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PRECISION THREAT DETECTION SYSTEM

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***Abstract*— This project enhances defense capabilities with an advanced dual-sensor system that detects and locates enemy positions along the X and Y axes. The system provides precise spatial data, calculates the estimated time of arrival (ETA) of threats, and securely stores it on a local server with robust password authentication. Authorized personnel can access real-time data from various smart devices via Wi-Fi, enabling rapid response and decision-making. The user-friendly web interface offers strategic insights, improving situational awareness and strengthening defense operations' security posture. This comprehensive solution empowers defense forces with actionable intelligence, enhancing their ability to respond to threats effectively.**

***Keywords*— Defense capabilities, Dual-sensor system, Enemy detection, Positioning (X and Y axes), Spatial data, Estimated time of arrival (ETA), Data security, Password authentication.**

I. INTRODUCTION

A. INTERNET OF THINGS

The defense sector is evolving rapidly, with technology playing a crucial role in enhancing national security. Detecting and locating enemy positions is a key challenge, and this project proposes an advanced dual-sensor system to address it. The system provides precise spatial data and calculates the estimated time of arrival (ETA) of detected threats. With real-time monitoring and strategic insights, defense forces can respond rapidly and effectively. By integrating advanced sensors, robust security, and user-friendly interfaces, this project enhances defense capabilities and modernizes national security infrastructure. The system's versatility and accessibility features facilitate rapid response and decision-making.

B. SCOPE AND OBJECTIVES

This project aims to enhance defense capabilities through an advanced dual-sensor system, detecting enemy positions and calculating estimated time of arrival (ETA). The scope includes developing a secure and user-friendly system for real-time monitoring and strategic insights. The objectives are to provide precise spatial data, ensure data security and confidentiality, and enable versatile accessibility through smart devices. The system will empower defense forces with actionable intelligence for rapid response and decision-making, improving situational awareness and strengthening the overall security posture of defense operations. The goal is to create a comprehensive solution for effective defense operations and threat detection.

C. SYSTEM DESCRIPTION

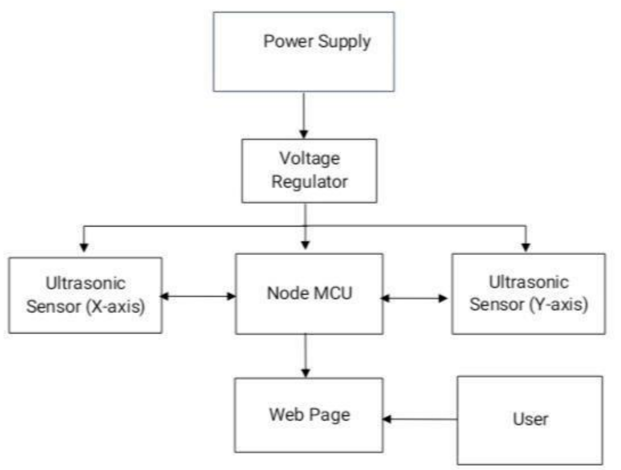

Fig. 1. Block Diagram of proposed system

The proposed system is designed to enhance defense surveillance by accurately detecting and localizing enemy movement along two perpendicular axes (X and Y) using ultrasonic sensors. The system architecture, as depicted in the block diagram, consists of the following core components:

Power Supply and Voltage Regulation The system is powered by a standard DC power source. To ensure compatibility with all electronic components, particularly the NodeMCU and sensors, the voltage is regulated using a voltage regulator. This maintains a stable supply voltage (typically 5V or 3.3V), thereby preventing component damage due to voltage fluctuations.

Ultrasonic Sensors (X-axis and Y-axis) Two ultrasonic sensors are employed to monitor spatial data along the X and Y axes, respectively. These sensors operate by emitting ultrasonic waves and calculating the time taken for the echo to return after hitting an object. This time-of-flight data is used to compute distances and accurately track object positioning in two dimensions. These measurements form the basis for determining the Estimated Time of Arrival (ETA) of incoming threats.

NodeMCU (ESP8266/ESP32) At the heart of the system is the NodeMCU microcontroller, which performs data acquisition, processing, and communication. It receives distance data from the ultrasonic sensors, calculates real-time coordinates and ETA values, and formats this information for transmission. The NodeMCU also hosts a Wi-Fi module that enables wireless communication and data access.

