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Using Arduino Software to Design Radar (Sonar) System

Submitted to Al-Karkh University of Science as a partial Fulfillment of Requirements for the Degree of Bachelor Degree in Remote Sensing

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Examining Committee Certification

We certify that we have read this project entitled, **"Using Arduino Software to Design Radar System"**, and as examining committee, examined the students**" Saja Ameer Salman, and Ali Ayad Hussen "** on its contents, and that in our opinion it is adequate for the partial fulfillment of the requirements for the Degree of Bachelor in Remote Sensing.

Signature:

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Date: / / 2020

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Date: / /2020

Approved for Al-Karkh University of Science for under graduate students at Remote Sensing.

Supervisor Certification

The preparation of this project was made under my supervision at the Collage of Remote Sensing and Geophysics/ department of Remote Sensing in Al-Karkh Univeristy of Science as partial fulfillment of the requirements for the Degree of bachelor in Remote Sensing.

Signature:

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Name: Dr. Fadia W. Al-Azawi

Date: /7 /2020

بسم الله الرحمن الرحيم

{ يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَ الَّذِينَ أُوتُوا الْعِلْمَ
دَرَجَات}

صدق الله العلي العظيم

سورة المجادلة

١١

الإهـــداء

اهدي هذا العمل المتواضع الى تلك الانسانة التي غمرتني بحنانها وحبها الى الحبيبة والاخت والصديقة والام وكل شيء في حياتي .... امي الحبيبة.

إلى الذين قال في حقهم الله عز وجل :(فلا تقل لهما أفٍ ولا تنهرهما وقل لهما قولا كريما)

صدق الله العلي العظيم

سورة الإسراء٢٣

إلى ميزان العدل والقسط ونهر العطاء والدفء إلى شمعة ميلادي ومن فاض بحبه فؤادي إلى من أنار لي طريقي وجعل من كلامه الجد لعملي إلى الأصل الطيب والحنون إلى من ساعدني لتحقيق أحلامي إلى والدي العزيز .

الى من وهبوني كل ما يملكون حتى أحقق لهم آمالهم كل أساتذتي والتدريسيين طيلة الأربع سنوات الماضية من قسم التحسس النائي الذين جعلوني اكمل سلم الصعود بالعلم قال تعالى: { يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَ الَّذِينَ أُوتُوا الْعِلْمَ دَرَجَات}

صدق الله العلي العظيم

إلى الشهداء الذين ذهبو ليعودو بالزنابق البيضاء ...إلى اؤلاءك الذين يسعون لرفع لواء الامة ...... ابطال العراق....

شكر وتقدير

أول مشكور هو الله عز وجل، ثم والداي على كل مجهوداتهم منذ ولادتي إلى هذه اللحظات، أنتم كل شيء أحبكم في الله أشد الحب .يسرني أن أوجه شكري لكل من نصحني أو أرشدني أو وجهني أو ساهم معي في إعداد هذا البحث بإيصالي للمراجع والمصادر المطلوبة في أي مرحلة من مراحله، وأشكر على وجه الخصوص أستاذتي الفاضله الدكتورة (د.فاديه وضاح العزاوي) على مساندتي وإرشادي بالنصح والتصحيح وعلى اختيار العنوان والموضوع، كما أن شكري موجه لإدارة كلية التحسس النائي والجيوفيزياء بجامعة (الكرخ للعلوم/ قسم التحسس النائي) والشكر للمجهودات المبذولة من قبل أساتذتنا الكرام في الجامعة لتوفير أفضل بيئة للدراسه في أفضل الأحوال التي تلائم طلبة العلم، و اخص بالذكر والشكر الى الدكتور المحترم د. لؤي كاظم عبود و الزميل عبدالله مهدي صالح جامعة تكنولوجيا المعلومات و الاتصالات كلية معلوماتية الاعمال/ أدارة انظمة معلوماتيه

Abstract

The radars have become the "eyes" of electronic devices and the use of radar has become increasingly popular in various fields of study. At the same time, these devices can also be used to assist people in all the fields the life. Ultrasonic radars can accomplish distance measurements by measuring the time delay between the emission of the ultrasonic signal and receipt of the echo signal. Microcontrollers can be connected to perform computations or control timers in these devices. The detection of the distance between the objects (targets) poses a challenge on the temporal resolution of the detector. The correct calibration of these radars is imperative given the fact that the safety of the user depends on the sensor system.

This goal of this project is the use of Ultrasonic Sensor by connecting to the Arduino UNO R3 board and the signal from the sensor further provided to the screen formed on the laptop to measure the presence of any obstacle in front of the sensor as well as determine the distance, range, and angle at which the obstacle is detected by the sensor. In this study ultrasound sensor worked as a radar. The use of the Arduino software to design a radar system because Arduino has more advantages like:

- It is an open-source project, software/hardware is extremely accessible and very flexible to be customized and a
- It is easy to use, connects to computer via USB and communicates using standard serial protocol, runs in standalone mode and as interface connected to PC/Macintosh computers.
- It is cheap.

- Arduino is backed up by a growing online community, lots of source code is already available and we can share and post our examples for others to use.

This project is about Radar System controlled via Arduino. This RADAR system consists of an ultrasonic sensor and servo motor. Ultra-sonic sensor is attached to the servo motor it rotates about 180 degrees and gives a visual representation of the software called processing IDE. Processing IDE gives graphical representation and it also gives an angle or position of the object and the distance of the object. This system is controlled through Arduino.

Radar (sonar) able to detect the presence of fixed and moved targets and can determine the distance between it and the targets in different angles $(0\text{-}180)^0$ which is the range can sweep by TowerPro SG90 Servo used in this project.

The detection of objects (targets) doesn't depend on the type of the material that the target made from it; it can detect all the types of objects in the range.

It is very important to use these techniques for security in government offices, street, banks, and so and instead of the camera system because it is more accurate, not affected by the weather conditions like (rain , snow, and fog).

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List of abbreviations

Symbol	Mean
RADAR	Radio Detection and Ranging
RDF	Radio Direction Finding
CPUs	complete central processing units
I/O	Input/Output
IDE	integrated development environment

Chapter One

Introduction

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Introduction

1- Introduction

1-1 Historical review of Radar

The word RADAR is an acronym derived from the words Radio Detection and Ranging. In the United Kingdom it was initially referred to as radio direction finding (RDF) in order to preserve the secrecy of its ranging capability (Boerner, W-M. *et al.*, 1985).

The scientist Heinrich Hertz, after whom the basic unit of frequency is named, demonstrated in 1886 that radio waves could be reflected from metallic objects.

In 1903 a German engineer obtained a patent in several countries for a radio wave device capable of detecting ships, but it aroused little enthusiasm because of its very limited range. Marconi, delivering a lecture in 1922, drew attention to the work of Hertz and proposed in principle what we know today as marine radar. Although radar was used to determine the height of the ionosphere in the mid-1920s, it was not until 1935 that radar pulses were successfully used to detect and measure the range of an aircraft. In the 1930s there was much simultaneous but independent development of radar techniques in Britain, Germany, France and America. Radar first went to sea in a warship in 1937 and by 1939 considerable improvement in performance had been achieved. By 1944 naval radar had made an appearance on merchant ships and from about the end of the war the growth of civil marine radar began. Progressively it was refined to meet the needs of peacetime navigation and collision avoidance (Alan Bole, Bill Dineley, and Alan Wall., 2005).

While the civil marine radars of today may, in size, appearance and versatility, differ markedly from their ancestors of the 1940s, the basic data that they offer, namely target range and bearing, are determined by exploiting the

same fundamental principles unveiled so long ago (Alan Bole, Bill Dineley, and Alan Wall., 2005).

The term 'Radar' is an acronym for radio detection and ranging (Boerner, W-M. *et al*., 1985). Radar system arrives in an assortment of sizes and have distinctive performance particulars. Some radars are utilized for aviation authority at air terminals and others are utilized for long range observation and early-cautioning frameworks (Onoja, A.E. *et al.*, 2017) There are some ways to show radar working data. There are also some modified radar systems which have advanced technology of handling the systems. These modified systems are used at higher levels to get or extract the helpful or important data (Tiwari, S. et al., 2018).

Technology has become available that can detect targets on the land, on the sea, in the air and outside the earth's atmosphere. These include aircraft, land vehicles, ships, air breathing and ballistic missiles and others. Radar has also been used to detect targets ranging from buried ordnance (Daniels, D.J., Gunton, D.J., and Scott, H.F., 1988) to weather systems (Mahapatra, P.R.,1998), to being the cruise control and collision avoidance sensor in luxury cars, to measure the distances and rotational speeds of our planetary neighbor's in the solar system (Eriksson, L.H. and Broden, S. 1996).

1-2 Basic Concepts of Radar

Radar is an electromagnetic system for the detect and determine the locations of objects and determine distance, and ranges. It operates by transmitting a particular type of waveform, a pulse-modulated, and detects the nature of the echo signal. Radar is used to extend the capability of one's senses for observing the environment, especially the sense of vision (Merrill l. Skolnik, 1981).

