International Journal Of Advance Research, Ideas And Innovations In Technology
IJARIIT
ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 3 - V7I3-2067)
Available online at: https://www.ijariit.com

# Buoy system for navigation

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## ABSTRACT

***A buoy or a group of buoys are deployed for various purposes such as water qualitytesting, temperature, weather and navigation. A buoy is a floating device which anchored down by a constant weight deep in the depth of ocean, it is able to stay working in harsh conditions such as hight tides and stormy conditions. Master buoy will bethe one that will receive the data transferred by the slave buoy to process them and to display them on the screen. Ultrasonic waves are transmitted at the frequency of20khz (kilo Hertz), it is much higher than the audible range of the human ear.***

***Keywords:*** *Buoy System, Navigation*

- A buoy or a group of buoys are deployed for various purposes such as water qualitytesting, temperature, weather and navigation. A buoy is a floating device which anchored down by a constant weight deep in the depth of ocean, it is able to stay working in harsh conditions such as hight tides and stormy conditions.
- We have developed a **master – buoy** system which can be used to perform function such as navigation, water traffic detection, real-time object detection, and military purpose (tracking targets). The buoy features a double ultrasonic sensor capable of 360-degree surface detection, the idea behind the word master – buoy system is that there must be several numbers of buoy's covering specific distance and area of water for monitoring the particular area covered by slave buoys. Master buoy will bethe one that will receive the data transferred by the slave buoy to process them and to display them on the screen.
- The buoy prototype which we have developed using the Arduino boards is capable ofsensing the object up-to 40cm and is capable of detecting and returning the current distance of the object on surface, it is also capable of detecting multiple objects on the water surface.
- The prototype is based on the principle of SONAR (sound ranging and navigation) It is a technique to find the distance of an object using sound waves rather than using electromagnetic waves. Ultrasonic waves are transmitted at the frequency of20khz (kilo Hertz), it is much higher than the audible range of the human ear.
- The basic understanding of the sound ranging and detection can be acquired by the definition of **echo it is the sound wave that is reflected back from the object that was hit by the sound wave. The speed of sound differs for every medium, in air the speed of sound is 343 m/s (metre per second).**
- **The equation of echo is as follows: [1]**

$$V = 2d/t$$

V = corresponds to velocity of sound in air or mediumd = the distance from the object
t = is time in seconds

Sound absorption

- Sound waves require a medium to travel or to propagate, we use ultrasonic waves having a frequency above 20 (kHz) which is also termed as the inaudiblesound to the human ear.
- In the case of object detection or ranging through sound waves lot of factorscome into play in affecting the sound wave as it travels through different mediums.

- Sound waves traveling from air to water medium will cause the loss of energy ofthe sound as well as absorption of the same.
- Sound wave energy is dependent on the amplitude and the frequency of thesound wave consisting of large amplitude will produce large amount of displacements.
- The sound wave transmitted at a specific frequency towards the water will undergo two changes, some of the sound waves will be absorbed by the molecules of the water and second the reflection of sound wave will also takeplace which results in loss of signals transmitted as well as poor detection capabilities.
- Sound wave travelling at higher frequency will result in heating of the water molecules causing rapid vibrations, but sound wave at higher frequency will haveshorter wavelengths resulting in loss of range and distance.
- The speed of sound in water is dependent on the temperature of the water thehigher the temperature the lower the speed of sound for example in water the speed is almost equivalent to 1493 m/s (metre per second).
- Hence for the sound waves to travel through water it requires higher frequencyand much more amount of energy to start the vibration. [2]
- The speed of sound in water depends on various factors like salinity, depth,ambient temperature, etc (Clemens Deutsch and Yedun Gao, 2017)
- As sound travels the fastest in solids as the atoms are closely packed together toeach other and the slowest in gaseous mediums.
- This the reason why most buoy systems does not consist of underwater scanningof objects due to lack of energy and frequency.