II. SOFTWARE IMPLEMENTATION

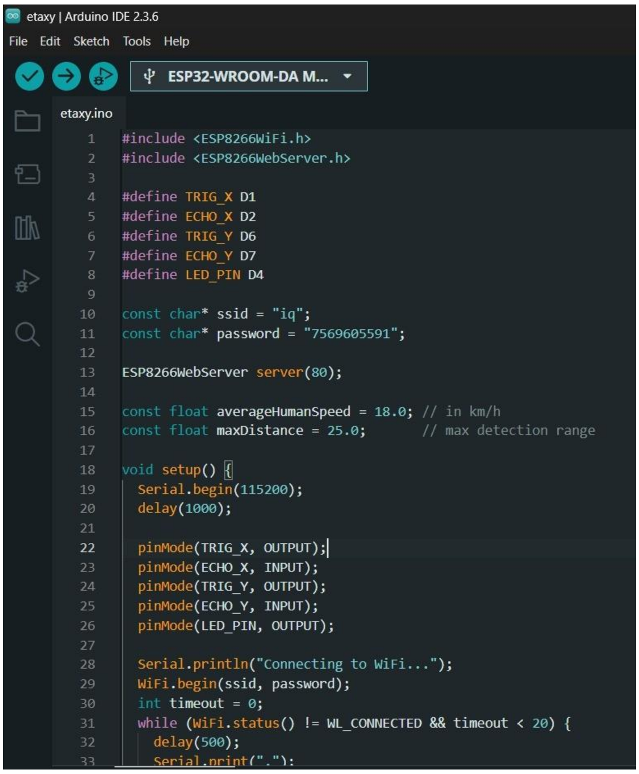

Fig.2 Implementation of Arduino

The **Arduino Integrated Development Environment (IDE)** is an open-source software tool used for writing, compiling, and uploading code to microcontroller boards such as the NodeMCU (ESP8266). It supports multiple libraries, provides an easy-to-use interface, and includes a serial monitor for debugging. We chose the Arduino IDE for this project due to its: User-friendly interface, ideal for rapid prototyping. Extensive community support and library availability, especially for IoT applications.Compatibility with the ESP8266 board, which is essential for connecting to Wi-Fi and hosting a web server. Using the Arduino IDE allowed us to quickly write and test embedded C++ code while directly interacting with the NodeMCU hardware.

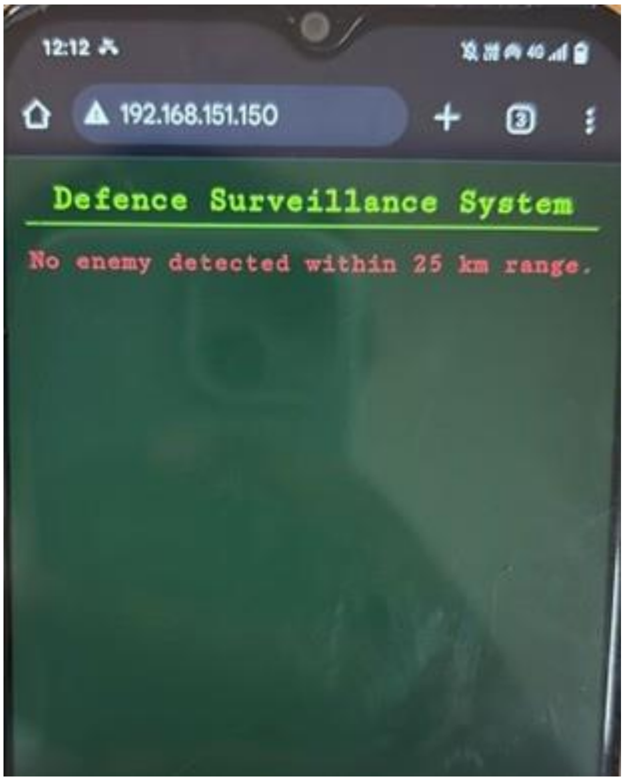

Fig.3 Web Interface

Web Interface Processed data from the NodeMCU is transmitted to a locally hosted web page. This web interface is accessible over a secured Wi-Fi network by authorized users. The interface displays real-time location data, distance measurements, and threat ETA in a user-friendly graphical format. It enhances situational awareness and provides actionable intelligence for quick decision-making.

III. THREAT DETECTION

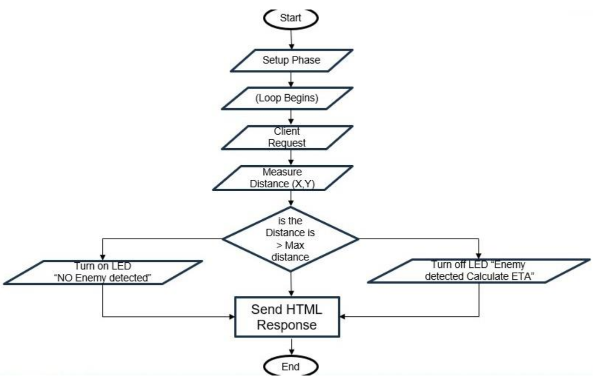

Fig.3 Flow Chart

The implemented system follows a structured and continuous workflow, as illustrated in the flowchart. The process begins with the initialization of the microcontroller and peripheral devices in the setup phase. During this phase, necessary components such as the ultrasonic sensors and the LED indicator are configured, and a Wi-Fi connection is established to enable communication with a web server hosted on the NodeMCU. Once the setup is complete, the system enters a loop where it continuously listens for client requests through the browser interface.

