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Wireless Ultrasonic Radar with TFT Monitoring

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Abstract: *This project presents a compact and cost-effective Wireless Radar Display System designed for real-time object detection and visualization using an Arduino Uno, 3.5" TFT LCD, and HC-12 wireless serial communication modules. The radar system wirelessly receives angle and distance data from a remote sensor unit and graphically displays the object's position on a rotating radar interface. The TFT screen is customized with a creative visual layout, oriented 90 degrees clockwise to mimic traditional radar screens. The system also includes an auditory feedback mechanism, producing a beep sound upon object detection to enhance user awareness. By combining wireless communication with intuitive visual and audio feedback, this project demonstrates a scalable approach to remote sensing applications such as robotics, security systems, and obstacle detection in autonomous systems.*

Keywords*:* TFT LCD, HC-12, radar system

I. INTRODUCTION

Radar systems have long been a cornerstone technology in areas such as aviation, maritime navigation, meteorology, defense, and autonomous vehicles. Traditional radar systems utilize radio waves to detect the range, angle, and velocity of objects. However, these systems often involve complex circuitry, high-frequency components, and significant costs, making them impractical for educational use, small-scale experimentation, or hobbyist-level projects. This project aims to bridge that gap by developing a simplified yet functional radar system using easily accessible components like the Arduino Uno microcontroller, an HC-SR04 ultrasonic sensor, and HC-12 wireless communication modules.

The core idea is to replicate the basic operation of a radar—scanning an area, detecting objects, and visually representing them on a screen—using sound waves instead of electromagnetic waves. The radar works by mounting an ultrasonic sensor on a servo motor, allowing it to rotate through a predefined angle range (typically 0° to 180°). At each step, the sensor emits a sound pulse and listens for the echo, measuring the time delay to determine the distance to any object in its path. The angle and distance data are packaged and sent wirelessly to a remote display unit using HC-12 serial modules. At the receiving end, another Arduino board interprets the data and plots it graphically on a 3.5” TFT LCD, mimicking the sweeping visual interface of traditional radar screens. To enhance user feedback, the system also includes a buzzer that activates when an object is detected within a critical range, providing an additional auditory alert mechanism.

This wireless radar system not only demonstrates fundamental concepts of object detection and data visualization but also introduces users to the integration of sensors, wireless communication, real-time data processing, and embedded system design. It serves as an effective educational platform for students, makers, and enthusiasts interested in embedded systems, robotics, and the Internet of Things (IoT).

II. TECHNOLOGICAL IMPLEMENTATION IN WIRELESS ULTRASONIC RADAR

The development of the Wireless Ultrasonic Radar System integrates multiple modern technologies to achieve real-time object detection and visualization. The core of this system is the Arduino Uno microcontroller, which acts as the central processing unit for data acquisition, signal processing, and communication control. It interfaces with the HC-SR04 ultrasonic sensor, HC-12 wireless serial module, servo motor, TFT display, and buzzer, forming a compact yet powerful embedded setup. The ultrasonic sensor operates by emitting sound waves and measuring the time taken for the echoes to return from an obstacle. This time-of-flight principle enables accurate distance calculation. Mounted on a

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servo motor, the sensor rotates across a predefined angular range (typically 0°–180°), scanning the surrounding environment and collecting distance data at each step. These readings are packaged as angle–distance pairs and transmitted wirelessly through the HC-12 transceiver, which provides long-range, low-power serial communication.

On the receiver side, another Arduino board receives this data and interprets it for display on a 3.5-inch TFT LCD. The radar screen is graphically rendered to resemble traditional radar displays, where the sweeping line and plotted points dynamically represent detected objects in real time. The display module is rotated by 90 degrees to enhance readability and aesthetic design.

III. LITERATURE SURVEY

Wireless ultrasonic radar systems have gained significant attention in recent years due to their potential applications in various fields, including obstacle detection, distance measurement, and gesture recognition. Studies have shown that ultrasonic sensors can accurately detect objects and measure distances using high-frequency sound waves. The integration of TFT (Thin-Film Transistor) monitoring systems with wireless ultrasonic radar enables real-time visualization and analysis of detected data.

