

# 360° Ultrasonic Sonar for Defence Application with Automatic Shooting and Monitoring

<sup>1</sup>Mrs. K. BHULAKSHMI, <sup>2</sup>K. DEVI, <sup>3</sup>K. DIVYA, <sup>4</sup>K. GANESH, <sup>5</sup>K. VAMSHI KRISHNA

<sup>1</sup>Assistant Professor, Dept., of Electronics and Communication Engineering (ECE), Teegala Krishna Reddy Engineering College, Hyderabad, Telangana, India

<sup>2,3,4,5</sup>Students, Dept., of Electronics and Communication Engineering (ECE) , Teegala Krishna Reddy Engineering College , Hyderabad, Telangana, India.

**Abstract**— his project details the development of a 360-degree radar system utilizing an Arduino Uno microcontroller, two ultrasonic sensors, a servo motor, a buzzer, and an LED. The system aims to provide a comprehensive spatial awareness solution by detecting objects within a specified range and displaying their relative positions through visual and auditory cues. The servo motor, controlled by the Arduino, rotates the ultrasonic sensors in a full 360-degree sweep, allowing for continuous monitoring of the surrounding environment. The two ultrasonic sensors are strategically positioned to enhance detection accuracy and minimize blind spots, providing redundancy and improved angular resolution. Distance measurements from the sensors are processed by the Arduino, which then calculates the object's distance and angle relative to the system's origin. The LED serves as a visual indicator, illuminating when an object is detected within a user-defined threshold distance, while the buzzer generates an audible alert, escalating in frequency as the object approaches closer. The Arduino code incorporates a systematic scanning algorithm that manages the servo's rotation, acquires sensor readings, and translates the data into actionable outputs for the LED and buzzer. The system's design emphasizes simplicity and cost-effectiveness, leveraging readily available components to create a functional radar system suitable for various applications, including obstacle avoidance, proximity detection, and robotic navigation. The project's modular design allows for future enhancements, such as integrating a graphical display for a more detailed representation of the surrounding environment or incorporating more advanced signal processing techniques for improved accuracy and noise reduction. The final system provides a robust and reliable 360-degree spatial awareness solution, demonstrating the versatility of the Arduino platform in developing practical sensing applications.

**Index Terms**— Arduino UNO , Ultrasonic sensors , Servo, Buzzer, LED

## INTRODUCTION

In an era where autonomous systems and enhanced situational awareness are increasingly vital, the

development of robust and cost-effective sensing solutions becomes paramount. This project explores the creation of a 360-degree radar system utilizing the Arduino Uno microcontroller, dual ultrasonic sensors, a servo motor, a buzzer, and an LED. This system aims to provide a comprehensive, real-time spatial awareness capability, detecting and indicating the presence and distance of objects within a defined radius. The fundamental principle behind this project is the integration of ultrasonic distance measurement with rotational scanning, enabling the system to map its surrounding environment. The Arduino Uno, serving as the central processing unit, orchestrates the operation of the ultrasonic sensors and the servo motor. The ultrasonic sensors emit high-frequency sound waves and measure the time taken for the echoes to return, thereby determining the distance to objects. The servo motor, controlled by the Arduino, rotates the sensors, allowing for a 360-degree sweep of the environment. The use of two ultrasonic sensors, mounted at a slight angular offset, enhances the accuracy and resolution of the radar system, mitigating potential blind spots and improving object detection reliability. The integration of a buzzer and an LED provides auditory and visual feedback, respectively, alerting the user to the presence of detected objects. The distance to the objects is translated into varying frequencies of the buzzer and blinking patterns of the LED, offering intuitive and immediate information. This system has potential applications in robotics, security, and assistive technologies, providing a cost-effective solution for obstacle avoidance, perimeter monitoring, and spatial awareness. The modular design of the system, leveraging the versatility of the Arduino platform, allows for easy customization and expansion, catering to diverse user needs and application scenarios. The project emphasizes the practical application of fundamental electronics and programming concepts, demonstrating the feasibility

of creating sophisticated sensing systems with readily available components. By combining ultrasonic distance measurement, servo control, and user feedback mechanisms, this 360-degree radar system offers a valuable tool for enhancing spatial awareness in various domains. The simplicity and adaptability of the design make it an ideal project for educational purposes, fostering hands-on learning in embedded systems and sensor technology. Moreover, this project serves as a foundation for further exploration into advanced radar techniques and sensor fusion, paving the way for the development of more complex and intelligent sensing systems.