An elementary form of radar consists of a transmitting antenna emitting electromagnetic radiation generated by an oscillator of some sort, a receiving antenna, and the receiver. A portion of the transmitted signal is intercepted by a reflecting object (target) and is radiated in all directions. The receiving antenna collects the returned energy and delivers it to a receiver, where it is processed to detect the presence of the target and to extract its location and relative velocity.

The distance to the target is determined by measuring the time taken for the radar signal to travel to the target and back. The direction of the target determined from the direction of arrival of the reflected wavefront (Merrill I. Skolnik, 1981).

The basic concept of a radar transmitting a signal and receiving a return from a target is shown in Figure (1-1).

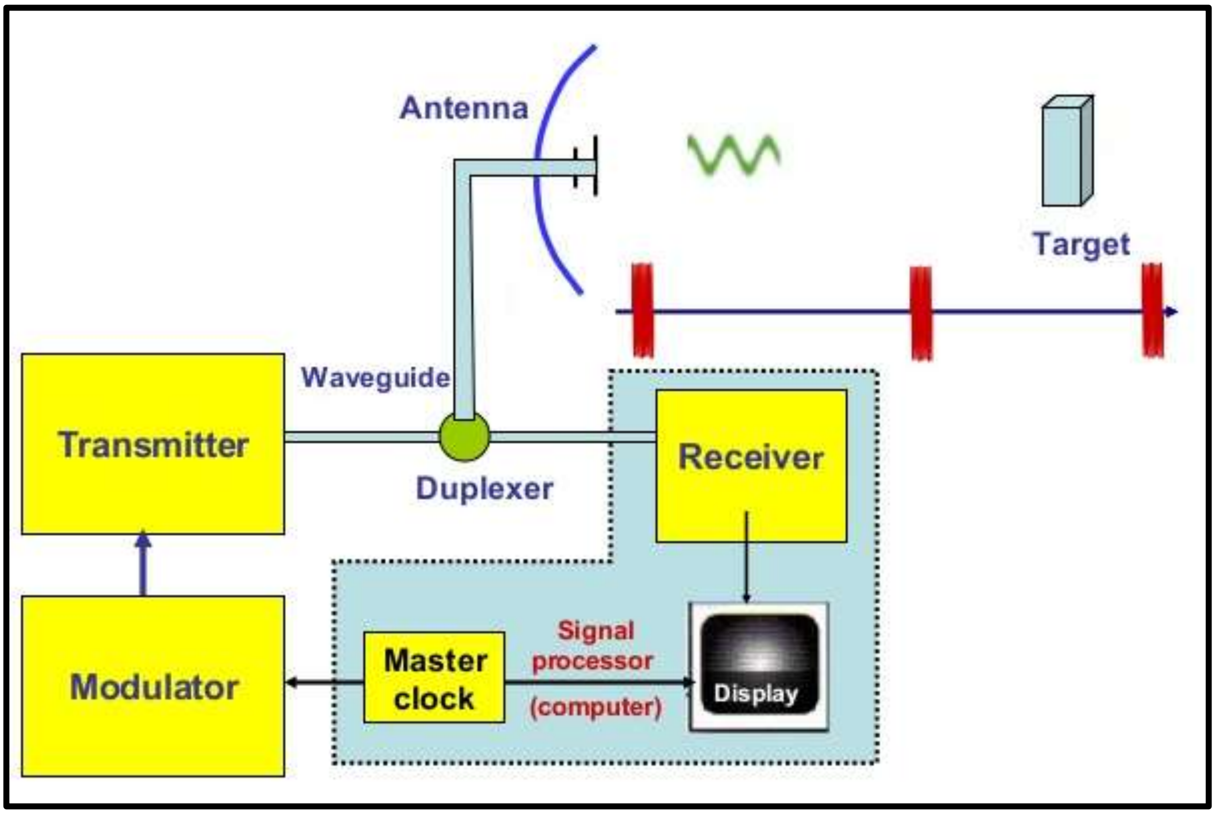

Figure (1-1): Simplified radar block diagram

The radar generates a signal, which is transmitted through an antenna into the desired direction. The antenna is designed to concentrate the radar energy in a particular direction. Only a small proportion of the transmitted radar energy reaches the target, with the rest missing it or illuminating other nearby objects, including the earth's surface or going off into space, as the radar beam is normally much wider than the angular dimensions of the target. The radar beam broadens as the wave propagates from the radar, so is reduced in strength with distance and the energy incident upon the target also reduces with distance (P. Tait, 2009).

1-3 The echoes principle (Alan Bole, Bill Dineley, and Alan Wall., 2005).

An object (normally referred to as a target) is detected by the transmission of a pulse of radio energy and the subsequent reception of a fraction of such energy (the echo) which is reflected by the target in the direction of the transmitter. The phenomenon is analogous to the reflection of sound waves from land formations. If a blast is sounded on a ship’s whistle, the energy travels outward and some of it may strike. The energy which is intercepted will be reflected by the cliff. If the reflected energy returns in the direction of the ship, and is of sufficient strength, it will be heard as an audible echo which, in duration and tone, resembles the original blast. In considering the echo principle the following points can usefully assist in a preliminary understanding of radar detection:

(a) The echo is never as loud as the original blast.

(b) The chance of detecting an echoes depends on the loudness and duration of the original blast.

(c) Short blasts are required if echoes from close targets are not to be *drowned* by the original blast.

(d) A sufficiently long interval between blasts is required to allow time for echoes from distant targets to return.

While the sound analogy is extremely useful, it must not be pursued too far, as there are a number of ways in which the character and behavior of radio waves differ from those of sound waves. In particular at this stage it is noteworthy that the speed of radio waves is very much higher than that of sound waves.

Aim of the project

This project aims at the use of Ultrasonic Sensor by connecting to the Arduino UNO R3 board and the signal from the sensor further provided to the screen formed on the laptop to measure the presence of any obstacle in front of the sensor as well as determine the distance, range, and angle at which the obstacle is detected by the sensor. In this study ultrasound sensor worked as a radar.

Chapter Two

Materials & Methods

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2- Materials & Methods
2-1 Materials

2-1-1 MB-102 Solderless Bread Board

The breadboard has 2 split power buses contents from 10 columns, and 63 rows with a total of 830 ties in points. All pins are spaced by a standard 0.1" as shown in figure (2-1).

This board also has a self-adhesive on the back. The boards also have interlocking parts.

Plugboard a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).

Table (2-1): The characteristics of each used part

No.	Contents	Characteristics
A-	1 Terminal Strips	Tip-point 630
B-	2 Distribution Strips	Tie-point 200
C-	Solderless breadboard	MB-102
D-	Wire size	20-29 AWG wires.
E-	Size	16.5 x 5.5 x 0.85 cm
Dimensions**: 6.5 x 2.1 x 0.38" (165.1 x 54.29 x 9.68mm).**		

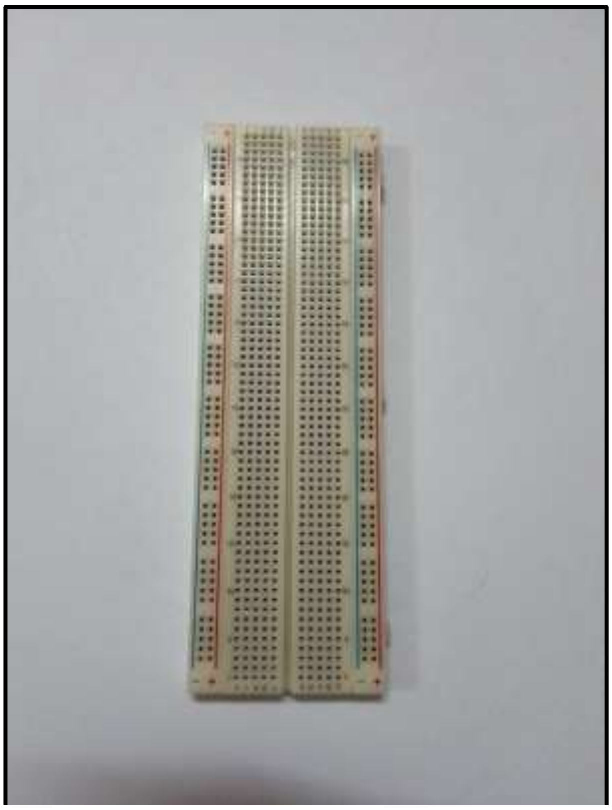


Figure (2-1): Breadboard, 830 Point Solderless PCB Breadboard MB-102.

2-1-2 the Jumper

The jumper is an electrical wire, or group of them in a cable, with a pin at each end, which is normally used to interconnect the components of a breadboard internally or with other components or equipment's without soldering.

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board or a piece of test component.

