International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Arduino Based Fire Fighting Robot

Deore Jagruti[1], Zalte Priyanka[2], Waghchaure Dhanashree[3], Shelke Pratiksha[4], Guide: Prof. Tathe S.G.

SND College of Engineering and Research Center, Yeola

Abstract

Fires pose a significant threat to life and property, demanding innovative and efficient solutions for mitigation. This project introduces an Arduino Uno-based Fire Fighting robot, a pioneering technological advancement in firefighting. The heart of this robot is the Arduino Uno microcontroller, which orchestrates its functions, integrating advanced hardware and software components. Equipped with an array of sensors and actuators, the robot can accurately detect fires, navigate challenging terrains, and access fire-affected areas swiftly. The intelligence of the robot stems from its programming capabilities, where the Arduino Uno processes sensor data, makes real-time decisions, and executes appropriate actions. It incorporates wireless communication modules for transmitting critical information to remote control stations, enhancing its adaptability in diverse fire scenarios. The compatibility of Arduino Uno with various programming languages and open-source libraries allows for the development of complex algorithms, contributing to the robot's versatility. This innovative Fire Fighting robot represents a groundbreaking fusion of robotics and firefighting technology, with the potential to revolutionize fire emergency responses. As technology continues to evolve, the application of Arduino-based solutions in critical sectors, such as firefighting, underscores remarkable strides towards enhancing human safety and disaster management.

Keywords: robot, firefighting, Arduino Uno

INTRODUCTION

An Arduino Uno-based Fire Fighting robot is a technologically advanced and innovative solution designed to combat and mitigate the destructive impact of fires in various environments. Fires pose significant threats to both life and property, and traditional firefighting methods often entail substantial risks. This robot integrates cutting-edge hardware and software components with the Arduino Uno microcontroller, a versatile and widely used platform for building interactive and programmable electronic systems. By leveraging the power of Arduino Uno, this fire-fighting robot offers an autonomous and efficient approach to detect, navigate, and extinguish fires, thereby enhancing overall firefighting capabilities. The heart of the Fire Fighting robot is the Arduino Uno microcontroller, which serves as the brain, orchestrating its functions. Equipped with an array of sensors such as temperature, smoke, and infrared detectors, the robot can accurately identify the presence and intensity of fires within its operational environment. Upon fire detection, the robot employs its motorized wheels or tracks for mobility, allowing it to navigate through challenging terrains and obstacles, ensuring timely response to fire incidents that might be hard to reach by human firefighters. The integration of Arduino-compatible actuators and servos further enhances its agility, enabling it to maneuver effectively and access fire-affected areas swiftly. The intelligence of the robot is derived from its programming, where the Arduino Uno processes sensor data, makes real-time decisions, and executes appropriate actions. Through the integration of wireless communication modules like Wi-Fi or Bluetooth, the robot can transmit critical information, such as fire location and status updates, to a remote

control station or a central monitoring system. Essence when it comes to fighting fires as even a few minutes delay can turn small fires into raging inferno. This robot is designed as a first response unit so it can suppress the fire keeps it under control till help arrives. This firefighting robotic system is controlled by an Arduino Uno development board. It is also equipped with the fire flame sensor for detecting fires. It is equipped with a water tank and a pump. So, on detecting fires it sprays water extinguishing the fire. Water spraying nozzle is mounted on servo motor to cover maximum area. Although there is a lot of scope for improvement, this could be a first step in developing a complete fire-fighting robot that could also rescue victims. The main function of this robot is to become an unmanned support vehicle, developed to search and extinguish fire. By using such robots, fire identification and rescue activities can be done with greater accuracy and securely without exposing the fire fighters to dangerous conditions.

