IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ESP32 Based Ultrasonic Radar System With TFT Visulization And Object Detection

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ABSTRACT

This project gives the best solution to replace the present paper-board system with advanced electronic notice board. Wireless electronic notice board have been designed, which completely eliminates paperwork and reduces the manual word and time. Building and reduces the manual word and time. Building a IOT based projects gives the fast transformation of data and the user can access the data from anywhere in the world. In this project, we have developed a **IOT based smart notice board**. The main objective of this project is developing an automatic, self- enabled and highly reliable electronic notice board. A display connected with the cloud will continuously waiting for the message from the user; if the user uploads the data through the server. The user can write the data from anywhere in the world . This will reduce the time to update the data as well as it will efficiently transfers the data to the end user.

INTRODUCTION:-

We know everything produces sound wave just by existence and effect flow of air around them with their natural frequency. These frequencies are beyond hearing range of humans. Wave of frequency range of 20000hz and thereabouts are called ultra-sonic wave and these waves can be detected by an ultrasonic sensor which helps us to get various knowledge. An Ultrasonic

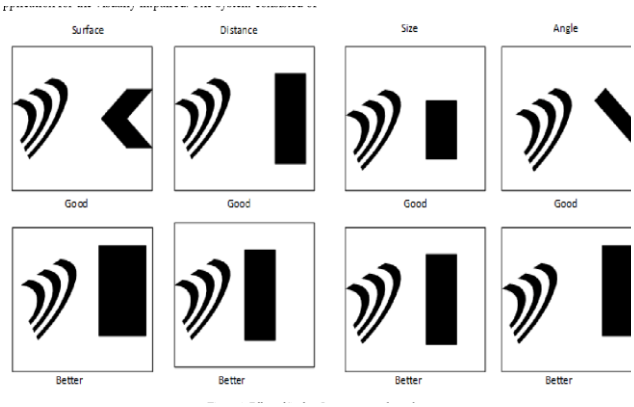
detector usually has a transducer which convert sound energy into electrical energy and electrical energy into sound energy. They are used for measuring object position and orientation, collision avoidance system, surveillance system etc. Ultrasonic technology provide relief from problem such as linear measurement problem, as it allows user to get non-contact measurements in this way distance between object and its speed etc can me easily measured. Speed of travel of sound wave depends upon square root of ratio between medium density and stiffness. Also, property of speed of sound can also be changed by natural environment condition like temperature. So basically, an ultrasonic sensor sends ultrasonic waves which travels in air and gets reflected after striking any object. By studying the property of reflected wave, we can get knowledge about objects distance, position, speed etc. A processing software and an Arduino software is used with hardware system for detection of objects various parameters. One of the most common application of ultra-sonic sensor is range finding. It is also called as sonar which is same as radar in which ultrasonic sound is directed at a particular direction and if there is any object in its path it strikes it and gets reflected back and after calculation time taken to come back we can determine distance of object. in real life this method is used by bats.

Key Future Scopes and Enhancements:

- **Sensor Upgrades & Fusion:** Replacing HC-SR04 with superior ultrasonic sensors or LiDAR for longer range and better accuracy. Combining ultrasound with infrared or camera sensors for improved detection.
- **IoT and Wireless Connectivity:** Integrating WiFi or Bluetooth modules (e.g., ESP32) to send data to a smartphone or cloud platform for real-time, remote monitoring.
- **AI and Machine Learning:** Implementing machine learning to enable the system to identify, classify, and respond intelligently to specific types of objects.
- **Advanced Mapping & 360-Degree View:** Using a specialized motor mount to achieve a full 360-degree scan for 3D mapping of the environment.
- **Enhanced Performance:** Utilizing faster servomotors for quicker scanning and higher data collection speed.
- **Application Expansion:** Moving beyond basic detection to autonomous robot navigation, advanced drone obstacle avoidance, and smart home security systems.

