21MHC101P

Elements of Mechatronics Systems

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MAPPING USING ULTRASONIC SENSOR WITH PAN AND TILT MECHANISM

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BONAFIDE CERTIFICATE

Certified that this project report titled "**Mapping using ultrasonic sensor with pan and tilt mechanism**" is the bonafide work of "**Anugrah Samuel Frank, D Armaan, George K Sajeev**", who carried out the project work under my supervision as part of the course 21MHC101P – Elements of Mechatronics Engineering during the Even Semester of the Academic Year 2022-23.

SIGNATURE OF THE COURSE INSTRUCTOR　　　　SIGNATURE OF THE HOD

Signature of the Internal Examiner　　　　Signature of the External Examiner

ABSTRACT

The project report focuses on the design and implementation of a mapping system using an ultrasonic sensor with a pan and tilt mechanism. The project work contains mechanical, electrical, electronics and programming, thus making it a mechatronics system.

The sensor is used to detect the distance between the sensor and the objects in the environment, and the pan and tilt mechanism enables the sensor to scan the entire area in a systematic manner.

The main objective of the project is to create a system that can scan a given area and create a map of the environment, which can be used for various applications such as surveillance, monitoring, and navigation.

The mapping system can be used to monitor a particular area, such as a building or a perimeter, and create a map of the area. This can be used for security and surveillance purposes, enabling security personnel to detect any anomalies or intrusions in the area. The mapping system can be integrated into robots, enabling them to navigate autonomously in an environment, avoiding obstacles and creating a map of the area.

ACKNOWLEDGEMENT

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CHAPTER 1

INTRODUCTION

The mapping using an ultrasonic sensor with a pan and tilt mechanism is a project that involves creating a device that can detect the distance between an object and the sensor using ultrasonic waves. The device is mounted on a pan and tilt mechanism, which allows it to move horizontally and vertically. The device is designed to create a map of its surroundings by scanning its environment and collecting distance data. The collected data is then used to create a map of the area.

1.1 Objective

The main objective of the project is to create a system that can scan a given area and create a 2D map of the environment, which can be used for various applications such as surveillance, monitoring, and navigation. Ultrasonic sensors transmit high-frequency sound waves which reflect off surfaces and return to the sensor. By measuring the time, it takes for the sound waves to return, the distance to the objects can be determined.

1.2 Mechatronics prospective:

Mapping using an ultrasonic sensor with a pan and tilt mechanism is a mechatronics project because it involves the integration of multiple fields, including mechanics, electronics, and computer science. Mechanics is involved in the design and implementation of the pan and tilt mechanism that rotates the ultrasonic sensor, as well as in the overall design of the mapping device. Electronics is involved in the design and implementation of the electronic circuitry that powers and controls the ultrasonic sensor, as well as in the design and implementation of the microcontroller that processes the data from the sensor. Computer science is involved in the development of software and algorithms used to control the mapping device, process the data, and generate the map of the environment. The integration of these fields is what makes mapping using an ultrasonic sensor with a pan and tilt mechanism a mechatronics project. The success of the project depends on the effective coordination of these fields to achieve the desired mapping outcome. The below figure 1.1 shows why this project is a mechatronics system.