When a client request is received, the system proceeds to measure the distance using two ultrasonic sensors placed along the X and Y axes. These sensors emit ultrasonic pulses and detect the time taken for the echo to return, allowing the system to calculate the distance of an object from the reference point. This calculated distance is then compared to a predefined maximum threshold value which defines the boundary of the surveillance area.

Based on this comparison, the system takes appropriate action. If the measured distance exceeds the maximum range, it indicates that no object or potential threat is within the sensitive area. In this case, the system turns on the LED and updates the web page to display a message stating "No Enemy Detected." On the other hand, if the object is within or equal to the maximum detection range, the system interprets this as a potential enemy presence. As a result, it turns off the LED to signify a warning and calculates the Estimated Time of Arrival (ETA) based on the object's speed. The web page is then updated to show "Enemy Detected" along with the calculated ETA.

Finally, the NodeMCU sends an HTML response containing the detection status, measured distances, object speed, and ETA. This response is displayed on the client-side browser for real-time monitoring. Once this cycle is completed, the system returns to the beginning of the loop, ready to handle the next request. This continuous and automated process ensures efficient and real-time enemy detection for surveillance applications.

IV. CIRCUIT DIAGRAM

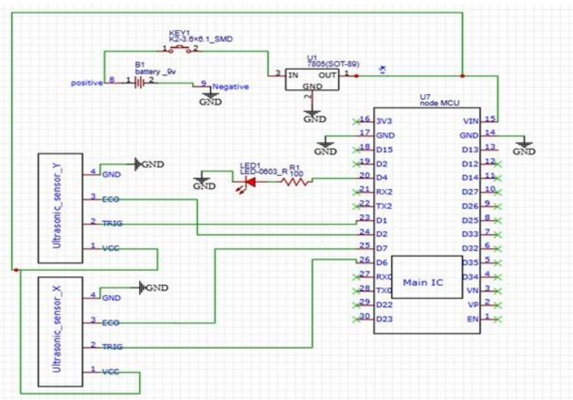

Fig.4 . Circuit Layout

The schematic diagram represents the complete hardware configuration of a surveillance system based on a NodeMCU microcontroller and ultrasonic sensors. The system is powered by a 9V battery (B1), which supplies voltage through a push-button switch (KEY1). To regulate the supply for the NodeMCU and other components, a 7805 voltage regulator (U1) is used to convert the 9V battery voltage down to a stable 5V output. This regulated 5V is then connected to the VIN pin of the NodeMCU (U7) and also powers the ultrasonic sensors.

Two ultrasonic sensors, labeled as Ultrasonic Sensor X and Ultrasonic Sensor Y, are used to detect the presence and position of an object in two-dimensional space. Each sensor has four pins: VCC (power), GND (ground), TRIG (trigger), and ECHO (echo). The VCC and GND of both sensors are connected to the 5V regulated output and ground respectively. The TRIG pins of both sensors are connected to separate GPIO pins on the NodeMCU, which send trigger pulses to initiate the distance measurement. The ECHO pins are also connected to separate GPIOs on the NodeMCU, which receive the reflected signals to calculate distance based on the time-of-flight principle.

An LED (labeled LED1) with a current-limiting resistor (R10) is connected to a GPIO pin on the NodeMCU to provide visual indication. When the system detects no object within the defined range, this LED is turned on. In contrast, the LED is turned off when an object or “enemy” is detected within the danger zone. This visual feedback is crucial for real-time awareness. The NodeMCU uses its digital pins (e.g., D1, D2, D6, D7, etc.) to handle the sensor input and output control, and it also manages the communication with the web server for client-side monitoring.

Overall, this hardware setup forms the foundation for a real-time enemy detection and tracking system. The regulated power supply ensures reliable operation, while the dual ultrasonic sensors and LED indicator enable effective two-dimensional area monitoring and immediate feedback.