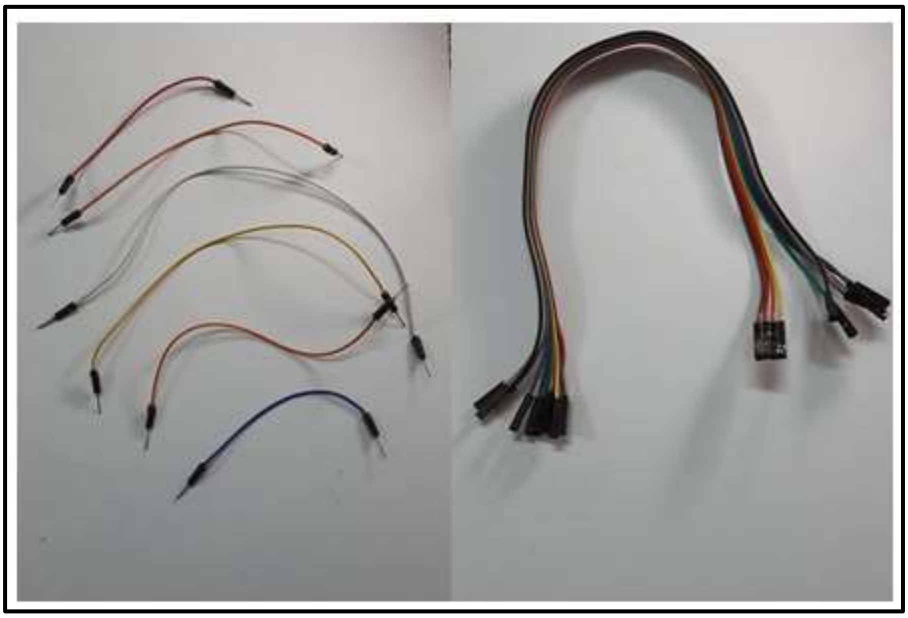


Figure (2-2): Jumper wires with different standards

2-1-3 Tower PRO ™ Microservo SG90

A servomotor is a rotary actuator that allows for precise control of velocity, acceleration, and angular position. It consists of a suitable motor coupled to a sensor for position feedback. It also contains a relatively sophisticated controller for a dedicated module designed specifically for use with servomotors. Servomotors uses servomechanism to achieve closed loop control with a generic open loop motor and are used in applications such as robotics, CNC machinery or automated manufacturing.

SG90 digital servo used to achieve this study, which is the new version of SG90 analog servo and its properties as in the following table (2-2).

Figure (2-3): TowerPro SG90 Servo

Table (2-2): TowerPro SG90 Servo Characteristics

Contents	**Characteristics**
Modulation:	Analog
Torque:	**4.8V:** 25.00 oz-in (1.80 kg-cm)
Speed:	**4.8V:** 0.12 sec/60°
Weight:	9 g
Dimensions:	**Length:** 0.91 in (23.0 mm) **Width:** 0.48 in (12.2 mm) **Height:** 1.14 in (29.0 mm)
Motor Type:	3-pole
Gear Type:	Plastic
Rotation/Support:	Bushing
Pulse Width:	500-2400 µs
Connector Type:	JR

2-1-4 The Transceivers

The transceivers work on a principle similar to radar or sonar which evaluate attributes of the objects (targets) by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor.

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in the air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

Table (2-3): Ultrasonic Sensor Pin Description

Pin No.	Pin Name	Description
1	Vcc	Vcc Pin powers the sensor, typically with +5v.
2	Trigger	Trigger pin is an input pin. This pin has to be kept high for 10us.
3	Echo	Echo pin is an output pin. This pin goes high for a period of time.
4	Ground	Ground pin is connected to the ground of the system.

Figure (2-4): HC-SR04 Sensor

Table (2-4): HC-SR04 Sensor characteristics

Parameter	Characteristics
Operation Voltage	DC 5V
Oeration Current	15 mA
Operation Frequency	40 Hz
Range	(2 cm – 4m)
Measuring Angle	15 Degree
Trigger Input Signal	10µS TTL pulse
Echo, Output Signal	Input, TTL lever signal and the range in proportion
Dimensions	45 * 20 * 15mm

2-1-5 Arduino UNO

Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices. In this project the systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The Arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages, C and C++ (Margolis, M. 2011). The Arduino UNO board is probably the most popular among the developers of electronic products based on the Arduino. It is ideal for debugging the software and hardware parts of devices during the development phase (Minns, P.D., 2013).

Table (2-5): Arduino UNO board characteristics

Parameter	Characteristics
Operation Voltage	DC 5V
Analog input pins	6
DC Current per I/O Pin	40 mA
Clock Speed	16 MHz
Board length	68.6 mm
Board width	53.4 mm
Weight	25 g
Digital I/O Pins 14 6 provide PWM output	

Figure (2-5): Arduino board

2-2 Methods

The tools and equipment's were mentioned above used to achieve this study, the electric circuits designed by us as in the following figures. The following circuit used to achieve the parts 1, 2, and 3 respectively.

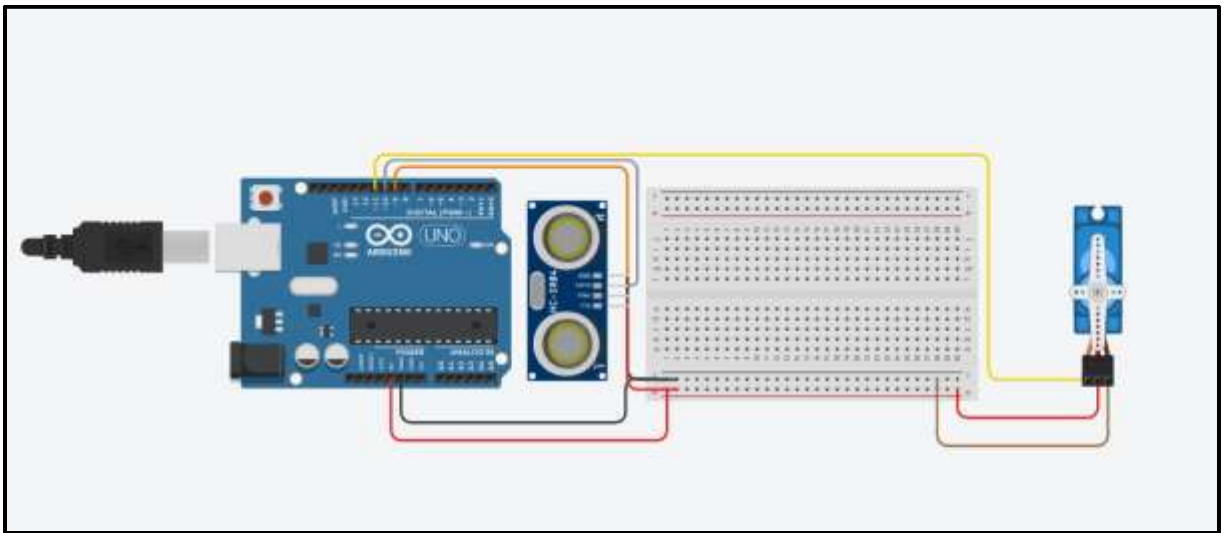


Figure (2-6): Schematic of setup for the parts from 1-3

In these parts of the project, ultrasound sensor used to determine the distance of the objects (targets) from the sensor; the details as in table (2-6) and figure (2-7).

Table (2-6): Target detection experiments using an ultrasound sensor

Experiment No.	No. of targets	Radar motion	Target's motion
1	**1**	**Fixed**	**Fixed**
2	**2**	**Fixed**	**Fixed**
3	**2**	**Fixed**	**Fixed**