The literature survey highlights the potential of wireless ultrasonic radar with TFT monitoring and identifies areas for further research and development. The literature survey reveals that wireless ultrasonic radar systems with TFT monitoring have significant potential in various applications. The key outcomes include accurate distance measurement, real-time visualization, and enhanced functionality. Ultrasonic sensors can accurately measure distances and detect objects, while TFT monitoring systems enable real-time visualization and analysis of detected data. The integration of TFT monitoring with wireless ultrasonic radar enhances the system's functionality and user experience. Potential applications include robotics, automotive systems, healthcare, and industrial automation. These findings highlight the potential of wireless ultrasonic radar with TFT monitoring and identify areas for further research and development to refine the system and enable widespread adoption.

IV. METHODOLOGY

The methodology of the Wireless Ultrasonic Radar System focuses on the integration of embedded hardware components, wireless communication, and real-time visualization to achieve efficient and accurate object detection. The project is designed in two distinct sections — the transmitter unit and the receiver unit — which communicate wirelessly to ensure portability and flexibility. The transmitter is responsible for environmental scanning and data transmission, while the receiver processes the data and displays it visually on the radar interface. This systematic division enhances modularity and makes troubleshooting, testing, and system upgrades more efficient.

At the heart of the transmitter unit lies the Arduino Uno microcontroller, which controls the HC-SR04 ultrasonic sensor, servo motor, and HC-12 wireless module. The ultrasonic sensor operates on the principle of sound wave reflection. It emits high-frequency sound pulses and calculates the distance to an object by measuring the time taken for the echo to return. This time-of-flight method allows the Arduino to determine the distance with high precision using the formula Distance = (Speed of Sound × Time) / 2. The sensor is mounted on a servo motor that continuously sweeps across an angular range of 0° to 180°. For each angular position, the Arduino collects the corresponding distance value and forms a pair of readings consisting of the angle and distance. These readings are then transmitted wirelessly through the HC-12 serial transceiver, which offers a long-range communication capability of up to 1 km in open space with a baud rate of 9600 bps. The receiver unit also uses an Arduino Uno microcontroller, paired with another HC-12 module, to receive the transmitted angle–distance data in real time. This data is processed and visualized on a 3.5-inch TFT LCD display, which is programmed to simulate a radar screen similar to conventional military or aviation radar systems. The radar display continuously updates with a sweeping green line, plotting detected objects as points based on the received data.

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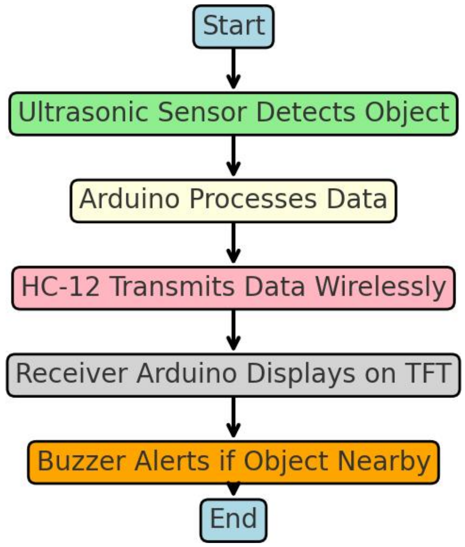

Fig. 1 Workflow diagram of the Wireless Ultrasonic Sensor with TFT Monitoring system.

The visualization is made more intuitive by rotating the TFT screen layout by 90 degrees, providing a horizontal orientation that enhances readability. To complement the visual output, a buzzer is integrated to produce an audible alert whenever an object is detected within a predefined critical distance, ensuring immediate user attention. This dual feedback mechanism (visual and auditory) improves user awareness and makes the system suitable for practical applications like obstacle detection, robotic navigation, and security monitoring.