V. RESULTS AND DISCUSSION

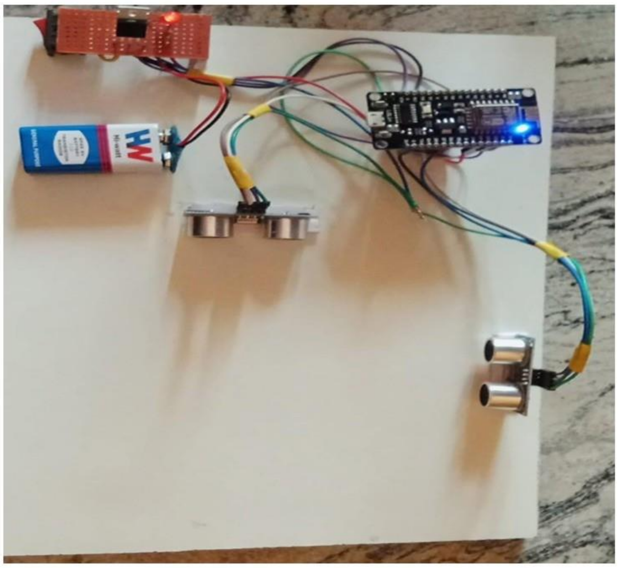

Fig.5 Prototype

The Defence Surveillance System is an innovative prototype designed to detect enemy presence within a predefined range using ultrasonic sensors and to display real-time data on a web interface. The system primarily comprises two ultrasonic sensors (sensor X and sensor Y), a NodeMCU ESP8266 microcontroller, a 9V battery, and a 7805 voltage regulator circuit. These ultrasonic sensors are strategically placed in perpendicular directions (X-axis and Y-axis) to detect obstacles or motion in two dimensions. The sensors operate by emitting ultrasonic waves and calculating the time it takes for the echo to return, using this duration to estimate the distance of the object from each axis. The formula used to calculate distance is:

Distance = (duration × 0.0343) / 2,

where 0.0343 cm/µs is the speed of sound in air.

The 9V battery powers the entire setup, and the 7805 voltage regulator ensures a stable 5V supply to the sensors and the NodeMCU. The NodeMCU gathers the distance data from both sensors, processes it, and serves it over a Wi-Fi-based web page. When no object is detected within the critical range (25 km in the simulated setup), the web page simply displays **"No enemy detected within 25 km range"** in red text under a green header. However, once an object is detected within the range on either axis, the system calculates the distances in both X and Y directions, computes the total distance, estimates the speed (based on successive readings), and calculates the Estimated Time of Arrival (ETA) to the defense line using the average speed.

All this information is displayed on the web interface in tabular form, including values such as **X-axis Distance, Y-axis Distance, Total Distance, Speed, and ETA**, along with the formulas used for each. This allows operators to quickly interpret enemy movement patterns and prepare appropriate defense actions. The physical prototype includes neatly wired components mounted on a baseboard, with LEDs indicating power status. The project effectively demonstrates a simple yet powerful IoT-based defense monitoring system using accessible components and real-time wireless communication

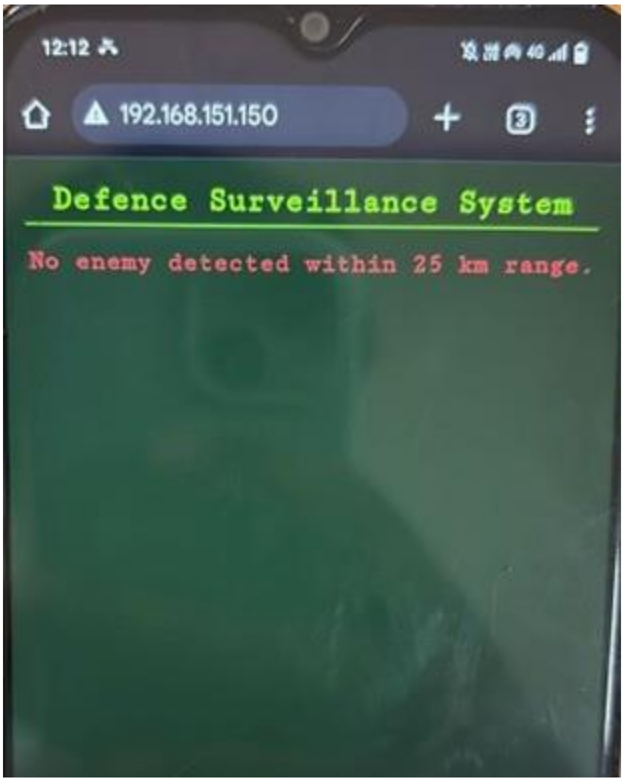

Fig.6 Before Enemy Detection

Fig.7 Once Enemy Detected

VI. CONCLUSION

The Defence Surveillance System successfully demonstrates how basic electronic components and sensors can be integrated with IoT technology to monitor and detect enemy movement in real-time. By using ultrasonic sensors and a NodeMCU, the system can accurately calculate distances, estimate speed, and provide an ETA of an approaching object. The real-time data displayed on a web interface makes it easy to monitor the surroundings efficiently. This project shows the potential for low-cost, effective surveillance solutions in defense and security applications.

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