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DESIGN AND IMPLEMENTATION OF SMART ROBOT FOR REAL TIME ASSISTANCE IN DISASTER MANAGEMENT

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ABSTRACT
Design and implementation of smart robots for real support in disaster management. It is a wireless and mobile robot system for rescue processes in dangerous environments. Integrates Arduino UNO, L298 Motor Driver, HC-05 Bluetooth Module, 100 U/MIN-BO Engine, ESP 32 Camera Module and audio system for interactive answers. The robot is controlled via a Bluetooth-enabled mobile device remote, allowing for efficient navigation. Performance analysis assesses exercise efficiency, performance management, and response time. The robot is powered by an 18650 battery, ensuring extended operation.This project finds applications in disaster management, military operations and dangerous space inspections. Future improvements include autonomous navigation and AI-based decision-making decision making to improve emergency functions

Keywords:
Arduino Uno, Bluetooth Control, Chatbot, Disaster Management, Motor Driver, Power Efficiency, Remote Navigation, Wireless Communication.

I. INTRODUCTION
In short, this chapter present the design and implementation of smart robots for realtime support in disaster management. This is a robotic system to improve the safety and efficiency of dangerous rescue processes. We highlight the limitations of traditional methods (e.g., risk of human rescuers, slow response times), and propose an automated solution that integrates Arduino, sensors, real-time video streaming, and chatbot communications or external assistance, which may lead to delays in controlling the fire.

1.1 Introduction
Today's world is facing an increasing frequency of natural disasters, industrial accidents and emergencies that require a rapid response. In these critical situations, time is essentially, and the need for efficient rescue operations is greater than ever. Traditional rescue methods often put human lives at risk when rescuers must enter dangerous environments such as collapsed buildings, internal combustion structures, or areas filled with toxic gases. To address these challenges, there is growing interest in using robotics to support rescue operations. Through integration of technologies such as Arduino microcontrollers, Bluetooth communication, sensors (ultrasound, smoke, temperature), and chatbot interfaces, robots can investigate, recognize dangers and communicate with rescue teams. This chapter provides an overview of the motivations behind a project, the problems that you want to solve, the proposed solution, the project's goals, and the methodology used in its development. Through integration of technologies such as Arduino microcontrollers, Bluetooth communication, sensors (ultrasound, smoke, temperature), and camera modules, robots can explore autonomously or far away,

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explore dangerous areas, recognize dangerous areas, and pass important visual data. This allows human rescuers to assess the situation from afar, reduce risk and improve the efficiency of emergency response scenarios before taking directmeasures.

II. ARCHITECTURE AND BLOCK DIAGRAM

The design and implementation of smart robots for realtime support in disaster management is designed for remote control processes via mobile devices with Bluetooth, and includes an ESP32 CAM module for realtime video streaming at the same time. The system consists of interconnected components that work together to enable navigation, monitoring, and remote monitoring during the rescue process. The chatbot communicates with a mobile phone (Bluetooth Control) that acts as the robot's main controller. Mobile devices send movement instructions to the Bluetooth module and receive live video feeds from the ESP32 CAM module over WiFi to monitor the environment in real time and in real time.

When a mobile device sends a move command, the Bluetooth module sends to the Arduino. The Arduino processes the instructions and the necessary signals are transferred to the motor driver for control of movement. Engine drivers typically receive these signals on the L298N or L293D, and control the speed and direction of the DC engine, allowing the robot to navigate in several directions. In contrast to the Bluetooth based motion control system, the ESP32 CAM module uses WiFi for video transmission, ensuring a stable connection for realtime monitoring. This allows operators to visualize the robot's surroundings from afar, making it extremely useful for rescue processes where manual intervention is difficult.