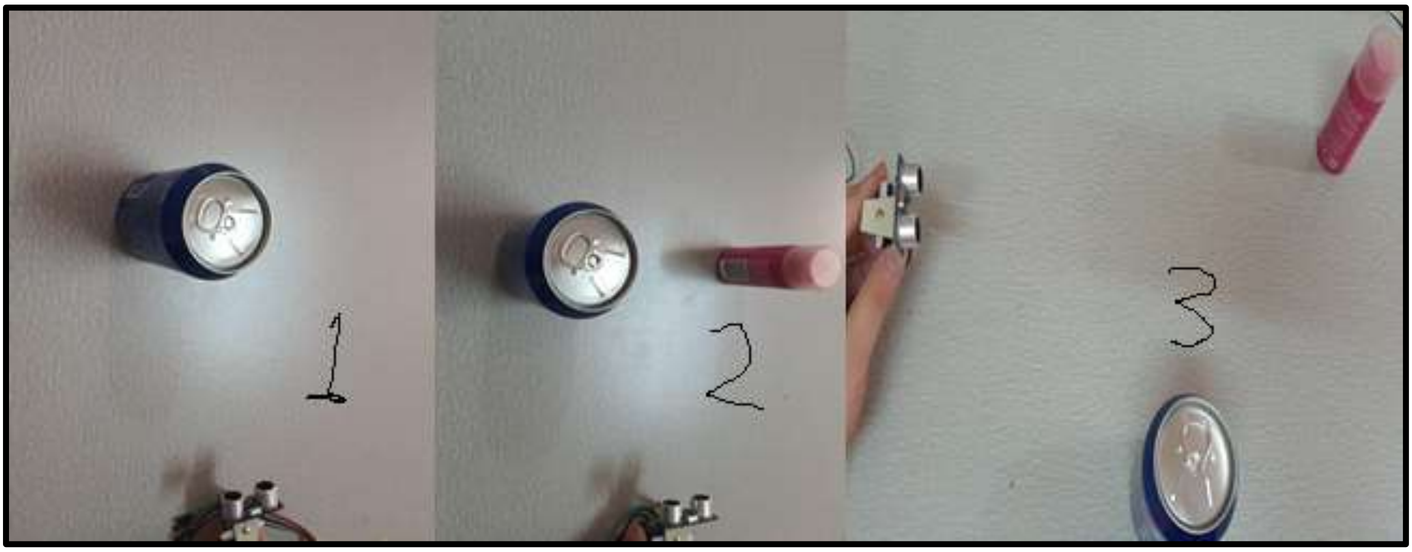


Figure (2-7): The detection of the objects (targets)
1: In the case of one target.
2: In the case of two targets at the same distance from the radar.
3: In the case of two targets at different distance from the radar.

In part 4 the radar was fixed and the target moved, the range of the radar is 3 m. The designed electric circuit used to achieve this experiment as in figure (2-8) in the presence of warning siren.

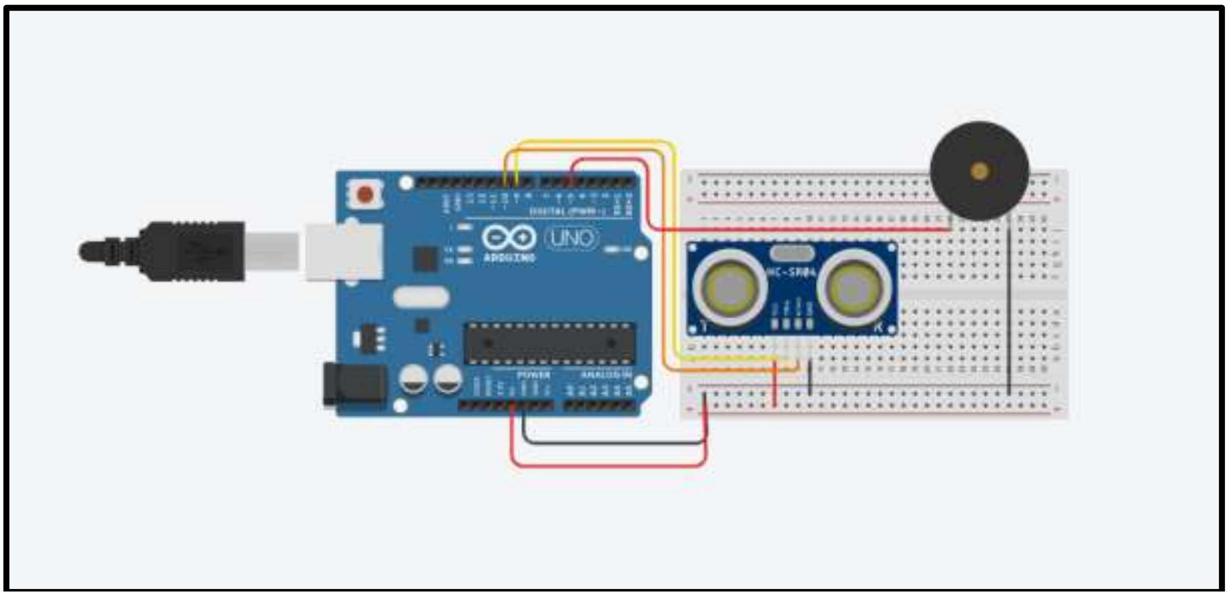


Figure (2-8): Schematic of setup for the part 4 using warning siren

In part 5, the Arduino was programmed so that the radar can locate the locations of the targets in two situations; first when an object is present in the allow range and second when object approached inside the forbidden zone, which was determined by 40 cm in this work. In this experiment warning bell and warning light was used.

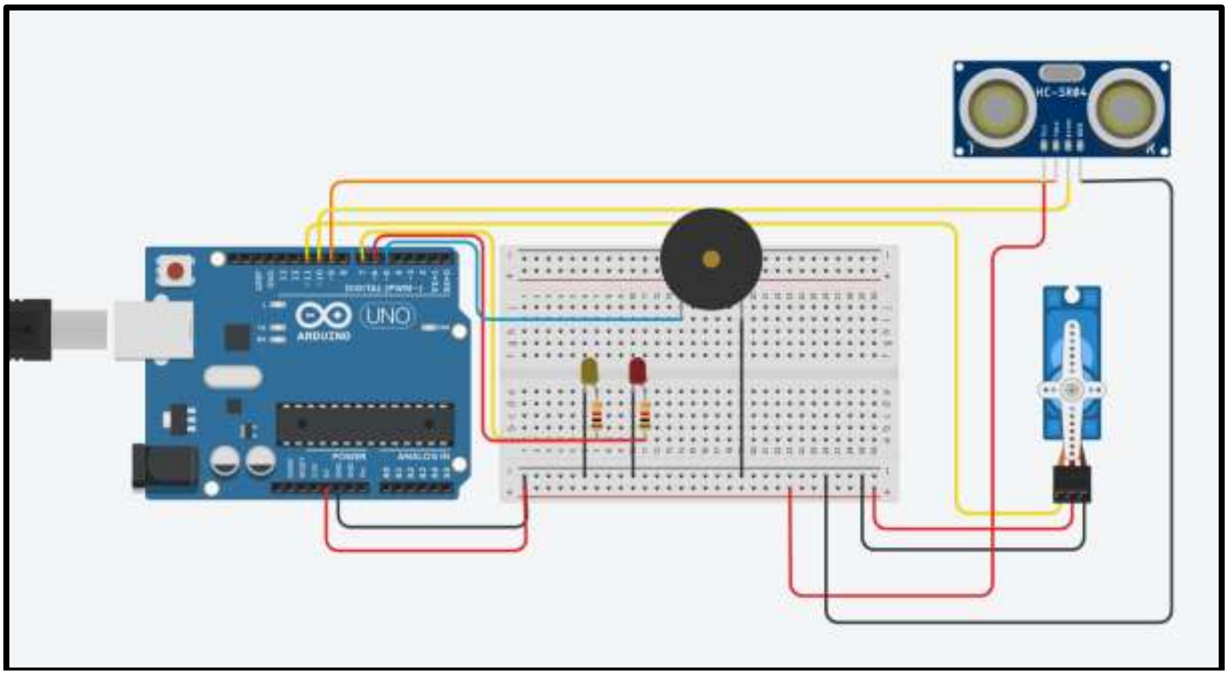


Figure (2-9): Schematic of setup for the part 5

The electric circuit used to achieve part 6 as in figure (2-10) using warning lamp to sense the presence of fixed near the target.

