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[Dharmendra et al., 10(4), Apr 2025]
ISSN : 2455-9679
SJIF Impact Factor : 6.008

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"BOMB DISPOSAL ROBOT"

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ABSTRACT

The rapid advancement of technology has enabled the creation of innovative solutions for handling hazardous tasks such as bomb disposal. This paper focuses on designing and implementing a remotely operated bomb disposal robot capable of navigating dangerous environments and performing precise operations involving explosive devices. The robot features a robust mechanical chassis with tracked locomotion, ensuring stability and maneuverability across uneven and challenging terrains. A multifunctional robotic arm equipped with grippers and cutting tools allows safe handling, inspection, and neutralization of suspicious objects.

To enhance situational awareness, the robot integrates a comprehensive sensor suite, including high-resolution cameras for real-time visual feedback, infrared sensors for detecting heat signatures, ultrasonic sensors for obstacle detection, and laser rangefinders for accurate distance measurement. Additional chemical and biological sensors may be incorporated to identify hazardous substances. The system is controlled through a microcontroller-based wireless interface, enabling operators to remotely maneuver the robot and control arm movements from a safe distance. Advanced algorithms support obstacle avoidance, path planning, and precise manipulation.

Emphasizing safety, reliability, and ease of operation, the robot undergoes rigorous testing to meet performance standards. By deploying such a system, the project aims to significantly reduce risks to human life and enhance public safety in explosive threat scenarios.

Key Words: *Wireless sensor, networks, Military computing, Arduino Uno, Bombs, Buzzer, Servomotors*

I. INTRODUCTION

The Bomb Disposal Robot Project is aimed at developing a reliable, efficient, and robust robotic system capable of identifying, handling, and neutralizing explosive devices. The robot incorporates advanced features such as remote operation, real time video surveillance, robotic arm manipulation, and precision control to safely neutralize threats in a controlled manner. In today's world, the increasing threat of terrorism and explosive hazards has necessitated the development of advanced tools and technologies to ensure public safety. Bomb disposal robots play a critical role in mitigating risks to human life while handling explosive devices. These robotic systems are designed to perform intricate and high-stakes tasks in hazardous environments, reducing the need for human intervention in potentially life-threatening situations.

At its core, the robot integrates multiple subsystems to ensure functionality and versatility. The mechanical framework is built to sustain rough terrains and provide stability during operations. The robotic arm, equipped with a claw or gripper, facilitates safe handling of suspicious objects. A camera module coupled with wireless transmission provides

ISSN : 2455-9679
SJIF Impact Factor : 6.008

the operator with real-time visuals, enabling precise decision-making. The integration of sensors, such as metal detectors and temperature sensors, enhances the robot's ability to detect explosives and assess environmental risks.

This manuscript focuses on developing a scalable and cost-effective solution to address the challenges faced by bomb disposal teams globally. It aligns with the objective of safeguarding human lives while improving efficiency in handling explosive threats.In addition to technical aspects, this project emphasizes ethical considerations, ensuring compliance with safety standards and operational guidelines. By simulating real-world scenarios and conducting extensive testing, the robot is designed to meet the practical demands of bomb disposal operations.The development of the bomb disposal robot not only addresses immediate security concerns but also contributes to advancements in robotics and automation. This innovation underscores the role of technology in enhancing safety and efficiency in high-risk environments, offering a solution that is both functional and lifesaving. Through interdisciplinary collaboration and research, this project aims to pave the way for future innovations in robotic systems designed for public safety and security.

II. LITERATURE REVIEW

The development of bomb disposal robots has evolved significantly over the last decade, focusing on improved mobility, manipulation capability, sensing accuracy, and intelligent control systems.

Design, kinematic and performance evaluation of a dual arm bomb disposal robot (2017) proposed a dual-arm robotic system with multiple Degrees of Freedom (DOF) to enhance manipulation flexibility. The study emphasized kinematic modeling using D-H parameters and evaluated performance metrics such as reachability and payload capacity. The dual-arm configuration improved precision in handling explosive devices compared to single-arm systems.

Similarly, Bomb disposal robot (2016) focused on an articulated manipulator controlled via microcontrollers and PWM-driven servomotors. The research highlighted prototype development and kinematic analysis for stable operation in hazardous zones.

In terms of embedded and low-cost solutions, Robotic Bomb Detection and Disposal: Application using Arduino (2022) implemented an Arduino Mega-based robot integrating metal detection sensors and wireless communication, making it suitable for trained personnel in field operations. Likewise, Wireless Synchronization of Robotic Arm With Human Movements Using Arduino for Bomb Disposal (2018) demonstrated motion synchronization using ZigBee modules, enabling intuitive arm control.