2. Related Literature :-

great many applications have been found for the ultrasonic sensing technology since its emergence and some of these include home security systems, robotics applications, distance measurement, tank level measurement, in production lines, and proximity detection applications . These innumerable applications have made it possible to solve technical problems faster and cheaper without compromising safety, quality and stability . The authors in addressed the use of ultra-sonic sensing capability for home security. The system's design is in such a way that the ultra-sonic sensor is mounted on a servo motor to allow a full 3600 rotations so that in any direction an intruder approaches, the sensor would be able to detect the proximity. Once an intruder is detected, the system automatically emits a beeping sound and following this, an SMS message is sent to the home owner, informing him of an intruder in the house using a GSM module. The authors indesigned a system to aid vehicle drivers to navigate blind spots easily in traffic by installing an ultra-sonic sensor on the vehicle's behind and light on the dashboard to indicate the proximity of other commuters that are coming behind. The sensor is calibrated as a range detecting apparatus and a threshold value set. The driver gets a flash of light on the dashboard when oncoming vehicles become closer than this threshold value.



In the authors designed and constructed a navigatetion application for the visually impaired. The system consisted of an embedded device for detecting local obstacles and an android application for issuing direction to the user verbally. The embedded device uses an ultra-sonic sensor for detecting local obstacles like cars, walls etc. and the data obtained from the ultra-sonic sensor is transmitted to the android application where appropriate decisions are made base on the incoming data and the user is advised accordingly. The remote monitoring system that was designed and constructed in features the use of ultra-sonic sensors for obstacle avoidance. The system comprises of a remote station (the robot) and a base station (user) who can send commands to the remote station for teleoperation. The remote station comprises of a GPS device, a GSM module, an ultra-sonic sensor-based obstacle avoidance system, a web enabled camera for remote monitoring. Based on the incoming data from the obstacle avoidance system, the GPS system, and the camera, the user is able to send commands to the remote station to alter course or otherwise. Sound Reflection For any meaningful measurement of the distance travelled by sound, the sound needs to be reflected because sound is only reflected when the dimension of the reflective surface is large compared to the wavelength of the sound. Figure 1 illustrates the effect that the dimension of the target surface has on measurement.

Surface: An ideal target surface is hard and smooth. This surface reflects a greater amount of signal than a soft, rough surface. A weak echo is the result of a small or soft object. This reduces the operating distance of an ultrasonic sensor and decreases its accuracy.

Distance: The shorter the distance from the ultrasonic sensor to an object, the stronger the returning echo is. Therefore, as the distance increases, the object requires better reflective characteristics to return a sufficient echo.

Angle: The inclination of an objects' surface facing the ultrasonic sensor affects how the object reflects. The portion perpendicular to the sensor returns the echo. If the entire object is at a greater angle, the signal is then reflected away from the sensor and no echo is detected.

size: A large object has more surface area to reflect the signal than a small one. The surface area recognized as the target is generally the area closest to the sensor.

Applications of Sound Reflection: Ultrasonic radar systems were birthed in the defense industry. Because of its myriad applications in under-water object sensing and identification plus identification and tracking of in-coming missiles and vessels , the navy and the air force are major names in the RADAR utilization community. In recent times, applications of this technology have diversified into consumer products such as automatic parking systems, accident prevention systems, and aircraft flight control systems. Another application is in the field of robotics where this technology is now being used by robots as a cheap way to detect, identify and if need be, avoid objects. This is especially effective as robotic home appliances need not have cameras in order to perform their assigned duties like vacuuming, exterminating household pests.

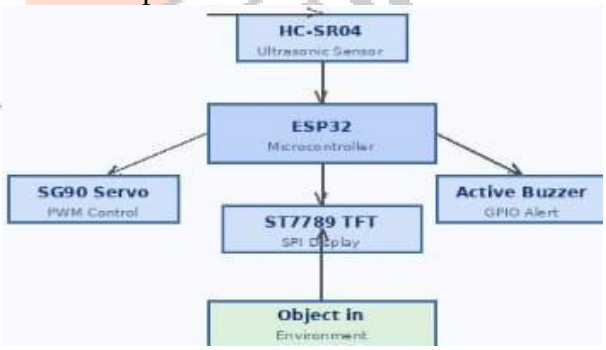
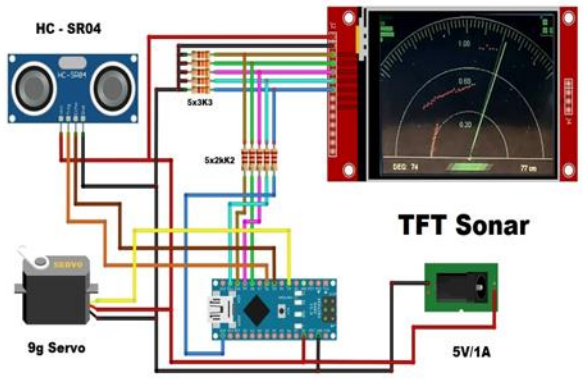


