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Review of Low-Cost Object Tracking Systems Using Arduino and Ultrasonic Sensors

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Abstract: *This project involves the development of a compact radar system utilizing Arduino technology to detect and track objects. An ultrasonic sensor is employed to measure the distance to these objects, while a servo motor facilitates the movement of the sensor in various directions. The radar data is displayed on a computer screen. This system proves beneficial in fields such as security, robotics, and monitoring. It is both costeffective and straightforward to construct. This initiative demonstrates the integration of sensors and microcontrollers to produce a functional radar system model. Radar serves as an object detection mechanism that employs radio waves to ascertain the range, altitude, direction, or speed of objects. The sensor emits waves that are used to gauge the distance to an object. The microcontrollers on the Arduino board can be programmed using C and C++ programming languages. When code is developed in the Arduino UNO IDE software, it can be connected to the board via a USB cable.*

Keywords: Arduino Uno, Ultrasonic Sensor, Servo Motor, Radar, Object Detection, Tracking, Distance, Angle, Real-time Scanning, Embedded System

I. INTRODUCTION

Radar technology plays a crucial role in various fields such as defense, aviation, automotive, and meteorology. Large radar systems tend to be expensive and complex; however, by utilizing small microcontrollers and sensors, we can create simpler models that function in a comparable manner. In this initiative, titled Object Tracking Using Arduino Radar System, we are developing a compact radar version using affordable components. An ultrasonic sensor is employed to identify objects by emitting sound waves and measuring the time it takes for them to return. A servo motor facilitates the rotation of the sensor, enabling it to scan in multiple directions.

The Arduino processes this information and transmits it to a computer. On the computer, the data is presented on a radar-like interface (graphical display). This project serves as an excellent educational tool for understanding object detection, distance measurement, and data visualization. It can also be utilized in robotics, small security systems, and automation projects to enhance environmental awareness.

The system is capable of tracking objects within a range of 2-400cm. To address this limitation, Arduinobased radar systems offer a budget-friendly and straightforward approach to object detection and tracking. By using an ultrasonic sensor mounted on a servo motor and connected to an Arduino microcontroller, the system can ascertain the presence, distance, and location of objects within a defined range.

The servo motor's movement allows the sensor to sweep across an angular field, effectively mimicking radar functionality. The acquired data can be visualized on a computer screen through Processing IDE or similar graphical platforms, which illustrate the radar-like scanning motion and emphasize the detected objects in realtime. This project exemplifies how embedded systems and sensors can be combined to create a low-cost radar model applicable for surveillance, robotics, and obstacle detection.

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II. LITERATURE SURVEY

Table 1: Comparative review of Object Tracking Using Arduino Radar System

Paper / Project	System Architecture	Cost	Ease of Implementation	Performance	User Experience	Limitations
Kumar et al. [1]	Arduino based Radar using ultrasonic sensor	Low (<Rs 2000)	Moderate (requires sensor integratio n)	Accurate Time tracking	Simple interface	Limited range
Patel& Sharma [2]	Arduin o Radar with servo motor	Moder ate (<Rs 3000)	Easy (Basic coding needed)	Real time tracking	User friendly app control	Dependent on servo accuracy
Singh et al.[3]	Arduino based Radar with HCSR04	Low (<Rs 1500)	Easy (Plug & Play setup)	Realible short range detection	Basic display output	Limited detection angle
Rao &Raddy [4]	Arduino Radar using IR sensor	Low (<Rs 1000)	Moderate (Sensor collibration needed)	Fast response time	Simple LED indicator s	Limited range & accuracy
Jain & Mehta. [5]	Arduino Radar with ultrasonic sensor	Moder ate (<Rs 2500)	Moderate (Bluetooth Integeation)	Real time tracking with alerts	Mobile app notificat ion	Limited Range due to Bluetooth
Verma et al. [6]	Arduino based detection	Low (<Rs 1800)	Easy (pre-built libraries)	Accurate obstacle detection	Basic LCD display	Limited multi object tracking

III. PROPOSED METHODOLOGY

The suggested approach for Object Tracking utilizing the Arduino Radar System relies on the concept of ultrasonic sensing combined with real-time angular scanning. This system is engineered to identify and monitor the location of objects within a defined range by assessing both the distance and direction of the target.