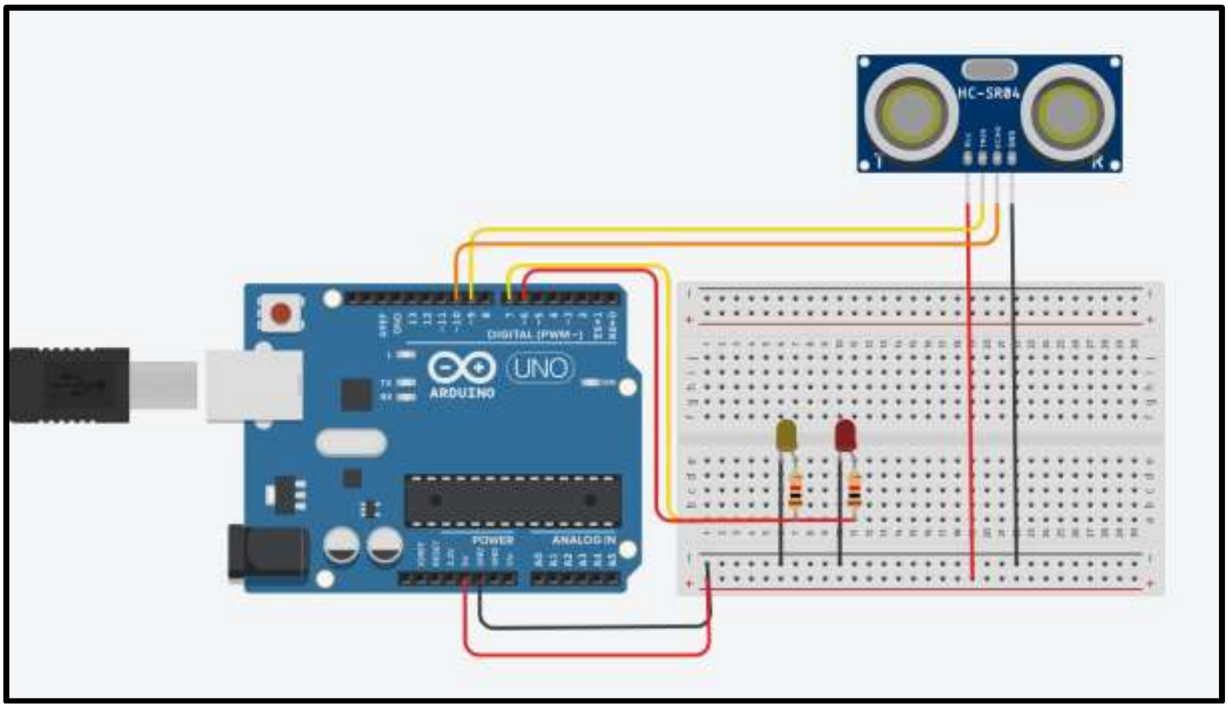


Figure (2-10): Schematic of setup for the part 6

Chapter Three

Results & Discussion

Chapter Three
Results & Discussion

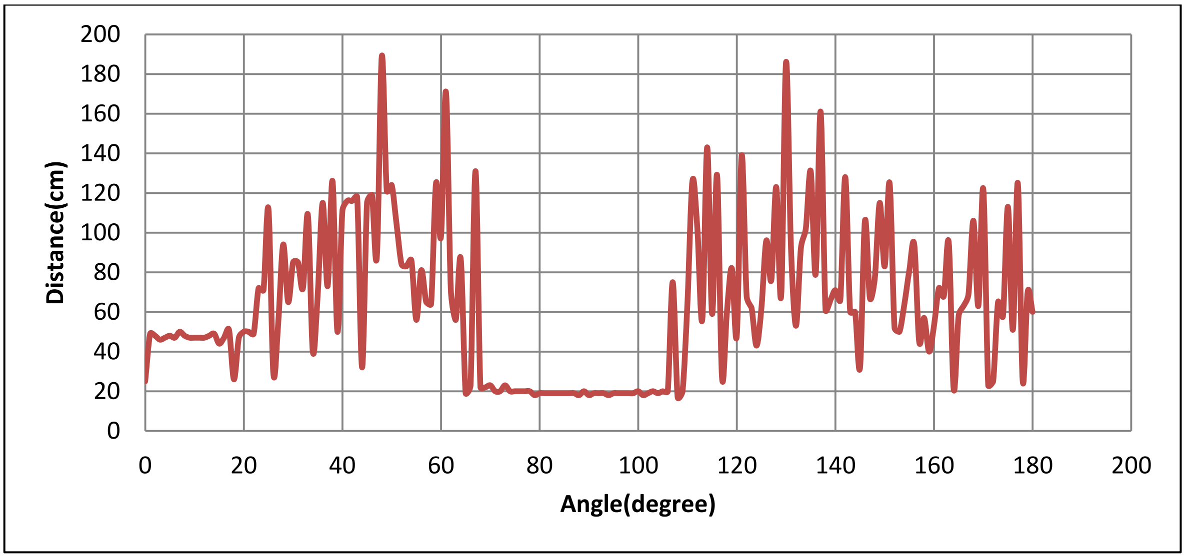
3- Results & Discussion

The statistical program (originpro) used to determine the relation between ultrasound sensor which work as radar and the targets. The situations of the radar and targets were shown in table (2-6) and the electric circuit was connected figure (2-7). The codes of the Arduino used to achieve the following results programmed as shown in Appendix 1 and 2. The results as shown in the following figures (3-1) to (3-3) in the fixed range = 3 m.

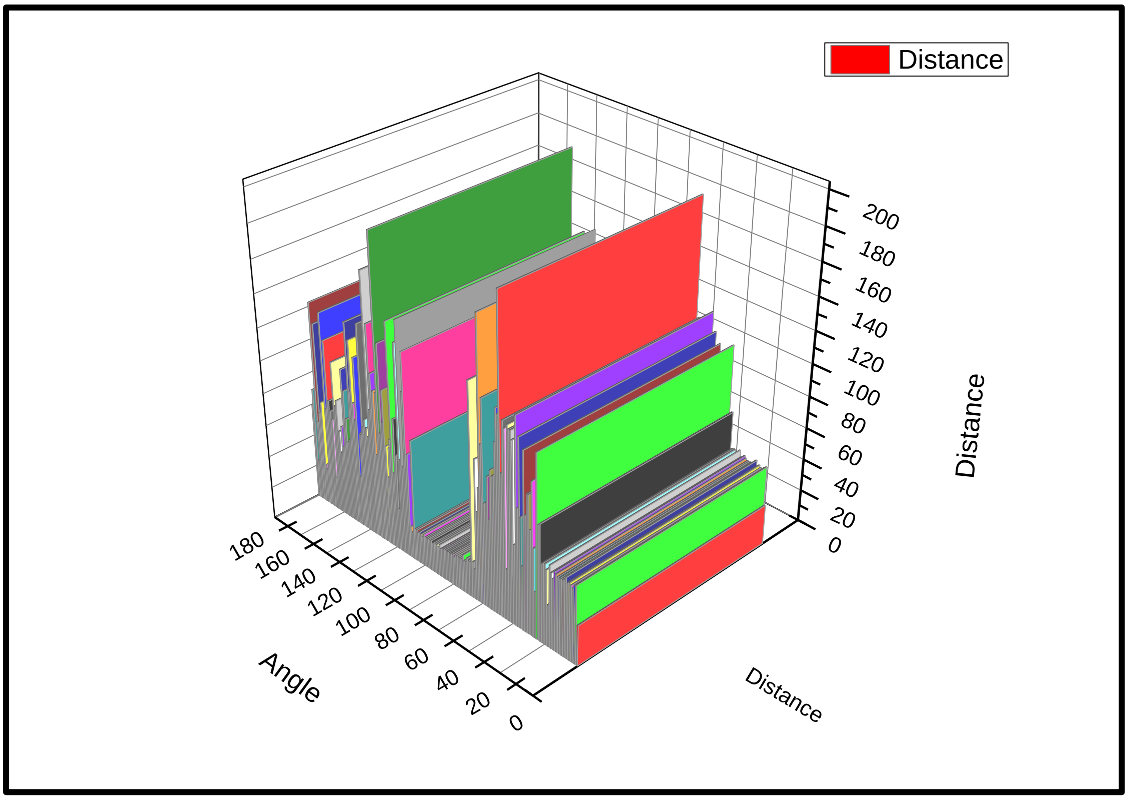
First part:

The distance between radar and target = 20 cm approximately.

The results showed that for the angles (65^0 to 109^0) approximately; the same distance when the angle (0^0 and 180^0). This represents reflux for the echoes of signals from the surroundings of the plate which radar upon it; while the readings (20^0 to 60^0) and (120^0 to 170^0) represents the echoes from the camera platform which using for imaging. There is some wrongs (errors) in the angles 43^0 and 130^0 because the echo signals from the wall of the room.



(A): 2D Diagram



(B): 3D Diagram

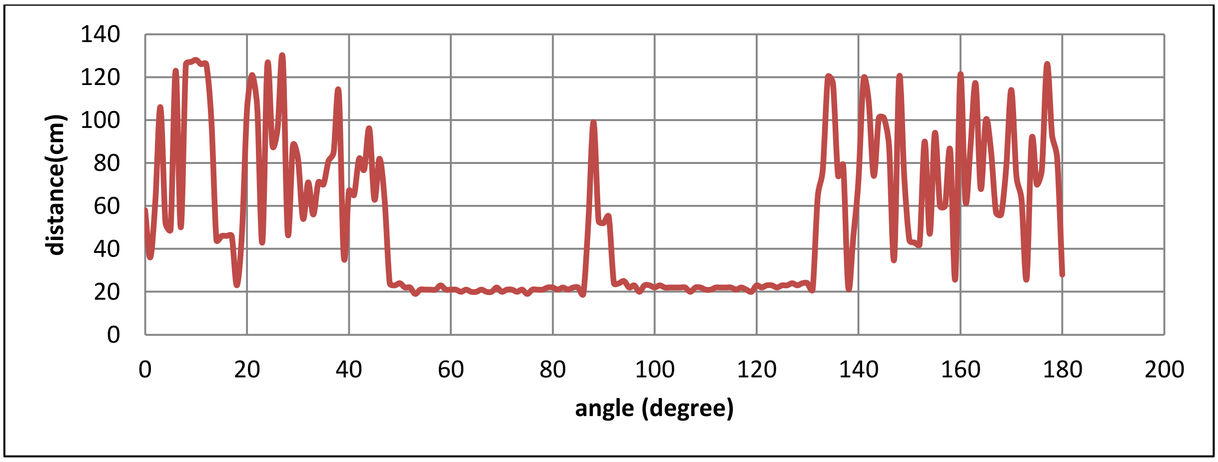
Figure (3-1) (A, and B): The relation between the angle and distance in the case of radar fixed and in the presence of one fixed target.

