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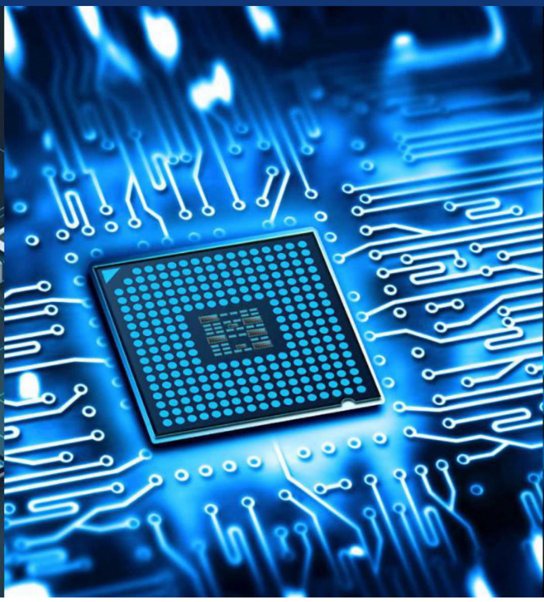

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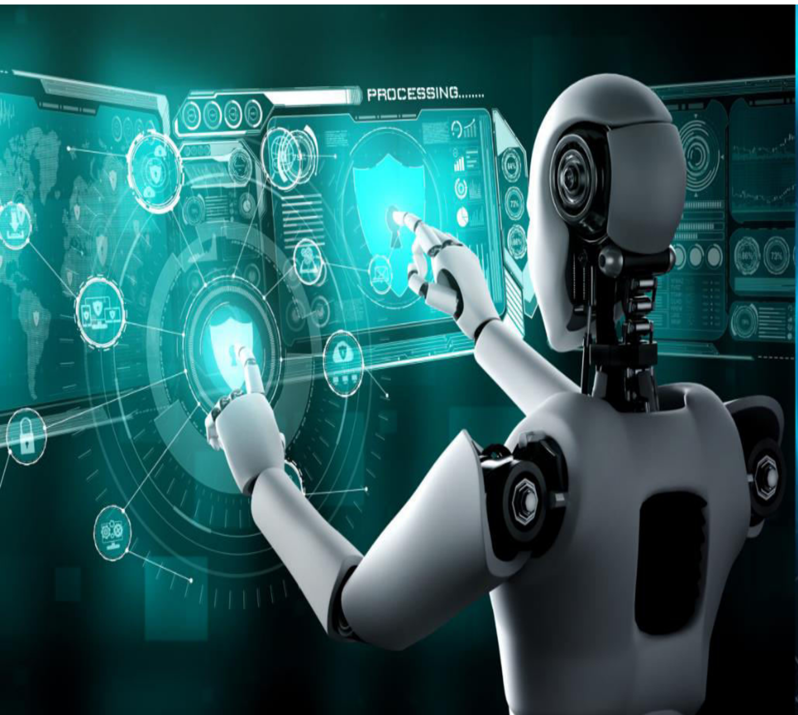

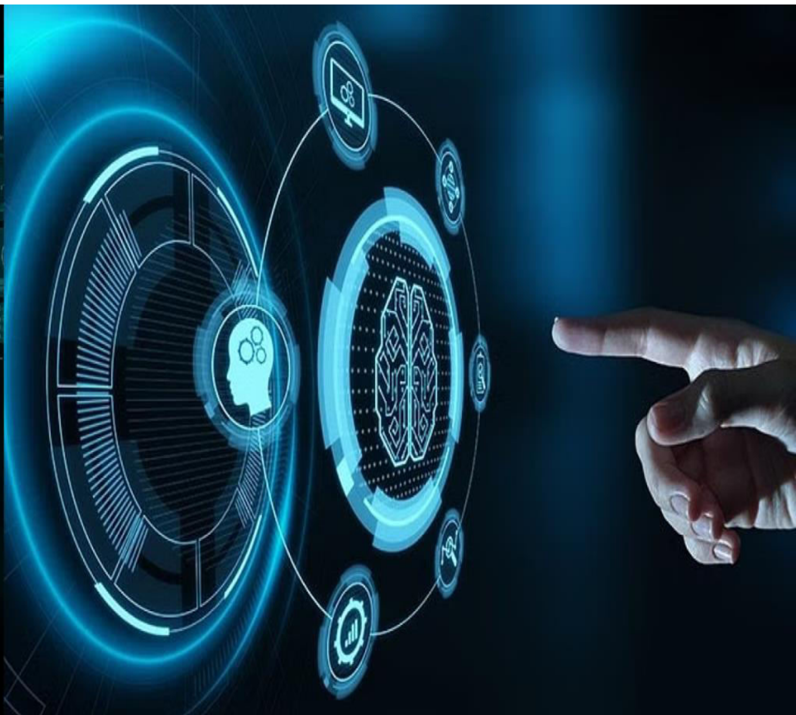

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IoT based Multifunctional Robot for Defence Applications

