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Remote Control Metal Detecting Robot to Assist Bomb Detection and Rescue Team

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***Abstract*— The project involves a vehicle equipped with a metal detector and diffusing system, controllable via Bluetooth technology from an Android device. This vehicle can move in all directions using Bluetooth commands from the Android app. Upon detecting a metal mine, the vehicle automatically stops and sends a signal to the Android device. It can then move backward and activate the diffusing system, which includes a cutter and water sprinkler. A wireless video camera module, the ESP32cam, is mounted on the vehicle to provide live video of the surroundings. The operator can analyze this video feed remotely to assess situations and control the vehicle accordingly. A small robot prototype demonstrates the concept practically, controlled via Bluetooth technology. The robot features DC motors for movement and a metal detector at the front. The metal detector sends signals to an Arduino microcontroller, which relays information to the Android device. This project combines Bluetooth and embedded systems technologies for various applications, including warfare and rescue operations.**

***Index Terms*— Arduino uno, Bluetooth module, ESP32 Camera, 2- channel Relay module, L293D motor driver, IR sensor, ARM cutter, Pumping motor**.

I. INTRODUCTION

The project's primary goal is to develop an unmanned ground vehicle (UGV) to assist police and bomb squads in safely disposing of bomb threats, minimizing the risks faced by personnel. The UGV is equipped with a metal detector to identify potential threats including a cutter mechanism through defuse bombs safely by severing trigger wires. The system consists of various components, including a microcontroller for UGV operation, a wireless video camera for remote monitoring, and Bluetooth modules for communication.

The UGV operates at 12V DC using a 1.3AH maintenance- free battery, a regulated power supply unit provides 5V DC for electronic circuits. Bluetooth technology is employed for short-range communications, offering a reliable data transmission rate of 9600 bps. This enables remote control of the UGV, typically with in an eight-meter range, using devices like smartphones.

The project emphasizes cost-effectiveness, aiming to make the technology accessible to police departments in economically disadvantaged regions. It provides a safer alternative to bomb disposal by allowing operators to control the UGV from a secure distance, reducing the risk to human life. The inclusion of a wireless video camera enhances the operator's ability to navigate and defuse bombs by providing a live feed. The UGV is versatile, suitable for various environments such as jungles, deserts, forests, and mountain terrains. Its capabilities extend to

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detecting metallic mines or explosives both above and below ground, addressing the challenges faced by bomb squads dealing with increasingly sophisticated threats. The project envisions broader applications in areas with extreme conditions, and its design allows for potential modifications for specific use cases.

II. Literature Survey

S. Keerthana, AR. Vellaiyan [1]: Proposed an approach for metal detection verified through a wireless camera to identify hazardous objects. Utilized a robotic arm to safely dispose of detected bombs.
Chaitrali Jadhav, Shamli Gibile [2]: Proposed an Android application to control the entire system. Commands from the Android application is transmitted via WIFI to a microcontroller. The Android application also facilitates commands for controlling the robot arm.
Anisha Cotta, Rajat Desai [3]: Aimed to enhance defense and safety for the military and bomb squad. Implemented a system where the specalist operates the robot at the location. Utilized Bluetooth module for transmitting and receiving data. Employed DC motors for the gripper arm cutter.
Saurabh Mahawadiwar, Pritipai [4]: Proposed serial communication with the robot using Bluetooth technology. Bluetooth connection facilitates commands transmitted through an Android application.
V.parameshwari,P. Premkumar, M.srinevasan [5]: Proposed IoT Enabled Intelligent Irrigation System for Agriculture Fields.
Desai, Rajat, Naik Pankaj [6]: Proposed a Cutting-edge Military Spy Robot and Bomb Disposal Technology.
Uphad, Rushikesh [7]: A safe spy robot designed to defuse bombs, operated through an Android app for enhanced security.
Dr. N. Muthukumaran [8]: proposed system for an automatic defense robot equipped with face detection technology to identify potential threats and enemies.
Bodkhe, R. Devendra [9]: Proposed an IoT Robot with Bomb Diffusing Application.
V. Abhilash, Pk. Mani [10]: Provided that wheeled robot gets controls from the bomb squad experts using mobile phone.

III. Proposed Methodology

The methodology for developing remote-controlled metal detecting robots for bomb detection and rescue teams involves several key steps. Initially, the system architecture is meticulously designed, encompassing both hardware and software components crucial for the robot's operation. Hardware development entails rigorous selection and integration of components such as sensors, actuators, microcontrollers, and communication modules to construct the robust physical structure of the robot.