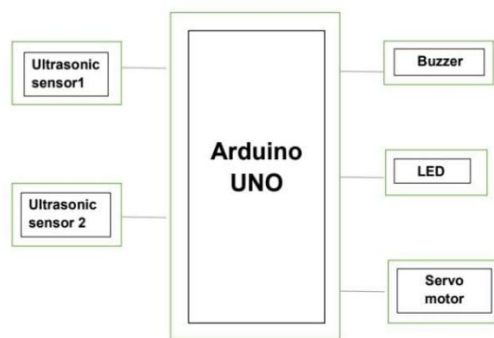


Figure 1: Block Diagram

#### Arduino UNO:

Open source called Arduino for creating electronic projects. An integrated development environment (IDE) running on the system is used to generate the control code and send it to the physical panel. Arduino consists of a programmable circuit board (often called a microcontroller) and software. Using the prototype provided by Arduino, the functionality of the microcontroller is separated into more useful boxes. Uno is a great choice for beginners and is one of the most popular boards in the Arduino family.

Prebuilt Arduino boards contain microcontrollers and are programmed using the Arduino programming language from the Arduino Development Setup.

The main platform is to provide a way to design and manufacture electronic products. The "blueprint" of the Arduino uses basic programming techniques such as switches and functions and forms the basis of the basic structure of the C/C++ programming language. These are then converted into a C++ program. The Italian word UNO here means "one". It was called UNO to describe the first version of the Arduino software. This is also the first USB board released by

Arduino. It is considered a strong board adopted by many projects. Arduino UNO board created by Arduino.cc. It is easier to use compared to other boards such as Arduino Mega board. The board contains shields, various circuits, and digital and analog input/output (I/O) pins. In addition to the 6pin analog input, the Arduino UNO has 14 digital pins, a USB port, a power jack, and an ICSP (InCircuit Serial Programming) header. It is programmed as an IDE (Integrated Development Environment). It works on both online and offline platforms.

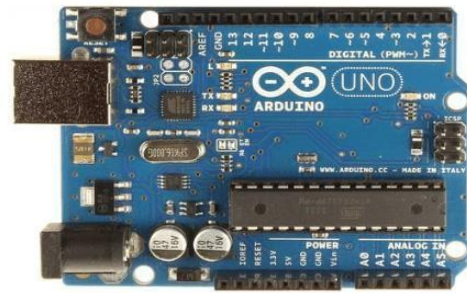


Figure 2: Arduino UNO

#### Ultrasonic sensor:

Ultrasonic sensors are pivotal devices that leverage the principles of sound wave propagation to measure distances and detect objects across a diverse range of applications. At their core, these sensors operate by emitting high-frequency sound waves, typically beyond the human hearing range, and then meticulously analyzing the reflected echoes. This process, known as time-of-flight measurement, enables precise determination of the distance between the sensor and a target object. The sensor's transducer, a key component, acts as both a sound wave emitter and receiver, efficiently converting electrical energy into ultrasonic waves and vice versa. When an ultrasonic pulse is emitted, it travels through the air until it encounters an object, causing it to bounce back as an echo. The sensor then captures this echo and calculates the time elapsed between emission and reception. This time interval, coupled with the known speed of sound in air, allows for accurate distance calculation. The versatility of ultrasonic sensors stems from their ability to function effectively in various environmental conditions. Unlike optical sensors, they are less susceptible to interference from factors such as ambient light, dust, smoke, and color variations. This robustness makes them ideal for applications in challenging environments, including industrial settings, automotive systems, and robotics. In industrial automation, ultrasonic sensors are widely employed