Design and implementation of a mobile robot used in bomb research and setup disposal (2013) introduced a TCP/IP-based mobile robot with ARM architecture and camera systems for remote monitoring. Advancing human–robot interaction, Controlling the Bomb Disposal Robot using Microsoft Kinect Sensor (2021) utilized Kinect-based motion tracking for gesture-controlled manipulation.

Intelligent automation was further explored in Real time speech—Interactive bomb disposal robot: With face and object recognition (2017), integrating speech recognition and vision-based object detection.

Overall, prior research demonstrates a progressive shift from basic teleoperated robots toward intelligent, multi-sensor, and AI-integrated systems. However, challenges remain in achieving higher autonomy, reduced communication latency, improved manipulation accuracy, and enhanced operational safety.

III. PROBLEM IDENTIFICATION

The increasing frequency of explosive threats in civilian and military environments has created a critical need for reliable and intelligent bomb disposal systems. Traditional bomb disposal methods heavily depend on trained personnel, exposing them to life-threatening risks. Although several researchers have proposed robotic solutions, significant limitations still exist in terms of autonomy, precision handling, communication reliability, and multi-sensor integration.

Earlier works focused primarily on kinematic modeling and dual-arm manipulation systems, improving degrees of freedom and flexibility. However, these systems often involve complex mechanical structures and higher costs, limiting large-scale deployment. Other studies implemented Arduino-based robots with RF communication, metal detection, and basic mobility control, but they lack advanced obstacle avoidance, real-time environmental analysis, and robust fail-safe mechanisms.

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IV. Solution

The current system utilizes an Arduino Uno, RF 433 MHz communication, L298N motor driver, servo-based robotic arm, and lithium battery for remote operation. While this configuration ensures cost-effectiveness and basic functionality, challenges remain in enhancing communication range, reducing signal latency, improving sensor accuracy, and integrating advanced detection mechanisms such as chemical or intelligent vision systems.

Therefore, the core problem identified is the need to develop a scalable, cost-effective, and more intelligent bomb disposal robot that ensures higher operational safety, improved manipulation precision, reliable wireless communication, and enhanced environmental sensing capabilities.

V. Proposed Methodology

The principle idea of the Bomb Disposal Robot Project is to develop a robotic system that ensures the safe disposal of explosive devices while minimizing risks to human life. This is achieved through the integration of advanced robotics, sensor technology, and remote-control capabilities. The robot operates as a remote extension of a human operator as shown in Figure 1, designed to function efficiently in hazardous environments.

The robot's mobility system enables it to traverse various terrains, including stairs, rough surfaces, and debris. This ensures accessibility to locations where explosives are typically placed. A robust robotic arm equipped with precise manipulators allows the robot to handle, disarm, or relocate explosive devices with accuracy.

To enhance situational awareness, the robot is equipped with a high-resolution camera system providing real-time video feedback to the operator. Additional sensors, such as metal detectors and gas sensors, help detect and analyze the presence of explosives. Remote operation is facilitated through wireless communication, allowing operators to control the robot from a safe distance. The system may include semi-autonomousfeatures for navigation and obstacle avoidance, ensuring efficiency in dynamic environments.Safety mechanisms, including fail-safe and redundant communication systems, are integrated to maintain reliability during critical missions. The robot's design prioritizes durability, precision, and adaptability, making it suitable for both civilian and military applications.This system aims to replace traditional, high-risk human bomb disposal operations with a safer, technology-driven alternative, highlighting the potential of robotics to enhance public safety.

BlockDiagram:

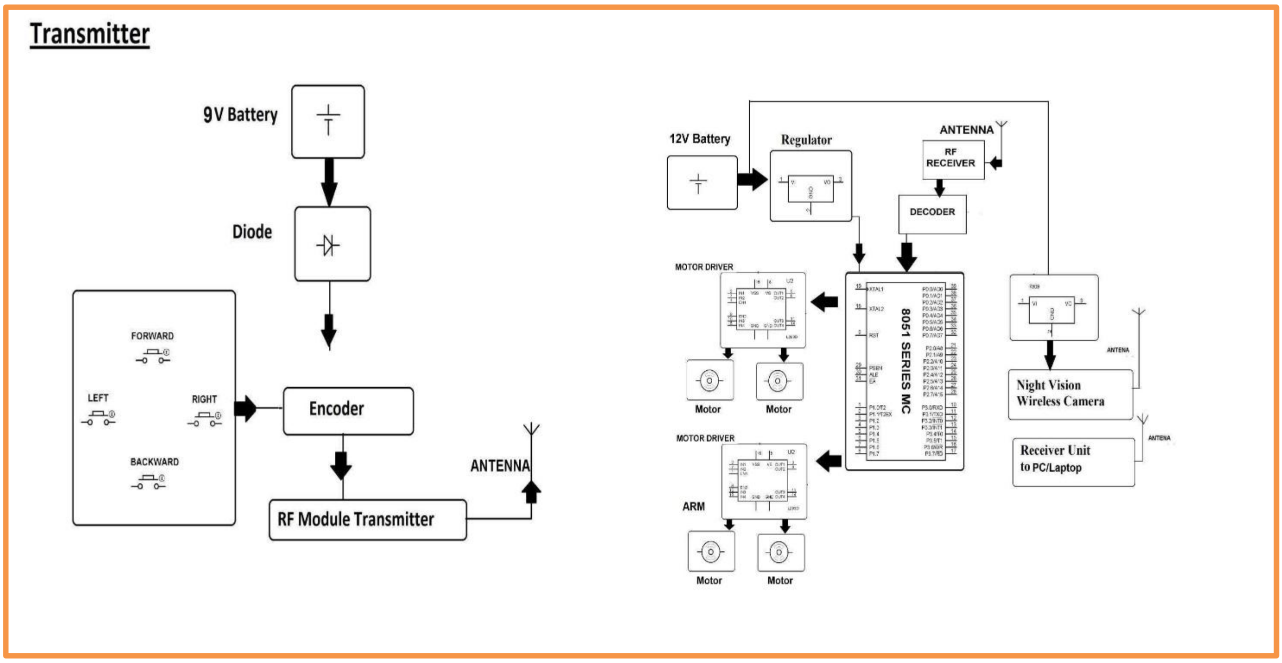

Figure1:BlockdiagramofBomb Dispoal Robot

The block diagram of the Bomb Disposal Robot shown in Figure 1, illustrates functional architecture and interaction

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between the major subsystems of the robot. The system primarily consists of a transmitter unit, RF communication module, microcontroller, motor driver, robotic arm mechanism, and power supply section. The transmitter section includes push buttons connected to a 433 MHz RF transmitter that sends control commands such as forward, backward, left, right, arm movement, and cutter activation. These commands are received by the RF receiver module mounted on the robot, which forwards the decoded signals to the Arduino Uno microcontroller.

The Arduino Uno acts as the central processing unit of the system. It interprets the received commands and generates control signals for locomotion and manipulation. The L298N motor driver module is interfaced with the Arduino to control the DC motors responsible for the movement of the wheels, enabling directional navigation. For object handling, servo motors are used to operate the robotic arm, gripper, and cutting mechanism with precision. The entire system is powered by a lithium battery, while the LM2596 DC-DC buck converter regulates voltage to ensure stable and safe operation of electronic components. Overall, the block diagram represents a wireless, remotely controlled robotic system designed for safe bomb disposal operations.

Component Details

1. Arduino Uno

Arduino Uno is the central control unit of the bomb disposal robot. It is based on the ATmega328P microcontroller and is responsible for processing all incoming commands from the RF receiver. It controls DC motors, servo motors, and other connected modules. With 14 digital I/O pins and 6 analog input pins, it provides flexibility for interfacing sensors and actuators. It operates at 5V and is programmed using the Arduino IDE.