LITURATURE SURVEY

Ligang Chen, ”Design and Manufacture of Indoor Intelligent Fire Fighting Robot,”[1] 2020 - This paper examines To meet the needs of fire prevention and rescue for families with high floors and no one at the time, a family firefighting robot with STM32F103ZET6 as the core was designed. The robot carried out firefighting operations. Robots are very powerful. The one-to-many communication mode is adopted to carry out real-time monitoring of each easy fire point. Data transmission is carried out through the industry-level NRF24L01 module. Remote control is carried out with the camera and the WIFI module connected to the Internet. The experimental results show that the control of the robot through the WIFI wireless module is stable, achieving the expected effect of extinguishing agent injection, reducing the workload of firefighters to a certain extent, effectively reducing household fire risk and reducing social losses. Monica P Suresh, ”An Arduino Uno Controlled Fire Fighting Robot for Fires in Enclosed Spaces,”

[2] 2022 ˆa A basic design of robot that can fight fires at an affordable cost could prove to be boon in fighting domestic fires, till help arrives. The robot developed consists of three elements which is the hardware, electronic interfacing circuits, and software program. The robot has four battery operated motor (BO motor). This firefighting robotic system is capable of detecting and extinguishing fire. These robots can be made to roll into places where it is not safe for humans to enter. Time is of In other words, robots can reduce the need to expose fire fighters to danger Xin Li; Qilin Shu, ”Research on Collaborative Fire Fighting Technology of Tunnel Fire Robot,”

[3] 2022 - Aiming at the complex fire environment in the tunnel, a track fire extinguishing robot with a suspended type in the tunnel is developed. Based on the leader-follower formation control framework and artificial potential field method to establish cooperative formation control model, through the state space of fire robot and fire task, in the form of ability vector to fire robot and task ability vector definition, set different threshold for the robot response ability to task difference, based on the size of the fire robot to fire point, proposed more mobile robot based on intelligent formation fire extinguishing strategy. Mat lab tool is used to establish an appropriate mathematical model simulation of fire extinguishing robot under tunnel environment. The simulation results show that the established mathematical model conforms to the actual situation and can provide an important theoretical basis for the actual firefighting work

AIM & OBJECTIVES

1. Fire Detection: - Implement a reliable fire detection system using sensors such as flame sensors, smoke detectors, or infrared sensors. - Ensure the system can distinguish between real fires and false alarms, minimizing the risk of false positives.

2. Robot Mobility: - Design a mobile platform for the robot using motors and wheels, allowing it to move freely in different directions. - Ensure the robot can navigate through various terrains commonly found in indoor environments.

3. Navigation and Obstacle Avoidance: - Implement obstacle avoidance mechanisms to prevent collisions with objects and ensure safe navigation. - Use sensors such as ultrasonic or infrared sensors to detect obstacles and adjust the robot's path accordingly.

4. Fire Extinguishing Mechanism: - Integrate a fire extinguishing mechanism such as a small water pump or a fire extinguisher that can be activated when a fire is detected. - Ensure the extinguishing system is effective in suppressing fires without causing harm to the robot or surroundings.

5. Autonomous Operation: - Develop algorithms for the robot to operate autonomously without human intervention. - Implement decision-making logic to prioritize tasks, such as locating and extinguishing fires while navigating obstacles.

6. Communication: - Include communication capabilities, such as Bluetooth or Wi-Fi, to enable remote monitoring and control of the robot. - Implement a user interface to receive feedback and status updates from the robot.

7. Energy Management: - Optimize the power consumption of the robot to maximize its operating time. - Implement a rechargeable battery system or a power management solution to ensure prolonged autonomy

MOTIVATION

The motivation behind the development of the Arduino Uno-based Fire Fighting robot is driven by the urgent need for more effective and safer firefighting methods in the face of escalating fire threats. Traditional firefighting techniques often entail significant risks to human lives, and in many cases, accessing remote or hazardous fire-affected areas is a formidable challenge. This project aims to harness cutting-edge technology to revolutionize emergency response efforts, offering a proactive and efficient solution to combat fires. By combining the versatility of the Arduino Uno microcontroller with advanced sensors, actuators, and wireless communication capabilities, this robot can accurately detect and respond to fires swiftly, thereby mitigating damage and improving overall safety. The project's ultimate goal is to reduce the risks faced by firefighters and enhance the speed and precision of fire interventions, underlining the remarkable potential of technology to safeguard lives and property in the face of catastrophic events