Moreover, sensors like metal detectors and wireless cameras are carefully integrated and calibrated to ensure precise detection and seamless operation during bomb-related missions.Additionally, the software aspect involves programming intricate algorithms for sensor fusion, autonomous navigation, and real-time data processing, enhancing the robot's efficiency and adaptability in diverse environments.

IV. Block Diagram

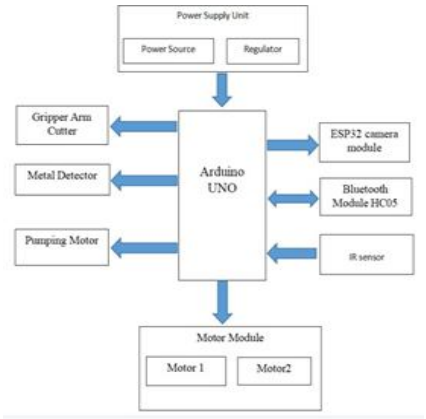

Figure 1. Proposed system block diagram

V. HARDWARE DESCRIPTION

A. Arduinouno

The Arduinouno is extensively employed in electronics projects. With its array of input/output pins, analog inputs, and communication interfaces, it offers versatile capabilities. It provides versatility for connecting various components. Powered at 5 volts, it can be powered through USB or external sources. Its ATmega328P microcontroller, running at 16MHz, is the core processing unit. With a simple C/C++ programming environment, the Arduino IDE, users can easily program the board. The Uno is reowned for its ease of use, making it suitable for both beginners and experts. Its open-source nature fosters a robust community, offering extensive resources like libraries and tutorials. The board is ideal for diverse applications, including robotics, home automation, and prototyping. Overall, the arduinouno emerges as a user- friendly and versatile platform highly favored by electronics enthusiasts.

Figure 2. Arduinouno

B. Bluetooth ModuleHC-05

The HC-05 Bluetooth module stands as a commonly utilized and adaptable wireless communication solution component used in electronics projects. With a compact design, it facilitates seamless integration into various applications. It operates on the Bluetooth 2.0 standard and supports the Serial Port Profile(SPP), facilitating seamless communication with other Bluetooth-enabled devices. The module offers a reliable and low-cost solution for establishing wireless connections between devices, making it widely utilized for data transmission and remote control applications. Featuring a simple yet effective design, the HC-05 is accessible for both beginners and experienced developers, providing a practical way to implement wireless connectivity in projects such as home automation, robotics, and Internet of Things (IOT) applications.

Figure 3. Bluetooth Module HC05

C. ESP32Camera

The ESP32 camera module is a compact and powerful component that integrates a camera along with the ESP32 microcontroller. This module facilitates the capture and processing of images or video within the ESP32 framework. With its versatility and ease of integration, it allows developers to create applications ranging from surveillance systems to image recognition projects. Operating on the ESP32 platform, it benefits from its dual-core processing power and built-in Wi-Fi connectivity, enabling seamless communication with other devices. The ESP32 camera module is widely employed for applications demanding visual data, offering a cost-effective and efficient solution for IoT, home automation, and embedded systems projects.

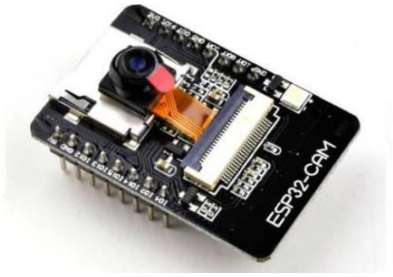

Figure 4. ESP32 Camera

D. ARMcutter

The ARM cutter is a precision cutting tool featuring advanced technology and ergonomic design. With its sleek and compact form, it provides accuracy and ease of use for various cutting applications. The cutter lever ages ARM architecture, ensuring efficient and reliable performance. Its robust construction makes it suitable for tasks requiring precision and control, from industrial applications to intricate DIY projects. Equipped with sharp blades and durable components, the ARM cutter delivers clean and consistent cuts. The ergonomic handle enhances user comfort, making it a versatile and indispensable tool for professionals and enthusiasts a like.

Figure 5. Arm Cutter

E. L293D Motor driver

The L293D motor driver is a well-known integrated circuit employed for regulating the direction and velocity of DC motors. It operates as an H-bridge, allowing bi-directional control of motors by controlling the polarity of the applied voltage. With built-in protection diodes, it safeguards the circuit from back EMF generated by the motor. The L293D can drive upto two motors simultaneously and is commonly used in robotics, automation, and motor control projects. Its user-friendly interface and ability to work with microcontrollers establish it as a favored option for both hobbyists and professionals a like. The IC provides a cost-effective and efficient solution for driving DC motors with ease andreliability.

