FIREFIGHTER ROBOT WITH HUMAN DETECTION AND ALERT

Nandana R
dept. of computer science & engineering
Mahaguru Institute Of Technology
Alappuzha, Kerala.
email address:nandanar.nb@gmail.com

Greeshma Haridas
dept. of computer science & engineering
Mahaguru Institute Of Technology
Alappuzha,Kerala.

Anagha P
dept. of computer science & engineering
Mahaguru Institute Of Technology
Alappuzha,Kerala.

Aravind J
dept. of computer science & engineering
Mahaguru Institute Of Technology
Alappuzha,Kerala.

Suma S G
Asst Professor
dept. of computer science & engineering
Mahaguru Institute Of Technology
Alappuzha, Keralal.

Abstract*— In recent years, robotic technology has been increasingly used in hazardous environments such as firefighting. Firefighter robots with human detection and alert capabilities are an emerging application of robotics that have the potential to revolutionize firefighting and rescue operations. These robots use advanced computer science techniques, such as computer vision, machine learning, and sensor fusion, to detect the presence of humans in hazardous environments and alert firefighters to their location. The robots are accoutered with a range of sensors, such as cameras, thermal imaging sensors, and laser range finders, which provide real-time data to the robot's onboard computer system. Even in low-visibility conditions, we can identify and locate humans by processing data using sophisticated algorithms. When a human is detected, the robot can use audio and visual feedback to alert firefighters to their presence, allowing for faster and more efficient rescue operations. This paper explores the current state of firefighter robots with human detection and alert capabilities and the advanced computer science techniques used in their development. It also discusses the potential future applications and advancements in this field, including the integration of AI and robotics for more autonomous firefighting operations.

***Keywords*— Computer Vision, Face Recognition, Robotics**

I. INTRODUCTION

Firefighter robots with human detection and alert capabilities are a fascinating example of how computer science is advancing the field of robotics. These robots use a variety of sensors and algorithms to detect the presence of humans in hazardous environments. These sensors include cameras, thermal imaging sensors, and laser range finders which work together to detect human shapes, heat signatures, and distance. The data fromthese sensors are processed using advanced computer vision algorithms, such as face recognition, to identify and locate humans in the robot's environment. At one point a human is detected, and the robot can use audio and visual feedback to alert firefighters to their presence. This can help save precious time and ultimately save lives. This process requires programming, machine learning, and computer vision techniques, which are all key areas of computer science. Overall, these are exciting examples of how computer science is being applied to solve real-world problems and improve public safety.

II. PROBLEM STATEMENT

To Develop and Implement Fire Fighter Robots with Human Detection and Alert using Arduino Uno, MIT APP Inventor to detect fire and human presence thereby Providing the Alert message to the system. Alert Message to the system includes – Analysing and Locating the fires, Conducting Search and Alert, Monitoring the hazardous variables, and the Primary fire task is controlling and suppressing.

III. OBJECTIVES

Objectives of a firefighter robot with human detection and alert capabilities are primarily focused on enhancing the safety and efficiency of firefighting operations.

Here are some key objectives:

Objective 1 - To detect fire in the disaster-prone area – Sensor.

Objective 2 - Extinguishes fire on detection – Water Pumping Mechanisms.

Objective 3 - Human detection and alerting – Using Computer Vision and Mit Android App.

IV. EXISTING SYSTEM

TAF20 Firefighting Robot: The TAF20 firefighting robot, developed by Thermite Robotics, is equipped with sensors and cameras for human detection. It uses thermal imaging cameras and computer vision algorithms to identify human presence in smoke-filled environments. When a human is detected, the robot can send alerts to the firefighting team.

Smoke Bot: Smoke Bot, developed by a European consortium, is a robotic system designed for firefighting and search and rescue operations. It utilizes a combination of sensors, including thermal cameras and laser scanners, for human detection in smoke-filled environments. The robot can generate 3D maps and send alerts to firefighters when humans are located.

Prometheus: Prometheus is a firefighting robot developed by the Italian Institute of Technology. It utilizes a combination of sensors, including thermal cameras and gas sensors, to detect humans and fires. The robot can autonomously navigate through hazardous environments, locate humans, and send alerts to firefighters.

These are just a few examples of existing systems for firefighter robots with human detection and alert capabilities. These systems highlight the use of sensors, cameras, computer vision algorithms, and communication technologies to enable the detection of humans in firefighting scenarios and provide timely alerts to enhance the safety and effectiveness of firefighting operations.

