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DEPARTMENT OF COMPUTER SCIENCE ENGINEERING

•ULTRASONIC SENSOR PROJECT•

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SUBJECT: INTERNET OF THINGS (IOT)

SEMESTER: 2ND

SECTION: H

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•PROBLEM STATEMENT•

Develop an ultrasonic radar system to address the following aspects:

- **Detection Range:** The radar system should be able to detect objects within a specified range, adjustable according to the application requirements.

- **Accuracy:** The system should provide accurate measurements of the distance, direction, and speed of detected objects. It should be able to differentiate between different types of objects, such as stationary objects, moving objects, and multiple objects within its range.

- **Real-time Tracking:** Implement real-time tracking of detected objects to monitor their movement continuously. The system should update the position of objects dynamically as they move within the radar's field of view.

- **User Interface:** Develop a user-friendly interface to visualize the radar data, including detected objects, their positions, and relevant information such as distance and speed. The interface should provide real-time updates and be intuitive for users to interpret.

- **Alert System:** Implement an alert system to notify users of any significant events, such as the presence of objects within close proximity or objects moving at high speeds.

- **Robustness:** Ensure the system is robust against environmental factors such as noise, interference, and varying conditions like temperature and humidity.

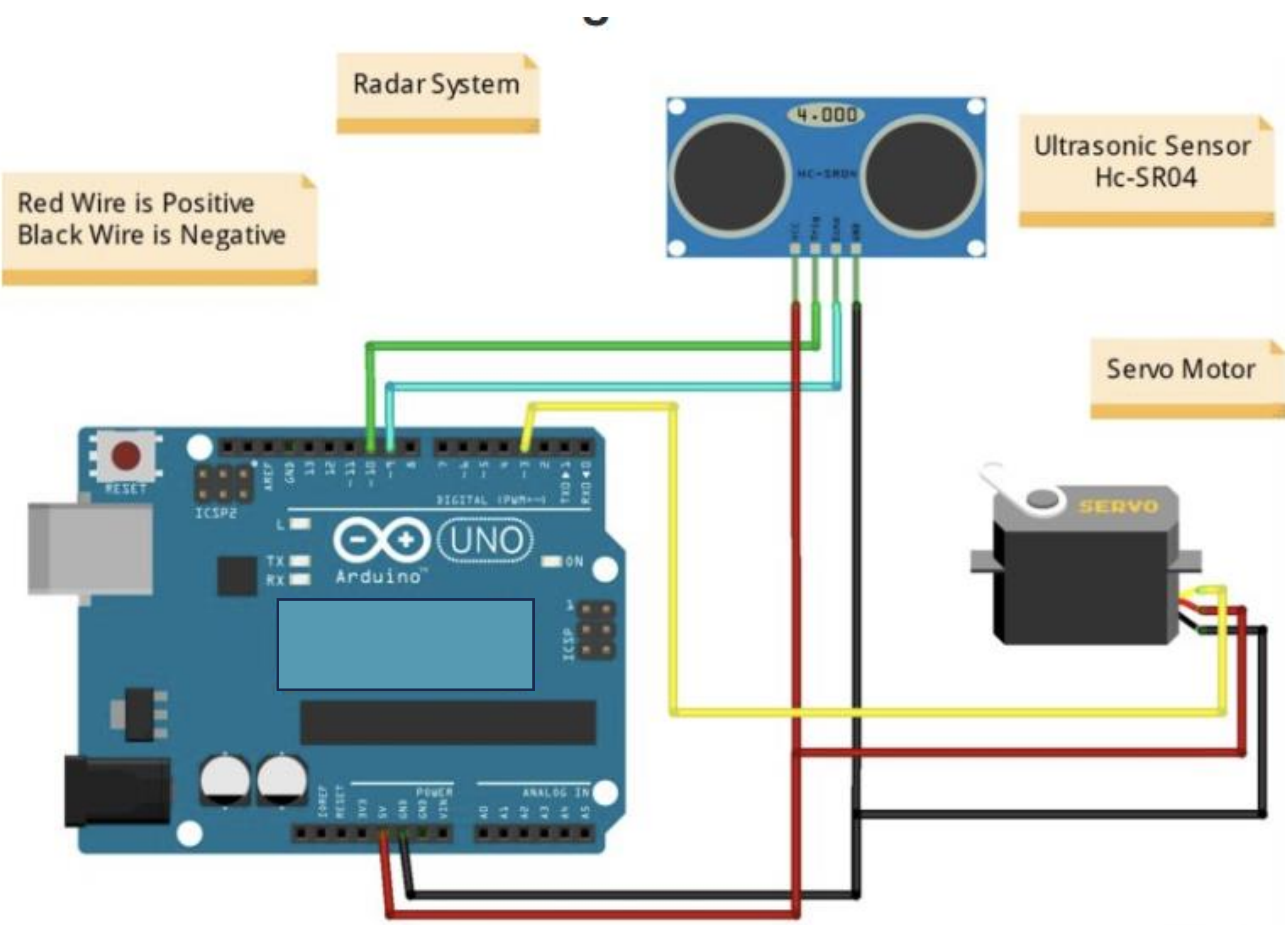
•INTRODUCTION•

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.

•CIRCUIT DIAGRAM•



•WORKING•

To start the Arduino Radar Sensor, you should know the programming code. There are two programming codes need to start the radar. One is the Arduino UNO and another one is the processing.

After uploading the code to Arduino, the servo sweeping from 0° to 180° and back again to 0°. Since the Ultrasonic Sensor is riding the Servo. Now open the processing application and run the code. If there is no error then another processing window open up. This is a Graphical representation of the data. The Ultrasonic Sensor represented in a radar type display. When the Ultrasonic Sensor detects any object within its range, the object will be shown on screen as a graphically.