2.1 Block Diagram

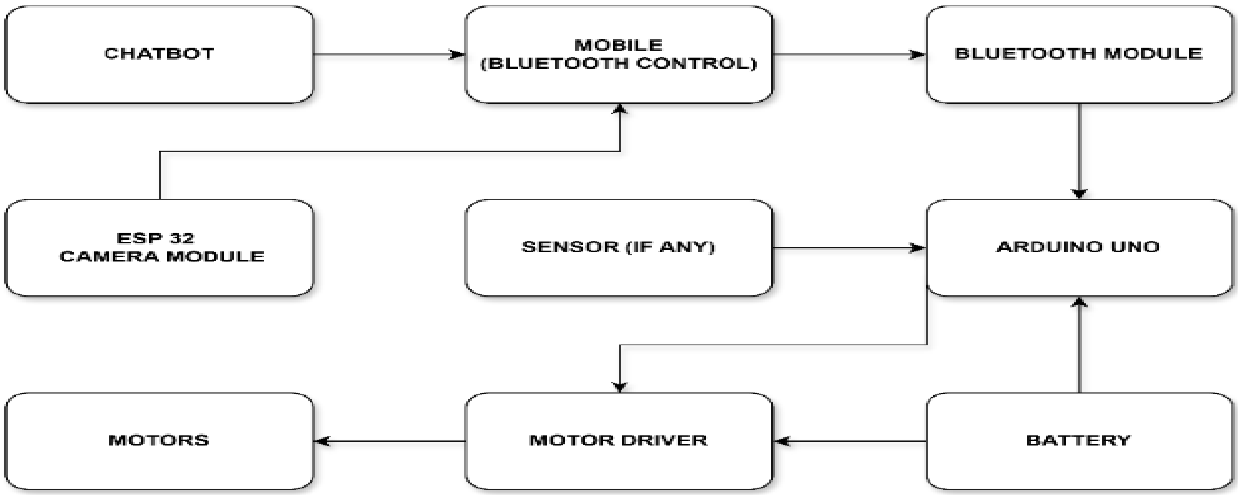

Fig 2.1.1 Block Diagram of Design and
Implementation of Smart Robot for Real Time Assistance in Disaster Management

The Arduino UNO acts as a central processing unit and coordinates the operation of the engine, sensors and other connected components. It receives power from the battery, which serves as the main power source throughout the system. The Arduino processes incoming commands from the Bluetooth module, sends control signals to the motor driver, and adjusts engine movement. B. Once sensors such as obstacle recognition and environmental sensors are integrated into the system, send data in real time to Arduino for decision-making.

Overall, the design and implementation of smart robots for reatime support in disaster management is a robust system that combines wireless control and realtime surveillance, making it an efficient device for the search and rescue process. The integration of the ESP32 CAM module improves functionality by providing live video streams and allowing users to navigate the robot with greater accuracy and remoteness. System performance is efficiently managed by a rechargeable battery, ensuring longer

operation in realworld applications. With the ability to control via a mobile app or chatbot, the design and implementation of smart robots for real support in disaster management is an innovative solution for remote exploration and rescue missions.nMovement control supplement, the integration of the ESP32 CAM module improves situational awareness. This module is a WiFi enabled camera that streams live video directly to your mobile device. In contrast to control signals sent over Bluetooth, the video feed is transmitted over WiFi, providing robust, high quality electricity that is very important for remote monitoring. The inclusion of ESP32 CAM allows operators to monitor the robot's environment in real time. This is extremely important for the rescue process where visual feedback can determine the success of the mission. This live video flow helps operators navigate in complex environments, identify obstacles and find people who may need rescue.
The power supply in the system is handled by a central battery that supplies all components including the Arduino, engine drivers and ESP32 CAM. The battery should be able to provide stable and sufficient performance to ensure uninterrupted operation, especially in scenarios where the robot can be used for longer periods of time. The design emphasizes efficiency and ensures that each component receives the right voltage and electricity without unnecessary power loss. A focus on performance management is extremely important in rescue situations. In this situation, reliability means the difference between success and failure.
The overall design of smart robot design and implementation for practical support in disaster management shows a mix of advanced control systems and robust communication networks. Each component from the chatbot and mobile control system to the Arduino and ESP32 CAM is selected and configured to maximize performance under actual conditions. The modularity of the system also allows for the integration of additional sensors, such as: B. Environmental sensors for gas recognition or heat cameras for fire detection. These sensors provide an additional layer of security and functionality, allowing the robot to perform several tasks simultaneously, including navigation, avoidance failures, and environmental monitoring. Chatbot and mobile (Bluetooth control) ensure that user commands are effectively transferred to the system, and the Bluetooth module and Arduino UNO work together to control the movement of the robot by the motor driver and DC engine. The addition of the ESP32 CAM module further improves the system by providing realtime video streaming for WiFi, which is essential for remote monitoring in rescue scenarios. The battery's robust power supply and the possibility of sensor integration make this design a reliable function in challenging and unpredictable environments.

