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Bomb Detection and Disposal Using an Autonomous Rover with Robotic Arm

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ABSTRACT: This Bomb detecting and disposal using an autonomous rover with robotic arm system aims to enhance safety and efficiency in bomb disposal operations by allowing remote manipulation and visual assessment of potentially dangerous objects .This Bomb detecting and disposal using an autonomous rover with robotic arm, controlled by an Arduino Uno microcontroller. The system utilizes an ESP32-CAM module for image capture and processing, enabling remote visual feedback for precise manipulation. Three servo motors, driven by the Arduino, actuate the robotic arm for handling hazardous materials. A buck converter regulates power for the servos and ESP32-CAM. The system is designed for remote operation, keeping human personnel at a safe distance.

KEYWORDS: ESP 32 CAM Module, Arduino uno, Lithium ion batteries, Robotic Arm, Servo Motor, DC Motors, Weels, Gripper.

I. INTRODUCTION

The increasing need for advanced bomb detection and disposal systems has become paramount in addressing modern security challenges. Traditional methods involving human intervention in bomb detection and deactivation pose significant risks to personnel due to the potential for detonation and exposure to hazardous environments. To mitigate these risks, autonomous rovers equipped with robotic arms and advanced sensing technologies offer a safer, more efficient, and reliable alternative for bomb detection and disposal.

This project introduces an Autonomous Rover with a Robotic Arm designed specifically for bomb detection, disposal, and surveillance in sensitive areas. The system integrates embedded systems, robotics, and sensor technology to perform tasks autonomously or via remote control, ensuring minimal human involvement. By utilizing a combination of metal detectors, EPS (Electronic Perception System) cameras, and smoke sensors, the rover can effectively identify potential threats, provide live situational feedback, and assist in disarming operations.

Incorporates a metal detector module based on electromagnetic induction principles to identify metallic explosives or suspicious devices. Provides real-time feedback to the operator or system controller. Surveillance and Monitoring Equipped with an ESP camera to stream live video feeds for visual assessment of the environment. The camera allows operators to monitor the rover's operations remotely in real time.

II. LITERATURE SURVEY

1. Vivek Kumar Chaubey, Ravi Rastogi, Shalinee Mishra, Ritesh Pratap Rao, Rohan Borgalli, Brijesh Kumar “Spying and Bomb Disposal Robot” 2023 First International Conference on Microwave, Antenna and Communication(MAC).
2. Ajay Sudhir Bale, Nithin Kumar NR, A N Somanna, Karthik K B, NagendraRao S N, Rithik S M “Explosive Projectile Detection with an Arduino- Controlled Robot” 2023 8th International Conference on Communication and Electronics Systems(ICCES).

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3. Rajesh G, Gurulakshmi A B, Kavya A, Kalahasti Charishma, Chilaka Bhavya,D. Sai Kumar "An Arduino Development Board Based Metal Detecting Robot for Terrestrial Applications" 2023 3rd International Conference on Innovative Practices in Technology and Management(ICIPTM).
4. Rhea Sawant Chetana Sing, Ariz Shaikh, AmanAggarwal, Priti Shahane, Harikrishnan R "Mine Detection using Swarm of Robots" 2022 International Conference on Advances in Computing, Communication and Applied Informatics(ACCAI)

III. METHODOLOGY

The proposed system employs an autonomous rover integrated with a robotic arm, metal detector, ESP32-CAM module, and various sensors to detect and dispose of explosives in critical environments.

- Microcontrollers: Dual Arduino Uno boards serve as the control units for coordinating the rover's motion, robotic arm movement, and sensor interfacing.
- ESP32-CAM Module: Facilitates real-time video streaming for remote monitoring and situational awareness.
- Robotic Arm: A motor-driven, multi-degree-of-freedom (DOF) robotic arm is mounted on the rover for object manipulation, such as bomb lifting or repositioning.
- Metal Detector: A sensor unit capable of identifying ferromagnetic materials is used to detect metal-based explosive devices.
- Smoke Sensor: Detects smoke or gas emissions as indicators of hazardous conditions during operations.
- Motor Control: The rover uses motor drivers to navigate autonomously or via remote control.
- Power Source: A rechargeable battery powers the entire system.