Second part:

The distance between radar and target = 20 cm approximately.

The first target: in the angle ($49^0 – 87^0$).

The second target: in the angle (97^0 – 132^0) and the other readings which, according to the reflux of signals from the camera platform, and the room walls itself.



(A): 2D Diagram

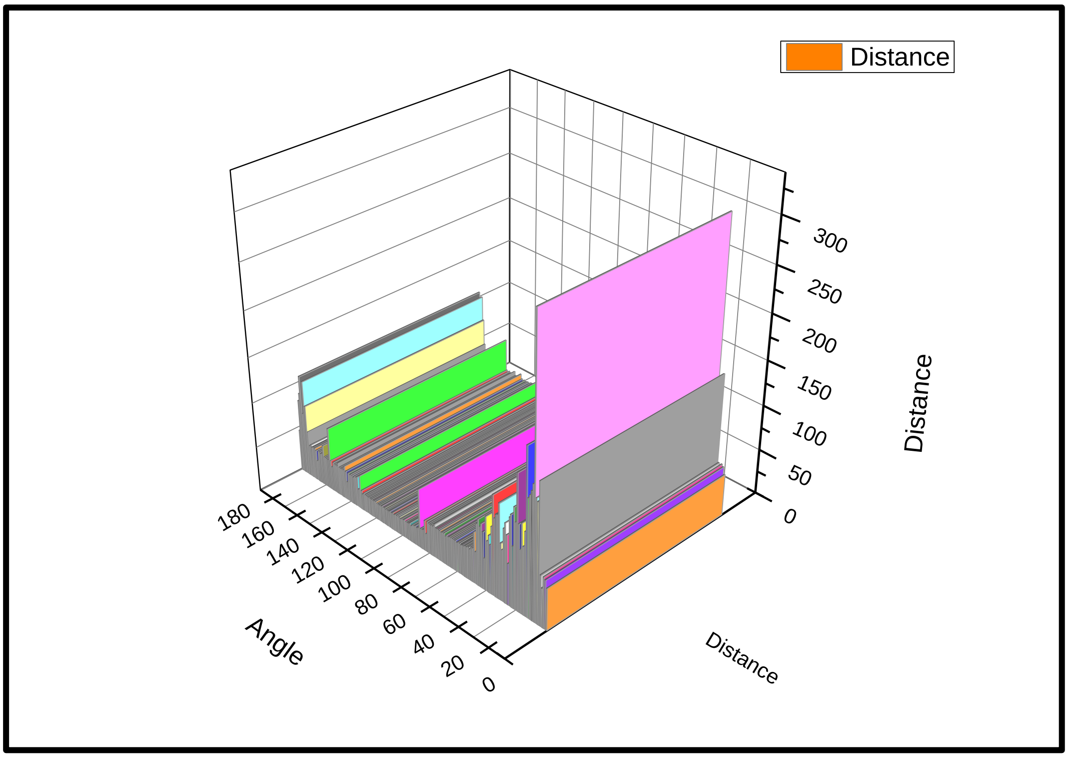


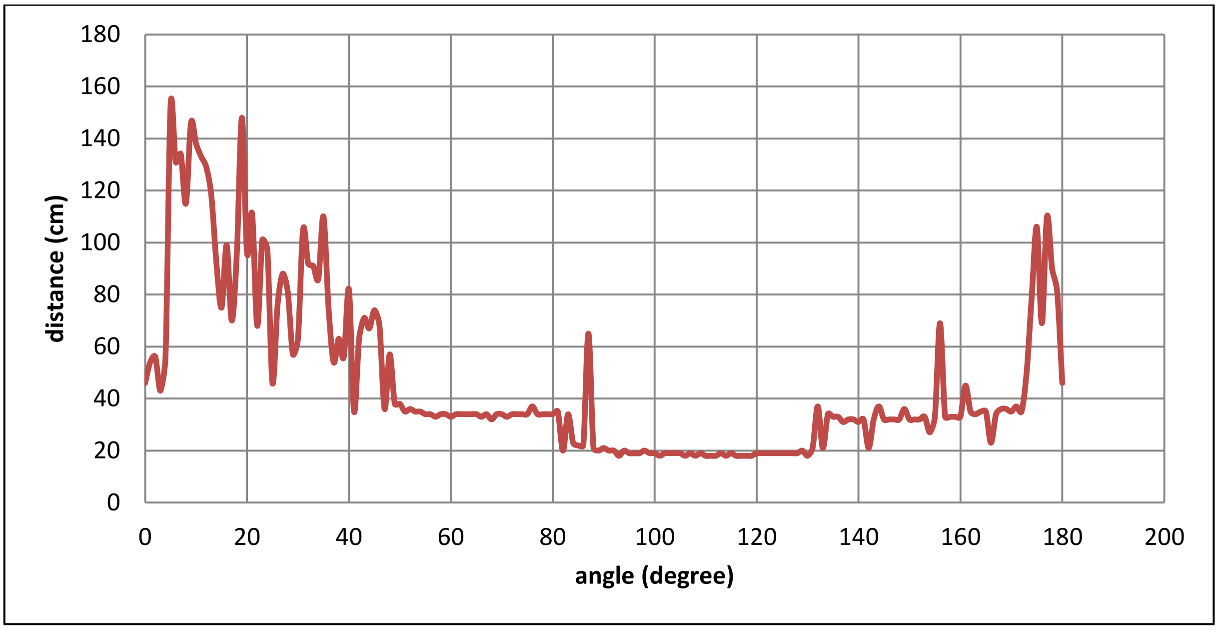
Figure (3-2) (A, and B): The relation between the angle and distance in the case of radar fixed and in the presence of two fixed targets at different angles and at the same distance from the target.
First target at angle 60^0.
Second target at angle 150^0.

Third part:

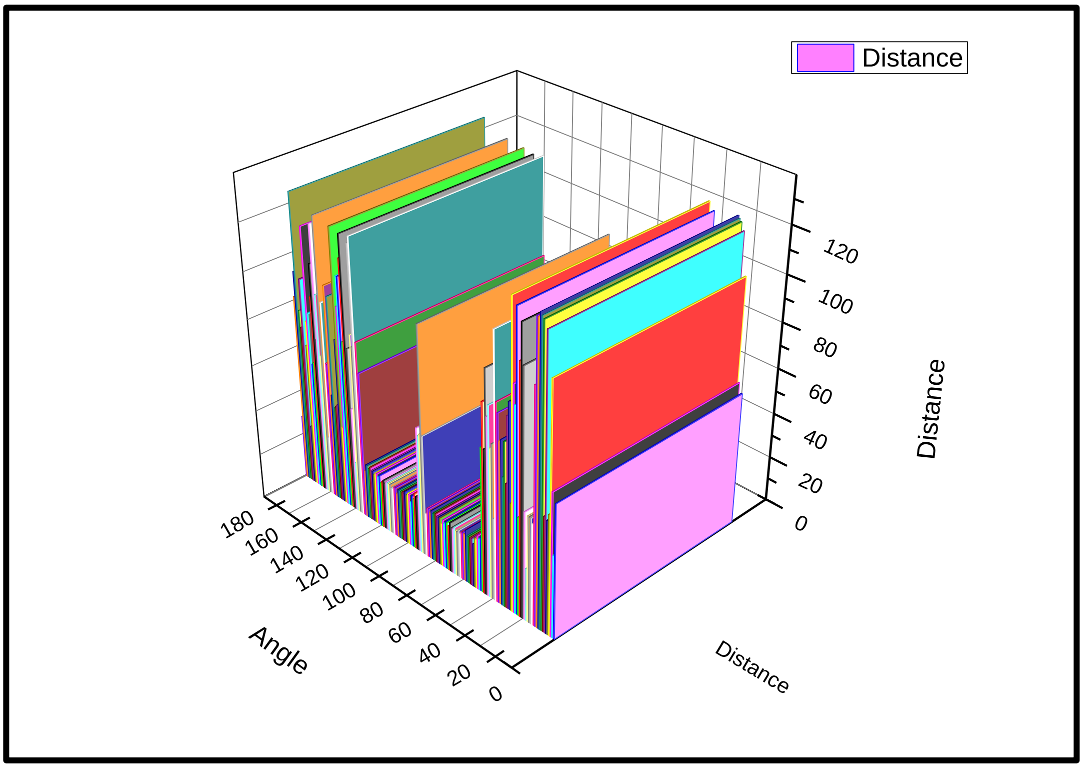
The distance between radar and target = 20 cm and 30 cm respectively.

The first target: in the angle (49^0 – 80^0) in distance = 30 cm.

The second target: in the angle (90^0 – 132^0) in distance = 20 cm and the other readings which, according to the reflux of signals from the camera platform, and the room walls itself.



