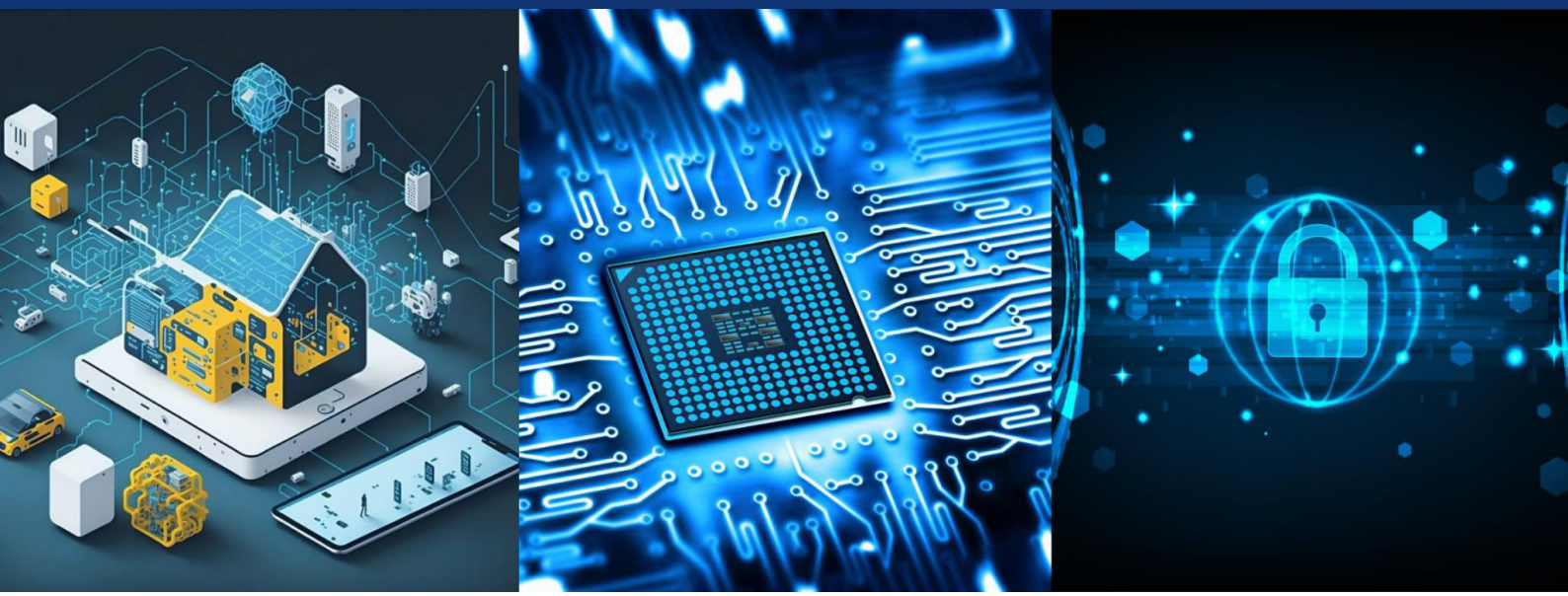
IJIRCCE

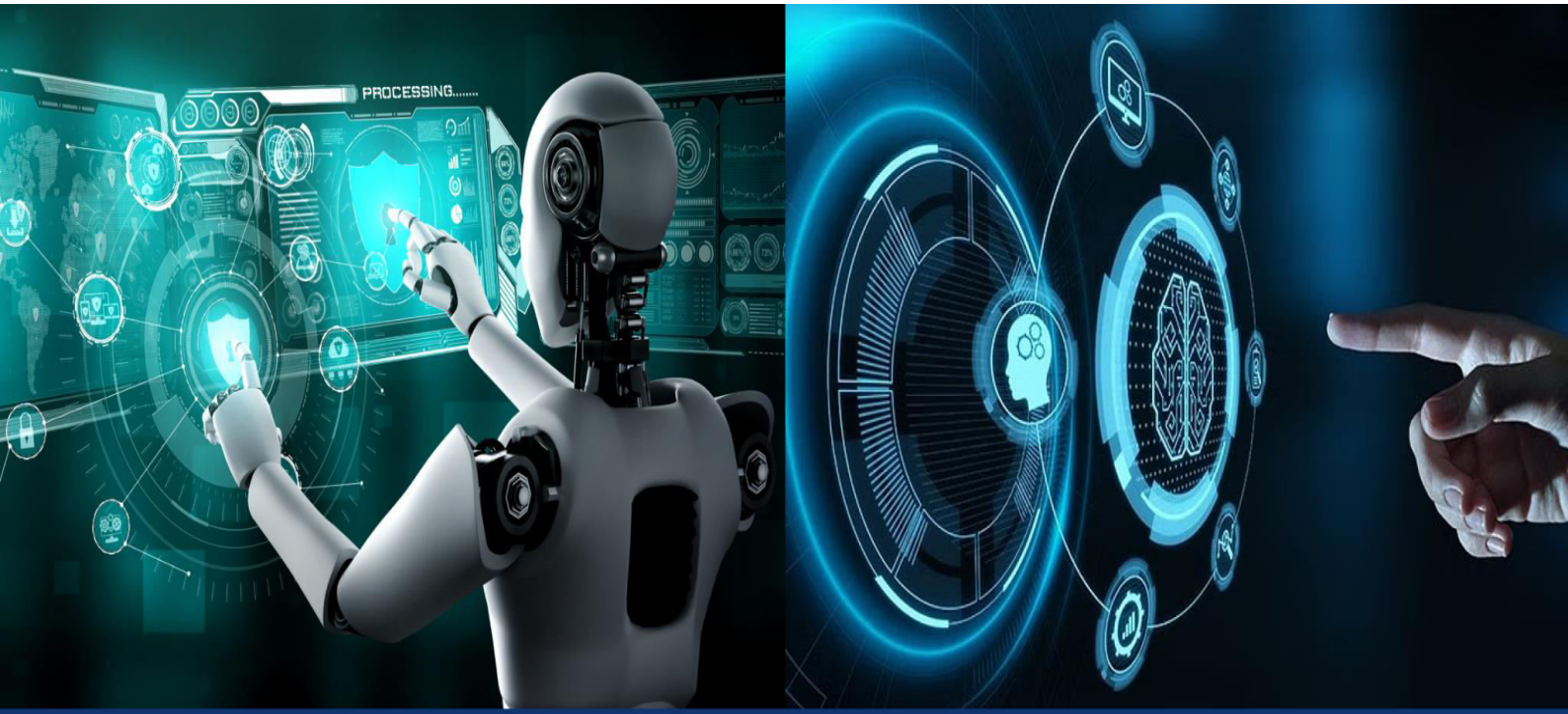
ISSN(O): 2320-9801

ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.771

Volume 13, Issue 4, April 2025

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI: 10.15680/IJIRCCE.2025.1304048

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Fire Extinguisher Robot Using Raspberry Pi

Ovhal Antara, Gopewad Anushree, Khanapurkar Shubhada, Prof. (Mrs.) A. P. Jadhav

UG Student, Department of E&TC, Sinhgad College of Engineering, SPPU, Pune, India

Assistant Professor, Department of E&TC, Sinhgad College of Engineering, SPPU, Pune, India

ABSTRACT: Fire incidents present serious risks, leading to casualties and extensive property damage, especially in industrial, commercial, and residential settings. Traditional firefighting methods depend heavily on human intervention, which can be dangerous and sometimes inefficient in high-risk scenarios. This project aims to develop a robotic fire extinguisher system that autonomously detects, locates, and responds to fires, thereby reducing risks to human firefighters and enhancing the effectiveness of fire control. This robotic system integrates OpenCV for image processing, enabling it to analyse the environment, identify fire hotspots, and navigate through obstacles. The project's goal is to create a robust, compact, and affordable firefighting solution that can operate in hazardous environments where human intervention is difficult or unsafe.

KEYWORDS: Fire Extinguisher, Extinguisher Robot, Image Processing, Raspberry Pi, Firefighting.

I. INTRODUCTION

This project proposes the development of a Fire Extinguisher Robot using Raspberry Pi. This robotic system is designed to autonomously detect, approach, and extinguish fires, thereby reducing the risks posed to human firefighters and enabling faster, more efficient fire response. Equipped with a Raspberry Pi 4 Model B, flame and infrared sensors, a camera module, and a servo-based extinguishing mechanism, this robot can identify flames, navigate obstacles, and spray fire-suppressing foam to control and extinguish fires. By utilizing Raspberry Pi, an affordable and versatile microcontroller, this project is designed not only to be cost-effective but also to be scalable for various applications. From personal use at home to broader applications in educational institutions and commercial environments, the system's versatility ensures that it can be adapted to meet a wide range of needs. The robot's autonomous features allow it to operate independently, making it ideal for deployment in high-risk areas. Through image processing and sensor integration, it can assess fire locations and respond quickly, making firefighting safer and more effective. This project aims to develop a reliable and versatile fire extinguisher robot that can be used in a variety of settings, providing an additional layer of fire protection and aiding firefighters in hazardous situations.