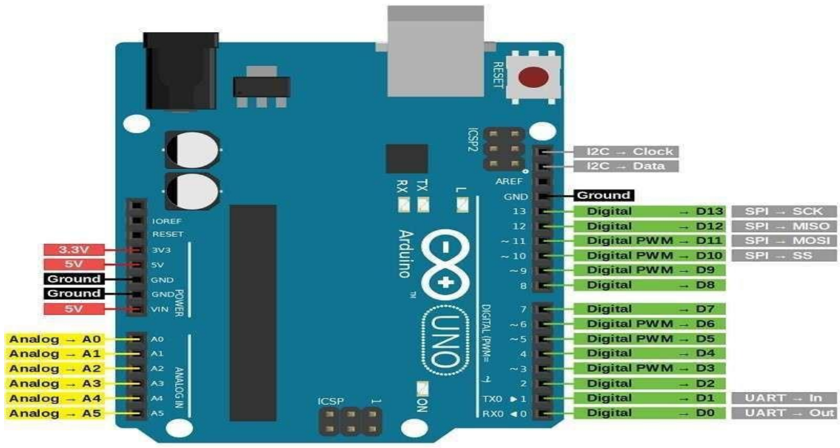

Figure 2: Arduino Uno

2. L298N Motor Driver: The L298N is a dual H-bridge motor driver used to control the DC motors of the robot. It allows bidirectional control (forward and reverse) and speed control using PWM signals from the Arduino. It supports voltages from 5V to 35V and currents up to 2A per channel, making it suitable for robotic locomotion.

Figure 3: L298N Moter Driver

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3. RF Transmitter and Receiver (433 MHz) : The RF module enables wireless communication between the operator and the robot. The transmitter sends control commands, and the receiver mounted on the robot receives and forwards them to the Arduino. This ensures safe remote operation from a distance.

4. Robotic Arm (Gripper) : The robotic arm is used to handle and manipulate explosive devices. It consists of multiple joints powered by servo motors, providing several degrees of freedom for precise movement.

Fig 4:Gripper (robotic arm)

5. Servo Motors: Servo motors are used to control the arm, gripper, and cutter mechanism. They provide accurate angular movement using PWM signals, ensuring precise handling of objects.

6. DC Motors: DC motors drive the wheels of the robot, enabling movement in forward, backward, left, and right directions. They provide high torque for mobility on rough surfaces.

7. LM2596 DC-DC Buck Converter : This module regulates voltage by stepping down higher battery voltage to a stable lower voltage required by the Arduino and other components, ensuring safe operation.

8. Lithium-Ion Battery : The lithium battery powers the entire system. It provides sufficient backup time and high discharge current necessary for motors and electronic components.

9. Switch : Switches are used for power control and emergency stop functions, ensuring operational safety during bomb disposal missions.

10. Jumper Wires : Jumper wires connect different electronic components, enabling signal and power transmission without soldering, which simplifies prototyping and troubleshooting.

11. Wheels, Screws, Nuts and Bolts : These mechanical components provide structural stability and secure mounting of motors and chassis parts, ensuring durability during operation.