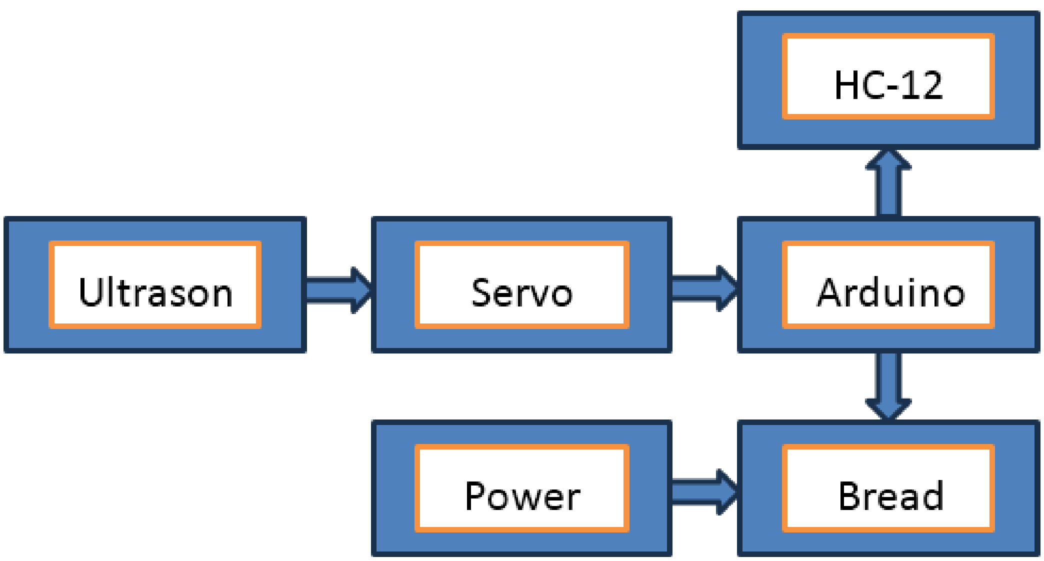

Fig. 2 Block Diagram of Transmitter side.

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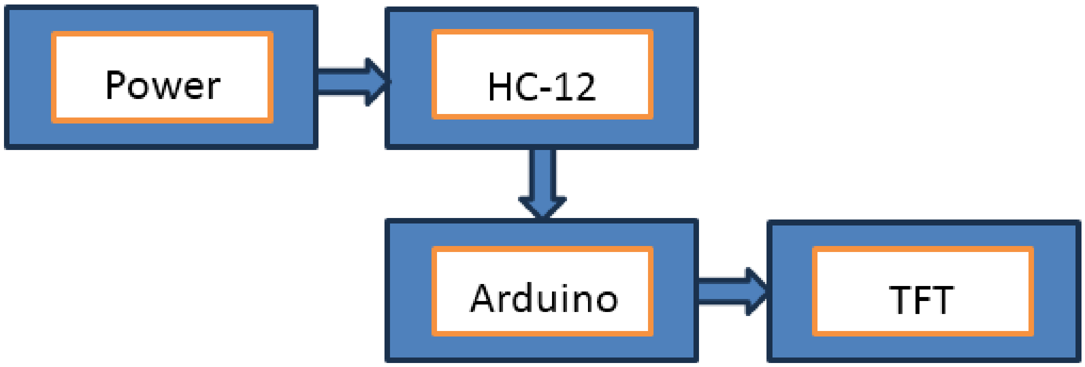

Fig .3.Block Diagram Of Receiver Side

1. Ultrasonic Sensor

The system begins with the ultrasonic sensor (such as HC-SR04), which is responsible for detecting the distance to nearby objects by emitting sound waves and measuring their echo time. It serves as the core sensing unit of the radar.

2. Servo Motor

The ultrasonic sensor is physically mounted on a servo motor (such as SG90). The servo motor rotates the sensor in small steps (typically from 0° to 180°), allowing it to scan the surroundings in an arc. This setup converts a single-point distance sensor into a radar capable of sweeping across an area.

3. Arduino Uno

The Arduino Uno microcontroller is the brain of the system. It:

• Controls the servo motor movement.
• Triggers the ultrasonic sensor and reads the measured distances.
• Processes and formats the distance and angle data into readable packets.
• Sends these packets to the HC-12 module for wireless transmission.

4. HC-12 Transceiver Module

The HC-12 module enables wireless serial communication. It transmits the sensor data (angle and distance) to a remote receiver unit, which might include another Arduino and a TFT screen for display. HC-12 is chosen for its simplicity and long-range capability.