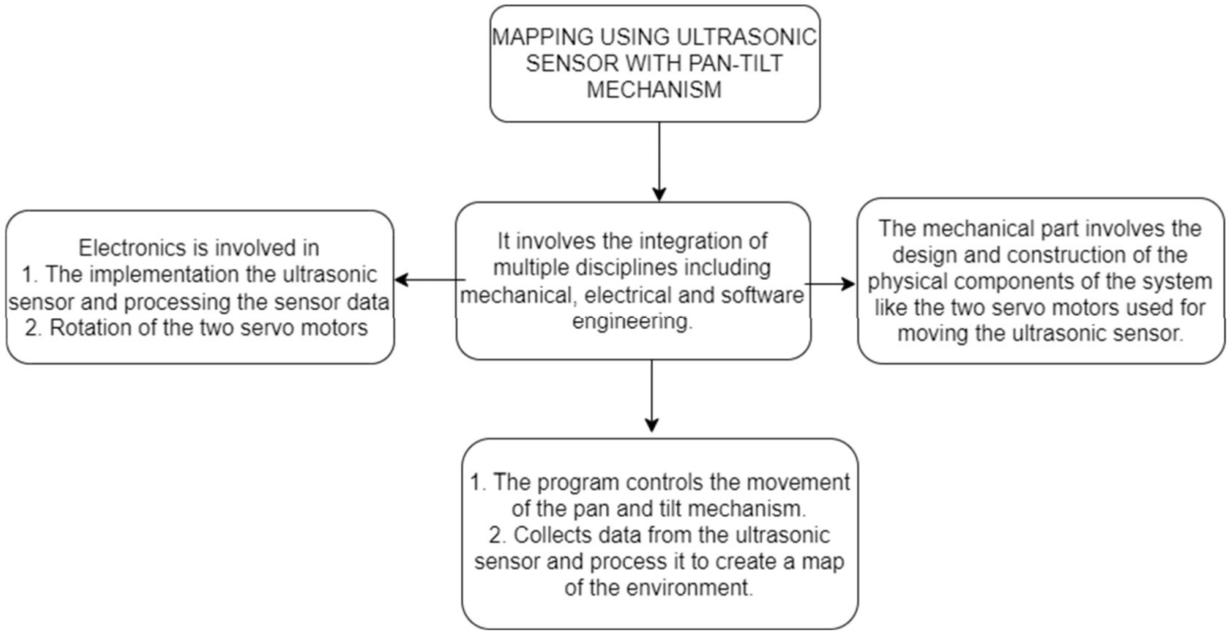

Fig. 1.1 - Diagram explaining how it is a mechatronics system

1.3 Context description

Once the power supply is given to the components the motor for panning starts rotating along with the ultrasonic sensor. For each angle the ultrasonic emits the ultrasonic waves and receives the wves after striking some objects in particular range of its surrounding environment, the waves are received by the echo pin of the sensor. Using the time taken to receive the signal the distance is calculated. After rotating the sensor by 180 degrees, it again returns to the zero-degree position of the servo motor for panning. Then the sensor is tilted to some other angle vertically by rotating the servo motor for tilting and the same thing is repeated. At the end, a map of the surrounding environment is generated in Matlab.

CHAPTER 2

DESIGN AND FABRICATION

2.1 Structural elements

The structural elements of the project are a 3D printed box which is hollow on one side and three clamps that are mounted on the 3Dprinted box. One clamp is for servo motor used for pan motion, second clamp for the servo motor used for tilt motion and the third one is used to attach the ultrasonic sensor holder. The servo motor for the pan is fixed in the static part and the motor for tilt is fixed in the moving part. The 3Dprinted box is the static part here. Fig 2.1 shows self-made clamp and 2.2 shows 3D printed box.

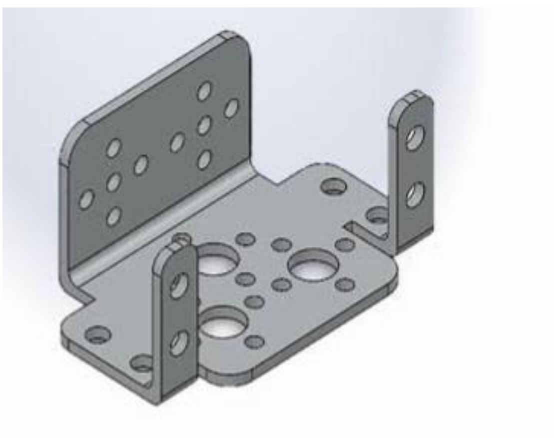

Fig 2.1 Clamp

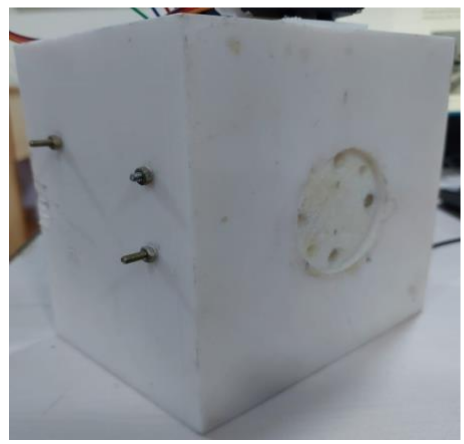

Fig 2.2 3D printed box

2.2 Mechanical elements

The mechanical parts of the project are the three clamps which are attached to the pan and tilt servo motors, and also to the ultrasonic stand.