System Pictures

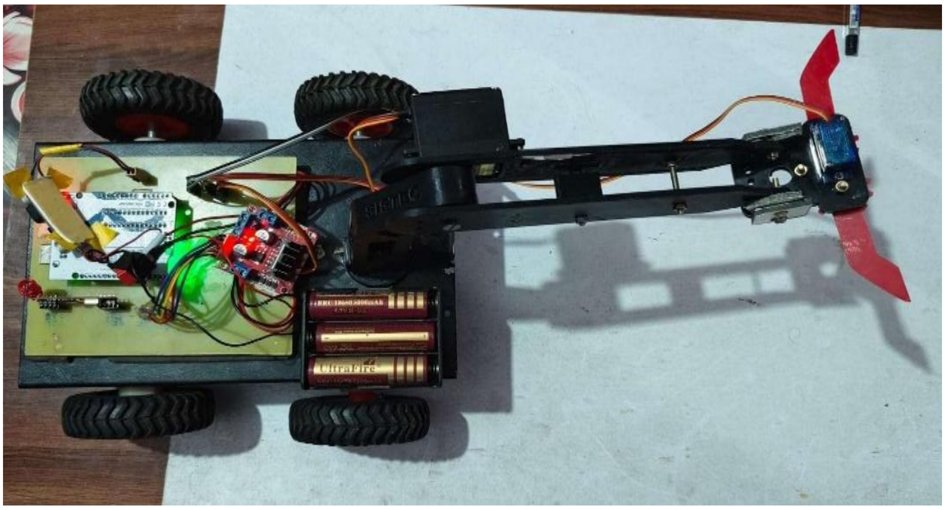

Figure 5:Picture of the Bomb Disposal Robot

VI. RESULT

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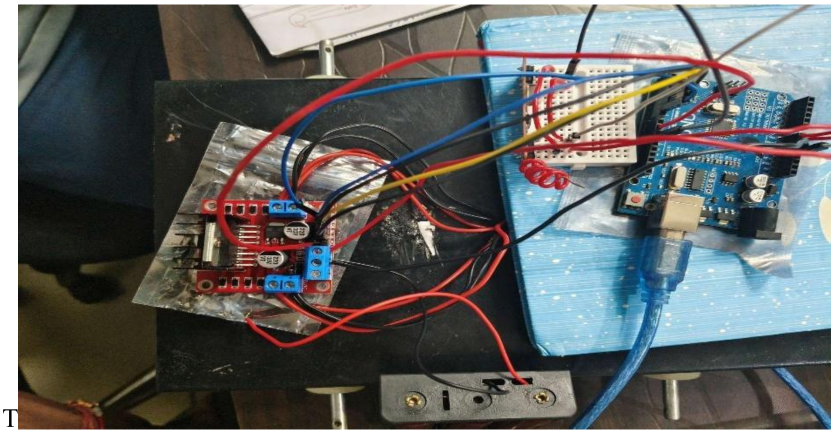

Figure 6: Picture1 of the Testing of Bomb Disposal Robot

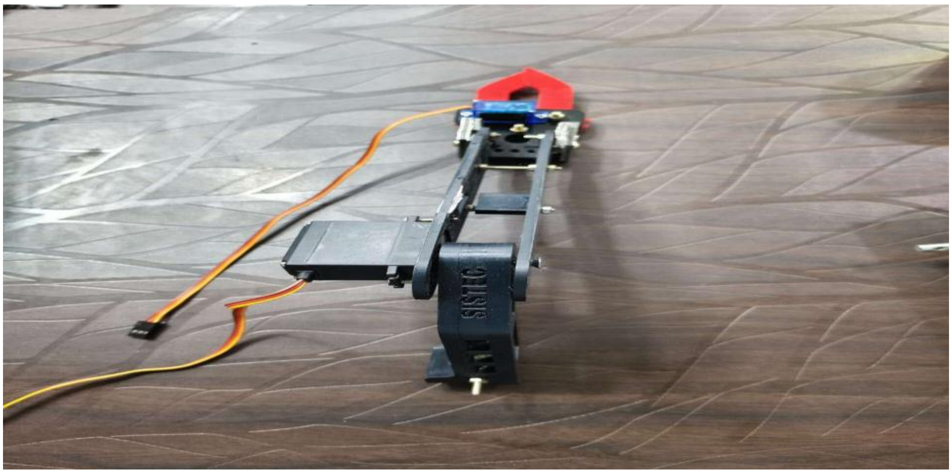

Figure 7: Picture2 of the Testing of Bomb Disposal Robot

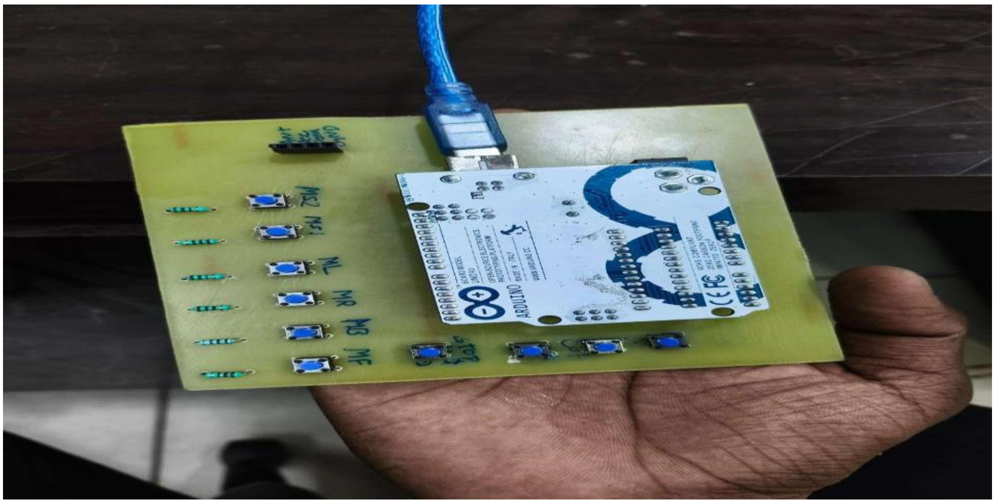

Figure 8: Picture3 of the Testing of Bomb Disposal Robot

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The developed Bomb Disposal Robot was successfully designed, fabricated, and tested as per the objectives defined in the earlier sections. The robot demonstrated effective wireless control using a 433 MHz RF communication system, enabling the operator to safely maneuver the robot from a remote location. During testing, the DC motors controlled through the L298N motor driver provided smooth directional movement including forward, backward, left, and right navigation. The robot was able to operate reliably on flat and moderately uneven surfaces, maintaining stability due to its properly secured mechanical structure.
The Arduino Uno microcontroller efficiently processed transmitted commands and executed motor and servo operations without noticeable delay. The robotic arm, powered by servo motors, successfully performed lifting, gripping, and wire-cutting actions with controlled angular precision. The cutter mechanism responded accurately to user commands, simulating real bomb neutralization operations. The LM2596 buck converter maintained stable voltage levels, preventing fluctuations and ensuring safe operation of sensitive electronic components. The lithium-ion battery provided adequate backup power for continuous operation during testing sessions.