II. RELATED WORK

Kristi Kokasih developed a tank-like intelligent fire-fighting robot using materials such as acrylic, plastic, aluminum, and iron. This robot is equipped with two servo motors, two DC motors, and several sensors like ultrasonic, compass, flame detectors, thermal array sensors, and infrared detectors. It is designed to search through an area, detect flames in various positions and room configurations, and extinguish them even in the presence of obstacles or disturbances.

H.P. Singh created an autonomous industrial fire-fighting robot focused on flame detection and extinguishing. Their robot uses five infrared sensors—two for movement control and three for detecting flames. It includes a DC water pump and water container as its extinguishing system, which is controlled by a microcontroller. The robot converts analog signals from the infrared sensors into digital data, allowing it to identify fire and take action accordingly.

Swati Deshmukh developed a wireless fire-fighting robot that can be operated from a distance. It can move forward, backward, and turn left or right. The robot is equipped with highly sensitive sensors that can detect even small fires. It is especially useful in places like homes, factories, buildings, and laboratories, providing a safe way to manage fires without putting human lives in danger.

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI: 10.15680/IJIRCCE.2025.1304048

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

III. METHODOLOGY

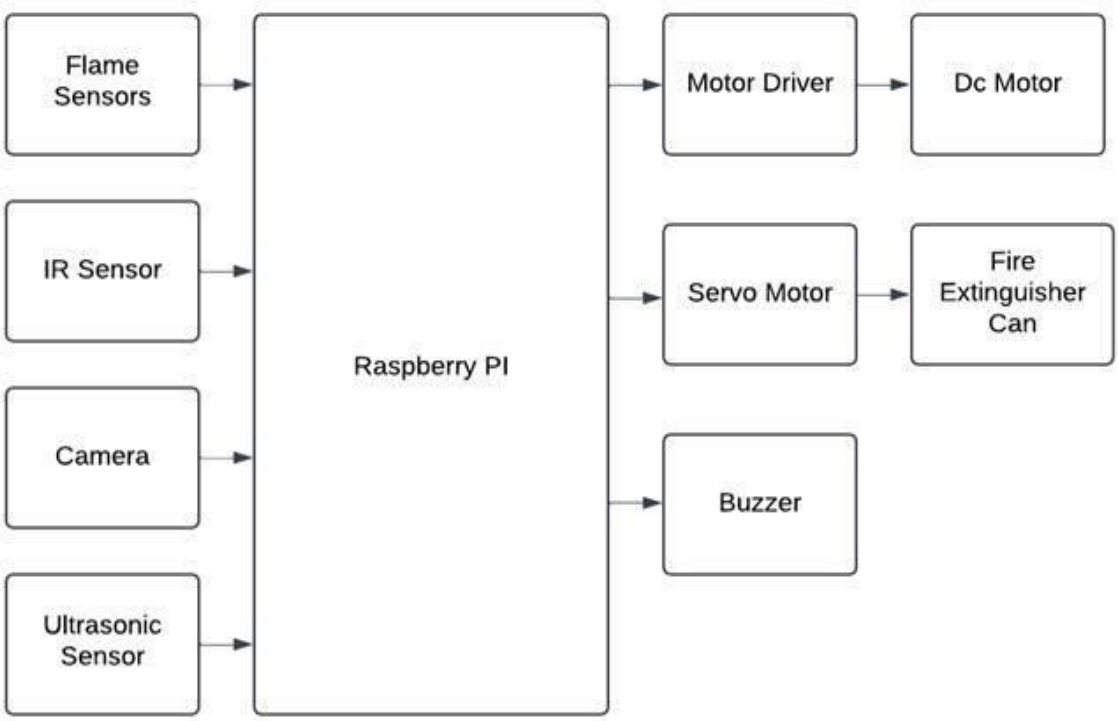


Fig. Block Diagram :- Fire Extinguishing Robot Using Raspberry Pi

a) **Input Sensors :**

- **Camera module :** Captures real-time video and images.
- **Flame sensor :** Detects infrared radiation emitted by flames.
- **IR sensor :** Detects the obstacle in the way.

b) **Processing Unit :**

- **Raspberry Pi:** Serves as the central controller, processing inputs and managing outputs.
- **Preprocessing:** Processes camera images (e.g., noise removal, resizing) for further analysis.

c) **Output Components :**

- **Servo motor and Fire extinguisher can:** If fire is found, the servo motor moves the nozzle to aim at the fire, and the pump sprays water or foam to put it out.
- **Buzzer :** Makes a sound to alert when certain actions or conditions are detected.

