue to evolve, they highlight the transformative potential of technology in mitigating the devastating effects of fires on communities and urban infrastructures.

REFERENCES

[1] Rangan M K, Rakesh S M, Sandeep G S P, C Sharmila Suttur. 2013. A Computer Vision based approach for Detection of Fire and Direction Control for Enhanced Operation of Fire Fighting Robot. IEEE. pp. 8-13.
[2] K. Altaf, A. Akbar, B. Ijaz. 2007. Design and Construction of an Autonomous Fire Fighting Robot. The IEEE International Conference on Information and Emerging Technologies, ICIET.
[3] B. Swetha Sampath. 2011. Automatic fire extinguisher robot. IEEE. pp. 215-218.
[4] Mukul Joshi, Rajashri Madri, Madhuri Joshi. 2013. Real Time Motion Tracking Algorithm for Search and Rescue Robots. IEEE. pp. 9-13.
[5] Kristi Kosasis, E.MerrySartika, M. Jimmy Hasugian, Dan Muliady. 2010. The Intellegent Fire Fighting Tank Robot. Electrical Engineering Journal. 1(1): 73- 80.
[6] Tawfiqur Rakib, M. A. Rashid Sarkar. 2016. Design and Fabrication of an Autonomous Fire Fighting Robot with Multisensor Fire Detection Using PID Controller. IEEE, 2016, pp. 909-914.
[7] Akib Islam, Navneet Kaur, Farogh Ahmad, P. Sathya. 2016. Intelligent Wireless Fire Extinguishing Robot. International Journal of Current Engineering and Technology. 6(1): 321-327.
[8] M. Vanitha, M. Selvalakshmi, R. Selvarasu. 2016. Monitoring and Controlling of Mobile Robot Via Internet Through Raspberry PI Board. IEEE. pp. 462- 466.
[9] Mohannad Ibrahim, Sharief Babiker, Ahmed Mohamed. 2015. Internet of Things based Smart Environmental Monitoring using the Raspberry-Pi Computer. IEEE. pp. 159-164.