This system is being built using Arduino. We plan to make this an unmanned system. It has several uses. It can, for example, be used by the military to detect threats and automatically respond to them. It can be used for water pollution checking as well by detecting certain larger particles

The primary goal of this system is to study self driving vehicles and their behaviour when they come across obstacles. The secondary buoy in our case can be made to gofurther than a self driving ship to look for obstacles and change course if one is sensed. It can also warn when something unexpected happens

The master buoy would be on the ship and receive data. Then the people in chargeof the ship can decide to take manual action against the event. An AI can also be used to automatically make decisions

Positioning of the buoys in the system can be done by simply using GPS. 3 GPS satellites would be needed for accurate positioning. The master buoy can cache GPSdata on behalf of the secondary buoys [3]

The buoy system can also be used for detecting marine life. Statistics on marine lifecan be collected and then the results can be used to understand areas that may be at risk due to pollution

We also propose a solution to use this system to detect water pollution. The entire systemcould be used to collect statistics on pollution (eg plastic bags in the ocean) and then automatically clean it or notify the person in charge

**Hardware used**

| | |
|---|---|
| Microcontroller | ATmega328P – 8-bit AVR family microcontroller |
| Operating Voltage | 5V |
| Recommended Input Voltage | 7-12V |
| Input Voltage Limits | 6-20V |
| Analog Input Pins | 6 (A0 – A5) |
| Digital I/O Pins | 14 (Out of which 6 provide PWM output) |
| DC Current on I/O Pins | 40 mA |
| DC Current on 3.3V Pin | 50 mA |
| Flash Memory | 32 KB (0.5 KB is used for Bootloader) |
| SRAM | 2 KB |
| EEPROM | 1 KB |
| Frequency (Clock Speed) | 16 MHz |

**Arduino UNO**


- **Ultrasonic sensor (HC SR04)**
- **Specifications**

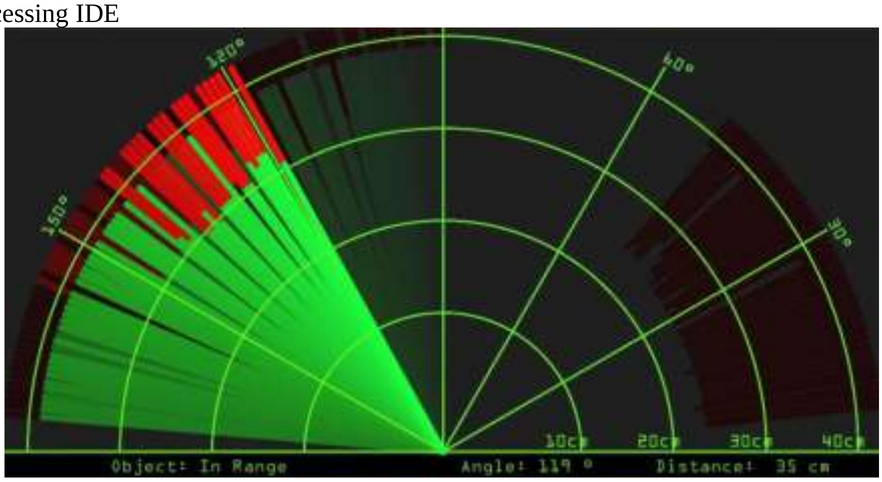
Operating voltage: +5V
Theoretical Measuring Distance: 2cm to 450cmPractical Measuring Distance: 2cm to 80cm Accuracy: 3mm
Measuring angle covered: <15°Operating Current: <15mA Operating Frequency: 40Hz


**Arduino to PC (A – B cable):**

- **Jumper wires:**
- **Male to male**
- **Female to female**
- **Male to female**

- **Software used:**
- Processing IDE – for graphics processing
- Arduino IDE – for controlling the components
- Screenshots of Processing IDE




- **Arduino code:**

```
#include <Servo.h>.
// Defines Tirg and Echo pins of the Ultrasonic Sensorconst int trigPin = 11;
const int echoPin = 12;Servo myservo;
// Variables for the duration and the distancelong duration;
int distance;

void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output pinMode(echoPin, INPUT); // Sets the echoPin as an Input
myservo.attach(8);
Serial.begin(9600);
}
void loop() {

// rotates the servo motor from 15 to 165 degreesfor(int i=0;i<=180;i++){
myservo.write(i);delay(30);
  distance = calculateDistance();// Calls a function for calculating the distance measured bythe Ultrasonic sensor for each degree
Serial.print(i); // Sends the current degree into the Serial Port
  Serial.print(","); // Sends addition character right next to the previous value needed later inthe Processing IDE for indexing
Serial.print(distance); // Sends the distance value into the Serial Port
  Serial.print("."); // Sends addition character right next to the previous value needed later inthe Processing IDE for indexing

}
// Repeats the previous lines from 165 to 15 degreesfor(int i=180;i>0;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 sensorint calculateDistance(){

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

}
```