•CODE•

```
import processing.serial.*;

import java.awt.event.KeyEvent;

import java.io.IOException;

Serial myPort;// defubes variables


String distance="";

String data="";

String noObject;

String angle="";

float pixsDistance;

int iAngle, iDistance;

int index1=0;

int index2=0;

PFont orcFont;

void setup() {


size (1280  ,720);

smooth();

myPort = new Serial(this,"COM4", 9600); // change this accordingly

myPort.bufferUntil('.'); // reads the data from the serial port up to the character '.'. So
actually it reads this: angle,distance.

}

void draw() {


fill(98,245,31);

// simulating motion blur and slow fade of the moving line

noStroke();

fill(0,4);

rect(0, 0, width, height-height*0.065);


fill(98,245,31); // green color
```

```
// calls the functions for drawing the radar

drawRadar();

drawLine();

drawObject();

drawText();

}

void serialEvent (Serial myPort) { // starts reading data from the Serial Port

// reads the data from the Serial Port up to the character '.' and puts it into the String variable "data".

data = myPort.readStringUntil('.');

data = data.substring(0,data.length()-1);


index1 = data.indexOf(','); // find the character ',' and puts it into the variable "index1"

angle= data.substring(0, index1); // read the data from position "0" to position of the variable index1 or thats the value of the angle the Arduino Board sent into the Serial Port

distance= data.substring(index1+1, data.length()); // read the data from position "index1" to the end of the data pr thats the value of the distance


// converts the String variables into Integer

iAngle = int(angle);

iDistance = int(distance);

}

void drawRadar() {

pushMatrix();

translate(width/2,height-height*0.074); // moves the starting coordinats to new location

noFill();

strokeWeight(2);

stroke(98,245,31);

// draws the arc lines

arc(0,0,(width-width*0.0625),(width-width*0.0625),PI,TWO_PI);

arc(0,0,(width-width*0.27),(width-width*0.27),PI,TWO_PI);
```

```
arc(0,0,(width-width*0.479),(width-width*0.479),PI,TWO_PI);

arc(0,0,(width-width*0.687),(width-width*0.687),PI,TWO_PI);

// draws the angle lines

line(-width/2,0,width/2,0);

line(0,0,(-width/2)*cos(radians(30)),(-width/2)*sin(radians(30)));

line(0,0,(-width/2)*cos(radians(60)),(-width/2)*sin(radians(60)));

line(0,0,(-width/2)*cos(radians(90)),(-width/2)*sin(radians(90)));

line(0,0,(-width/2)*cos(radians(120)),(-width/2)*sin(radians(120)));

line(0,0,(-width/2)*cos(radians(150)),(-width/2)*sin(radians(150)));

line((-width/2)*cos(radians(30)),0,width/2,0);

popMatrix();

}

void drawObject() {

pushMatrix();

translate(width/2,height-height*0.074); // moves the starting coordinats to new
location

strokeWeight(9);

stroke(255,10,10); // red color

pixsDistance = iDistance*((height-height*0.1666)*0.025); // covers the distance
from the sensor from cm to pixels

// limiting the range to 40 cms

if(iDistance<40){

// draws the object according to the angle and the distance

line(pixsDistance*cos(radians(iAngle)),-pixsDistance*sin(radians(iAngle)),(width-
width*0.505)*cos(radians(iAngle)),-(width-width*0.505)*sin(radians(iAngle)));

}

popMatrix();

}

void drawLine() {

pushMatrix();

strokeWeight(9);

stroke(30,250,60);

translate(width/2,height-height*0.074); // moves the starting coordinats to new
location
```

```
line(0,0,(height-height*0.12)*cos(radians(iAngle)),-(height-
