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Ultrasonic Mapping: An Application of Ultrasonic Sensor

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***Abstract*—Ultrasonic mapping is used to detect objects in an environment. A sensor generates a sound and listens for the echo. The distance of an object is determined by the time it takes for the echo to be heard. Ultrasonic mapping finds applications in defense and rescue sectors. This manuscript presents details for the development of a two dimensional map of an environment using an ultrasonic sensor. The key components of this ultrasonic distance mapper include an ultrasonic distance sensor, an Arduino Uno microcontroller board, and a servo motor. Excel is used to collect data from the sensor.**

Keywords—mapping; ultrasonic sensor; environment

1. INTRODUCTION

Mapping is a technique which builds the map of an indoor environment thereby locating static objects in the defined space [1]. Through the use of intelligent sensors, data gathering is done to identify the indoor environment and to construct the map [2]. Different types of sensors that can be used include vision sensors, ultrasonic sensors, lasers, and infrared range finders. For ultrasonic mapping, an ultrasonic sensor is used. By making use of ultrasonic mapping, it is possible to see objects or realize depths that are not visible due to hazards or visibility issues. Another application of ultrasonic mapping involves mapping areas that are not easily accessible to humans, such as, the depth of ocean bed [3]. There are many ways to develop an ultrasonic map. As described in [4], an Arduino microcontroller was used along with MATLAB to develop the map. In [5], an Arduino Nano microcontroller system was used along with a Raspberry P*i*2 for the mapping. The Raspberry P*i*2 controlled the ultrasonic sensor and communicated with the Arduino microcontroller system to control the position of the servo motor. Windows 10 IoT (Internet of Things) core and visual studio was used to develop the map. However, there were issues pertaining to the stopping of servo motor.

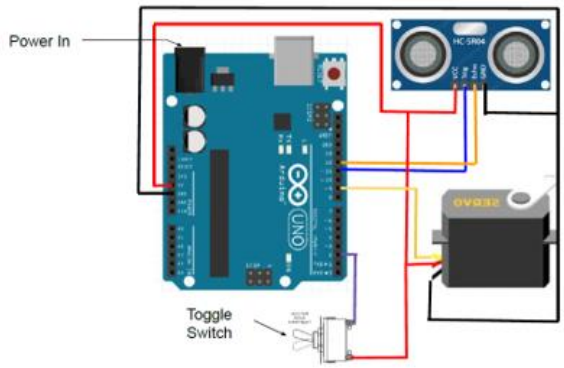
The ultrasonic mapping approach described in this manuscript makes use of Arduino Uno. The maximum distance that the ultrasonic sensor measures with the set up described in this manuscript is 50 cms. The basic functional diagram for this ultrasonic mapping system is provided in Fig. 1.

Fig. 1 Basic functional diagram

The functional diagram shows how the components of the mapping system are interconnected.

2. SYSTEM DESCRIPTION

The basic circuitry for the ultrasonic mapping is presented in Fig. 2.



Key

Color	Type	Terminal
Red	(+) 5 VDC	5 V
Black	(-) 5 VDC	GND
Blue	Trig	11
Orange	Echo	12
Yellow	PWM/Signal	9
Purple	Scan Mode	2

Fig. 2 Basic Circuitry

The servo motor in Fig. 2 is controlled by PWM. An Arduino Uno controller is used to send PWM signals to the servo motor. Data collected from the Ultrasonic sensor provide an accurate measurement of how far the objects are located. A stable platform is used for the placement of the servo motor.

A sheet which depicts all the collected data is shown in Fig.2 below.