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ABSTRACT: A modern approach for surveillance at remote and border areas using multifunctional robot based on IOT used in surveillance, defence and military applications. In Modern world, Automation robot is used in many of the fields such as defence, surveillance, medical field, industries and so on. This robot is electromechanical as well as artificial intelligent machine controlled by computer programming. It is designed to replace human beings in various hazardous areas.The robotics and automation industry which is ruled the sectors from manufacturing to household entertainments. It is widely used because of its simplicity and ability to modify to meet changes of needs. The project is designed to develop a robotic vehicle using android application for remote operation with multiple features like wireless camera for monitoring purpose, Metal Detector for land mines detection , Gass sensor for detecting flues gases in surrounding areas, Object moving detection with automatic Notifications sending to ground station using IoT technology. A robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer. A robot can be controlled by a human operator, sometimes from a great distance. In such type of applications wireless communication is more important.The control signal from transmitter is sent to the receiver which is connected to an object or device or vehicle that is to be remotely controlled. Similarly, this project mentions about a wirelessly controlled commando robot controlled using IOT.

KEYWORDS: IoT, Defence Robotics, Surveillance Robot, NodeMCU, Sensors, Metal Detector, Blynk

I. INTRODUCTION

In recent years, robotics has become an essential aspect of modern defence technology, transforming how military operations are conducted. These advanced machines are designed to undertake tasks that are either too dangerous or practically impossible for humans to perform. From landmine detection and hazardous area monitoring to real-time surveillance, robots are increasingly used to support tactical and strategic operations on the battlefield.

One of the most significant advantages of integrating robotics into defence is the potential to mitigate human risk. Robots equipped with advanced sensors and mobility can access zones that may be contaminated, explosive-prone, or otherwise unsafe for soldiers. Additionally, such systems can operate continuously without fatigue, thus increasing mission endurance and effectiveness.

The inclusion of Internet of Things (IoT) technology has further elevated the capabilities of these robotic systems. IoT allows real-time data collection, monitoring, and control through wireless communication networks. By leveraging cloud-based platforms like Blynk, military personnel can remotely operate robotic systems, analyze environmental data, and receive instant alerts in critical scenarios.

This project addresses the growing need for a low-cost, scalable, and modular robotic platform specifically designed for defence applications. It utilizes readily available electronic components, such as the NodeMCU ESP8266 microcontroller, ultrasonic sensors, gas sensors, metal detectors, and wireless cameras, to develop a robust and multifunctional robot. The result is an intelligent robotic system capable of remote surveillance, hazardous gas detection, metal object identification, and obstacle avoidance, all controlled via a mobile application.

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Objectives

The primary objectives of this project are:

- To design a multifunctional robot capable of supporting defence applications.
- To integrate IoT for real-time monitoring and control via mobile applications.
- To implement sensors for detecting metal, gas, and obstacles in hazardous environments.
- To enable live video surveillance through a Wi-Fi-enabled camera.
- To improve the operational safety of defence personnel by reducing human exposure.

II. LITERATURE SURVEY

Existing research shows significant advancements in robotic systems for defence, particularly in areas such as RF and Bluetooth-based control mechanisms, metal detection systems, and environmental monitoring through various types of sensors. Bluetooth and RF-controlled robots have been widely explored due to their simplicity and affordability; however, they suffer from a limited range and lack scalability for broader operational use in field conditions. Metal detection capabilities have proven effective in identifying landmines or hidden metallic objects, which is a crucial application in minefield clearance and border security operations. Gas detection sensors, especially those in the MQ series, have been integrated into robotic systems to detect hazardous leaks or the presence of harmful gases in potentially contaminated zones.

Despite these advancements, most existing robotic defence systems lack integrated communication with cloud-based platforms or real-time data logging capabilities. This restricts their operational flexibility, as they are unable to provide situational data to command centers remotely. Studies such as those by Chen et al. highlight the growing importance of IoT in modernizing military infrastructure and equipment. IoT-based defence systems allow not only remote control and monitoring but also facilitate predictive maintenance, data analytics, and live mission updates through cloud interfacing.

