WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design and Development of Fire Fighting Robot

Anirudh Anant Kharche[1], Pardeshi Pratik Mahendrasing[2], Kulkarni Vishwambhar Kiran[3], Kolkar Shivam Arjunrao[4], Prof. S. S. Gadekar[5]

[1,2,3,4,5] **Department Electronics and Telecommunication Shreeyash College of Engineering and Technology, Chh. Sambhajinagar (MS), India**

ABSTRACT:

Fire accidents can cause significant damage to life and property if not detected and controlled in time. This project presents an automated fire detection and suppression system using a microcontroller. The system is designed to detect fire using a flame sensor and take immediate action by activating a water pump through a relay module. Additionally, it incorporates a motor and motor driver to enable movement, which can be useful for mobile fire suppression systems. The system also features Bluetooth communication (HC-05), allowing remote monitoring and control. A battery-powered supply unit ensures the system operates independently without reliance on external power sources. By integrating these components, the project aims to provide a cost-effective, automated, and efficient fire response solution that can be deployed in residential, industrial, and commercial environments.

Keyword: Arduino Uno, Motor drive, Bluetooth module, HC-05, Motors.

1. INTRODUCTION

Fire hazards remain a significant threat to urban environments, industrial facilities, and residential areas, often putting human lives and valuable property at risk. With the rapid advancement of robotics and embedded systems technology, innovative solutions have emerged that aim to enhance fire detection and suppression while minimizing human exposure to danger. One such innovation is the Bluetooth-based firefighting robot, designed to operate autonomously in complex and hazardous environments. This robot leverages a suite of modern sensor technologies to detect and respond to fires efficiently. Fire outbreaks pose a significant threat to life, property, and the environment. In many cases, fires spread rapidly due to delayed detection and response. Traditional fire suppression methods rely heavily on manual intervention, which may not be efficient in critical situations. The lack of an automated, real-time fire detection and suppression system increases the risk of severe damage and casualties. To address these challenges, this project aims to design and implement a microcontroller-based fire detection and suppression system. The system integrates various components to ensure a quick and efficient response. A flame sensor detects fire, and upon detection, a relay module activates a water pump to suppress the fire. Additionally, a motor and motor driver provide mobility, making it adaptable for mobile fire-fighting applications. A Bluetooth module (HC-05) enables wireless communication, allowing remote monitoring and control via a smartphone. The entire system is powered by a battery unit, ensuring independent and uninterrupted operation. This automated system can be deployed in various environments, including homes, offices, industries, and warehouses, to enhance fire safety and minimize damage. By integrating real-time detection and suppression, this project provides a cost-effective and efficient solution for fire emergencies.

Need of firefighting robot

Robotic firefighting systems are designed with certain tasks in mind. These include analyzing and locating fires, conducting search and rescue, monitoring hazardous variables and the primary task of fire control and suppression.

Objectives:

- The main objective of the project is to automatically or manually design and implement a fire fighter robot to extinguish fire. The robot is equipped with sensors that help us detect fire, smoke or any obstacles in its path.
- The robot will allow for firefighters to not only put out a fire remotely, but allow rescuers to scout a burning building before sending any firefighters inside. The implementation of this robot will increase the safety of firefighters and therefore help mitigate deaths from unsafe conditions.

2. LITERATURE SURVEY

The design and development of a firefighting robot using the Arduino microcontroller platform is covered in this research article. With the help of a water pump and nozzle set, the robot can manually walk around a space and put out flames. The robot's hardware and software components, such as the motor control system, sensors, and obstacle and fire detection algorithms (OpenCV), are presented in the paper. Additionally, the robot has a Bluetooth module system for wireless communication, which allows for remote control and activity monitoring. All things considered, this study shows that building sophisticated firefighting robots on Arduino-based platforms is both feasible and efficient. [1]

The design and development of a firefighting robot using the Arduino microcontroller platform is covered in this research article. With the help of a water pump and nozzle set, the robot can manually walk around a space and put out flames. The robot's hardware and software components, such as the motor control system, sensors, and obstacle and fire detection algorithms (OpenCV), are presented in the paper. Additionally, the robot has a Bluetooth module system for wireless communication, which allows for remote control and activity monitoring. Overall, this study demonstrates the feasibility and effectiveness of using Arduino-based platforms for the development of advanced firefighting robots. [1]

A fire event is a calamity that may result in fatalities, property damage, and long-term disability for the victim. Being a firefighter is a significant and dangerous job. To stop additional harm and devastation, the fire must be put out quickly and safely by a fireman. Detecting and putting out fires is a dangerous job that always puts a firefighter's life at jeopardy. Firefighter robots are among the most effective instruments for putting out fires early. Fire detection is crucial in the majority of industries to avoid significant losses. Engineers on hazardous industrial sites can be saved by robots equipped with these embedded technologies.It is desirable to design a robot that can detect fire and extinguish the fire as quickly as possible. [3]