A. Workflow :

- The camera module takes images to look for fire.
- Ultrasonic sensors check if there are any obstacles in front of the robot.
- Flame sensor checks if the obstacle is actually a fire.
  - If it's not fire, the robot turns in another direction to avoid it.
  - If it is fire, the robot starts the firefighting system.
- Once activated, the servo motor moves the nozzle into position.
- The fire extinguisher system sprays water or foam to put out the fire.

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI: 10.15680/IJIRCCE.2025.1304048

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IV. PROPOSED ALGORITHM

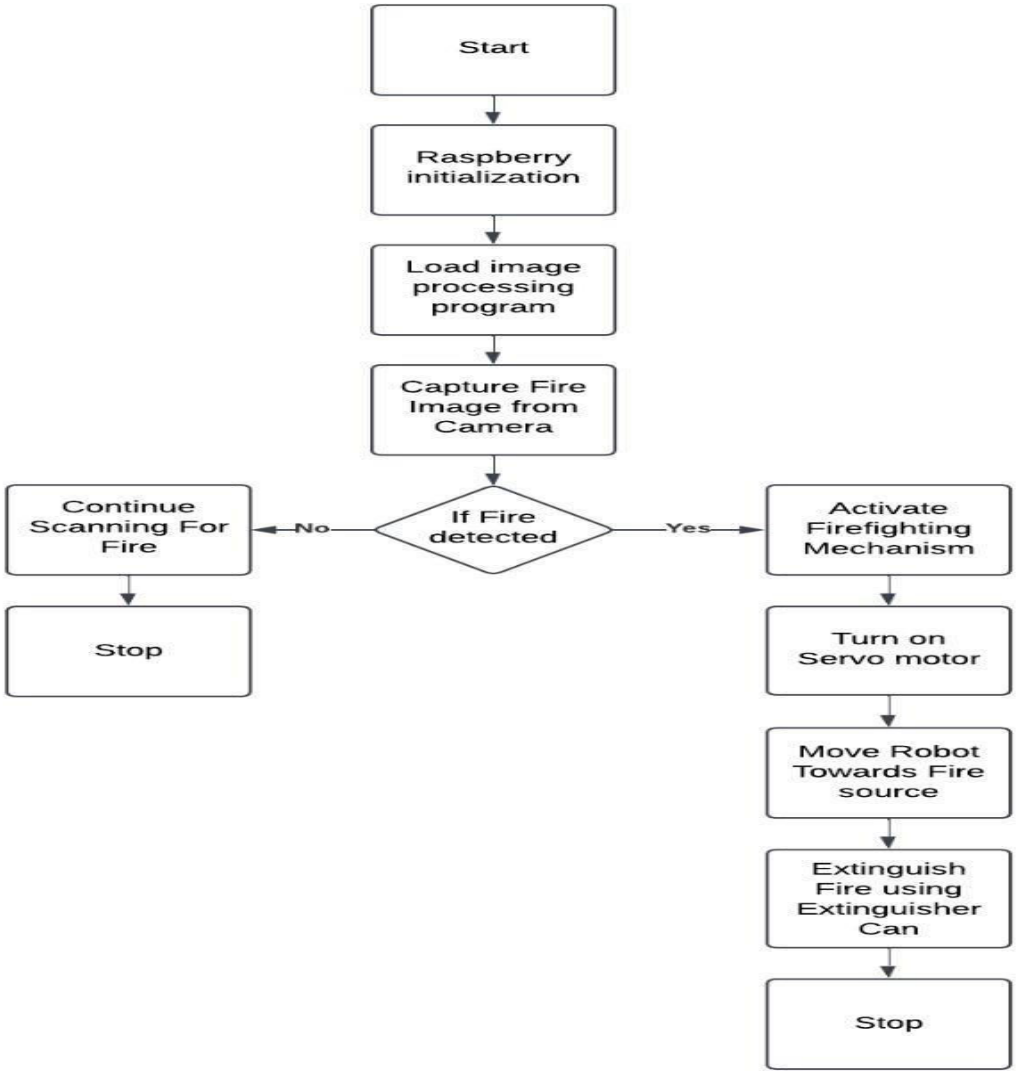


Fig. Flowchart :- Fire Detection

a) Fire Detection Algorithm: The flame sensor and camera module provide data that is pro- cessed using image processing algorithms. The OpenCV library is employed to analyse images for signs of fire, using colour and brightness thresholds to detect flame patterns. If fire is detected, the robot activates the motors to move toward the fire source.