V. LITERATURE REVIEW

In the study titled "Design and Implementation of Fire Fighting Robot with Human Detection System"[4], the authors developed a robot that can navigate through a fire-prone area and detect humans using a thermal imaging camera. The robot is equipped with an alarm system that can alert firefighters if a human is detected. [1]The study concludes that the robot is effective in detecting humans in a fire-prone area and can be useful in assisting firefighters.

One of the recent studies on this topic [2][3]. They proposed a firefighting robot that uses a combination of computer vision and machine learning algorithms to detect human presence in a burning building. The robot is equipped with a thermal camera, which is used to detect the presence of flames and smoke. Once the robot detects a human, it sends analert to the firefighter's control center, providing them with the location and status of the human.

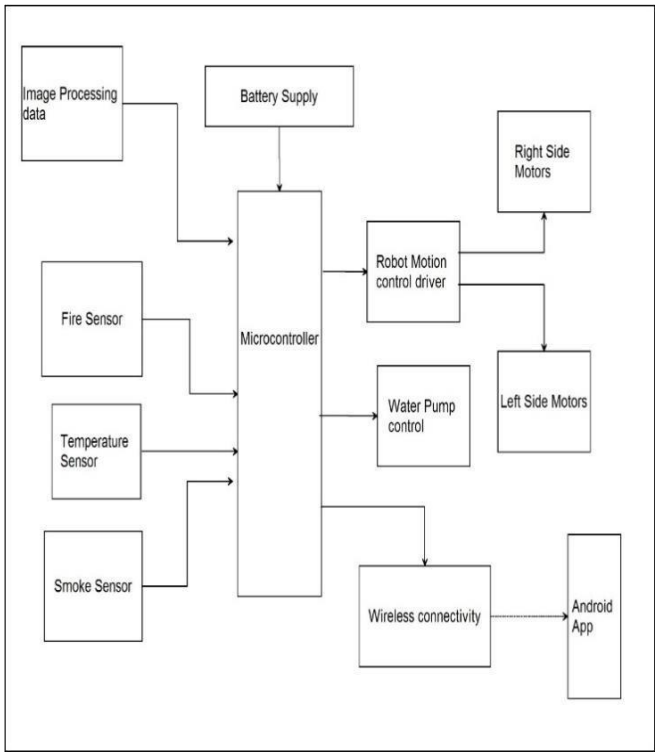
Another study by Park et al. (2021)[4][5] proposed a firefighting robot that can navigate complex environments and detect humans in real time. The robot is equipped with a 360-degree camera, LIDAR sensors, and a thermal camera, which are used to detect and track humans in real time. The robot also includes an emergency alert system that sends an alert to the firefighter's control center when it detects a human in danger.

Design and Development of a Firefighting Robot with Human Detection and Alert System Using Deep Learning Techniques in this study[6][7], While extinguishing the fire, firefighters find it difficult to reach the specified areas due to confined space.. In urban cities and industrial areas, there are firefighters ready in case of emergencies. This can lead to a shortage of manpower. Thus, the firefighting robot can act as support for firefighters and will also reduce the risk to their life.

Firefighting Robot with Human Detection and Alert System Using Machine Learning Algorithms In this study[8][9] they proposed firefighting robot has high accuracy in extinguishing fire belonging to class E type and as of now, it can only be used in the household to extinguish fires caused due to electric appliances.

VI. PROPOSED SYSTEM

- The main part of the system is atmega328 based microcontroller.
- Sensors are connected to the microcontroller.
- If a fire occurs, the sensors will detect it and at the same time, the microcontroller will trigger the relay module to turn on the water pump.
- Human detection is done through computer vision by using python face detection techniques.
- The system will monitor temperature, smoke, and human presence in a real-time and will provide proper alerts.



VII. TOOLS & METHODOLOGY

HARDWARE REQUIREMENTS

Operating System: Windows 11

System Type: 64 bit

Installed RAM: 8GB

GPU : Higher Web Cam

Hardware Used : Arduino, Fire Sensor, Flame Sensor, Smoke Sensor, Temperature Sensor, L298 Driver Module, DC Water Pump, BluetoothModule.

SOFTWARE REQUIREMENTS

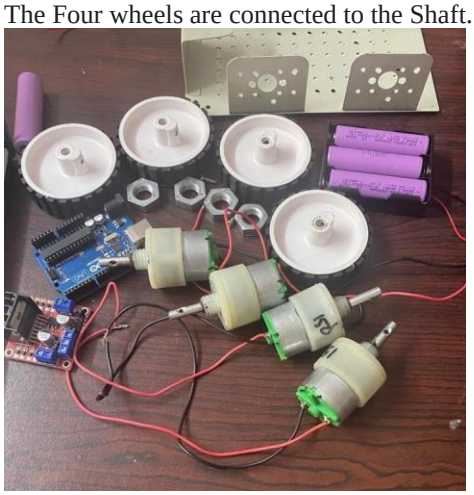
The software used in this project is Python. Python is an interpreted, high-level, general-purpose programming language that was created by Guido van Rossum and first released in 1991. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented ,and functional programming.