As human development advances, fire safety has grown to be a major concern. For contemporary security systems, fire hazards can be harmful and lethal. These days, fires happen frequently, and firemen struggle to save lives. In order to assist firemen, this article determined that firefighting robots are essential. Finding fire occurrences and assisting firefighters are the primary objectives. With the aid of a temperature sensor, the robot will identify a fire and proceed to the precise location without colliding thanks to an ultrasonic sensor. The microcontroller and a camera sensor will receive feedback when it catches fire. In order to properly comprehend the scenario, it will deliver a real-time photograph. A few MATLAB and Arduino commands and codes are created in order to create the appropriate surveillance robot. Fuzzy logic is being used as input so that the robot may quickly take turns and move after detecting any obstacles. Simulations and real-world data were used to successfully operate the robotics system. This study helps firefighters combat fire accidents by providing improved safety measurements during fire events. [4]

These days, robots are employed in many different fields for a variety of purposes. They are used everywhere these days, from pick and place in large enterprises to house cleaning. Because they operate quickly, produce accurate results, and—above all—reduce human labor. Humans can make mistakes, but robots follow instructions and don't. Robots are mostly employed in large industries, hospitals, factories, the military, etc. They can also be employed to carry out challenging and risky tasks. One aspect of that is putting out fires; it's crucial to put out or contain large fires to a certain degree before the fire truck comes. This fire may occur in a house, workplace, school, college, etc. One of the biggest issues facing the globe now is putting out fires without endangering people. If the right parts and materials are chosen, robots can also be utilized for that purpose. However, the materials used to make these robots need to have some fire and heat resistance. This paper discusses a review of several materials and components. [5]

3. PROPOSED SYSTEM

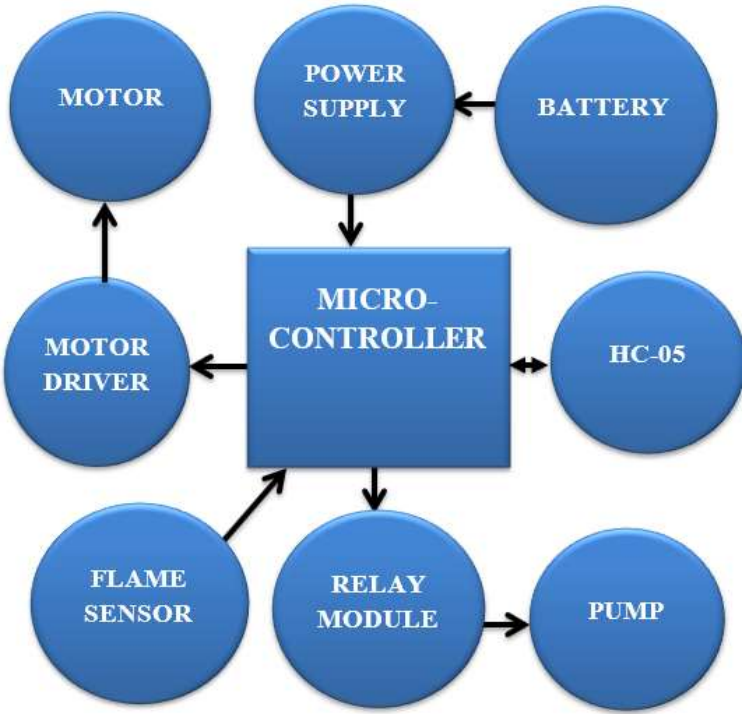

Fig.1: Block diagram

Robot uses microcontroller to drive three flame sensors, and transmit distance range to main controller of the firefighting robot through series interface. To drive the all the components 5v dc and 12 v dc are required. The output is given to the full wave rectifier. The rectifier eliminates the negative peek voltage of the input voltage. The output of the rectifier is the pulsating DC. The error pulses are eliminating by using capacitor filter. Then the output at the parallel of the capacitor is the 12v dc. But the Micro Controller is work on 5v dc. To convert the 12v dc into 5v dc a regulator (7805) is used. The output of the regulator is constant irrespective of the input voltage. The Micro Controller requires the preset logic circuit for protection of the internal program and internal clock in case of power failure. A sudden change in the power may cause data error resulting in the corruption of the internal program. The reset logic circuit contains one capacitor and a resistor. The driver circuit generally made by using one transistor and one relay. The driver circuit is mainly operated by the Micro Controller. The Micro controller changes the state of the output pin from the low to high, i.e. from O level to the1 level. The transistor will act as an ON/OFF switch corresponding to the input of the base. If the base current of the transistor is high the transistor is under ON condition else it is in OFF state. These conditions will be used to control the relay. The thermal sensors provide the senses the heat from within the room. First sensor will give the data to the micro controller if it finds the heat. The micro controller pin bit will go low when the fire is present. The micro controller will always scan the input signal of sensors. If the first sensor gives the data about fire to the micro controller, it then finds the movement to reach the fire by calculating the input data. The micro controller can give the output to two motors. One motor is used to move in forward direction to reach the destination point and the other is used to put off the fire. After end of fire the robot will go back to the original position.