Moreover, emerging research explores the use of edge computing, where data is processed closer to the sensor or device, reducing latency and dependency on central systems. This is particularly important in tactical scenarios requiring quick decision-making. Additionally, artificial intelligence (AI) is being investigated to enable autonomous navigation, object detection, threat recognition, and path planning in robotic defence platforms. The convergence of AI, IoT, and robotics is expected to redefine how military operations are executed, making systems more responsive, intelligent, and self-reliant.

III. EXISTING SYSTEM

Conventional military robots primarily rely on **Bluetooth or RF communication**, which significantly restricts their operational range and limits the ability to transmit critical data over long distances. These communication methods are often **line-of-sight dependent**, making them unreliable in complex or obstructed terrains such as urban environments or dense forests. Moreover, these systems generally lack **bi-directional data exchange**, resulting in minimal or no feedback to the user regarding sensor readings, system health, or environmental conditions. Short-range wireless communication.

Common issues faced by these legacy systems include:

- No real-time data sharing.
- Limited night vision or video feedback.
- Absence of environmental hazard detection.
- Lack of remote control capabilities over long distances.

IV. PROPOSED SYSTEM

The proposed system uses Wi-Fi-enabled NodeMCU with the Blynk IoT platform for real-time control. The robot includes:

- Camera module for live video feed.

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- Gas sensor for environmental safety.
- Metal detector for landmine detection.
- Ultrasonic sensor for obstacle avoidance.
- DC motors driven by L293D IC.

The robot connects to a mobile application over Wi-Fi, enabling remote navigation and monitoring, and enhances situational awareness.

V. METHODOLOGY

The robot is programmed using Arduino IDE and connected to Blynk for IoT interfacing. Sensor data is read via NodeMCU's GPIOs and transmitted over Wi-Fi. The camera streams video through a local IP, and sensor data is visualized on the Blynk app. Alerts are sent when gas or metal is detected. The system employs interrupt handling for real-time responses and PWM for motor control.

VI. HARDWARE USED

1.NodeMCU ESP8266:

NodeMCU ESP8266 is an open-source IoT development board built around the ESP8266 Wi-Fi module. It features built-in Wi-Fi capabilities, making it ideal for wireless communication in embedded applications. The board includes digital I/O pins, ADC, and UART interfaces, allowing it to interface with various sensors and modules. It is programmable using the Arduino IDE and supports real-time data transmission, making it highly suitable for IoT-based defence and automation projects.

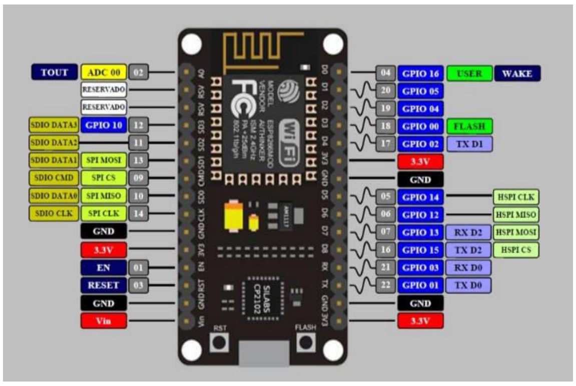

Fig1: NodeMCU

2.Ultrasonic Sensor (HC-SR04):

This is a widely used distance measurement module that operates by emitting ultrasonic sound waves and measuring the time it takes for the echo to return. It works on the principle of **echo ranging** and provides accurate measurements between **2 cm to 400 cm** with an accuracy of about **3 mm**. The sensor includes two components: a **transmitter (Trig pin)** and a **receiver (Echo pin)**. It is commonly used in obstacle detection and avoidance systems in robotics due to its simplicity, affordability, and reliable performance in various environments.

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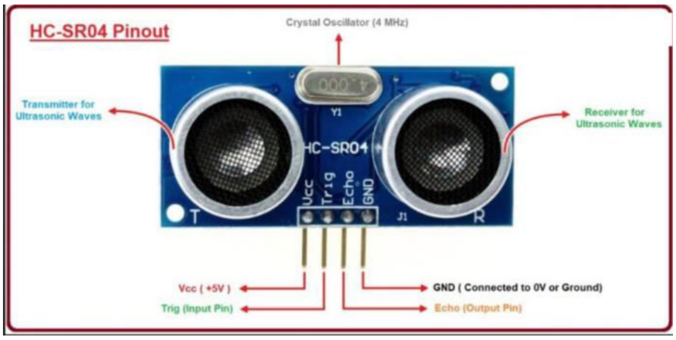

Fig2: Ultrasonic Sensor

3.Metal Detector Circuit (IC555-based)

It uses a 555 timer IC configured in **astable mode** to generate a continuous square wave signal. A **search coil** is connected to the circuit, and when a metallic object comes close to the coil, it causes a change in the inductance. This change affects the oscillation frequency of the 555 timer circuit. The variation is then detected as a signal, typically indicated by an LED or buzzer. This simple and low-cost metal detector setup is commonly used in robotic applications for mine detection or locating concealed metal objects.