OPEN CV

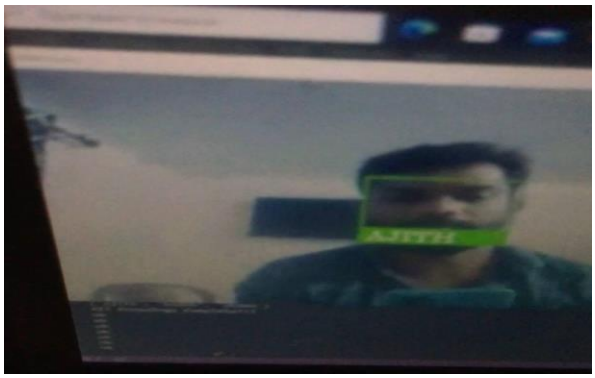
OpenCV is a library of programming functions mainly aimed at real-time computer vision. The library is cross-platform and free to use under the open-source BSD license. It was originally developed by Intel and later supported by Willow Garage.

VIII. PROPOSED METHODOLOGY

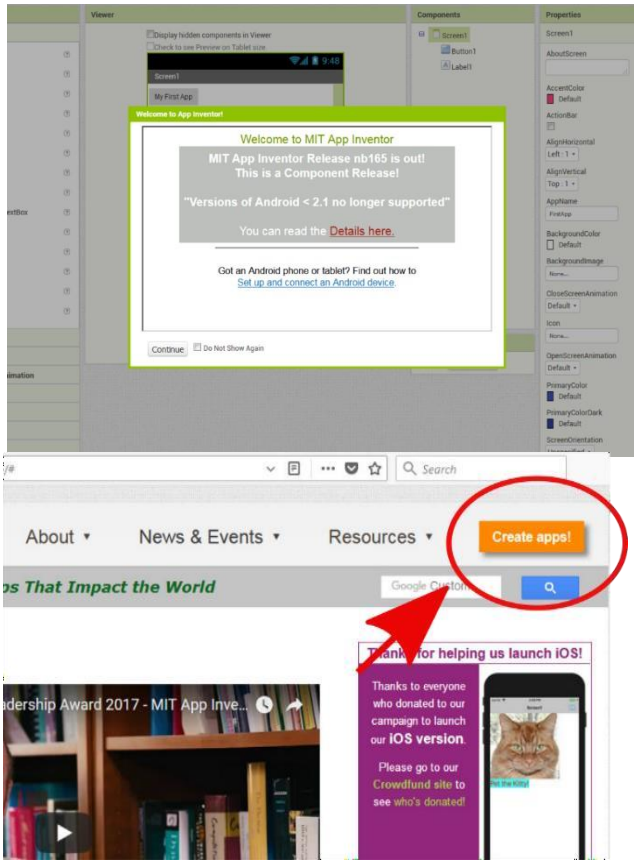
DC MOTOR : Here we are using four motors, each motor having two wires (red and black). The two red wires on the left side are twisted together to form one red wire wise the black wire on the left side is twisted. Similarly, we are doing the same thing on the right side. The Four wheels are connected to the Shaft.



FACE RECOGNITION AND ALERT : For face recognition a program to activate the camera is performed, already the photo and details of our members are saved in the folder. So once we activate the program if there is a human presence then it will display a green border with the name of that member. It will display an 'OK' message that is alerted in our system.