2.3 Electrical elements

The electrical elements used in this project are the two servo motors. One motor is used for panning and the other one is used for tilting the ultrasonic sensor. Fig 2.3 shows MG996R servo motor.

Fig. 2.3 MG996R servo motor

2.4 Electronics Elements

Three electronic elements are used in the project, the HC SRO4 ultrasonic sensor, controller (Arduino UNO) and the power source. The ultrasonic sensor is used to measure the time it takes for the waves to return to calculate the distance between the sensor and the object. The power supply provides the necessary electrical power to the ultrasonic sensor and servo motors. The Arduino controls the motion of the servo motors and also calculate the distances using the signal it receives from the echo pin of the ultrasonic sensor. Fig 2.4 shows Arduino UNO and fig 2.5 shows ultrasonic sensor.

Fig 2.4 Arduino UNO

Fig 2.5 HC SRO4 ultrasonic sensor

2.5 Hardware Diagram

The hardware diagram shows the various components of the circuit and how they are connected to each other. The figure given below is the hardware diagram of the project. The diagram shows that the PC is connected to the controller (Arduino Uno) and Arduino Uno is connected to the two servo motors and that is connected to the ultrasonic sensor.

Fig 2.6 shows hardware diagram

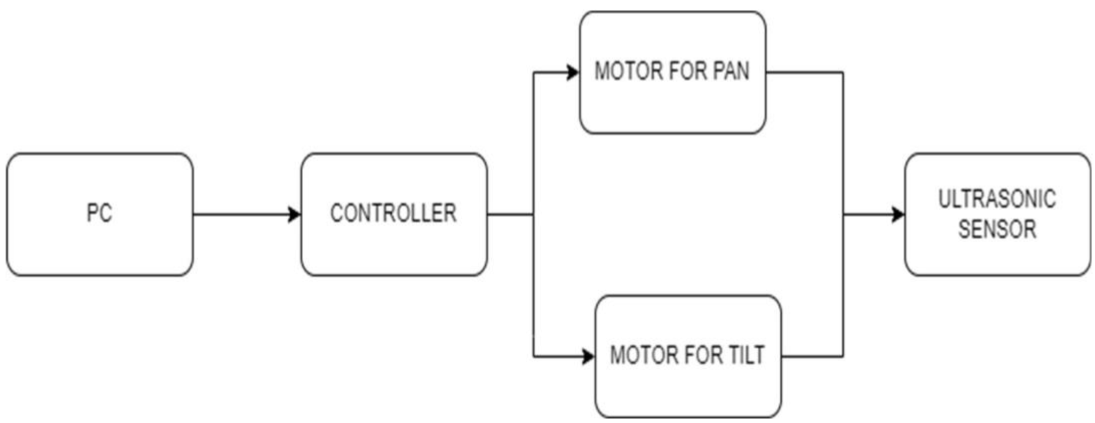

Fig. 2.6 Hardware block diagram

2.6 Electrical Circuit diagram

The circuit diagram gives all the necessary connections required for the project. First from the power supply the 5 volt and the ground wires are connected to the power receiving wire and ground wire of the MG996R servo motors. The power supply is also connected to the ultrasonic sensor with VCC to the 5 V supply and ground pin to the ground wire of the power supply. On other hand the signal pins of the servo motors are connected to the 5^{th} and 7^{th} pins of the Arduino Uno. And the echo pin and trig pin are connected to 12^{th} and 13^{th} pin on the Arduino Uno. From the figure it is clear that the power supply is provided only to the servo motors and the ultrasonic sensor. The power for Arduino is taken from the pc where the map of the environment should be displayed on matlab. Fig 2.7 shows electrical Circuit diagram