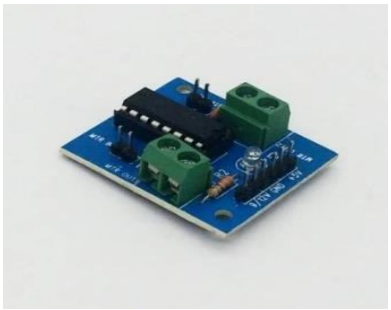

Figure 6. L293D Motor driver

F. Infrared(IR) sensor

An Infrared (IR) sensor is a device designed to detect infrared radiation present in its environment. By leveraging the concept that objects emit heat through infrared radiation, these sensors are capable of recognizing temperature

fluctuations. Typically utilized for proximity detection and object identification, IR sensors comprise an emitter and a receiver. The emitter emits infrared light, while the receiver picks up the reflected light. As an object enters the sensor's detection range, it modifies the reflection pattern, prompting a reaction. Widely used in applications such as motion detectors, automated lighting systems, and remote controls, IR sensors provide a non-contact and reliable method for detecting the presence of objects or individuals.

Figure 7. IR Sensor

G. Metal Detector

A metal detector is an virtual device designed to find out the presence of steel gadgets in its vicinity. Operating on the principle of electromagnetic induction, these detectors emit a magnetic field and identify disturbances caused by metal. When a metal object enters the magnetic field, it induces an electric current in the detector, triggering an alert. Metal detectors find extensive use in security screenings, archaeological excavations, and treasure hunting.They typically consist of a coil that produces the magnetic field and a control unit that processes the signals. Portable and efficient, metal detectors play a crucial role in various fields, ensuring the detection of concealed metallic items.

Figure 8. Metal Detector

VI. SOFTWARE DESCRIPTION

A. Arduino Bluetooth controller

An Arduino Bluetooth controller is a versatile device that enables wireless communication between an Arduino microcontroller and other Bluetooth-enabled devices, like smartphones or tablets. It typically utilizes Bluetooth modules such as HC-05 or HC-06 to establish a reliable connection. This controller allows users to remotely send commands or data to the Arduino, making it ideal for applications such as robotics, home automation, or smart devices. The user-friendly interface simplifies the integration of Bluetooth communication, providing an intuitive and efficient means to control and monitor Arduino projects. With this technology, users can create interactive and remotely operated systems, enhancing the functionality and accessibility of Arduino- based projects.

B. ArduinoIDE

The Arduino Integrated Development Environment (IDE) serves as a software platform crafted specifically for programming Arduino microcontroller boards. It presents auser-friendly interface for writing, compiling, and uploading code to Arduino boards. Supporting both the C and C++ programming languages, the IDE caters to individuals ranging from novices to seasoned programmers. With features like syntax highlighting, code completion, and a serial monitor, it simplifies the development process.The IDE is compatible with various operating systems and is freely available for download.It serves as a central tool for creating an extensive array of Arduino projects, ranging from basic LED blinking programs to intricate robotics and IoT applications.

VII. RESULT

A. Output of the Proposed model

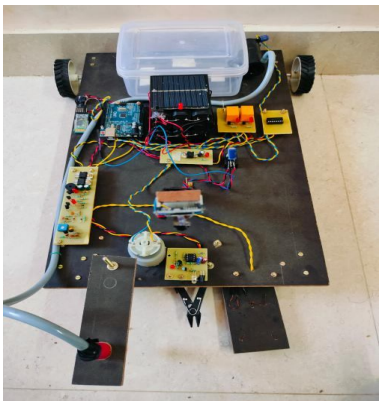

Figure 9. Proposed system output.

TABLE I. KEYS TO CONTROL THE MOVEMENTS.

S.NO	Robot Movements	Keys
1	Forward Movement	F
2	Backward Movement	B
3	Left side Movement	L
4	Right side Movement	R
5	ARM Cutter	C
6	Pumping motor	P
7	Automatic Movement	A

VIII. CONCLUSION

In summary, the creation of the remote-controlled metal- detecting robot for bomb detection and rescue missions marks a notable stride in improving the safety and effectiveness of these crucial endeavors. By integrating metal detection capabilities, wireless communication, and a robotic platform, the system provides a remote and secure approach to handling explosive threats. The versatility of the robot makes it applicable to various environments, from jungles to deserts, addressing the challenges faced by bomb detection teams globally. The incorporation of advanced technologies, including Bluetooth and video cameras, further empowers operators in real-time decision-making. Overall, this project demonstrates a valuable tool for law enforcement and rescue teams, significantly reducing the risks associated with manual bomb disposal operations while increasing the overall effectiveness of response efforts.

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