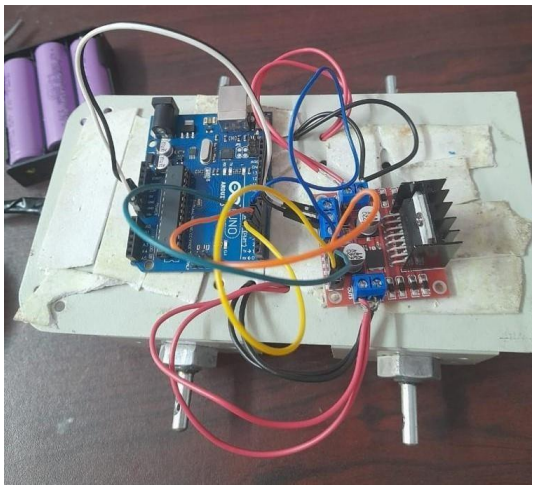


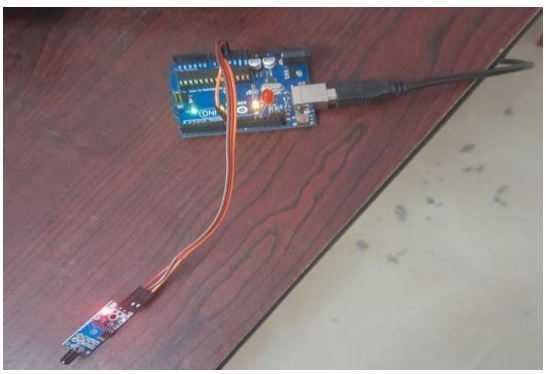
APP DEVELOPMENT : App Inventor is a cloud-based tool, by which you can build android applications using web browser. This website offers all the support you'll need to learn how to build your own apps.



By clicking on the orange "Create Apps!" button from any page on this website you can get the MITapp login page or you can go directly from *ai2.appinventor.mit.edu*. In the back end, we have four letters B, L, R, and F to indicate the backward, left, and forward movements.

L298 DRIVER AND ARDUINO MODULE : The joined positive (red) wire from the left side of the motor is connected to out1. The negative (black) from the left side of the motor is connected to out2. The positive wire from the right side of the motor is connected to out3. The positive wire from the right side of the motor is connected to out4. The four input pins of the 298 Driver module are connected to the 2nd,3rd,4th, and 5th pins in the Arduino respectively. It having 4 output pins named OUT1, OUT2, OUT3, OUT4 and 4 input pins named IN1,IN2,IN3,IN4.

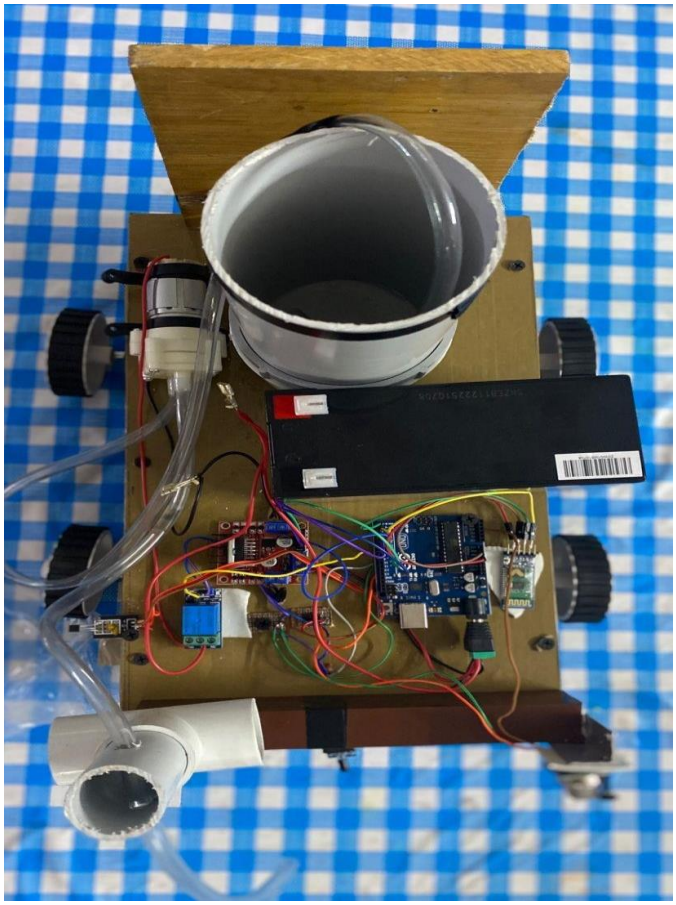




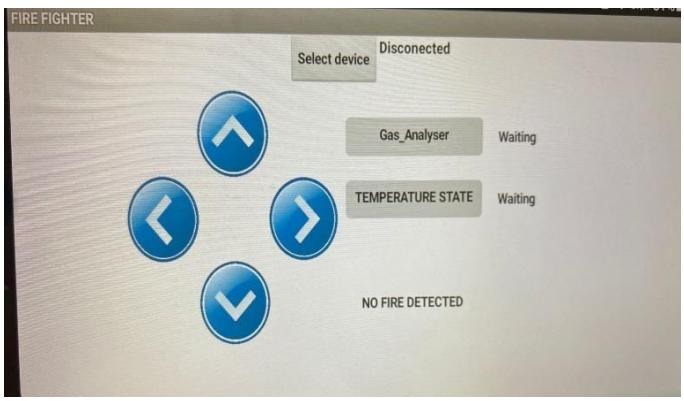
IX RESULT

ROBOT

The robot is equipped with all the components that are required for performing different functions such as Movement, obstacle and flamedetection, manual control, and fire extinguishing. The robot is turned on, we are required to connect with the Android app via Bluetooth module, then we can decide whether to control the robot manually or automatically