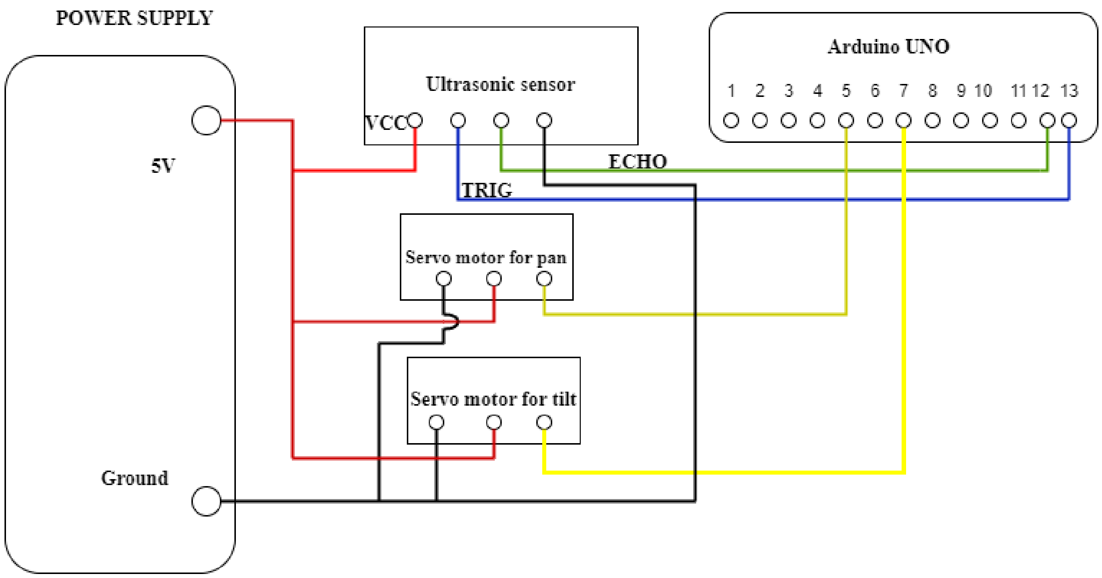

Fig. 2.7 Electrical Circuit diagram

Fig 2.8 shows the completely fabricated prototype

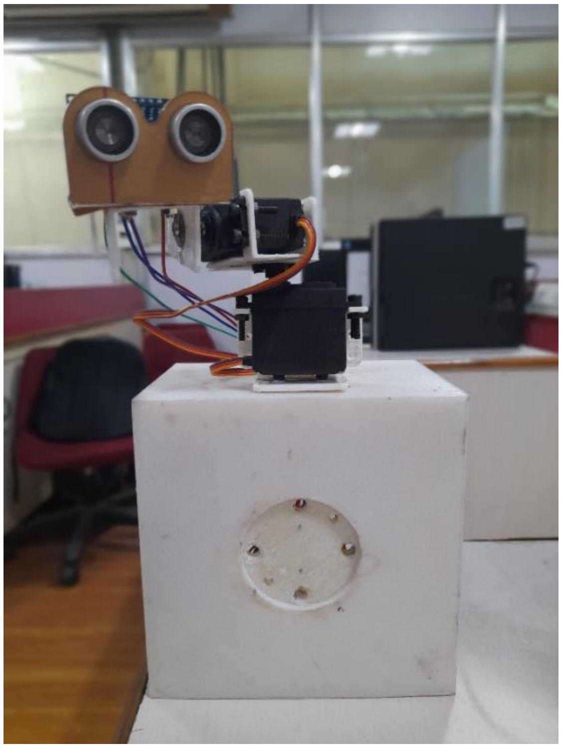

Fig 2.8 Completely fabricated model

CHAPTER 3
FUNCTIONAL INTEGRATION

3.1 Type of control

The type of control used is a combination of manual and automated control. The pan and tilt mechanism would allow for manual control of the sensor's orientation, allowing the operator to adjust the direction in which the ultrasonic pulses are emitted and the resulting data collected. At the same time, an automated control system would be used to process the data collected by the ultrasonic sensor and create a detailed map of the area being scanned. This automated system would use algorithms and software to analyze the data and create a visual representation of the space being mapped.