APPLICATION:

– Indoor Firefighting: The robot can navigate through indoor environments, such as homes, factories, and warehouses, to detect and suppress fires in areas that may be challenging for human firefighters to access.
– Wildfire Management: In remote or forested areas, the robot can be deployed to detect and combat wildfires, providing critical support to firefighting teams and helping to control the spread of fires.
– Hazardous Material Handling: The robot can be used to handle hazardous materials in environments

where human exposure can be dangerous. It can assess and mitigate risks without risking human lives

SYSTEM ARCHITECTURE

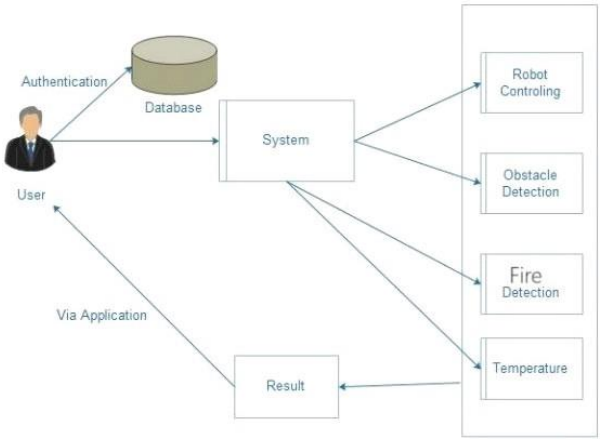


Fig -1: System Architecture Diagram

ADVANTAGES

– Enhancing Fire Detection and Early Warning Systems: The primary objective of the Fire Fighting robot is to improve the accuracy and speed of fire detection. By integrating advanced sensors like temperature and smoke detectors, the robot aims to identify fires in their early stages, enabling quicker responses and potentially preventing fires from escalating into larger, more dangerous situations.

– Autonomous Fire Suppression: The robot seeks to provide an autonomous solution for fire suppression. Through the integration of actuators, servos, and extinguishing mechanisms, the robot aims to effectively combat fires without requiring direct human intervention. This objective reduces the risk to firefighters and enhances overall firefighting efficiency.

– Navigating Challenging Environments: Another goal is to develop a robot capable of navigating through difficult and hazardous environments, such as confined spaces or areas with structural damage. By utilizing motorized wheels or tracks and advanced mobility algorithms, the robot can access locations that might be inaccessible or unsafe for human firefighters.

FUNCTIONAL & NON-FUNCTIONAL REQUIREMENTS

Functional Requirement:

1. Fire Detection: The robot should be equipped with sensors (e.g., temperature, smoke, and infrared detectors) to accurately identify the presence and intensity of fires within its operational environment.

2. Navigation and Mobility: The system should intelligently control the chlorine dosing process based on the actual water volume in the tank to ensure precise disinfection

3. Real-Time Data Processing:: The Arduino Uno microcontroller should process sensor data in real-time, enabling the robot to make quick and informed decisions based on fire conditions.

4. Remote Monitoring: It should provide remote access to real-time data and control functionalities, allowing operators to monitor and adjust the system remotely, enhancing operational efficiency.

Nonfunctional Requirements

Security:

1. All sensitive data stored in the various components of the system must be encrypted before they are stored. 2. The system must be able to use facility of qualified electronic signature of all documents uploaded in the system. 3. System must support appropriate security controls, including user roles with pre-defined access rights which control the data and functionality each user has access to

Auditability

1. For critical system events (e.g. tender bid submission, auction bid submission, etc.), System must support methods with which the sender of data can be provided with evidence of delivery. Such evidence will be implemented by means of e-Mail.

2. System must be able to audit all system and user actions. System should ensure that all actions performed on received/stored data are recorded, keeping track of actors, date/time, input/output data and any other information necessary to allow specialized personnel to monitor and fully reconstruct a transaction.