height*0.12)*sin(radians(iAngle))); // draws the line according to the angle
popMatrix();
}
void drawText() { // draws the texts on the screen

pushMatrix();
if(iDistance>40) {
noObject = "Out of Range";
}
else {
noObject = "In Range";
}
fill(0,0,0);
noStroke();
rect(0, height-height*0.0648, width, height);
fill(98,245,31);
textSize(25);

text("10cm",width-width*0.3854,height-height*0.0833);
text("20cm",width-width*0.281,height-height*0.0833);
text("30cm",width-width*0.177,height-height*0.0833);
text("40cm",width-width*0.0729,height-height*0.0833);
textSize(40);
text("Techmates", width-width*0.875, height-height*0.0277);
text("Angle: " + iAngle +" °", width-width*0.48, height-height*0.0277);
text("", width-width*0.26, height-height*0.0277);
if(iDistance<40) {
text(" " + iDistance +" cm", width-width*0.225, height-height*0.0277);
}
textSize(25);
fill(98,245,60);
```

```
translate((width-width*0.4994)+width/2*cos(radians(30)),(height-height*0.0907)-width/2*sin(radians(30)));

rotate(-radians(-60));

text("30°",0,0);

resetMatrix();

translate((width-width*0.503)+width/2*cos(radians(60)),(height-height*0.0888)-width/2*sin(radians(60)));

rotate(-radians(-30));

text("60°",0,0);

resetMatrix();

translate((width-width*0.507)+width/2*cos(radians(90)),(height-height*0.0833)-width/2*sin(radians(90)));

rotate(radians(0));

text("90°",0,0);

resetMatrix();

translate(width-width*0.513+width/2*cos(radians(120)),(height-height*0.07129)-width/2*sin(radians(120)));

rotate(radians(-30));

text("120°",0,0);

resetMatrix();

translate((width-width*0.5104)+width/2*cos(radians(150)),(height-height*0.0574)-width/2*sin(radians(150)));

rotate(radians(-60));

text("150°",0,0);

popMatrix();

}
```

•APPLICATIONS•

Object Position and Orientation: Ultrasonic sensors can determine the position and orientation of objects in their vicinity. This capability is crucial in robotics, where precise object manipulation and navigation are required.

Collision Avoidance Systems: In automotive and industrial settings, ultrasonic sensors play a vital role in detecting obstacles and preventing collisions. They provide real-time feedback to automated systems, allowing for safe and efficient operation.

Surveillance Systems: Ultrasonic sensors are used in security systems for perimeter monitoring and intrusion detection. They can detect the presence of intruders even in low visibility conditions.

Non-Contact Measurements: Ultrasonic technology overcomes the limitations of contact-based measurement methods. By emitting ultrasonic waves and analyzing their reflections, non-contact measurements of distance, speed, and other parameters become possible.

•ADVANTAGES•

1. Non-Contact Sensing: Ultrasonic radar systems allow for non-contact sensing, which means they don't require physical contact with the objects they detect. This is particularly advantageous in applications where physical contact is impractical or undesirable.

2. Distance Measurement: Ultrasonic radar systems can accurately measure distances to objects without physical contact. This is useful in various applications such as obstacle detection, navigation, and automated systems.

3. High Accuracy: Ultrasonic radar systems offer high accuracy in distance measurements. They can detect objects with precision, providing accurate information about their location and distance from the sensor.