Technical Specification

Arduino Uno MCU: IDE, which stands for Integrated Development Environment, is an official software introduced by Arduino.cc that is primarily used for authoring, compiling, and uploading code to the Arduino device. The Arduino Uno MCU is also known as the Arduino IDE. This software, which is open source and easily accessible, may be used with almost any Arduino module to begin compiling code while on the fly.

Fig.2: Arduino uno

Flame Sensor: It switches the relay's contacts from one position to another using an electromagnetic coil.

Fig.3: Flame sensor

Bluetooth: The robot and the remote control device would be able to interact thanks to a Bluetooth module. The robot would get directions from the device to switch on its camera, spray water, and move in a specific direction.

Fig.4: Bluethoot

Water Pump: An Arduino microcontroller is used in this kind of system to regulate the functioning of a water pump. The Arduino may be used to control the water's flow rate and direction, as well as to switch the pump on and off.

Fig.5: Water pump

Motor Driver L298N: A dual full-bridge motor driver module with high voltage and high current, the Motor Driver L298N is used to control stepper and DC motors. It has the ability to regulate two DC motors' rotational direction and speed.

Fig.6: Motor driver

4. RESULT & DISCUSSION

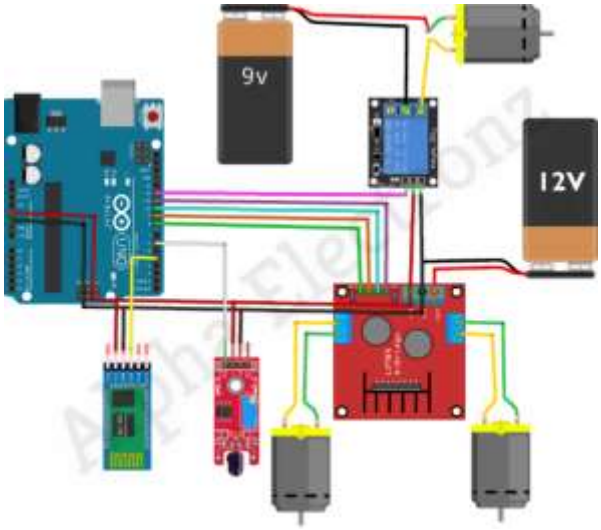

Fig.7: Circuit diagram

The firefighting robot circuit consists of an Arduino Uno microcontroller, an HC-05 Bluetooth module for wireless control, a flame sensor for fire detection, an L298N motor driver for movement control, a relay module, and a water pump or fan for fire extinguishing. The system is powered by a 12V battery for the Arduino and a 12V battery for the motor driver and relay. The Arduino processes sensor data and controls two DC motors via the L298N driver to navigate the robot. The flame sensor helps detect fire, allowing the robot to avoid collisions. When fire is detected, the Arduino activates the relay, which controls a motor-driven water pump to spray water and extinguish the fire. The Bluetooth module enables remote operation of the robot. After extinguishing the fire, the robot returns to its original position. This setup enables an autonomous and remotely controlled firefighting mechanism, making it useful for hazardous environments.

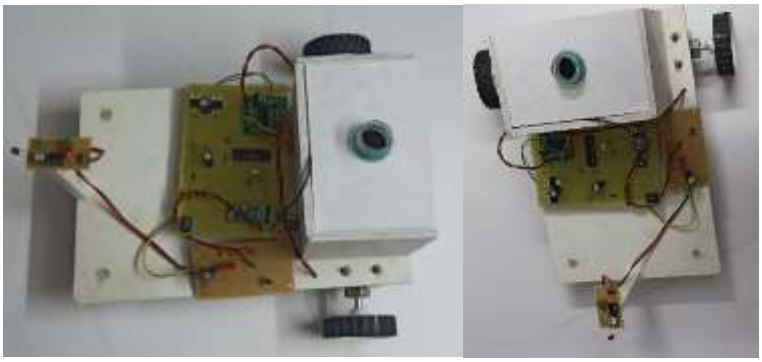

Fig.8: Final project

Fig.9: Bluetooth app

5. CONCLUSION

The Fire Fighting Robot is fabricated with locally available materials and some tests are done to observe its effectiveness at different situations. As the Fire Fighter Robot has to endure different situation, this effectiveness test will help us to make a better model. The Fire Fighting Robot is effective enough to fight against fire on a small scale. It can sense fire flame better at darker places. It is made as a preventer robot. Because it can detect fire instantly and can extinguish it before spreading. This multisensory based robot may be a solution to all fire hazards. With enough funding and scope, this design of robot can also fight against large fire with larger reserving capacity and an improved sensing unit can provide even an earlier detection of fire at all circumstances.

