Northern University
Of Business and Technology

Project Report

Project name: Military Radar System

Course code: CSE 3102

Course title: Computer architecture Lab

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Military Radar System

Introduction:

The Military Radar System using an ultrasonic sensor is an innovative project designed to replicate the functionality of a radar system on a smaller scale. This project uses an ultrasonic sensor to detect the presence and distance of objects in its vicinity. The sensor, mounted on a servo motor, rotates within a specified range to scan the surrounding environment. Data gathered is displayed in real-time, making it an ideal demonstration of radar technology's principles. This project has significant applications in security, surveillance, and obstacle detection.

The system is easy to construct and serves as a prototype for understanding how real-world radar systems operate. By integrating electronics and programming, this project showcases the potential of embedded systems in enhancing situational awareness and safety in military and civilian applications.

Components Required:

1. **Arduino UNO**: A microcontroller board that serves as the brain of the project, managing the components and processing data.
2. **Ultrasonic Sensor (HC-SR04)**: Emits ultrasonic waves and calculates the distance of objects by measuring the time taken for the waves to bounce back.
3. **Servo Motor**: Enables the ultrasonic sensor to rotate within a specific angular range, allowing the system to scan a broader area.
4. **Jumper Wires**: Used for creating electrical connections between components.
5. **Breadboard**: A prototyping platform for connecting components without soldering.

Other components are Buzzer, LED (Red & Green), Resistor (220Ω).

Provides the necessary voltage and current to power the Arduino and connected components.

Additional Tools:

- **Laptop/PC**: For programming and monitoring data using the Arduino IDE.

Algorithm of the Military Radar System:

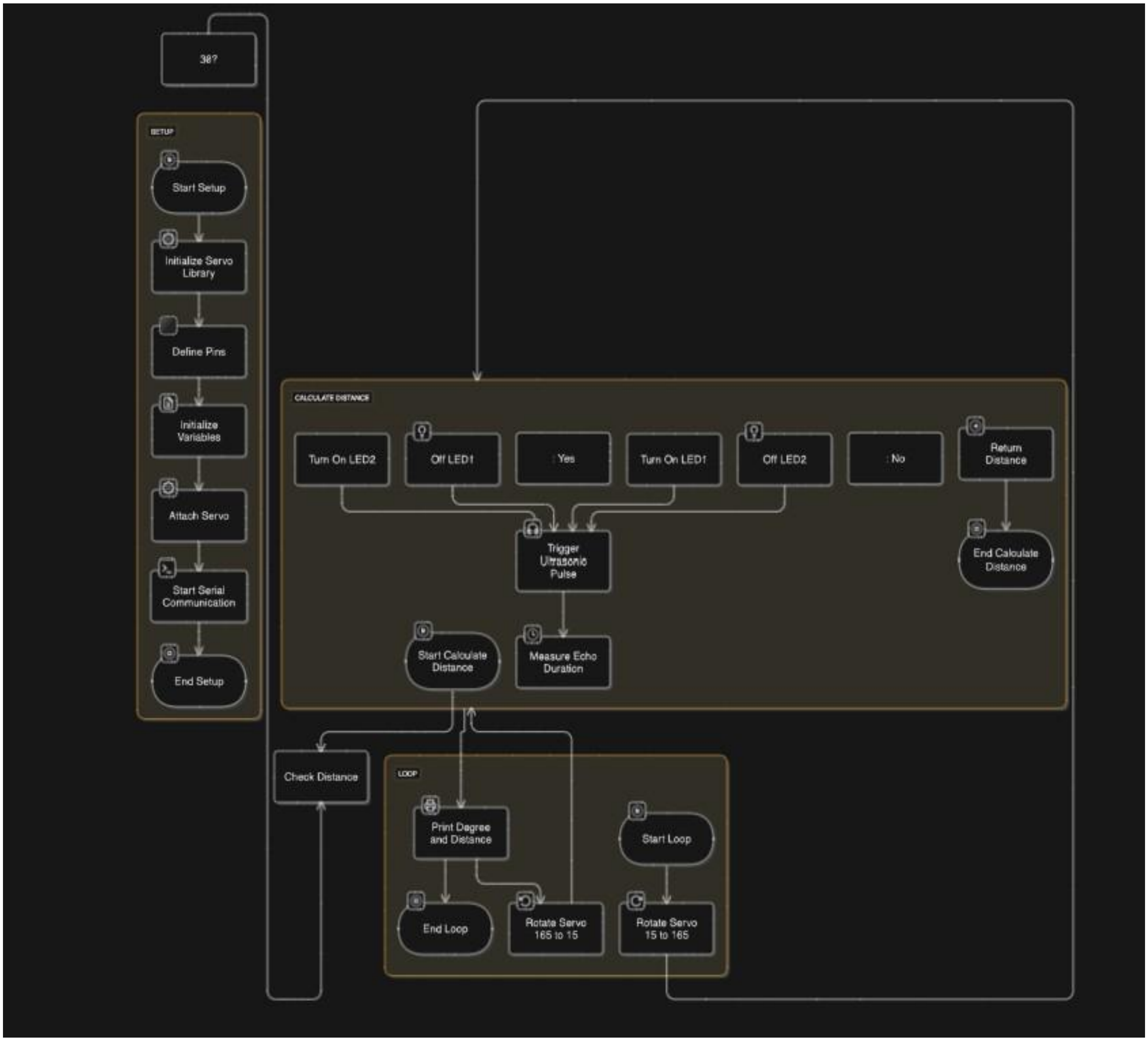
1. **Initialize Libraries and Pins**:

- Include the Servo library.
- Define pins for the ultrasonic sensor's Trigger (trigPin) and Echo (echoPin).
- Declare variables for duration and distance.
- Create a Servo object to control the servo motor.