- **Processing IDE code:**

```
import processing.serial.*; // imports library for serial communication
import java.awt.event.KeyEvent; // imports library for reading the data from the serial portimport java.io.IOException;
Serial myPort; // defines Object Serial
// defubes variablesString angle=""; String distance=""; String data=""; String noObject; float pixsDistance; int iAngle, iDistance;
int index1=0;
int index2=0;void setup() {
```

```
size (1920,1080);
smooth();
 myPort = new Serial(this,"COM3", 9600); // starts the serial communication 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 linenoStroke();
fill(0,4);
rect(0, 0, width, 1010);

fill(98,245,31); // green color
// calls the functions for drawing the radardrawRadar();
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 Stringvariable "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 IntegeriAngle = int(angle);
iDistance = int(distance);
}

void drawRadar() {pushMatrix();
translate(960,1000); // moves the starting coordinats to new locationnoFill();
strokeWeight(2); stroke(98,245,31);
// draws the arc lines arc(0,0,1800,1800,PI,TWO_PI); arc(0,0,1400,1400,PI,TWO_PI); arc(0,0,1000,1000,PI,TWO_PI); arc(0,0,600,600,PI,TWO_PI);
// draws the angle linesline(-960,0,960,0);
line(0,0,-960*cos(radians(30)),-960*sin(radians(30))); line(0,0,-960*cos(radians(60)),-960*sin(radians(60))); line(0,0,-960*cos(radians(90)),-960*sin(radians(90))); line(0,0,-960*cos(radians(120)),-960*sin(radians(120))); line(0,0,-960*cos(radians(150)),-960*sin(radians(150))); line(-960*cos(radians(30)),0,960,0);
popMatrix();
}
void drawObject() {pushMatrix();
translate(960,1000); // moves the starting coordinats to new locationstrokeWeight(9);
stroke(255,10,10); // red color
pixsDistance = iDistance*22.5; // covers the distance from the sensor from cm to pixels
// limiting the range to 40 cmsif(iDistance<40){
  // draws the object according to the angle and the distance line(pixsDistance*cos(radians(iAngle)),-pixsDistance*sin(radians(iAngle)),950*cos(radians(iAngle)),-950*sin(radians(iAngle)));
}
popMatrix();
}
void drawLine() { pushMatrix(); strokeWeight(9); stroke(30,250,60);
translate(960,1000); // moves the starting coordinats to new location
  line(0,0,950*cos(radians(iAngle)),-950*sin(radians(iAngle))); // draws the line according tothe 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, 1010, width, 1080);fill(98,245,31);
textSize(25); text("10cm",1180,990);
text("20cm",1380,990);
text("30cm",1580,990);
text("40cm",1780,990);
textSize(40);
text("Object: " + noObject, 240, 1050); text("Angle: " + iAngle +" °", 1050, 1050);text("Distance: ", 1380, 1050); if(iDistance<40)
{
text("                              " + iDistance +" cm", 1400, 1050);
}
textSize(25); fill(98,245,60);
translate(961+960*cos(radians(30)),982-960*sin(radians(30))); rotate(-radians(-60));
text("30°",0,0);
resetMatrix();
translate(954+960*cos(radians(60)),984-960*sin(radians(60))); rotate(-radians(-30));
text("60°",0,0);
resetMatrix();
translate(945+960*cos(radians(90)),990-960*sin(radians(90))); rotate(radians(0));
text("90°",0,0);
resetMatrix();
translate(935+960*cos(radians(120)),1003-960*sin(radians(120))); rotate(radians(-30));
text("120°",0,0);
resetMatrix();
translate(940+960*cos(radians(150)),1018-960*sin(radians(150)));
rotate(radians(-60));text("150°",0,0);
popMatrix();
}
```

## REFERENCES

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