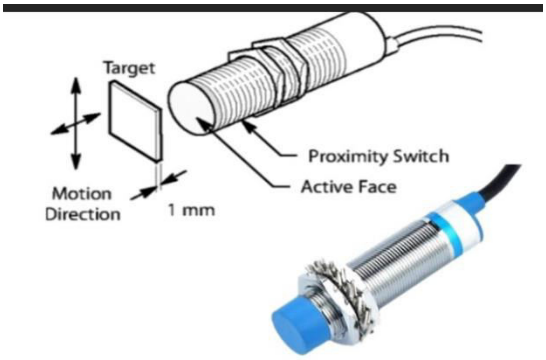

Fig 3: Metal Detector

4.L293D Motor Driver IC:

It is a dual H-bridge motor driver that allows DC motors and stepper motors to be driven in both **forward and reverse directions**. It can control **two DC motors simultaneously**, each in both directions, by using simple logic inputs. The IC can handle voltages up to **36V** and a current of **600mA per channel**. It acts as an interface between the microcontroller (like NodeMCU) and the motors, enabling low-power control signals to drive high-power motors. L293D also features built-in **diodes for back EMF protection**, making it ideal for use in robotic vehicles and other embedded motor applications.

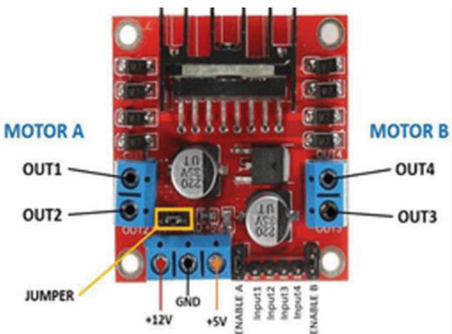

Fig4: L293 Motor Driver IC

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5.Wireless Camera:

Wireless Camera modules are used for real-time video surveillance and monitoring in robotics and IoT applications. These cameras transmit video data over **Wi-Fi** or RF communication to a smartphone or remote display. In this project, a Wi-Fi-enabled camera provides a **live video feed** that can be accessed via a mobile application or web browser using a local IP address. It helps in observing the robot's environment remotely, especially in dangerous or inaccessible areas, making it an essential component for **defence and surveillance robots**.

Fig5: Wireless Camera

6.16x2 LCD Display with I2C:

It is a user-friendly output device used to display alphanumeric characters and symbols. It can show **2 lines with 16 characters each**, making it ideal for compact data display in embedded systems. The addition of the **I2C (Inter-Integrated Circuit) module** drastically reduces the number of GPIO pins required for connection—from 6 or more to just **2 wires (SDA and SCL)**. This makes it perfect for microcontrollers like **NodeMCU**, which have limited I/O pins. The display is commonly used for showing sensor values, system status, or alerts in real-time.

Fig6: 16x2 LCD Display

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VII. SOFTWARE USED

Blynk IoT Platform:

It is a cloud-based platform that allows developers to build, monitor, and control IoT devices using smartphones or web dashboards. It supports a wide range of hardware like **NodeMCU, ESP8266, ESP32**, and Arduino. With Blynk, you can create custom interfaces using **virtual buttons, sliders, gauges, and displays**—all through a drag-and-drop mobile app. It uses **virtual pins** to communicate data between the microcontroller and the app.

In this project, Blynk enables **remote control of the robot, real-time sensor monitoring, and alert notifications**, making it a powerful tool for IoT-based defence and automation systems.

VIII. RESULT

Testing revealed the system performed reliably in indoor and semi-open environments. It detected gas leaks within a 2meter radius, metal objects up to 5 cm depth, and effectively streamed video up to 50 meters on Wi-Fi. The robot also demonstrated reliable obstacle avoidance and timely alerts through the app.