2.2 Description

Microcontroller

Here we use the Arduino UNO Microcontroller. The board is equipped with digital and analog input/output needles (E/O) statements that may be connected to different expansion boards and other circuits. The board has 14 digital E/A pencils (6 PWM output powers) and 6 analog E/A pencils, which are programmable with an ArduinoIde (integrated development environment). Can be operated with a USB cable or an external 9volt battery. The Arduino board design uses a variety of microprocessors and controllers. The board is equipped with digital and analog input/output needles (L/O) statements. The board has a serial communications interface that includes a universal serial bus (USB) for some models that are also used to load programs on HR computers. Microcontrollers are usually programmed in the dialects of functionality in the programming languages C and C++. The controller board functions as the brain of a robot. This system uses an Atmega 328p controller board. Arduino is a prototype platform (open source) based on userfriendly hardware and software. In this system, all sensors, relays and LCDs act as brains in the Arduino. It's easy to use and doesn't have to be complicated to program. The Arduino is equipped in a complete package form, including a 5V controller, burner, oscillator, microcontroller, serial communication interface, LEDs and headers for connections.

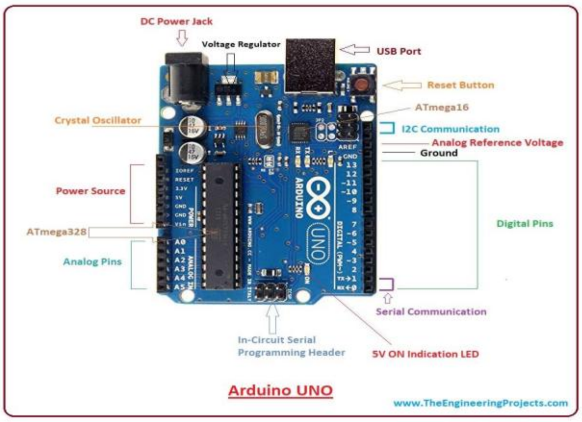

Fig.2.2.1 Arduino Uno

Features of the Arduino UNO:
1) Microcontroller: ATmega328
2) Operating Voltage: 5V
3) Input Voltage (recommended): 7-12V
4) Input Voltage (limits): 6-20V
5) Digital I/O Pins: 14 (of which 6 provide PWM output)
6) Analog Input Pins: 6
7) DC Current per I/O Pin: 40 mA
8) DC Current for 3.3V Pin: 50 mA
9) Flash Memory: 32 KB of which 0.5 KB used by bootloader
10) SRAM: 2 KB (ATmega328)
11) EEPROM: 1 KB (ATmega328)
12) Clock Speed: 16 MHz

Bluetooth Module

Fig 2.2.2: Bluetooth Module

Bluetooth is a wireless technology standard for exchange of data from festivals and mobile devices (PANS) construction (using UHF radio waves with short wavelengths of 2.4-2.485 GHz ISM bands) (Harada, Brother Industries Ltd., 2016). The Bluetooth module allows you to send and receive signals. Receive text from your Android phone and forward it to the Arduino UNO serial port. The Bluetooth module used here is the 05 module of HC. This is a simple Bluetooth module (serial port protocol) designed for transparent serial connection systems. The Serial Sports Bluetooth Module uses fully qualified Bluetooth V2.0+EDR (Extended Data Rate) 3Mbit/smodulation Full FIF2.4GHz radio and baseband. CSR Blue Core 04 external single chip - Bluetooth system uses CMOS technology and AFH (Adaptive Frequency Hopping Function). Slave Disability Baud rate is 9600. It is automatically connected to the last device for power supply. The connections are point-to-point or multi-point, with a maximum range of 10 meters. In this study, data transmission speeds are 1MBPS.Bluetooth module HC05. Establish a connection between the microcontroller and the Android device.

ESP 32 Camera Module

Fig 2.2.3: ESP 32 Camera Module

The ESP32 CAM is an inexpensive and compact camera module with integrated WLAN and Bluetooth connectivity, making it ideal for real-time image transmission during the rescue process. It has an OV2640 camera sensor that can capture high

resolution images and video streaming videos, allowing remote monitoring of dangerous areas. With the ability to process images locally and transfer data wirelessly, ESP32 CAM improves situational awareness for rescue teams and reduces the need for direct human intervention in dangerous environments. Furthermore, low power consumption and MicroSD card support are suitable for battery-operated rescue robots that require continuous monitoring and data storage. By integrating ESP32 CAM into smart robot design and implementation for

realtime support in disaster management, it enables victims, environmental assessments, and fault detection, ultimately improving the effectiveness and effectiveness of search and rescue missions

L298N Motor Driver Module

Fig 2.2.3: L298N Motor Driver Module

The L298N engine driver module consists of a 5-V jumper with L298 engine driver-C, 78M05 - voltage regulator, resistors, capacitors, performance LEDs and integrated circuits. The voltage controller is only active when the jumper is placed. If the power supply is low or equal to 12 V, the internal circuitry can be equipped with a voltage controller and the microcontroller can be run using a 5V pen as the initial pen. If the power supply exceeds 12V and 5V above 5V exceeds 5V clamp, do not place jumpers if internal circuitry needs to be performed.