2. **Setup**:
    - Set trigPin as an output and echoPin as an input.
    - Begin serial communication at a baud rate of 9600.
    - Attach the servo motor to its designated pin.
3. **Main Loop**:
    - **Rotate Servo Forward**:
        - Use a for loop to increment the servo motor's angle from 15° to 165°.
        - Rotate the servo motor to the current angle.
        - Call the calculateDistance() function to measure the distance at the current angle.
        - Send the angle and distance data to the serial monitor.
    - **Rotate Servo Backward**:
        - Use another for loop to decrement the servo motor's angle from 165° back to 15°.
        - Repeat the steps of rotating the servo, measuring the distance, and sending data to the serial monitor.
4. **Calculate Distance Function**:
    - Set the trigPin low, then high for 10 microseconds, and back to low.
    - Measure the time taken for the ultrasonic wave to return using the pulseIn() function on echoPin.
    - Calculate the distance using the formula: Distance=Duration×Speed of Sound2\text{Distance} = \frac{\text{Duration} \times \text{Speed of Sound}}{2}Distance=2Duration×Speed of Sound where the speed of sound is approximately 0.034 cm/μs.
    - Return the calculated distance.
5. **Repeat**:

- Continuously rotate the servo motor forward and backward, measuring distances and sending data to the serial monitor for real-time display.

Hardware Block Diagram:



Connection Details:

01. Power Connection (UNO to Breadboard):

- UNO 5V → Breadboard Positive Rail

- UNO GND → Breadboard Negative Rail

02. Servo Motor Connection:

- VCC (Red) → Breadboard Positive (5V)
- GND (Black) → Breadboard Negative (GND)
- Signal (Yellow/White) → Pin 12 (UNO)

03. Ultrasonic Sensor Connection:

- VCC (Red) → Breadboard Positive (5V)
- GND (Black) → Breadboard Negative (GND)
- Trig → Pin 10 (UNO)
- Echo → Pin 11 (UNO)

04. LED & Buzzer Connection:

- UNO GND → Breadboard GND

05. Green LED:

- Positive → 220Ω Resistor → Pin 9 (UNO)
- Negative → Breadboard GND
- Red LED & Buzzer (Common Connection):
- Red LED Positive → 220Ω Resistor → Pin 8 (UNO)
- Buzzer Positive → Pin 8 (UNO)
- Buzzer Negative → Breadboard GND

Description About Hardware Block Diagram:

1. Power Supply

The power supply ensures that all components receive adequate power for functioning. The Arduino board can be powered via a USB cable or an external battery.

2. Arduino UNO

The Arduino UNO acts as the central control unit. It processes inputs from the ultrasonic sensor and sends commands to the servo motor. Additionally, it sends data to a serial monitor for visualization.

3. Ultrasonic Sensor

The ultrasonic sensor detects objects by emitting ultrasonic waves. It measures the time taken for the waves to return after hitting an object, calculating the distance using the formula:

Distance = (Time * Speed of Sound) / 2

4. Servo Motor

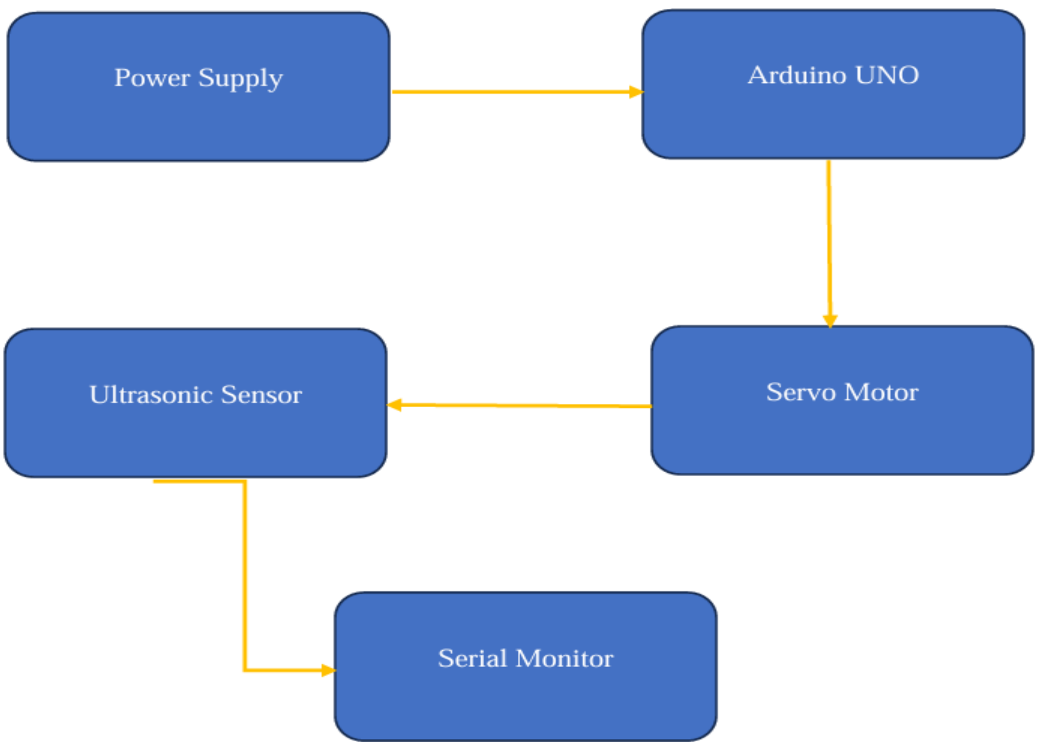
The servo motor is responsible for rotating the ultrasonic sensor between 15° and 165°. This movement allows the system to scan a wide area and detect objects across different angles.

5. Serial Monitor

The serial monitor, connected to the Arduino via USB, displays the sensor's readings. It shows the angle of the servo motor and the corresponding distance of detected objects.

6. Data Visualization

The data gathered by the radar system can also be displayed graphically using processing software. By representing the distance data in a circular pattern, a user can better visualize the scanning range of the system.



Working Principle:

The ultrasonic sensor emits high-frequency sound waves. When these waves encounter an object, they reflect back to the sensor. The system measures the time delay between the emission and reception of sound waves to calculate the distance of the object. The servo motor rotates the ultrasonic sensor across its range, enabling the system to scan the environment. Data is continuously sent to the Arduino IDE's serial monitor for display.

Arduino Code:

```
#include <Servo.h>

const int trigPin = 10;

const int echoPin = 11;

const int led1 = 9;

const int led2 = 8;

long duration;

int distance;

Servo myServo;

void setup() {

  pinMode(trigPin, OUTPUT);

  pinMode(echoPin, INPUT);

  pinMode(led1, OUTPUT);

  pinMode(led2, OUTPUT);

  Serial.begin(9600);

  myServo.attach(12);

}

void loop() {

  // rotates the servo motor from 15 to 165 degrees

  for(int i=15;i<=165;i++){

  myServo.write(i);

  delay(15);

  distance = calculateDistance();
```

```
  Serial.print(i);
  Serial.print(",");
  Serial.print(distance);
  Serial.print(".");
  }
  // Repeats the previous lines from 165 to 15 degrees
  for(int i=165;i>15;i--){
  myServo.write(i);
  delay(30);
  distance = calculateDistance();
  Serial.print(i);
  Serial.print(",");
  Serial.print(distance);
  Serial.print(".");
  }
}
// Function for calculating the distance measured by the Ultrasonic sensor
int calculateDistance(){
    if (distance < 30){
    digitalWrite(led1, LOW);
    digitalWrite(led2, HIGH);
  }
  else{
    digitalWrite(led1, HIGH);
    digitalWrite(led2, LOW);
  }
  digitalWrite(trigPin, LOW);
```

```
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH); // Reads the echoPin, returns the sound wave travel time in microseconds
  distance= duration*0.034/2;
  return distance;
}
```

Applications:

1. **Military Surveillance**: Detect intruders or obstacles in restricted areas.
2. **Industrial Automation**: Use in robotic systems to detect and avoid obstacles.
3. **Home Security**: Implement as part of an automated security system for detecting motion or unauthorized access.
4. **Educational Demonstrations**: Serve as a practical example of radar and sensor technologies for students.

Conclusion:

The Military Radar System using an ultrasonic sensor effectively demonstrates the principles of radar technology in a simplified and practical manner. The system's ability to detect and measure distances, coupled with real-time data display, makes it a valuable prototype for educational and experimental purposes. The project highlights the potential applications of ultrasonic sensors in fields such as surveillance, obstacle detection, and automation. With further modifications, this system can be enhanced to cover larger areas and provide more precise data.

By integrating this prototype with wireless communication modules, such as Bluetooth or Wi-Fi, the radar system can transmit data to remote devices, making it more versatile and user-friendly.

References:

1. Arduino Official Documentation: https://www.arduino.cc/

2. Ultrasonic Sensor HC-SR04 Datasheet
3. Tutorials on Servo Motors and Ultrasonic Sensors from various online resources
4. Processing IDE for Visualization: https://processing.org/
5. Sivanagaraju, V. (2025). RADAR MANAGEMENT SYSTEM USING AURDINO. INTERANTIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT, 09(01), 1–9.
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