Fig no.1 Block diagram IOT Based Radar Model Using Ultrasonic Sensor



Figno. IOT Based Radar Model Using Ultrasonic Sensor

Choose an Arduino Nano (v3.0). Unlike the **ESP8266 or ESP32,** this board does not have Wi-Fi but is perfect for processing sensor data and controlling displays.Ultrasonic Sensor & ServoThe HC-SR04 is used to measure distances, while the 9g Servo rotates the sensor to scan the area (0° to 180°), acting like a physical radar sweep.TFT Display & Logic Shifting A 240x320 TFT Display (ILI9341) is used to visualize the radar map. Since the Arduino outputs 5V and the display requires

3.3V, 2.2kΩ and 3.3kΩ resistors are used as voltage dividers to protect the screen.

Power Supply

Provide a stable 5V/1A external power supply. This is critical because the servo motor can draw high current, which might cause the Arduino to crash if powered only by a computer's USB port.

CONCLUSION

Effective Prototyping: The system successfully detects stationary and moving objects within a short range (typically 2cm to 400cm using an HC-SR04 sensor) and maps their position in real-time.

Operational Precision: By rotating the sensor on a servo motor (often 0° to 180°), the system provides a wide-angle sweep that accurately identifies an object's distance and angle relative to the source.

Visual Representation: Integrating the hardware with software like Processing IDE allows for a professional, radar-like graphical interface, displaying detected obstacles as points or arcs.

Cost-Efficiency: Unlike high-end military or industrial radar that uses expensive radio wave hardware, this model uses inexpensive, widely available components like the Arduino Uno, making it ideal for educational and hobbyist projects.

FUTURE WORKS

1. **Health Monitoring and Wellness Features:** With growing interest in health and wellness, future iterations of the Bluetooth clock could incorporate advanced health monitoring features such as sleep tracking, stress detection, and biometric analysis. These features could provide users with valuable insights into their well-being and support proactive health management.

2. **Enhanced Customization and Personalization:** Offering users greater control over customization and personalization could be a key focus for future development. This could include features such as customizable clock faces, dynamic lighting effects, and adaptive alarms tailored to

➢ REFERENCE:

Key Academic & Research Papers

"Short Range Radar System using Arduino Uno" — Bochare, A., & Saini, M. (2017). Published in the International Research Journal of Engineering and Technology (IRJET).

"Radar System using Arduino and Ultrasonic Sensor" — Mehta, S., & Tiwari, S. (2018). Featured in the International Journal of Novel Research and Development (IJNRD).

"Design and Implementation of Ultrasonic Radar System for Distance Measurements" — Published in the International Journal of Engineering & Technology (2018).

"Ultrasonic RADAR Using Arduino Uno" — Ali, Haitham K., et al. (2015). Published in the International Journal of Emerging Science and Engineering (IJESE).

2. Technical Documentation & Manuals

HC-SR04 Ultrasonic Sensor Datasheet — Provides essential pinout details and timing diagrams for the trigger (10µs pulse) and echo signals.

Foundational Textbooks:-

"Introduction to Radar Systems" — Merrill I. Skolnik (1980). A seminal text on the physics and math behind ranging and detection.

"Getting Started with Arduino" — Massimo Banzi & Michael Shiloh (2014). Essential for beginners understanding hardware interfacing.

"Programming Arduino: Getting Started with Sketches" — Simon Monk (2016). Detailed guide for writing efficient code for sensor-based projects.