100RPM DC Motor

Fig 2.2.4: 100RPM DC Motor

This is a BO Series 1 100 rpm DC engine for plastic engines. The BO series straight motors offer superior torque and speed with lower operating stress. This is the biggest advantage of these engines. Small waves with the right bike provide the perfect design for your application or robot. The holes and lightweight body assembly allow for placement in creation. This engine can be used with 69 mm diameter wheels for plastic gear-in-wheel engines and 87 mm diameter multipurpose wheels for plastic tooth wheels. This replaces the Metal Gear DC engine. It is supplied with an operating voltage of 3-12 V, making it ideal for building small and medium-sized robots. Available at 60 rpm and 150 rpm.

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The engine is perfect for DIY enthusiasts. This engine set is cheap, small, easy to install, and is perfect for use in mobile robot cars. These are commonly used on 2WD platforms.

PAM8403

Fig 2.2.5: PAM8403

The PAM8403 is a very efficient stereo audio amplifier module with low performance, based on the PAM8403-IC. It operates a 5-V power supply and is perfect for DIY-Audio projects, Bluetooth speakers, and small speakers with embedded sound systems (4î© or 8î©). The PAM8403 is a compact 3W Class D-Stereo audio amplifier developed for low performance applications and operates from a 2.5 V supply. It is usually 5V. It provides high efficiency (>90%), low distortion (THD <0.1%) and pop noise reduction. Excessive circuitry and short circuit protection ensures reliable performance in embedded systems. When designing and implementing smart robots for real support in disaster management, it can be used for rescue motivation, audio feedback, and survivor interactions. This means that emergency services can help communicate important information remotely. Its low power consumption, transparent audio output and compact size make it a critical component for rescue robots that function in dangerous environment.

car chassis

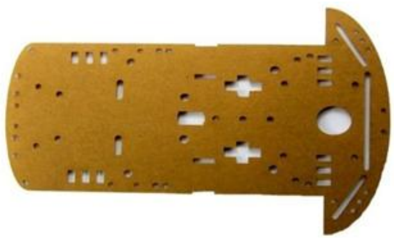

Fig 2.2.7: car chassis

The acrylic car chassis is a lightweight, durable, transparent base structure used in robotic vehicles, RC vehicles and selfdriving vehicle projects. It offers assembly points for motors, sensors and controllers, making it a popular choice for DIY and educational robots. The acrylic car chassis is a light, durable, transparent base frame used to assemble small robotic cars. Made of PMMA (Polymethyl Methacrylate), it offers high strength, impact resistance and corrosion resistance, making it ideal for a robust environment. The chassis is simple, reduces power consumption and improves mobility, but the adaptability makes it easy to install the engine, wheels, sensors and controllers. Its nonconductive species ensures the security of electronic components, and the transparent design provides a clear view of simple wiring and maintenance. When designing and implementing smart robots for real support in disaster management, the acrylic chassis serves as the basis for assembly sensors, cameras and control units to ensure stability and efficient movement of the disaster zone**.**

DC connectors

Fig 2.2.8: DC connectors

DC connections are used for power connections for electronic devices, robotics and DIY projects. They are male (plug) and female (jack/socket) types that are often used to connect power to devices such as Arduino, Raspberry Pi, LED strips, CCTV cameras, amplifiers, and more.