b) Navigation and Obstacle Avoidance Algorithm: The IR sensors are used to measure the robot's surroundings and detect obstacles. The algorithm ensures the robot can navigate around obstacles and avoid collisions while moving toward the fire.

c) Fire Suppression Activation Algorithm: Once the robot reaches the fire, the servo motor is activated to position the nozzle, and the fire extinguisher can is triggered to release foam. This algorithm calculates the optimal time to deploy the suppression system and ensures the extinguishing agent is applied effectively.

d) Battery Management Algorithm: A power management system monitors the battery level, ensuring that essential components (like the Raspberry Pi and motors) remain operational. If the battery is low, the system can disable non-essential components to conserve power.

© 2025 IJIRCCE | Volume 13, Issue 4, April 2025| DOI: 10.15680/IJIRCCE.2025.1304048

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

V. SIMULATION RESULTS

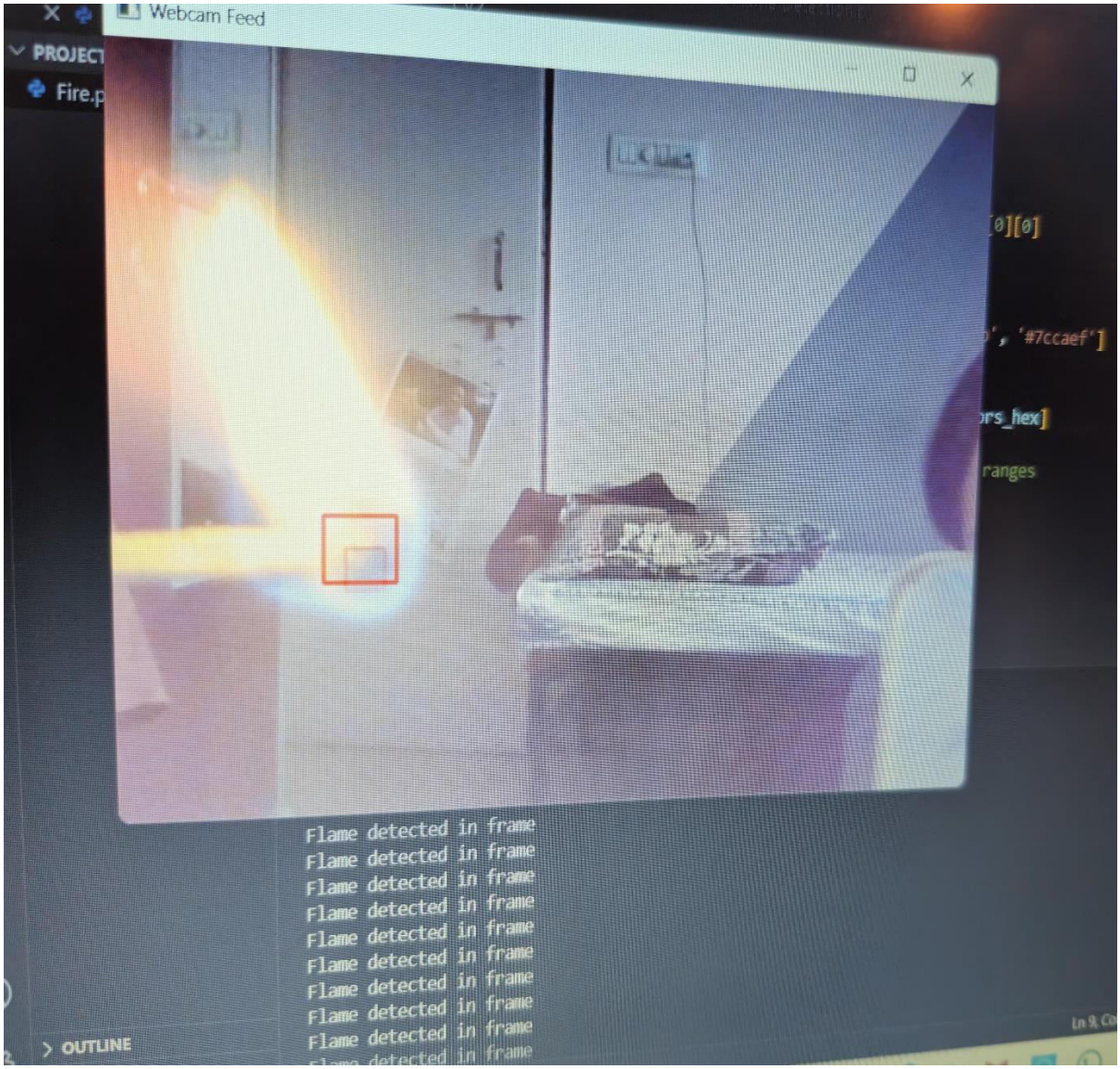


Fig. Simulation Result

- **Raspberry Pi:** Acts as the brain of the robot, running the necessary software to process sensor data and control the motors.
- **Flame Sensor:** Detects infrared radiation emitted by flames, providing fire detection capabilities.
- **Camera Module:** Captures real-time video and images, which are processed to identify fire and analyse its location.
- **IR Sensors:** Used for obstacle detection and navigation, these sensors help the robot avoid collisions while moving toward the fire source.
- **Motors and Motor Driver:** Enable movement and steering, with the motor driver con- trolling the DC motors based on commands from the Raspberry Pi.
- **Servo Motor and Water Pump:** Once a fire is detected, the servo motor adjusts the position of the fire extinguisher nozzle, and the water pump activates to dispense water or foam.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Once the hardware components are selected, they are physically connected, and communication protocols (such as GPIO pins and serial communication) are established to enable the Raspberry Pi to interact with the sensors and actuators.

VI. CONCLUSION AND FUTURE WORK