(A):



(B):

Figure (3-3) (A, and B): The relation between the angle and distance in the case of radar fixed and in the presence of two fixed targets at different angles and at different distance from the target.

Part 4: In this part, the Arduino was programmed so that the radar can locate the locations of the targets; there are two cases:

- First case: When an object is present in the allow range, the yellow light turn on.
- Second case: when object approached inside the forbidden zone, which was determined by 20 cm in this work, then the red light turn on furthermore the warning siren to give hints that there is an object enter the forbidden zone. As shown in figure (3-4) and the codes programmed to achieve these results as in Appendix 3.

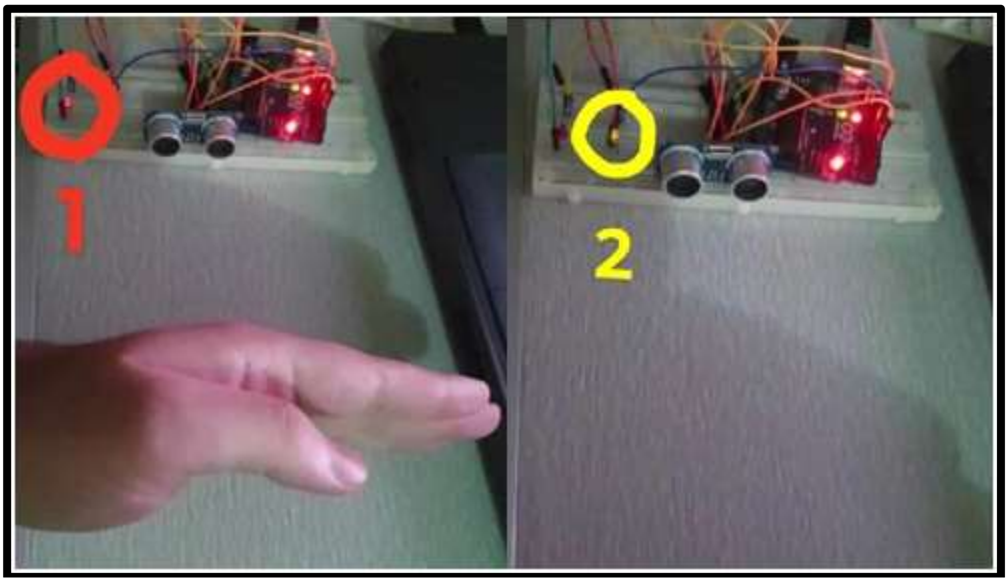
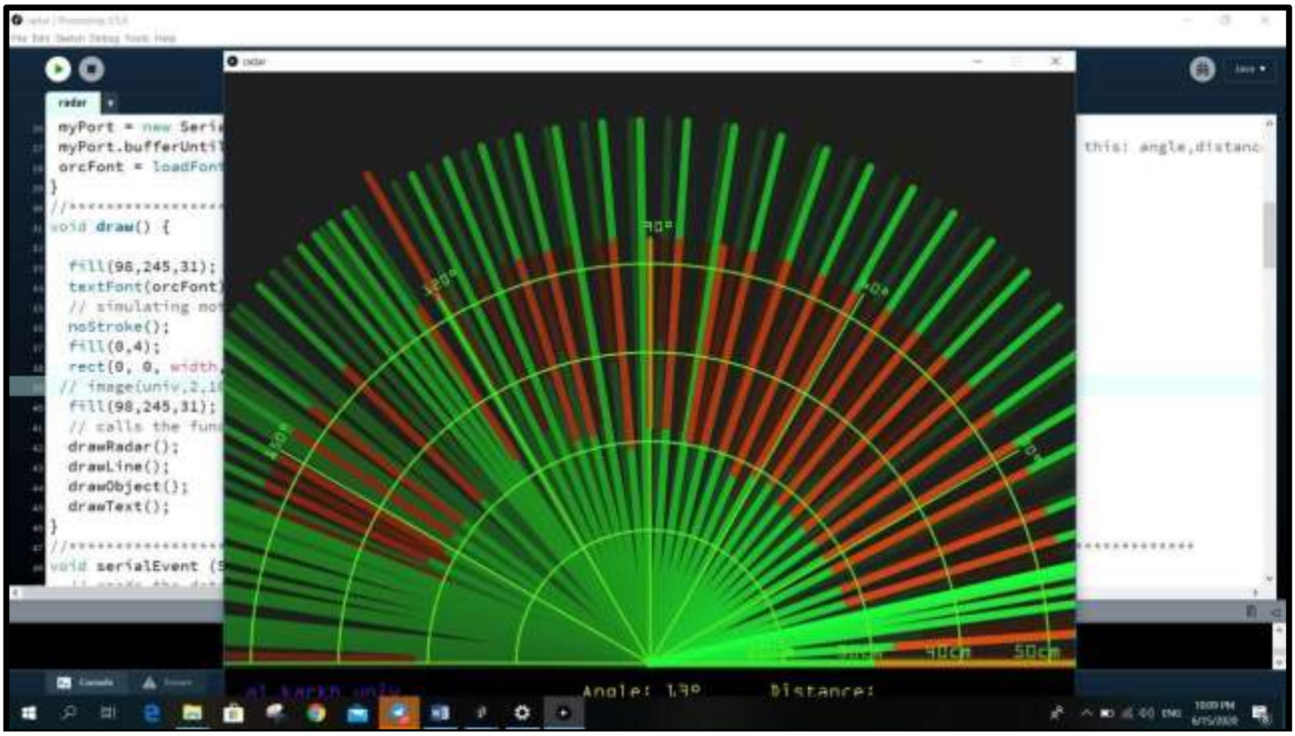


Figure (3-4) (1, and 2): 1:red lamp turn on automatically when any object enters the forbidden zone.
2: yellow lamp turn on automatically when any object presented in allow a range.

The results were shown on the laptop screen using processing software and the coding to achieve this goal as shown in appendix 4, figure (3-5 A,B)



A:

B:

Figure (3-5) (A, and B): Processing IDE Screen displaying output of the system which were tested by placing objects. Convert the reading for signals and display them on a laptop screen.

These results agreed with previous studies Tar A. and Cserey G., in 2011 which focus on connecting Low-cost infrared sensors to an Arduino. The primary target was to use these infrared sensors for measuring distance. The concept was to use multiple infrared sensors, simultaneously in order to eliminate the blind zone of the infrared range finder; This paper combines a short range and a long range infrared sensor to detect an obstacle and measure its distance. Other study in 2018 by Ayush Soni and Ankish Aman were determined the distance of an object using ultrasonic sensors with Arduino and GSM modle.

Chapter Four

Conclusions & Recommendations

Chapter Four
Conclusions & Recommendations

4-1 Conclusions

Radar (sonar) able to detect the presence of fixed and moved targets and can determine the distance between it and the targets in different angles $(0\text{-}180)^0$ which is the range can sweep by TowerPro SG90 Servo used in this project.

The detection of objects (targets) doesn't depend on the type of the material that the target made from it; it can detect all the types of objects in the range.

It is very important to use these techniques for security in government offices, street, banks, and so and instead of the camera system because it is more accurate, not affected by the weather conditions like (rain , snow, and fog).

4-2 Recommendations

1. Using of other sensors work as radar to determine the distance, motion, range of an object (targets) for a wide range of distances.

2. Using the technology in the department by exam committees to find out if any person tries to enter the exam committee room or near from it and not take into consideration the distance allowed.

3. Using this technique and methods as military batches, by operating the alarm when any object approaches the restricted (forbidden) zone.

4. Recommendation to use this technique and method to protect the traces by investing one of the benefits of the radar, which is not affected by weather conditions from rain, snow and fog compared to the camera.

5. The sensor can be placed in the car to alert the driver as he approaches an object and to decrease the accident occurs in the street.