2.3 Circuit Diagram

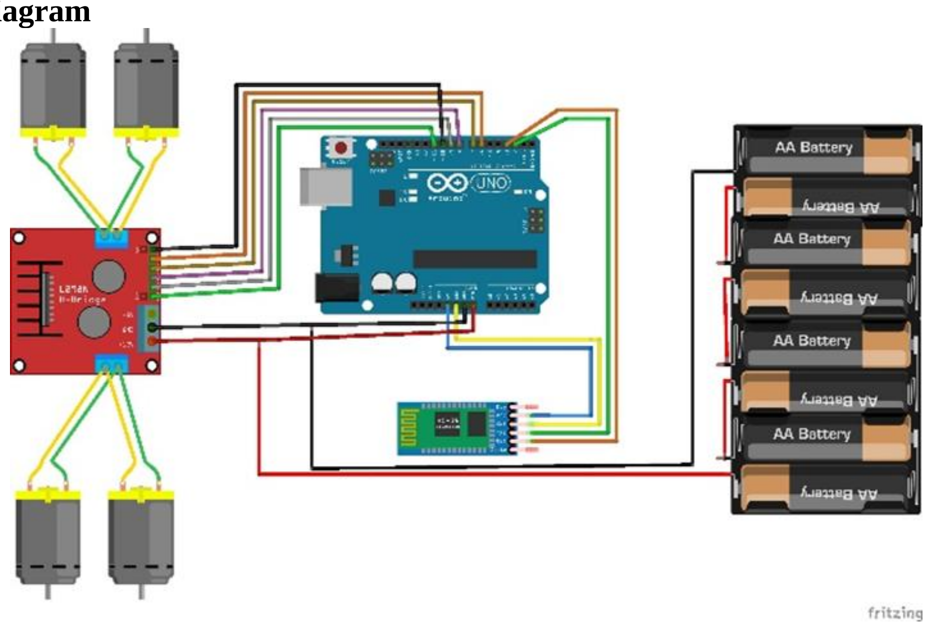

Fig 2.3.1: Circuit Diagram

The specified schematic shows the design task and implementation of smart robots for real-time support in disaster management, controlled by an Arduino UNO, Bluetooth module (HC-05), and L298N motor driver. The Arduino UNO acts as a central microcontroller and enters the men that are received wirelessly via the HC05 Bluetooth module. These commands sent by mobile devices are interpreted by Arduino to control the movement of the robot. The L298N engine driver is responsible for driving four 100 rpm engines, allowing movement in a variety of directions, including forward, rear, left, right. The power source comes from a battery that provides the voltage required for both the Arduino and the engine driver. A suitable cable ensures that the Bluetooth module communicates efficiently with the Arduino via the TX and RX pencils, and the engine driver is controlled by the Arduino digital output needle. This integrated system allows the robot to work wirelessly and respond to realtime user commands, making it extremely effective for remotely controlled rescue processes.

2.4 Prototype and Final Connections

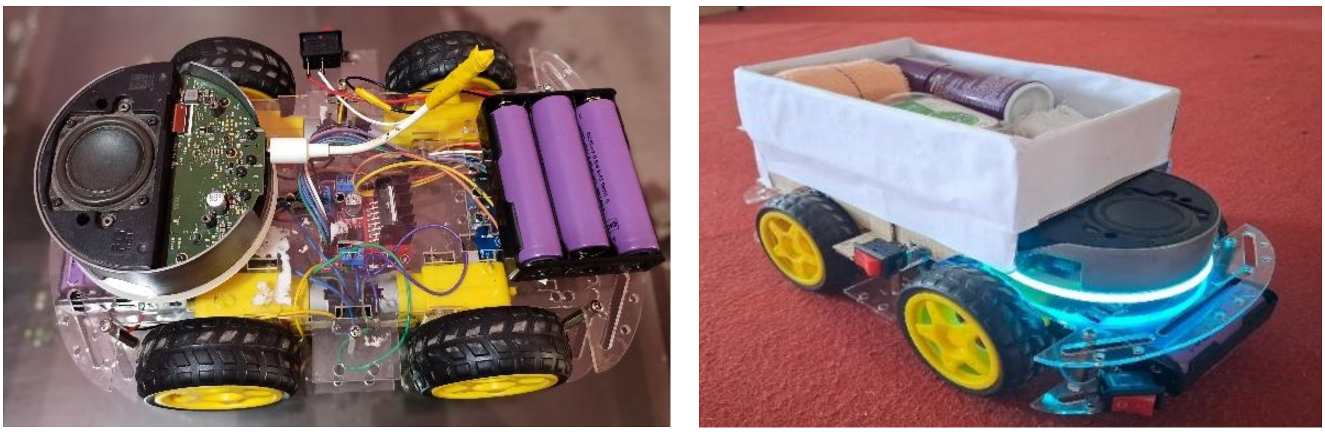

Fig 2.4.1: Prototype with final result (Design and Implementation of Smart Robot for Real Time Assistance in Disaster Management)

III. BENEFITS, LIMITATIONS, APPLICATIONS & FUTURE SCOPE

3.1 BENEFITS

1. Remote operation can be checked wirelessly via Bluetooth. This reduces the need for human prese nce in dangerous areas.
2. Efficient rescue support can help search and support victims in areas at risk of disasters.
3. It uses affordable components such as the Arduino UNO, Bluetooth module, and motor driver.
4. Can be used quickly in emergencies where human intervention is dangerous.
5. Additional sensors (heat cameras, alley sensors, etc.) can improve tuning and scalability to improv e rescue missions.
6. Realtime surveillance provides live video feeds from dangerous areas and improve situational awa reness of rescue teams.