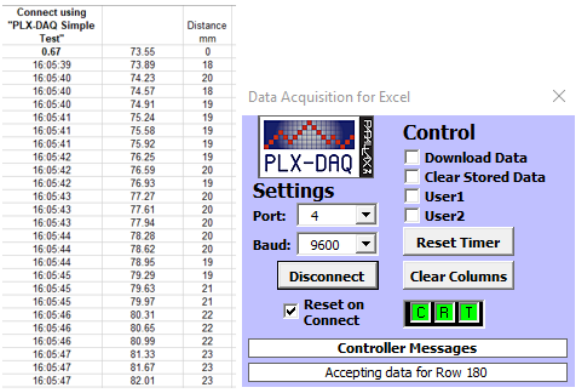


Fig. 3 Sheet depicting the collected data

There are 180 rows when the scan is complete. One row is equivalent to one degree moved. When the PLX-DAQ control is configured correctly, the data will populate the sheet shown above in Fig. 3. The file shown in Fig.3 is credited to [6]. To get the graph to display correctly, 360 points need to be used. Only 180 points have data because these are all the points that are being measured. The points go from 90 to 0, 0 to -180, and 90 to 180. The cells from 90 to 9 display the first 90 collected points. Cells from 0 to -180 are empty. The cells from 90 to 180 are filled with data. The sensor moves from left to right and the cells are also populated from left to right. Fig. 4 depicts a picture of the 2D ultrasonic distance mapper.

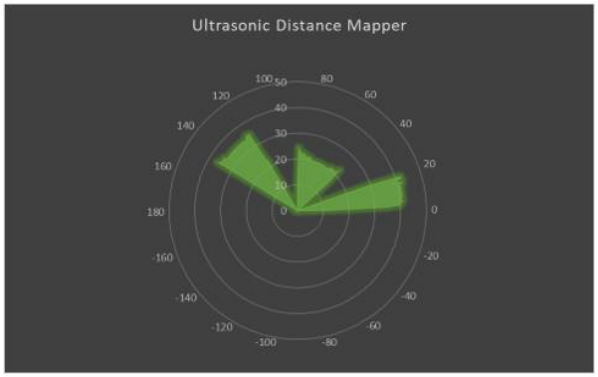


Fig. 4 An image of the 2D ultrasonic distance mapper

The code developed for this ultrasonic distance mapper is provided in Fig. 5

```
#include <Servo.h>
#include <NewPing.h>
#define TRIGGER_PIN  12
#define ECHO_PIN     11
#define MAX_DISTANCE 50
NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE);
Servo myservo;
const int switchPin = 2;
int switchState = 0;
int pos = 0;
int it = 10;

void setup() {
  myservo.attach(9);
  Serial.begin(9600);
  Serial.println("CLEARDATA");
  Serial.println("Label,Time,Started Time,Register value");
  Serial.println("RESETTIMER");
  delay(6000);
  pinMode(switchPin, INPUT);
}
void loop() {
  int i = 0;
  int t = 0;
  int a = 0;
  for (i = 0; i < 180; i ++)
  {
    if (switchState == HIGH){
  break;
  } else {
    unsigned int uS = sonar.ping();
    myservo.write(i);
    delay(20);
    for (t = 0; t < it; t++)
    {
     uS = sonar.ping();
     a = uS/US_ROUNDTRIP_CM + a;
      delay(30);
    }
    a = a / (it-1);
    Serial.print("DATA,TIME,TIMER,");
    Serial.println(a);
    t = 0;
    a = 0;
}
}
  switchState = digitalRead(switchPin);
  if ((switchState == LOW)&&(i = 180))
{
  delay(6000);
  Serial.println("CLEARDATA");
}
}
```

Fig. 5 Code for the Ultrasonic Distance Mapper

3. CONCLUSIONS

Ultrasonic mapping constitutes one of the key applications of ultrasonic sensor. The sensor sends out a sound signal and waits for it to return. The time it takes for the signal to return indicates how far the object is away from the sensor. The ultrasonic mapping system described in this manuscript is developed using Arduino Uno microcontroller board, ultrasonic, and a servo motor. Excel is used to gather data from Arduino Uno and a graph is created. The ultrasonic mapper described in the manuscript is fairly accurate.

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