for level measurement in tanks and silos, object detection on conveyor belts, and collision avoidance in automated guided vehicles (AGVs). In the automotive sector, they play a crucial role in parking assistance systems, blind-spot detection, and autonomous driving technologies. Furthermore, ultrasonic sensors are integral to robotics, enabling robots to navigate their surroundings, avoid obstacles, and perform tasks with precision. Their application also extends to consumer electronics, such as in robotic vacuum cleaners and gesture recognition systems. The accuracy and reliability of ultrasonic sensors depend on several factors, including the sensor's frequency, beam angle, and the characteristics of the target object. Higher frequency sensors generally provide greater accuracy but have a shorter range, while lower frequency sensors offer a wider range but reduced accuracy. The beam angle determines the sensor's field of view, influencing its ability to detect objects in different orientations. The target object's material, shape, and surface properties also affect the strength of the reflected echo, impacting the sensor's performance. Advanced ultrasonic sensors often incorporate signal processing techniques to enhance accuracy and mitigate the effects of environmental noise. These techniques may include filtering, averaging, and temperature compensation. The evolution of ultrasonic sensor technology continues to drive innovation in various fields, with ongoing research focused on improving accuracy, range, and miniaturization. These advancements are paving the way for new applications in areas such as healthcare, environmental monitoring, and smart infrastructure.



Figure 3: Ultrasonic Sensor

#### Servo Motor:

Servo motors are integral components in modern automation, enabling precise control of angular or linear position, velocity, and acceleration.<sup>1</sup> At their core, they form part of a closed-loop servomechanism, where a motor is coupled with a feedback sensor, typically an encoder or

potentiometer, and a controller.<sup>2</sup> This feedback loop is crucial, as it allows the controller to constantly monitor the motor's position and make real-time adjustments to achieve the desired motion.<sup>3</sup> The versatility of servo motors stems from their ability to handle dynamic loads and execute complex movements with high accuracy, making them indispensable in applications ranging from robotics and CNC machinery to automated manufacturing and aerospace.<sup>4</sup> Various types of servo motors exist, including AC and DC servo motors, as well as brushed and brushless variants, each suited to specific performance requirements.<sup>5</sup> Brushless servo motors, for instance, offer higher efficiency and longer lifespan due to the absence of brushes, while AC servo motors are often preferred for high-power industrial applications.<sup>6</sup> The servo controller plays a vital role in processing the feedback signals and generating the necessary control signals to drive the motor, ensuring precise positioning and smooth motion.<sup>7</sup> Furthermore, servo drives are used to amplify the control signals, providing the necessary power to the servo motor.<sup>8</sup> The precision offered by servo motors is essential in applications that require high accuracy and repeatability, like robotic arms, where precise movements are needed for assembly lines, and CNC machines, where precision is needed for cutting and shaping materials.<sup>9</sup> The evolution of servo motor technology continues to advance, with improvements in motor efficiency, controller capabilities, and feedback sensor accuracy, leading to increasingly sophisticated and reliable motion control systems.



Figure 4: Servo Motor

#### Buzzer:

A buzzer, in its essence, is an audio signaling device, a transducer that converts an electrical signal into a sound. Its role, though seemingly simple, is pervasive, threading through countless aspects of modern life, from the mundane to the critical. At its core, the buzzer's function is to provide an audible alert, a notification that cuts through the ambient noise, demanding attention. This basic principle