3.2 Control system block diagram

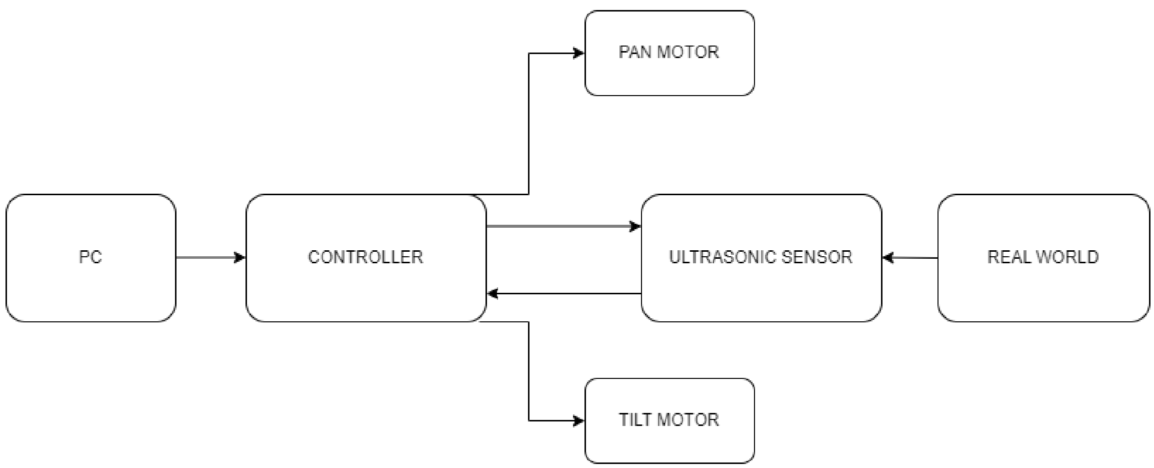

Fig. 3.1 Control system block diagram

3.3 Flow chart

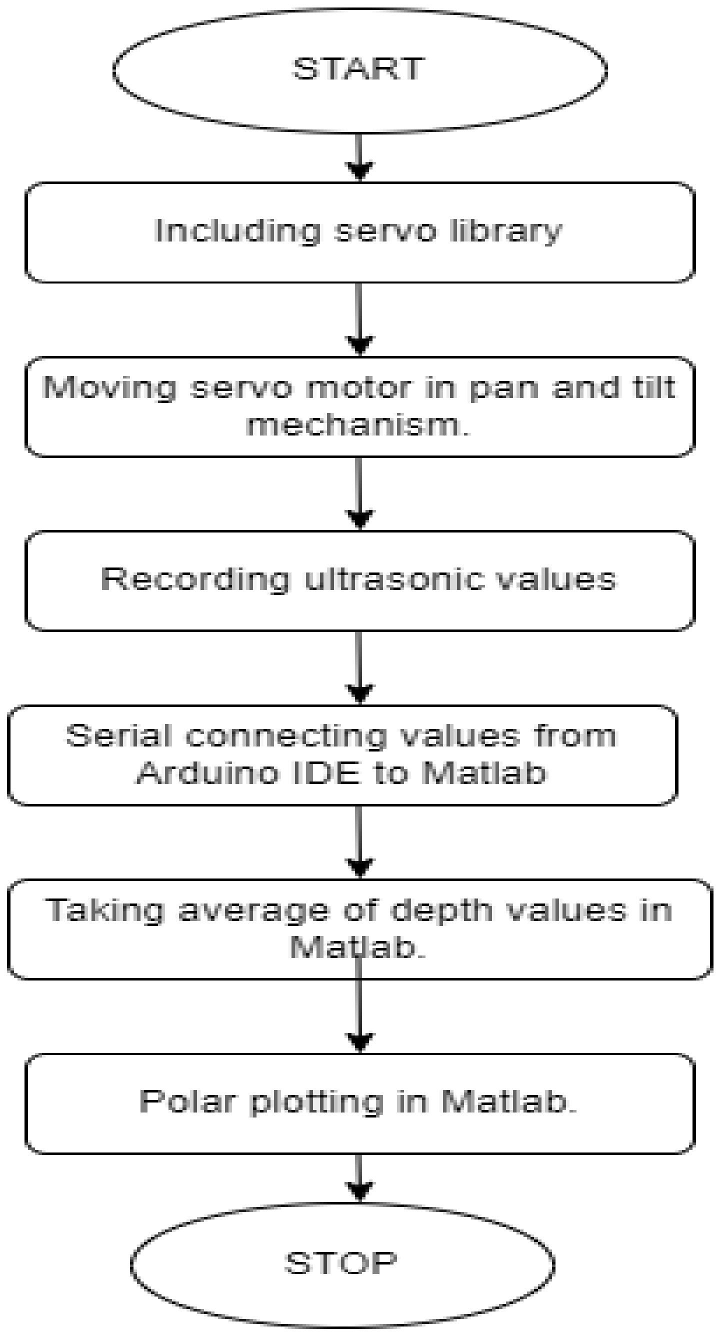

Fig. 3.2 Flow chart

3.4 Comments on performance

This project gave us good knowledge about a lot of things, it taught us what exactly mechatronics is. We had many ups and downs but in the end we were able to get good results. We had many challenges, firstly we needed 3d printing for our project and for that we had to learn to construct things on solid works, it took us time but we learnt it but again there were some errors in the 3d printed clamps, we had to make some changes to it and adjust it . Then there was a bigger challenge that was codding as none of us knew to code, we learnt the syntax and started trying to run the motors and sensor, we had many failures in the beginning but later when we were able to