3.2 LIMITATION

1. Bluetooth connection in limited areas limits the operating area (usually 10 meters).
2. Listening to navigation issues without advanced sensors allows the robot to fight complex terrain.
3. Continuous operation of battery life depends on the battery power supply and requires frequent ch arging.
4. The lack of AI-based decision-making basic chatbot functionality limits autonomous decision-making.
5. Manual tax dependency - users need to control them via mobile statements and reduce full autono my.

3.3. APPICATIONS

1. Disaster rescue mission assistance, flood-affected buildings, locations of earthquakes, or victims of local prisoners.
2. Military and defense can be used to search operations, surveillance and detect explosives.
3. Firefighting allows dangerous areas to navigate to find survivors and provide real data.
4. When investigating hazardous environments such as industrial security aid gas lofing areas and ch emical plants.
5. Medical emergency situations can provide first aid kits or essentials in areas that are inaccessible.

3.4. FUTURE SCOPE

1. AI & ML Integrated implementation of AI for autonomous navigation and decision-making.
2. Enhanced control and monitoring for the use of GPS and long distance communication Wi-Fi or GSM modules.
3. Advanced Sensors - Add thermal, infrared, or alley sensors to increase detection.
4. Autonomous navigational lidar, ultrasound sensors, or computer vision for self-disconnection.
5. Provision of several robot swarm robots for cooperation in large-scale rescue operations.

IV. CONCLUSION

The design and implementation of smart robots for practical support in disaster management projects demonstrates the potential of robotics in improving emergency response and disaster management. By integrating components such as Arduino UNO, Bluetooth module, live streaming camera, engine drivers, and chatbot interfaces, the robot supports the rescue process in dangerous environments, allowing for improved remote control and security during rescue missions. The robot is cheap and easy to adjust. This forms a strong basis for future advancements in autonomous rescue systems. Continuing research and development may play an even more important role in emergency responses, contributing to faster, safer and more efficient rescue operations.

V. REFERENCES

1. A. Gupta, B. Singh, and C. Kumar, "Robust Robotic Search and Rescue in Harsh Environments: An Example and Open Challenges," International Journal of Advanced Robotic Systems, vol. 19, no. 1. 1, pp. 1-15 Jan. 2023.

2. A. K. Saha, A. K. Saha, and S. K. Saha, "A Smart Approach to Human Rescue and Environment Monitoring Using Four-Wheeled Robot," International Journal of Mechanical Engineering and Robotics Research, vol. 10, no. 2, pp. 85-90, Mar. 2021.
3. A. Patel, R. Singh, and M. Gupta, "AI-powered chatbot integration for smart rescue robots," IEEE Transactions on Artificial Intelligence, vol. 5, no. 1, pp. 88-95, 2023.
4. H. Osooli, P. Robinette, K. Jerath, and S. R. Ahmadzadeh, "A Multi-Robot Task Assignment Framework for Search and Rescue with Heterogeneous Teams," arXiv preprint arXiv:2309.12589, 2023.
5. J. Lee, K. Park, and H. Kim, "Power optimization techniques for battery-powered rescue robots," IEEE Transactions on Power Electronics, vol. 36, no. 5. 5, pp. 1123-1135.
6. J. Li and S. X. Yang, "A Novel Feature Learning-based Bio-inspired Neural Network for Real-time Collision-free Rescue of Multi-Robot Systems," arXiv preprint arXiv:2403.08238, 2024.
7. M. R. Hasan, M. T. Islam, and M. A. Hossain, "Wireless control of a mobile robot using Bluetooth and Android application," IEEE Transactions on Automation Science and Engineering, vol. 18, no. 3, pp. 567-575, 2022.
8. S. Kumar and A. Verma, "Efficient motor control using L298N H-Bridge drivers in mobile robots," IEEE International Conference on Mechatronics and Automation (ICMA), pp. 987-992, 2020.