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Design of RADAR Detection System Management with MATLAB

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Abstract: Radio detection and ranging, that is, RADAR is a radio wave technique to determine the range, altitude, direction of objects. The radar dish or antenna transmits pulses of radio waves or microwaves which bounces off any object in their path. It works by launching a short pulse at the ear audible frequency, after that microcontroller listens for echoes. The information about the distance to the object is given at the time elapsed during transmission to the echo reception. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at same site as the transmitter. High tech radar systems are associated with digital signal processing and are capable of extracting useful information from very high noise levels.
Keywords: Radar, Principle of Radar, Ultrasonic Module, Arduino, Matlab.

I. INTRODUCTION

One of the most important characteristics of RADARs is their capability to penetrate cloud cover and to obtain data either by day or by night. It is this all-weather capability that has contributed extensively to the various commercial applications of RADAR. There are situations where is a need to keep a watch over the prohibited area in order to provide safety and security and for that it is expensive and unreliable to assign a man for 24 x 7time. Therefore, the ultrasonic radar system is designed for unauthorized object detection. The system can monitor a limited range of areas and uses to display and alert the authorities. Here, to run this system, there is a requirement of microcontroller circuit that is connected to an ultrasonic sensor mounted on a servo motor for monitoring. As soon as the object is detected, the detected data is processed and sent to the authority, and the display of traces of object is been shown.

II. PRINCIPLE OF RADAR

The term "RADAR" was officially coined as an acronym by U.S. Navy Lieutenant Commander Samuel M. Tucker and F. R. Furth in November 1940. The acronym was by agreement adopted in 1943 by the Allied powers of World War II and thereafter received general international acceptance. Radar's modern use is highly diversified, including air and traffic control, radar astronomy, air defense systems, anti-missile systems, flight control systems, missile target positioning systems and range control radar. High-tech radar systems involve the use of digital signal processing and machine learning.
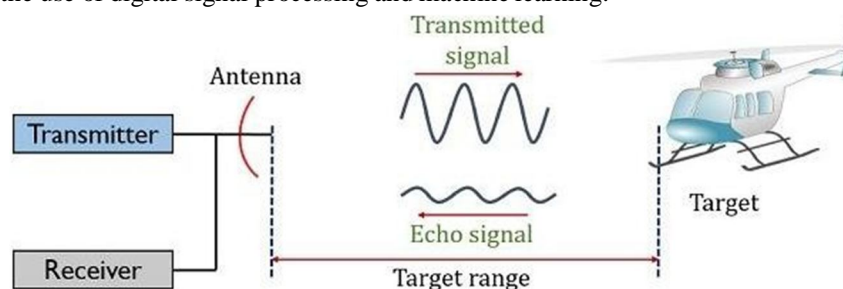

Fig 1: Radar System

The radar consists of a transmitter that emits a radio wave called a radar signal in a predetermined direction as soon as the waves are in contact with the object, they are reflected in an undefined direction. The signal which is reflected back to the transmitter makes the radar works. If the object moves toward or away from the transmitter, the frequency of the radio waves caused by the Doppler Effect has an equivalent change. There are different types of radar which is primary radar consists of Frequency Modulation Continuous Wave (FMCW), Unmodulated Continuous Wave, Basic pulse radar, Moving Target Indication Radar and secondary radar.

III. PROJECT ARCHITECTURE

The most elementary function of a radar system starts with

1) Generating a Waveform.
2) Feeding it into transmitter to amplify it.
3) Transmit the signal through an array.
4) As the signal propagates, it experiences different environmental effects, like rain and fog.
5) It hits the target and comes back to the radar.
6) Along with desired signal, we might have interference and return from unwanted objects.
7) The return signal is collected at the receive antenna. In our case, we have a monostatic radar. So, thetransmitter and the receiver are the same.
8) It gets amplified by the receiver and then onto the signal processor. Here different signal processing techniques separate the desired from undesired signals and gets displayed using a variety of visual aid tools.
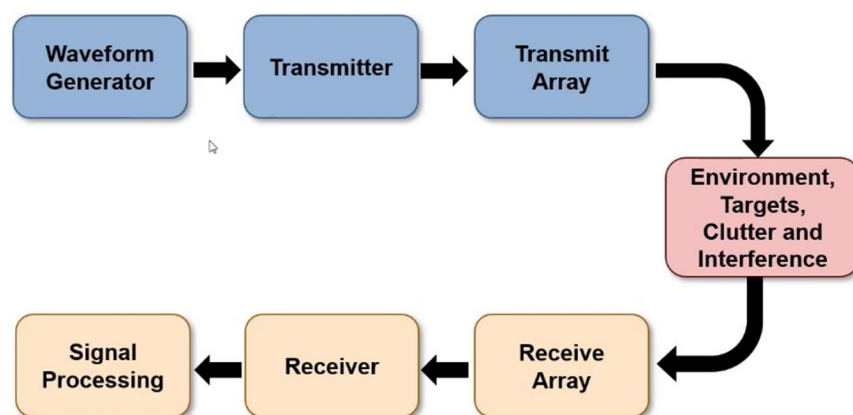