control them. Then the next challenge was to plot the ultrasonic values on the radar, we tried a lot but the result was not coming as expected. We thought we will not be able to complete the project as we were close to the deadline but then our faculty guided us, told what to be done and gave us hope. We worked on it and were able to see better results. Fig 3.3 shows mapped data.

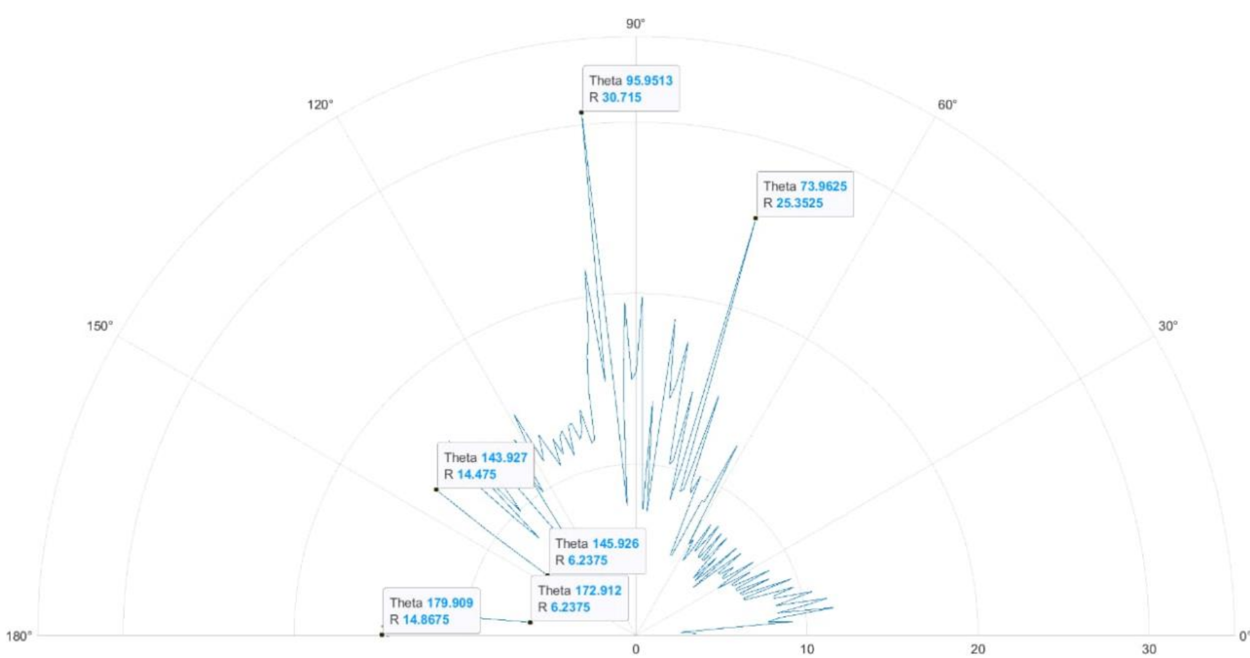

Fig 3.3 Mapped data

CHAPTER 4
CONCLUSION AND FUTURE SCOPE

4.1 Future Scope

The future scope of mapping using ultrasonic sensors is quite promising. Ultrasonic sensors can be used for a variety of applications, including distance measurement, obstacle detection, and mapping. Example - Autonomous vehicles, indoor mapping, archaeology, search and rescue. As technology continues to advance, it is likely that we will see even more innovative uses for ultrasonic mapping.