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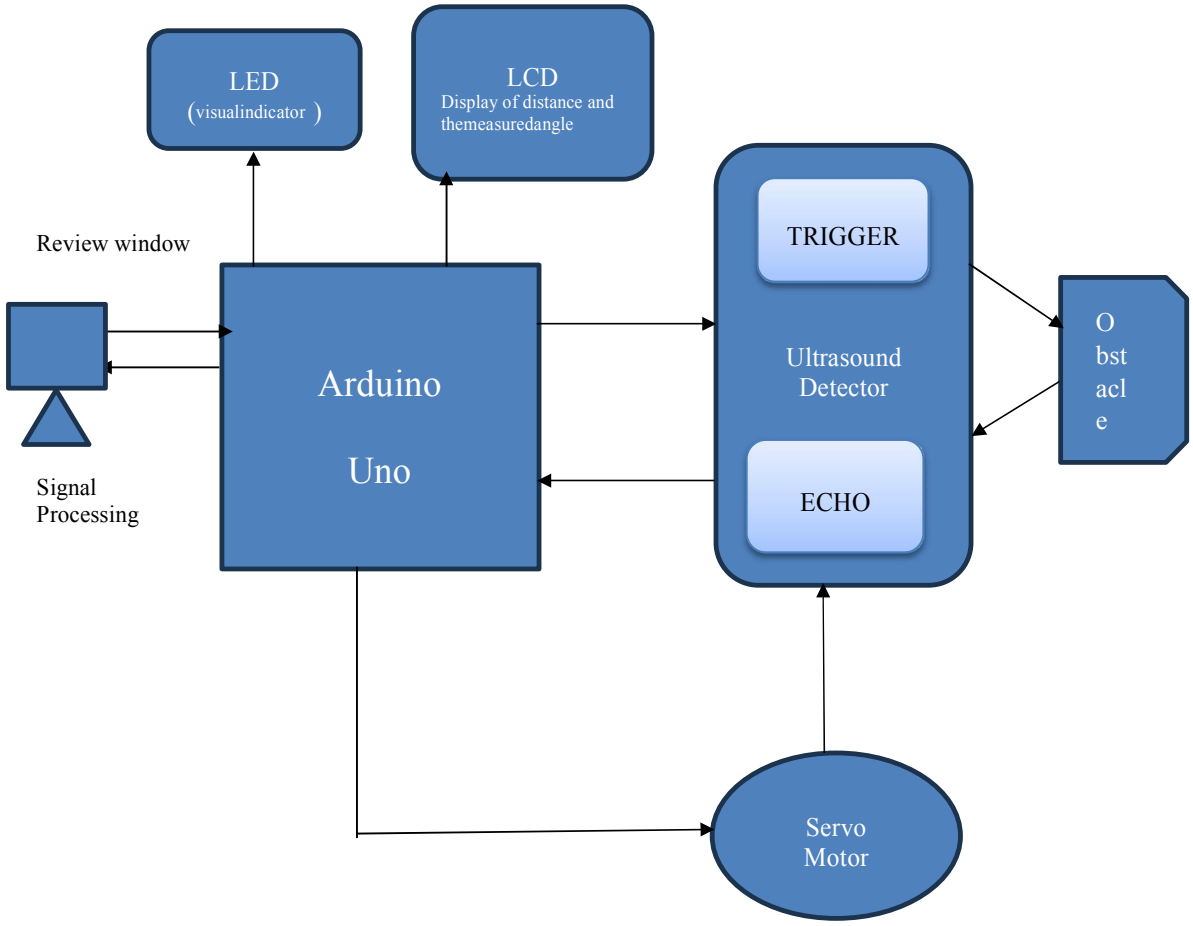

Figure 1: Object Tracking using Arduino Radar System

The Arduino radar system designed for object tracking consists of three primary components: An ultrasonic sensor (HC-SR04), a servo motor, and an Arduino Uno microcontroller.

In both configurations, the ultrasonic sensor is mounted atop the servo motor, allowing it to rotate and survey the environment.

The servo motor facilitates the lateral movement of the sensor, thereby providing the radar with its scanning functionality.

The Arduino Uno board serves as the controller, obtaining distance measurements from the sensor and transmitting control signals to the servo.

The gathered data is sent to a computer through a USB cable, where it is visualized in a radar-like format using software such as Processing IDE.

IV. CONCLUSION

The Object Tracking using the Arduino Radar System project effectively illustrates the integration of an ultrasonic sensor with an Arduino microcontroller to detect objects and measure their distance in real-time. This system offers a clear visual display of object locations on a radar screen, facilitating easy comprehension and interpretation of the surrounding environment. It represents a 5% cost-effective solution for robotics, security monitoring, and obstacle detection.

Moreover, the project provides practical insights and a straightforward implementation applicable to various small-scale applications, including sensor interfacing and Arduino programming. It also lays the groundwork for the development

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of more sophisticated radar-based systems. Future enhancements may involve extending the scanning range, incorporating multiple sensors for wider coverage, or integrating wireless communication for remote monitoring, thus improving its functionality and adaptability in real-world scenarios. The object tracking capability extends to distances of 2-400 cm. The Arduino radar for object tracking is primarily utilized for detecting nearby objects, marking a significant achievement in object detection at close distances.

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