ANDROID APP



Android App is developed for selecting the mode of operation of the robot andcontrolling the robot manually. This app operates when the application is connected to the

Bluetooth module. When the app is opened there consists of four types of button modes forward, backward, left, and right. The control page is the most important page in the app. For controlling the robot we need to connect the Android app to the robot which canbe done by clicking the Bluetooth button. Afterconnecting with the robot, the user can select the mode of operation manual or automatic. When gas is formed, it indicates danger gas is detected. The water is pumped automatically for extinguishing the fire. In manual mode, the robot and the water pump can be controlled by the user.

X. FUTURE SCOPE

The Firefighter Robot With Human Detection And Alert will become increasingly autonomous and will be able to navigate dangerous environments, detect and analyze fires, and take action to extinguish them. The Future of this project indicates holding the camera module with the robot to efficiently detect obstacles, humans, and fire.

XI. CONCLUSION

We are trying the development of advanced firefighter robot with human detection and alert. The robot detects temperature, smoke, and flame at the site where the robot exists. This robot can move wirelessly using an Android application. The robot is helping the area where natural calamities and bomb explosions where occurred. If the fire is detected with the help of sensors, MCU operates the water pump mechanism through a relay circuit.One of the important added features of our work is the computer vision-based human detection andalerting function.

XII. ACKNOWLWDGEMENT

We would like to express our sincere gratitude to everyone who has assisted us in finishing this project. Due to a lack of knowledge and expertise, we encountered numerous difficulties while working on the project, but these individuals assisted us in overcoming all of these obstacles and in the successful realization of our plan to create a sculpture. We would like to express our gratitude to Asst. Prof. Mrs. Suma S G for her guidance and Asst.prof Mrs. Namitha T N for coordinating our

project which enabled our entire team to understand the minute details of the project work.

We would like to express our appreciation to our HOD Mrs. Suma S G for her ongoing assistance and supervision during the project work.Last but not least, we would like to express our gratitude to the administration of Mahaguru Institute of Technology for giving us this learning opportunity.

XIII. REFERENCES

[1] "Design and Development of a Firefighting Robot with Human Detection and Alert System Using Deep Learning Techniques" by B. M. N. Uddin and M. M. Rahman, Proceedings of the 2022 6th International Conference on Robotics and Automation Engineering (ICRAE), pp. 213-218, 2022.

[2] "Firefighting Robot with Human Detection and Alert System Using Machine Learning and SensorNetworks" by S. S. Shalabi and A. H. Alharbi, Proceedings of the 2022 6th International Conference on Control, Robotics and Cybernetics(CRC), pp. 148-153, 2022.

[3] "Development of a Firefighting Robot with Human Detection and Alert System Using Machine Learning Algorithms and a Raspberry Pi" by F. A. Alqahtani and A. H. Alsaedi, Proceedings of the 2022 International Conference on Intelligent Systemsand Computer Vision (ISCV), pp. 26-31, 2022.

[4] "Design and Implementation of a Firefighting Robot with Human Detection and Alert System" by O. A. Awodele and O. A. Olaniyi, IEEE Access, vol. 9, pp. 6673-6682, 2021.

[5] "Firefighting Robot with Human Detection and Alert System Using Deep Learning" by A. M. Alsalman and A. M. Al-Salman, Proceedings of the 2021 8th International Conference on Control, Decision and Information Technologies (CoDIT),pp. 185-190, 2021.

[6] "Design and Development of a Firefighting Robot with Human Detection and Alert System Using Raspberry Pi" by M. A. Kamruzzaman and M. M. Hossain, Proceedings of the 2021 11th International Conference on Computer and Automation Engineering (ICCAE), pp. 347-352,2021.

[7] "A Firefighting Robot System with Human Detection and Alert Functionality." by N. N. N. Myint, H. M. Tun, and W. W. Lwin, International Journal of Advanced Computer Science and Applications, vol. 11, no. 2, pp.

123-130, 2020.

[8] Abad UB, Asif M, Ahmad MB, Mahmood T, Hashmi A, Cheema MA (2019) Towards Reducing the Damage of Fire through Firefighting AutonomousRobot. Tech J 24(02).

[9] Development of firefighting robot with human detection and alert system." by M. R. Shaikh and S. M. Lakkadwala, International Journal of Innovative Research in Science, Engineering and Technology, vol. 8, no. 4, pp. 19535-19540, 2019.