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Appendix

Appendix 1: First code for exp. 1,2,3 used in Arduino ide
A: Radar codes depending on serial monitor

```
#include <Servo.h>
const int trigPin=9,echoPin=10;
long d;
int des;
Servo radarServo;
void setup() {
 pinMode(trigPin,OUTPUT);
 pinMode(echoPin,INPUT);
 Serial.begin(9600);
}
   void loop (){
   radarServo.attach(11);
    for(int i=0;i<=180;i++){
      radarServo.write(i);
      delay(10);
      digitalWrite(trigPin,LOW);
      delayMicroseconds(2);
      digitalWrite(trigPin,HIGH);
     delayMicroseconds(2);
      digitalWrite(trigPin,LOW);
      d=pulseIn(echoPin,HIGH);
      des=d*0.034/2;
      Serial.print("\n");
      Serial.print(i);
      Serial.print("*");
      Serial.print(des);
      Serial.print("#");
     }
     for(int i=179;i>=1;i--){
    radarServo.write(i);
      delay(10);
      digitalWrite(trigPin,LOW);
      delayMicroseconds(2);
      digitalWrite(trigPin,HIGH);
      delayMicroseconds(2);
      digitalWrite(trigPin,LOW);
      d=pulseIn(echoPin,HIGH);
       des=d*0.034/2;
      Serial.print("\n");
      Serial.print(i);
      Serial.print("*");
      Serial.print(des);
      Serial.print("#");
     }
     }
```

B: Radar codes independent on serial monitor

```
#include <Servo.h>

const int trigPin = 9;
const int echoPin = 10;

long duration;
int distance;
Servo myServo;
void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
  myServo.attach(11);
}
void loop() {
  // rotates the servo motor from 20 to 160 degrees
  for(int i=0;i<180;i++){
  myServo.write(i);
  delay(3);
  distance = calculateDistance();
  Serial.print(i);
  Serial.print(",");
  Serial.print(distance);
  Serial.print(".");
  }

  // Repeats the previous lines from 160 to 20 degrees
  for(int i=179;i>=1;i--){
  myServo.write(i);
  delay(3);
  distance = calculateDistance();
  Serial.print(i);
  Serial.print(",");
  Serial.print(distance);
  Serial.print(".");
  }
}
```

Appendix2

//***************** calculating the distance measured by the Ultrasonic sensor ****************

```
int calculateDistance(){
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(2);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance= duration*0.034/2;
  return distance;
}
```

Appendix 3: codes for waring equipements, and turn on-off the light

```
const int trigPin=9,echoPin=10,Gled = 8,Rled=11,b=5;
long deu;
int dec;
void setup() {
  // put your setup code here, to run once:
  pinMode(trigPin,OUTPUT);
  pinMode(echoPin,INPUT);
  pinMode(b,OUTPUT);
 Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(trigPin,LOW);
        delayMicroseconds(2);
        digitalWrite(trigPin,HIGH);
       delayMicroseconds(2);
        digitalWrite(trigPin,LOW);
        deu=pulseIn(echoPin,HIGH);
        dec=deu*0.034/2;

  if (dec>30)
  {
 digitalWrite(11,LOW);
 digitalWrite(8,HIGH);
  analogWrite(5,LOW);
           Serial.print(dec);
      }
```

```
   else if
     (dec<=30)
     {
  digitalWrite(11,HIGH);
  digitalWrite(8,LOW);
analogWrite(5,5);
delay (100) ;
Serial.print(dec);
     }
}
```

Appendix 4
Software to display radar on the laptop screen
Processing program code

```
/*   Arduino Radar Project
 *
 *   Updated by  ali ayad , fadia al-azawi, saja ammer
 */

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

 size (1280, 960); // ***CHANGE THIS TO YOUR SCREEN RESOLUTION***
 smooth();
 univ=loadImage("univ.png");
 myPort = new Serial(this,"COM9", 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.
 orcFont = loadFont("OCRAExtended-30.vlw");
}
//************************************************************************
*********************************
```

```
void draw() {

  fill(98,245,31);
  textFont(orcFont);
  // simulating motion blur and slow fade of the moving line
  noStroke();
  fill(0,4);
  rect(0, 0, width, height-height*0.065);
 image(univ,10,10);
  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(12);
  stroke(255,78,18); // red color
  pixsDistance = iDistance*((height-height*0.3800)*0.025); // covers the distance from the
sensor from cm to pixels
  // limiting the range to 40 cms
  if(iDistance<60){
    // 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(12);
  stroke(30,250,60);
  translate(width/2,height-height*0.074); // moves the starting coordinats to new location
  line(0,0,(height-height*0.15)*cos(radians(iAngle)),-(height-
height*0.15)*sin(radians(iAngle))); // draws the line according to the angle
  popMatrix();
}
//*************************************************************************
*******************************************
void drawText() { // draws the texts on the screen

  pushMatrix();

  fill(0,0,0);
  noStroke();
  rect(0, height-height*0.0648, width, height);
  fill(98,245,31);
  textSize(30);

  text("20cm",width-width*0.3854,height-height*0.0833);
```

```
  text("30cm",width-width*0.281,height-height*0.0833);
  text("40cm",width-width*0.177,height-height*0.0833);
  text("50cm",width-width*0.0729,height-height*0.0833);

  textSize(30);
  fill(113,10,250);
  text("al karkh univ ",width-width*0.975, height-height*0.0207);
  fill(250,238,10);
  text("Angle: " + iAngle +"°", width-width*0.58, height-height*0.0207);
  text("Distance: ", width-width*0.36, height-height*0.0207);
  if(iDistance<80) {
  text("    " + iDistance +"cm", width-width*0.225, height-height*0.0207);
  }
  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();
}
```

الخلاصة:

اصبحت الرادارات عيون للأجهزة الالكترونية واصبحت هناك زيادة في استخدام الرادار وانتشر بصورة عامة في مجالات مختلفة من الدراسة.

في نفس الوقت، ممكن استخدام هذه الأجهزة ايضا لمساعدة الناس في مختلف مجالات الحياة. يمكن لرادارات الموجات الفوق الصوتية قياس الزمن بين انبعاث الاشارة الفوق الصوتية واستلام صدى الأشارة من قبل المتحسس الذي يعمل عمل الرادار. يمكن توصيل وحدات التحكم الدقيقة لإجراء العمليات الحسابية أو التحكم في المؤقتات في هذه الأجهزة. يشكل الكشف عن المسافات بين الأجسام (الأهداف) تحديًا على الدقة الزمنية للكاشف. تعد المعايرة الصحيحة لهذه الرادارات أمرًا ضروريًا نظرًا لأن سلامة المستخدم تعتمد على نظام المستشعر.

ان الهدف من هذا المشروع هو استخدام جهاز الاستشعار بالموجات فوق الصوتية عن طريق الاتصال بلوحة Arduino UNO R3 وإشارة المستشعر المقدمة إلى الشاشة التي تم تشكيلها على اللابتوب لقياس وجود أي عقبة أمام جهاز الاستشعار، وكذلك تحديد المسافة، والنطاق، والزاوية التي يكتشف فيها المستشعر العائق. في هذه الدراسة ، عمل جهاز الاستشعار بالموجات فوق الصوتية كرادار. تم استخدام هذا النوع من المتحسسات في هذه الدراسة وذلك لاحتوائه على عدة ميزات وفوائد ومنها:

- هو مشروع مفتوح المصدر ، البرامج / الأجهزة يمكن الوصول إليها بسهولة ومرونة.
- إنه سهل الاستخدام ، ويتصل بالكمبيوتر عبر USB ويتواصل باستخدام بروتوكول تسلسلي قياسي ، ويعمل في الوضع المستقل وكواجهة متصلة بأجهزة الكمبيوتر / Macintosh
- أنها رخيصة.
- يتم دعم Arduino من خلال مجتمع متزايد عبر الإنترنت ، يتوفر بالفعل الكثير من التعليمات البرمجية المصدر ويمكننا مشاركة ونشر أمثلة ليستخدمها الآخرون أيضًا.

يتضمن هذا المشروع استخدام نظام الرادار من خلال التحكم فيه عبر Arduino. يتكون نظام RADAR هذا من مستشعر فوق صوتي ومحرك سيرفو. يتم إرفاق مستشعر فوق صوتي بمحرك سيرفو يدور حوالي ١٨٠ درجة ويعطي تمثيلًا مرئيًا للبرنامج الذي يسمى معالجة IDE.

تعطي معالجة IDE تمثيلًا رسوميًا ويمكن من خلالها تحديد موضع الهدف، مسافة الهدف، الزاوية كما بينت النتائج.

لوحظ من النتائج قدرة الرادار (السونار) على اكتشاف وجود أهداف ثابتة ومتحركة ويمكن تحديد المسافة بينه وبين الأهداف في زوايا مختلفة (٠-١٨٠) درجة، وهو النطاق الذي يمكن أن يتم تغطيته بواسطة TowerPro SG90 Servo المستخدم في هذا المشروع.

لا يعتمد اكتشاف الأجسام (الأهداف) على نوع المادة التي صنعها الهدف منها ؛ يمكنه الكشف عن جميع أنواع الاجسام في ضمن منطقة المدى.

من المهم جدًا استخدام هذه التقنيات للأمان في الدوائر الحكومية، والشوارع، والبنوك، وهكذا وبدلاً من نظام الكاميرا لأنه أكثر دقة ، ولا يتأثر بالظروف الجوية مثل (المطر، والثلج، والضباب).

وزارة التعليم العالي والبحث العلمي

جامعة الكرخ للعلوم

كلية التحسس النائي والجيوفيزياء

قسم التحسس النائي

استخدام برنامج الاردوينو لتصميم نظام الرادار

دراسة بحث مقدمة الى جامعة الكرخ للعلوم / كلية التحسس النائي والجيوفيزياء/ قسم التحسس النائي وهي جزء من متطلبات نيل شهادة البكلوريوس في التحسس النائي

تقدم بها

سجى امير سلمان

علي اياد حسين

اشراف

د. فادية العزاوي

دكتوراه تحسس نائي ومعالجة صورية

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