4. Wide Range of Detection: Ultrasonic radar systems can detect objects over a wide range, depending on the sensor's capabilities. This makes them suitable for applications ranging from close-range obstacle detection to long-range surveillance.

5. Adaptability to Various Environments: Ultrasonic radar systems can operate in various environmental conditions, including indoor and outdoor settings. They are not affected by factors like light, color, or transparency of objects, making them versatile in different environments.

6. Low Power Consumption: Ultrasonic sensors typically consume low power, making them suitable for battery-powered devices and applications where energy efficiency is important.

7. Fast Response Time: Ultrasonic radar systems provide fast response times, allowing for real-time detection and tracking of moving objects. This is crucial in applications such as collision avoidance systems and robotics.

8. Cost-Effective: Ultrasonic sensors are relatively inexpensive compared to other sensing technologies like LIDAR (Light Detection and Ranging) or RADAR (Radio Detection and Ranging). This makes them cost-effective for a wide range of applications.

9. Simple Integration: Ultrasonic sensors are easy to integrate into electronic systems and microcontroller-based projects. They typically require minimal hardware and can be easily interfaced with popular platforms like Arduino and Raspberry Pi.

10. Robustness: Ultrasonic radar systems are robust against environmental factors such as dust, humidity, and temperature variations. They provide reliable performance even in challenging conditions.

11. Multiple Object Detection: Ultrasonic radar systems can detect multiple objects simultaneously within their detection range, providing comprehensive situational awareness.

12. Customizable Parameters: Ultrasonic radar systems often allow for customizable parameters such as detection range, sensitivity, and scanning patterns, enabling optimization for specific applications.

•FUTURE SCOPE•

1. Enhanced Sensing Capabilities: Future ultrasonic radar systems are likely to feature enhanced sensing capabilities, including higher resolution, increased detection range, and improved accuracy. This could be achieved through advancements in sensor technology, signal processing algorithms, and integration with other sensing modalities such as infrared or visual cameras.

2. Miniaturization and Integration: There's a growing trend towards miniaturization and integration of sensor technologies. Future ultrasonic radar systems may become smaller, more lightweight, and more integrated into various devices and systems. This could lead to the widespread adoption of ultrasonic sensors in applications such as wearable devices, smartphones, drones, and autonomous vehicles.

3. Advanced Object Recognition: Future ultrasonic radar systems may incorporate advanced object recognition and classification algorithms. This would enable them to not only detect objects but also identify them based on shape, size, material composition, and other characteristics. Such capabilities would be valuable in applications like industrial automation, security surveillance, and autonomous navigation.

4. Multi-Modal Sensor Fusion: Integration of ultrasonic radar with other sensor modalities, such as LIDAR, RADAR, and cameras, could lead to the development of multi-modal sensor fusion systems. By combining data from multiple sensors, these systems can provide a more comprehensive understanding of the environment, with improved accuracy, reliability, and robustness. This would be particularly beneficial in applications like autonomous driving, robotics, and smart infrastructure.

5. Real-Time 3D Mapping: Future ultrasonic radar systems may enable real-time 3D mapping of environments. By continuously scanning and processing ultrasonic data, these systems could generate detailed 3D maps of surroundings, including the shapes and positions of objects. This capability would be valuable in applications such as indoor navigation, virtual reality, and augmented reality.

6. Smart Environmental Monitoring: Ultrasonic radar systems could be used for smart environmental monitoring in various contexts, including agriculture, industrial facilities, and smart cities. By monitoring parameters such as air quality, water levels, and structural integrity, these systems could help optimize resource usage, improve safety, and mitigate environmental risks.

7. Energy-Efficient Design: Future ultrasonic radar systems are likely to focus on energy efficiency and sustainability. This could involve the development of low-power sensors, energy harvesting techniques, and optimized signal processing algorithms. Energy-efficient ultrasonic sensors would be essential for battery-powered devices, IoT applications, and remote monitoring systems.

8. Artificial Intelligence and Machine Learning: Integration of artificial intelligence (AI) and machine learning (ML) techniques could significantly enhance the capabilities of ultrasonic radar systems. AI/ML algorithms could be used for real-time data analysis, predictive modeling, anomaly detection, and decision-making. This would enable ultrasonic radar systems to adapt to dynamic environments, learn from experience, and improve performance over time.

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