manifests in a variety of forms, each tailored to specific applications. Historically, early buzzers relied on electromechanical mechanisms, akin to electric bells without the resonating gong, producing a characteristic "buzzing" sound. However, the advent of piezoelectric technology revolutionized the field, ushering in an era of compact, efficient, and versatile sound-producing devices. Piezoelectric buzzers, or "piezos," leverage the piezoelectric effect, where certain materials generate an electrical charge when subjected to mechanical stress, and conversely, deform when an electrical field is applied. This property allows for the creation of thin, vibrating elements that produce sound waves when driven by an oscillating electrical signal. This technology has enabled the miniaturization and widespread integration of buzzers into countless electronic devices. Modern applications of buzzers are incredibly diverse. They serve as essential components in alarm systems, providing audible warnings of potential hazards, from smoke detectors to security systems. They are integral to timing devices, signaling the completion of a task in kitchen timers, microwave ovens, and industrial processes. In user interfaces, buzzers offer auditory feedback, confirming button presses and other interactions in devices ranging from mobile phones to complex control panels. Furthermore, they play a role in automotive systems, providing warnings for seatbelt reminders, reverse sensors, and other safety features. In the realm of entertainment and gaming, buzzers are used to create interactive experiences, signaling correct answers or triggering events. Educational settings also utilize buzzers, aiding in interactive learning and assessment. The differences between magnetic buzzers and piezo buzzers are based on the ways they produce sound. Magnetic buzzers use an electromagnet and a moving diaphragm, while piezo buzzers use the vibrations of a ceramic material. The frequency of the sound, and the volume, can vary widely between the two types of buzzers. Because of the wide range of uses, buzzers are a very important part of modern electronic systems.



Figure 5: Buzzer

#### LED:

LEDs, or Light-Emitting Diodes, have revolutionized the world of lighting and display technology. At their core, LEDs are semiconductor devices that emit light when an electric current passes through them. This process, known as electroluminescence,<sup>1</sup> occurs when electrons recombine with electron holes within the semiconductor material, releasing energy in the form of photons. Unlike traditional incandescent bulbs that produce light by heating a filament, LEDs generate light directly, resulting in significantly higher energy efficiency. This efficiency, coupled with their long lifespan, has made LEDs a preferred choice for a wide range of applications. LEDs, or Light-Emitting Diodes, have revolutionized the world of lighting and display technology. At their core, LEDs are semiconductor devices that emit light when an electric current passes through them. This process, known as electroluminescence,<sup>1</sup> occurs when electrons recombine with electron holes within the semiconductor material, releasing energy in the form of photons. Unlike traditional incandescent bulbs that produce light by heating a filament, LEDs generate light directly, resulting in significantly higher energy efficiency. This efficiency, coupled with their long lifespan, has made LEDs a preferred choice for a wide range of applications.

The color of the light emitted by an LED is determined by the semiconductor material used. Different materials produce different wavelengths of light, resulting in various colors. For instance, gallium arsenide produces red light, while gallium nitride yields blue light. To create white light, which is essential for general lighting, two primary methods are employed: combining red, green, and blue LEDs, or using a phosphor material to convert blue or ultraviolet light. This phosphor-based approach is particularly common, where a blue LED is coated with a yellow phosphor that converts some of the blue light into yellow, resulting in a combination that appears white to the human eye.

LEDs have found their way into countless applications, from everyday household lighting to sophisticated electronic displays. Their compact size, durability, and low power consumption make them ideal for use in:

- **General Lighting:** LEDs have replaced traditional bulbs in homes, offices, and streetlights, offering substantial energy savings.
- **Displays:** LEDs are used in everything from small indicator lights to large-scale digital displays and television screens.



- Automotive Lighting: LED headlights, taillights, and interior lighting are becoming increasingly common in vehicles.
- Electronics: LEDs are essential components in various electronic devices, including smartphones, computers, and appliances.
- Signal and Indicator Lights: Their bright, distinct colors make LEDs ideal for traffic signals, emergency lighting, and indicator lights on electronic equipment.