In conclusion, the Fire Extinguisher Robot using Raspberry Pi successfully demonstrates a functional solution for detecting, navigating, and extinguishing fires in various environments. The integration of sensors such as flame detectors, IR sensors, and a camera module with the Raspberry Pi enabled the robot to effectively detect fires, avoid obstacles, and activate the fire suppression system when required. The image processing algorithm proved to be efficient in flame detection, and the navigation system showed reasonable adaptability to dynamic environments. While the robot performed well in controlled test conditions, there are areas for improvement, particularly in terms of environmental adaptability, obstacle avoidance precision, and fire suppression efficiency. The ability to fine-tune the system based on real-world conditions will enhance the robot's overall performance. Further developments, such as incorporating more advanced sensors for navigation and refining the suppression system, are expected to improve the robot's effectiveness and make it a reliable tool for firefighting tasks in various industries and residential areas.

REFERENCES

[1] M. S. Khan, M. F. Anwar, and A. U. Rehman, "Fire Detection and Suppression System Using Raspberry Pi," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 8, no. 5, 2017.
[2] N. R. Subramanian, "Fire Fighting Robot Using Image Processing," International Journal of Advanced Research in Electrical, Electronics, and Instrumentation Engineering, vol. 6, no. 3, 2017.
[3] M. H. Alzahrani, and A. A. Alarifi, "Robotic Fire Detection and Suppression System: Design and Implementation," International Journal of Robotics and Automation (IJRA), vol. 34, no. 2, 2019.
[4] M. M. Hashim, and S. T. Salim, "Design and Development of Fire Fighting Robot Using Rasp- berry Pi," International Journal of Engineering and Technology, vol. 7, no. 4, 2018.
[5] M. T. Haroon, R. Javed, and M. H. S. Bukhari, "Obstacle Avoidance in Mobile Robots Using IR Sensors and Raspberry Pi," IEEE Access, vol. 6, 2018.
[6] R. Sharma, and R. K. Pandey, "Image Processing for Fire Detection: A Survey," International Journal of Computer Applications, vol. 62, no. 19, 2013.
[7] J. Kumar, and D. S. Kumar, "Development of Fire Extinguishing Robot Using Arduino and Raspberry Pi," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 5, no. 12, 2016.
[8] M. M. Akpan, S. B. Olaniyan, and T. B. Olanrewaju, "Design and Implementation of Fire Extinguisher Robot," International Journal of Robotics and Automation, vol. 7, no. 4, 2019.
[9] S. G. Tiwari, and R. S. Vishwakarma, "Fire Fighting Robot Using Arduino and Raspberry Pi," International Journal of Science and Research (IJSR), vol. 6, no. 4, 2017.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

doi crossref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details