Overall, the integrated system performed as expected, validating the feasibility of a cost-effective, remotely operated bomb disposal robot suitable for hazardous environments.

VII. Conclusion

The Bomb Disposal Robot project successfully integrates mechanical design, embedded systems, wireless communication, and power management into a functional safety-oriented robotic platform. The system effectively reduces human intervention in high-risk bomb disposal scenarios by enabling remote operation and precise manipulation of suspicious objects. Key components such as the Arduino Uno, L298N motor driver, RF communication module, servo motors, and lithium battery worked cohesively to achieve reliable mobility and object handling.
The project highlights the practical implementation of robotics in real-world security applications. It demonstrates that a scalable and cost-effective robotic solution can be developed using readily available components while maintaining operational efficiency. Although the current system operates primarily through manual remote control, it establishes a strong foundation for future enhancements such as advanced sensors, real-time video transmission, autonomous navigation, AI-based threat detection, and improved communication systems.
In conclusion, the developed robot serves as a safe, reliable, and efficient alternative to manual bomb disposal methods, contributing to enhanced public safety and technological advancement in hazardous operation management.Top of Form.

REFERENCES

[1] J. Islam, S. S. Alam, K. T. Ahammad, F. K. Nadim and B. Barua, "Design, kinematic and performance evaluation of a dual arm bomb disposal robot," *2017 3rd International Conference on Electrical Information and Communication Technology (EICT)*, Khulna, Bangladesh, 2017, pp. 1-6.

[2] D. S. Navare, Y. R. Kapde, S. Maurya, D. B. Pardeshi and P. William, "Robotic Bomb Detection and Disposal: Application using Arduino," *2022 7th International Conference on Communication and Electronics Systems (ICCES)*, Coimbatore, India, 2022, pp. 479-483.

[3] K. Bin Motaleb, M. B. Hoque and M. A. Hoque, "Bomb disposal robot," 2016 International Conference on Innovations in Science, Engineering and Technology (ICISET), Dhaka, Bangladesh, 2016, pp. 1-5.

[4] A. Unluturk and O. Aydogdu, "Design and implementation of a mobile robot used in bomb research and setup disposal," Proceedings of the International Conference on ELECTRONICS, COMPUTERS and ARTIFICIAL INTELLIGENCE - ECAI-2013, Pitesti, Romania, 2013, pp. 1-5.

[5] L. M. V. Creo, G. M. Dacanay, L. C. P. Jarque, C. J. P. Umali and E. R. E. Tolentino, "Controlling the Bomb Disposal Robot using Microsoft Kinect Sensor," 2021 International Conference on Communication, Control and Information Sciences (ICCISc), Idukki, India, 2021, pp. 1-6.

[6] A. Sabarivani, A. Anbarasi, A. Vijayaiyyappan and S. Sindhuja, "Wireless Synchronization of Robotic Arm With Human Movements Using Aurdino for Bomb Disposal," *2018 International Conference*

ISSN : 2455-9679
SJIF Impact Factor : 6.008

on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, 2018, pp. 229-234.

[7] Rakshith, P. Prakash, S. Fernandes and S. Rahul, "Real time speech — Interactive bomb disposal robot: With face and object recognition," *2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT)*, Mysuru, India, 2017, pp. 1-12.

[8] Jayant, A. A. Joshi, A. Chamakeri, S. Shakthi and S. Vijaykumar, "Design and Development of Multi-Sensor Bomb Detection and Detonation Robot System," *2023 7th International Conference on Design Innovation for 3 Cs Compute Communicate Control (ICDI3C)*, Karnataka, India, 2023, pp. 102-.

[9] N. V. Krishnamoorthy, V. V. Sujatha, G. Naresh, R. Ratheesh and M. Dinesh, "Revolutionizing Military Operations: A Smart Fabrication of Bomb Detection and Diffusing Robot with Location Sharing Feature," *2024 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)*, Chennai, India, 2024, pp. 1-7.