IV. BLOCK DIAGRAM

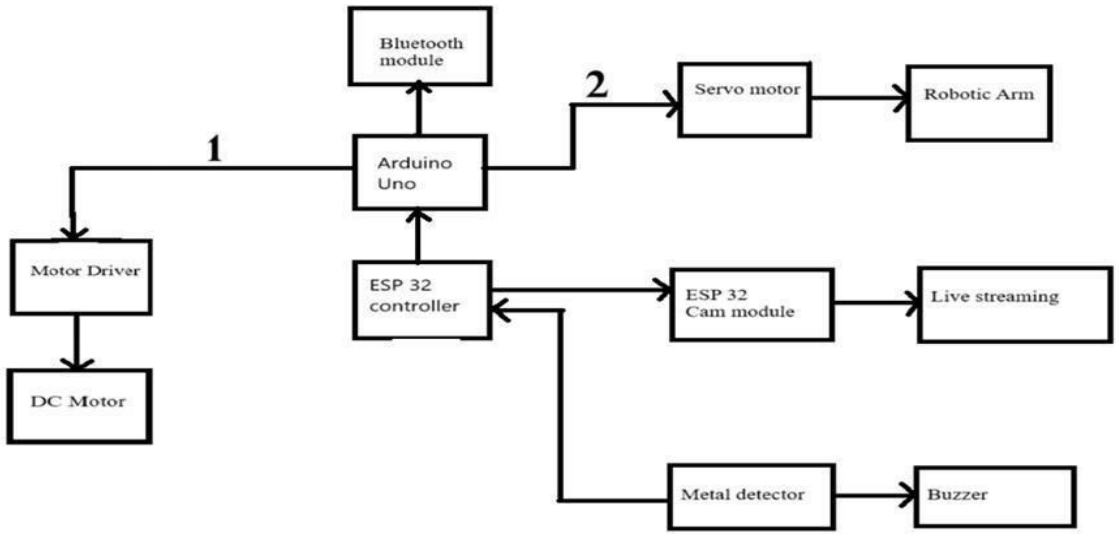

Figure 1: Block diagram showing the setup

This block diagram depicts a robotic arm control system. An Arduino Uno, receiving input from a Bluetooth module, controls a servo motor for the arm's movement. An ESP32 Cam module enables live streaming, while a separate ESP32 controller manages a metal detector and buzzer, potentially for object identification or alerts. A motor driver and DC motor are also shown, likely for additional arm functionality.

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V. EXPERIMENTAL RESULT

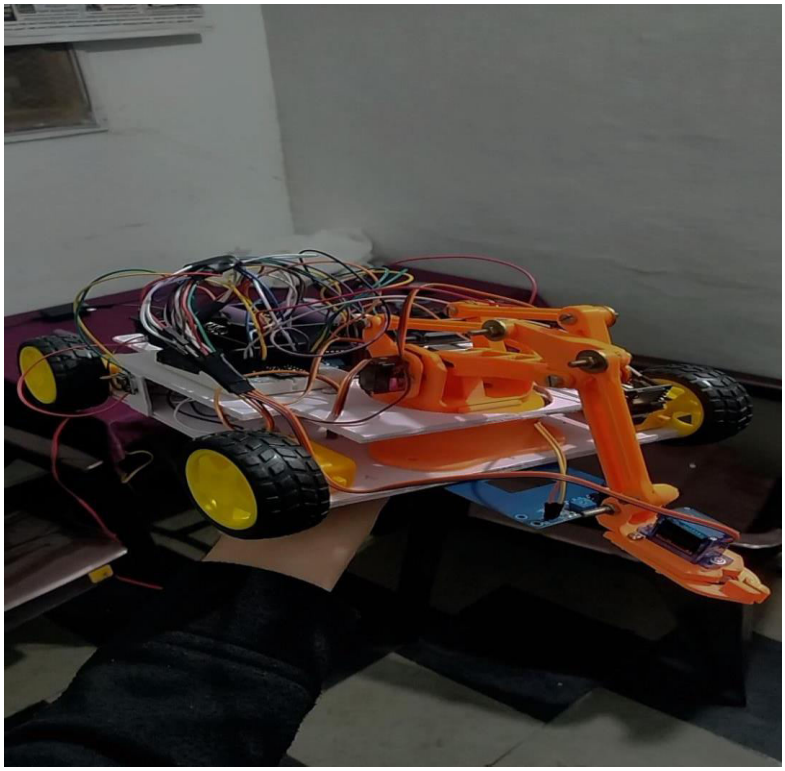

Figure 2: Final Result of the Project

The bot car with a robotic arm is an advanced mechatronic system designed for real-time surveillance, metal detection, and environmental monitoring in hazardous and sensitive areas. The robotic arm integrates a metal detector for identifying metallic objects, an EPS camera for live video streaming, enabling multi-functional performance. The system is controlled using two Arduino Uno boards, ensuring effective communication between the robotic arm and the mobile platform for precise operation and maneuverability.

VI. CONCLUSION

The bot car with a robotic arm is an advanced mechatronic system designed for real-time surveillance, metal detection, and environmental monitoring in hazardous and sensitive areas. The robotic arm integrates a metal detector for identifying metallic objects, an EPS camera for live video streaming, enabling multi-functional performance. The system is controlled using two Arduino Uno boards, ensuring effective communication between the robotic arm and the mobile platform for precise operation and maneuverability.

The integration of multiple sensors and actuators, coupled with robust embedded programming, highlights the system's efficiency in real-world applications. This project demonstrates a strong understanding of sensor interfacing, embedded systems design, and robotic automation, providing a scalable foundation for future advancements in autonomous and remote-controlled robotics.

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