4.2 Concluding Remarks

In conclusion, mapping using ultrasonic sensors is a promising area of research with numerous potential applications. Ultrasonic sensors can be used to create maps of indoor environments, underground structures, disaster zones, and more. These maps can be used for a variety of purposes, including navigation, obstacle avoidance, inventory management, and search and rescue. As technology continues to advance, it is likely that we will see even more innovative uses for ultrasonic mapping in the future. Overall, ultrasonic sensors have the potential to revolutionize the way we map and navigate our environment, and it will be exciting to see where this technology takes us in the years to come.

APPENDIX - CODES RELATED TO THE PROJECT

(1) Servo motor and ultrasonic sensor code

```
#include <Servo.h>
float distance1,distance2;
int i,j,dist_c,dist_an,pos=0;
int trigPin=12;
int echoPin=13;
int table[20][2];
int pinTravelTime;
int z =0 ;
Servo myservo;
void setup() {
  // put your setup code here, to run once:
 myservo.attach(10);
 pinMode(trigPin,OUTPUT);
 pinMode(echoPin,INPUT);
 Serial.begin(9600);
}

void loop()
{
  if (z==0){
  // put your main code here, to run repeatedly:
  i=1;
  for (pos = 0; pos <= 180; pos += 1)
  {  myservo.write(pos);
     distance1=ultrasonic();
```

```
    delay(0.5);
    distance2=ultrasonic();
    dist_c=(distance1+distance2)/2;
    dist_c=round(dist_c);
    i++;
    Serial.println(dist_c);
    Serial.println(i);
  }

  j=1;
  for (pos = 180; pos >= 0; pos -= 1)
  {
   myservo.write(pos);
    distance1=ultrasonic();
    delay(0.5);
    distance2=ultrasonic();
    dist_an=(distance1+distance2)/2;
    dist_an=round(dist_c);
    j++;
    Serial.println(dist_an);
    Serial.println(j);
 }
 z=1;
  }
}
float ultrasonic()
{
  digitalWrite(trigPin,LOW);
 delayMicroseconds(2);
 digitalWrite(trigPin,HIGH);
 delayMicroseconds(2);
```

```
 digitalWrite(trigPin,LOW);

 pinTravelTime=pulseIn(echoPin,HIGH);
 Serial.println(pinTravelTime*0.0034);
 pinTravelTime=pulseIn(echoPin,LOW);
 return pinTravelTime*0.0034;

}
```

(2) Arduino to matlab code

```
arduino=serial('COM4','BaudRate',9600);
fopen(arduino);
j=1;
for i=1:10000
        a(i)=fscanf(arduino,"%f");
        n(i)=j;
        j=j+1;

end
disp(a);

fclose(arduino);
delete(instrfind({'Port'},{'COM4'}));
```

(3) Average values code

```
for j = 1:1:180
    avg(j)=(a(1,(4*j)+1)+a(1,(4*j)+2))/2;
    disp(avg)
end
```

REFERENCES

1. Image of MG996 R servo motor

https://m.media-amazon.com/images/I/413PYX5J9yL.jpg

2. Image of Arduino Uno

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcS3xeBwgLU_v60L8sSm3WTQXPlxtQDLkWwXxYizYlzPRdjWOlIcakusRpsY5HNXY-v3-fw&usqp=CAU

3. Image of HC SRO4 Ultrasonic sensor

https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSPT_in40eqAq7-KSSpHl7ADDGxpOS24DodwVnrdExNt1Jm5ErGit7mx2ww5MUBn1Z5Ry4&usqp=CAU