6. Advantages

- Prevention from dangerous incidents
- Minimization of –ecological consequences –financial loss –a threat to a human life.
- The robot is going to be used at places where it's dangerous for humans to enter.
- It can move automatically inside the area with none supervision.
- It has a provision of manual handling when robot misbehaves by using android application
- It can spread the water in all direction consistent with fire sense by sensor

7. Applications

- Industrial Fire Safety**:** Used in factories, chemical plants, and warehouses to detect and extinguish fires before they spread.
- Residential Fire Protection: Can be deployed in homes and commercial buildings to provide early fire suppression.
- Disaster Management: Useful in firefighting operations where human intervention is risky, such as in forest fires or gas leak explosions.
- Military and Defense: Can be used in military bases or hazardous zones to detect and control fires without risking human lives.
- Smart Cities and IoT Integration: Can be integrated into smart home and city networks for automated fire detection and response.

8. Future Scope

- AI and Machine Learning Integration: Future models can use AI to predict fire behavior and take proactive measures.

- Autonomous Navigation**:** Using advanced sensors like LiDAR and thermal cameras, the robot can navigate complex environments without manual control.
- Swarm Robotics: Multiple robots can work together to control large-scale fires efficiently.
- Enhanced Fire Extinguishing Mechanisms: Future designs can incorporate different fire suppression methods like foam, CO_2, or chemical retardants.
- 5G and IoT Connectivity: With high-speed communication, these robots can be remotely controlled in real time from anywhere.
- Drones for Aerial Firefighting: Aerial firefighting robots can be developed to detect and extinguish fires from above, especially in high-rise buildings.

REFERENCES

[1]. Control of an Autonomous Industrial Fire Fighting Mobile Robot by HP SINGH, Department of Mathematics, Sri Venkateswara College, University of Delhi

[2]. An Autonomous Firefighting Robot Real Time Man-Robot Control of a Group of Specialized Mobile Robots VassilSgurev, StanislavDrangajov, LyubkaDoukovska Institute of Information and Communication Technologies, 1113 Sofia

[3]. A System Architecture of Wireless Communication for FireFighting Robot by Korea Advanced Institute of Science and Technology (KAIST), 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea

[4]. Develop a Multiple Interface Based Fire Fighting Robot by 1Department of Electronic Engineering WuFeng Institute of Technology Ming-Hsiung

[5]. FIRE FIGHTING ROBOT Sahil S.Shah1 , Vaibhav K.Shah2 , Prithvish Mamtora3 and Mohit Hapani4 1,2,3,4D.J.Sanghvi College of Engineering, Vile Parle – West, Mumbai, India

[6]. Development of a Firefighting Robot for Educational Competitions by Taiser T. T. Barros and Walter Fetter Lages Electrical Engineering Department Federal University of Rio Grande do Sul Porto Alegre.

[7]. http://eprints.uthm.edu.my/5529/1/NOR_AYUNI_BINTI_ABD_M AJID.

[8]. Joga D. Setiawan, MochamadSubchan, and AgusBudiyono “Virtual Reality Simulation of Fire Fighting Robot. Dynamic and Motion.” ICIUS, October 24-26 2007.

[9]. Gerald Weed, Michael Schumacher, Shawn McVay, Jack Landes “Pokey the Fire-Fighting Robot. A Logical Design Using Digital and Analog Circuitry”, May 11 1999.

[10]. Chris Flesher, Devona Williams, Sean Benbrook, Somendra Sreedhar “Fire Protection Robot. Final Report” p. 1-78, 2004.

[11] Che-Bin Liu and Narendra Ahuja, “Vision BasedFire Detection,” International Conference on PatternRecognition, pp.134 – 137, 2004.

[12] I.Doshay, "Robotic fire protection system," U.S. PatentNo.6,364,026,April 2002.

[13] J. H. Hwang, S. Jun, S. H. Kim, D. Cha, K. Jeon and J. Lee, "Novelfire detection device for robotic firefighting,"ICCAS 2010, Gyeonggido,2010, pp. 96-100.

[14] K. L. Su, "Automatic Fire Detection System Using Adaptive FusionAlgorithm for Fire Fighting Robot," 2006 IEEE International Conference on Systems, Man and Cybernetics, Taipei, 2006, pp. 966-971.

[15] M. Hefeeda, and M. Bagheri, "Wireless sensor networks for earlydetection of forest fires." Mobile Adhoc and Sensor Systems, 2007.MASS 2007. IEEE International Conference on, pp. 1-6, October 2007.M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.