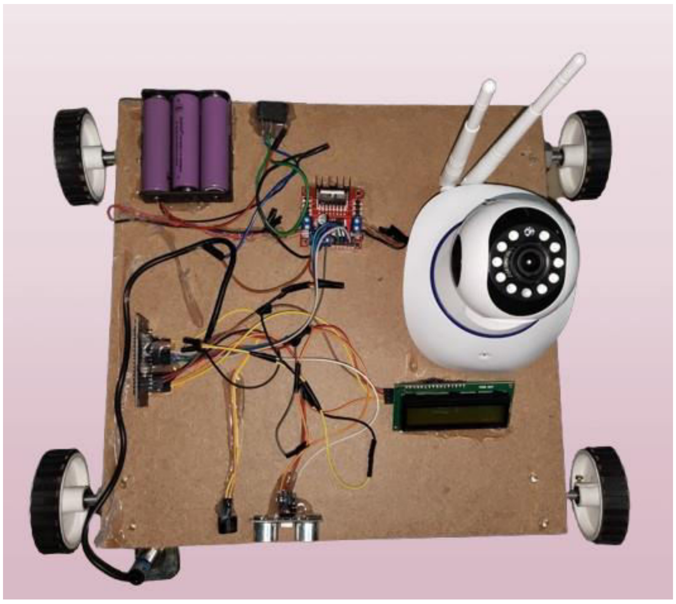

Fig7: Result

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This image shows a **16x2 LCD display module** connected to a robotic system, actively displaying the message:

INFRONT OBJECT DETECTED ALERT:

This indicates that the robot has detected an obstacle in its path—likely using an **ultrasonic sensor**—and is issuing a real-time alert. The LCD, interfaced via an **I2C module**, provides clear and immediate visual feedback, which is essential for debugging, monitoring, and ensuring the robot's autonomous decision-making works effectively in dynamic environments. This alert mechanism helps the robot avoid collisions and enhances operational safety, especially in defence or hazardous zones.

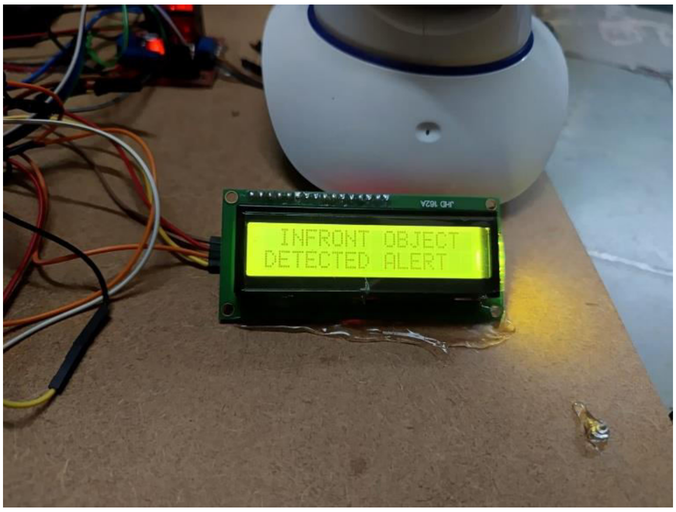

Fig8: Infront Object Detected Alter

LAND MINE IS DETECTED ALERT:

This alert is triggered by the robot's **metal detection module**, likely built around an **IC 555 timer-based circuit**. The system is designed to identify buried metallic objects—such as landmines—beneath the ground. Upon detection, a signal is sent to the microcontroller, which updates the LCD in real time. This feature is crucial for **mine detection in military applications**, enhancing safety by warning soldiers before entering high-risk zones.

Fig9: Landmine is Detected Alert

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IX. CONCLUSION

The project successfully integrates IoT technology with multiple sensors to create a versatile, multifunctional robot tailored for defence and security applications. By leveraging wireless communication via the NodeMCU ESP8266 and the Blynk IoT platform, the robot enables real-time monitoring and remote control from mobile devices. Key features such as metal detection, gas leakage alerts, obstacle avoidance, and live video surveillance enhance the system's capability to operate efficiently in hazardous environments where human intervention is risky.

This robot not only demonstrates the feasibility of low-cost, scalable defence automation but also shows how modular sensor integration can provide multi-layered functionality. Its real-time alert system and visual feedback through LCD and camera modules contribute to improved decision-making and situational awareness in the field.

Future developments could involve the integration of **GPS for location tracking**, **AI-based image recognition** for intelligent threat assessment, **thermal or infrared night vision** for low-light operations, and **solar charging modules** to enhance endurance during long-term deployments. With these advancements, the system can evolve into a fully autonomous solution for surveillance, rescue, and reconnaissance missions in military zones and disaster-prone areas.

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