Extendibility:

1. System must be built in a modular approach that will allow the addition of new functional modules without impacting the overall system functionality. The need for this SW type of architecture is to allow the development of the system by different SW vendors, to avoid possible lock-downs or delays in system implementation and deployment cycle. 2. System must be based in an architecture that will allow the addition of extra HW resources to enhance the systems capabilities (e.g. performance, storage, bandwidth, etc.)

Portability:

1. System must be designed in a manner that will not be coupled to any hardware specific technologies. 2. System must be possible to be deployed on different HW and SW infrastructures and not dependant on the software technology used for implementation. However, it is preferable to be implemented in one of the major and proven technology

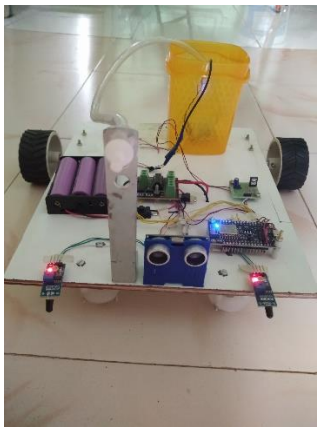
Performance:

System must follow state-of-the-art interoperability standards so that its integration or communication with external systems can be achieved. System should be developed following Service Oriented Architecture (SOA) and Open standard architecture. System needs to be developed in a way that will allow the creation and support of ˆaWeb Servicesˆa to exchange information between the system and external systems.

SYSTEM REQUIREMENTS

Software Used:
1. Operating System : Windows xp/7/8/10 2. Software Version : 3.1 3. Tools : Arduino IDE
Hardware Used:
1. Arduino Uno 2. Ultrasonic sensor 3. Connecting Wires 4. Servo Motor 5. Relay 6. Motor Driver 7. Bluetooth

RESULT





CONCLUSION

In conclusion, the development of an Arduino Uno-based Fire Fighting robot represents a transformative synergy of technology and emergency response, offering the potential to revolutionize fire management through advanced sensor integration, autonomous mobility, and real-time communication capabilities. By addressing the challenges of accurate fire detection, safe navigation in hazardous environments, and autonomous fire suppression, this innovation holds the promise of minimizing risks to human firefighters, enhancing overall response times, and safeguarding lives and property. As these robots continue to evolve and find their place in the realm of disaster management, they underscore the remarkable potential of technology to mitigate the devastating impact of fires on communities and urban landscapes.

REFERENCES

1. H. Pranamurti, A. Murti and C. Setianingsih, ”Fire Detection Use CCTV with Image Processing Based Raspberry Pi”, Journal of Physics: Conference Series, 2019.
2. O. Moses, ”FireNETdataset”, 2019, [online]
3. S. Kirubakaran, S.P. Rithanyaa, S.P. Thanavarsheni and E. Vigneshkumar, ”Arduino based firefighting Robot”, In Journal of Physics: Conference Series, vol. 1916, no. 1, pp. 012204, 2021.
4. M. Diwanji, S. Hisvankar and C. Khandelwal, ”Autonomous fire detecting and extinguishing robot”, In 2019 2nd International Conference on Intelligent Communication and Computational Techniques (ICCT), pp. 327-329, 2019.

5. I. Prasojo, P.T. Nguyen and N. Shahu, ”Design of Ultrasonic Sensor and Ultraviolet Sensor Implemented on a Fire Fighter Robot Using AT89S52”, Journal of Robotics and Control (JRC), vol. 1, no. 2, pp. 55-58, 2020.

6. C. Wu, F. Ge, G. Shang, M. Zhao, G. Wang, H. Guo, et al., ”Design and Development of Intelligent Fire-fighting Robot Based on STM32”, In Journal of Physics: Conference Series, vol. 1748, no. 6, pp. 062019, 2021.

7. M. Aliff, M.I. Yusof, N.S. Sani and A. Zainal, ”Development of fire fighting robot (QROB)”, Development, vol. 10, no. 1, 2019.

8. M. Kanwar and L. Agilandeeswari, ”IOT based fire fighting robot”, International Conference on Reliability Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO), pp. 718-723, 2018.