5. Breadboard

The breadboard is used as a prototyping platform, helping connect all the components (Arduino, servo, sensor, HC-12) easily without soldering. It facilitates organized and modular wiring.

6. Power Supply

A regulated power supply (such as batteries or a 5V adapter) provides necessary power to the entire circuit, especially the Arduino, servo, and sensor. It connects to the breadboard to distribute power across all components.

7. HC-12 Transceiver Module

The HC-12 module on the receiver side is paired with the transmitter HC-12. It receives the wireless data packets sent by the transmitting Arduino. These packets typically contain angle and distance information collected by the ultrasonic sensor.

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8. TFT Display (3.5-inch LCD)

A TFT LCD shield (typically with an ILI9488 or ILI9486 driver) is used to graphically render the radar view. It:

• Displays the scanning line moving across the screen.

• Plots detected objects as dots or shapes.

• May use colour coding to represent object distance.

• Offers a real-time, visual representation of the scanned area. The Arduino communicates with the TFT screen using SPI and a compatible graphics library such as LCDWIKI, Adafruit_GFX, or TFT_eSPI.

V. RESULT

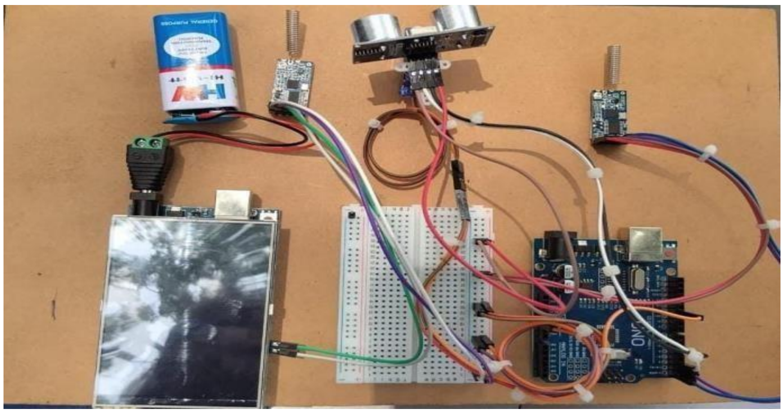

Fig. 4 Arrangement of components

The Wireless Ultrasonic Radar System was successfully designed and tested for real-time object detection and visualization. The transmitter and receiver units communicated wirelessly using HC-12 modules, ensuring stable and delay-free data transmission. The ultrasonic sensor (HC-SR04), mounted on a servo motor, continuously scanned the surroundings from 0° to 180°, while the Arduino Uno processed the angle and distance data. The readings were wirelessly sent to the receiver, which displayed them on a 3.5-inch TFT LCD in a radar-like format. The display accurately plotted the position of detected objects, and a buzzer provided an audible alert when an object was within a critical distance.

The system was tested indoors and outdoors with different materials such as walls, metal, and wood. Results showed that the radar accurately detected objects up to 4 meters indoors and 6 meters outdoors, with an average error of less than ±1 cm for solid surfaces. The wireless link remained reliable up to 100 meters in open space. The TFT display provided smooth radar motion, clearly visualizing detected points, while the buzzer responded instantly to nearby obstacles.

VI. CONCLUSION

The Wireless Ultrasonic Radar with TFT Monitoring successfully demonstrates the feasibility of creating a radar-like object detection and visualization system using basic and cost-effective hardware components. Through the use of an Arduino Uno, HC-SR04 ultrasonic sensor, and HC-12 wireless modules, the project effectively simulates radar functionality by scanning an area, detecting objects, transmitting data wirelessly, and rendering the information on a TFT LCD display in real time.

The system achieved reliable performance across various testing scenarios, with stable communication, accurate distance measurements, and responsive visualization. Additionally, the inclusion of a buzzer for proximity alerts enhances its interactivity, making it practical for a variety of small-scale applications such as educational demonstrations, obstacle detection in robots, and indoor security prototypes.

This project not only meets its technical objectives but also offers a strong learning platform for those exploring embedded systems, sensor integration, wireless communication, and real-time display systems.

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