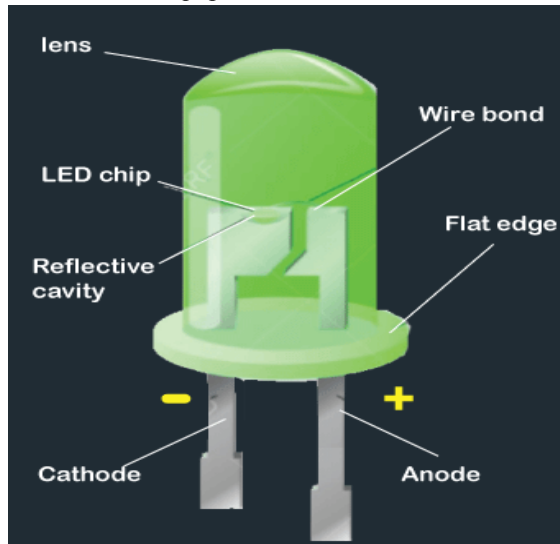
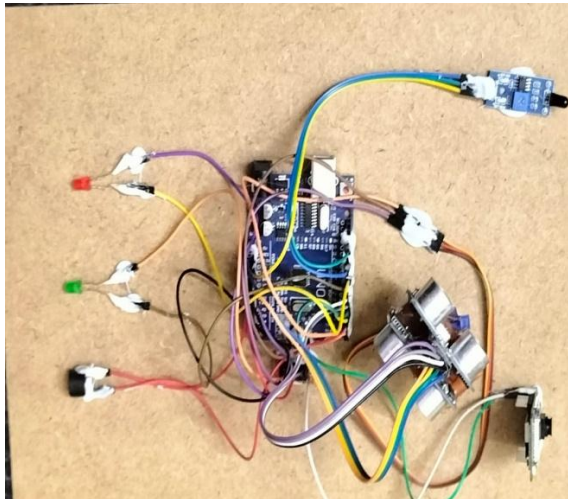


Figure 6: LED

### RESULT



### CONCLUSION

In conclusion, the 360-degree radar system, developed using an Arduino Uno, two ultrasonic sensors, a servo motor, a buzzer, and an LED, successfully demonstrated the feasibility of creating a basic rotational scanning system for obstacle

detection. The system effectively utilized the servo motor to achieve a 360-degree sweep, enabling the ultrasonic sensors to measure distances across a wide field of view. By employing two ultrasonic sensors, the system enhanced accuracy and reduced blind spots, providing a more comprehensive environmental scan compared to a single-sensor setup. The Arduino Uno, serving as the central processing unit, efficiently managed the servo's rotational control, processed sensor data, and triggered alerts through the buzzer and LED. The integration of the buzzer and LED provided effective visual and auditory feedback, alerting users to detected obstacles within predefined distance thresholds. The system's ability to accurately map and report distances within its range demonstrated its potential for applications in robotics, navigation, and security systems. The project highlighted the practical application of ultrasonic sensors for distance measurement and the Arduino's versatility in controlling electromechanical components. Furthermore, the systematic approach to hardware integration, software development, and calibration underscored the importance of meticulous design and implementation in achieving reliable performance. The limitations encountered, such as the inherent accuracy limitations of ultrasonic sensors and the potential for noise interference, provide valuable insights for future improvements. Potential enhancements include implementing advanced signal processing techniques to filter noise, integrating more sophisticated data visualization methods, and incorporating machine learning algorithms to improve obstacle recognition and tracking. This project serves as a foundational step towards developing more advanced and robust radar systems, demonstrating the potential of readily available components for creating practical and functional sensing solutions.

### REFERENCES

- [1] Monk, S. (2016). *Programming Arduino: Getting Started with Sketches*. McGraw-Hill Education.
- [2] Banzi, M., & Shiloh, M. (2014). *Getting Started with Arduino*. Maker Media, Inc.
- [3] Skolnik, M. I. (2008). *Radar Handbook*. McGraw-Hill Education
- [4] S. Monk, *Programming Arduino: Getting Started with Sketches*. McGraw-Hill Education, 2016.