Fig 2: Radar Block Diagram

IV. IMPLEMENTATION OF THE PROJECT

The process is initiated by sending a trigger pulse to the ultrasonic module. When the reset pulse is supplied to the processor, it generates a 15µs trigger pulse and sends it to the HC-SR04 ultrasonic module. The trigger signal must be a pulse of 10µS high time. When the module receives a valid trigger signal, it emits 8 pulses of 40 kHz ultrasonic from the transmitter. The echo of the sound is picked up by the receiver, and after the echo of the ultrasonic wave, the module generates a signal at the echo pin, which is proportional to the distance measuring.
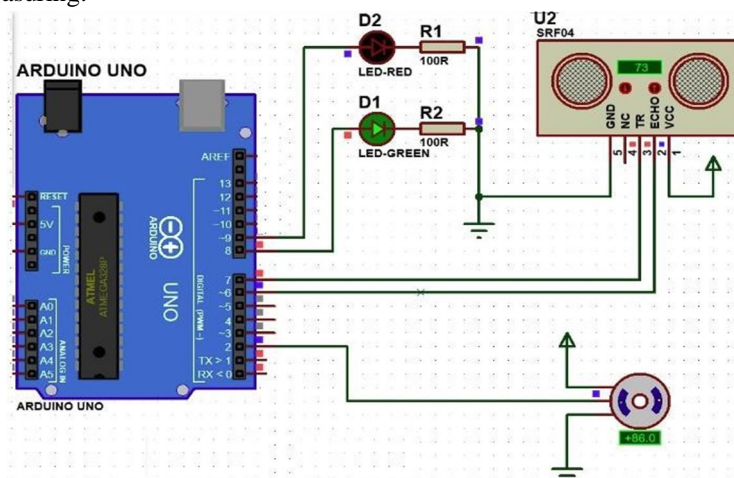

Fig 3: Schematic Diagram

Connect the components as shown in the above Figure 3. Here the resistors and the LED lights are optional which doesn't affect the resultant of the output. Check the Arduino UNO initially with a basic code in Arduinoide whether it is working or not.

V. ARDUINO

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Implement the Arduino code into the Arduino Uno using software Ide and check whether there is an error. Select the board and connected port in Arduino Ide and dump the given code.

Code:

```
#include <Servo.h>Servo myservo;
#define echo 6 //Echo pin #define trigger 7 //Trigger pin
#define G_led 8 // choose the pin for the Green Led#define R_led 9 // choose the pin for the Red Led int distance;
int degree;
void setup() { // put your setup code here, to run onceSerial.begin(9600);
myservo.attach(2); // declare Servo Motor as output
pinMode(echo, INPUT );// declare ultrasonic sensor Echo pin as input pinMode(trigger, OUTPUT); // declare ultrasonic sensor
Trigger pin as OutputpinMode(R_led,OUTPUT); // declare Red LED as output pinMode(G_led,OUTPUT); // declare Green LED as
output
delay(100); }void loop() {
for(degree=1; degree<180; degree+=1){myservo.write(degree);
delay(80);data(); }
for(degree=180; degree>1; degree-=1){
myservo.write(degree);delay(80);
data(); }
}
void data(){ digitalWrite(trigger, LOW);delayMicroseconds(2); digitalWrite(trigger, HIGH);delayMicroseconds(10);
long time = pulseIn(echo, HIGH);distance = time / 28.5 / 2; if(distance>100){distance = 100;}if(distance>50){
digitalWrite(G_led, HIGH); // LED Turn OndigitalWrite(R_led, LOW); // LED Turn Off
}
else{
digitalWrite(G_led, LOW); // LED Turn OffdigitalWrite(R_led, HIGH); // LED Turn On
}
Serial.print(degree); Serial.print( " "); Serial.println(distance);
}
```

VI. MATLAB

The matrix-based MATLAB language is the most natural way to express computational mathematics. Run the below code for the resultant of radar by running the code in live while model is been connected. Here set the serial port of your Arduino in this code.

Code:

```
clc; clear all;
%Customize graph figure('units','normalized','outerposition',[0 0 1 1]);whitebg('black');
%Draw Scale Data
th = linspace(0,pi,1000);R = 10:10:100;
for i=1:length(R);x = R(i)*cos(th);
y = R(i)*sin(th);
plot (x,y,'Color', [0.603922 , 0.803922 , 0.196078] ,'LineWidth',1);
hold on;end
%Draw Axis data
x0 = [0 100 0 0 0 0 ]; x1 = [0 100 86.60 50 -50 -86.60]; y0 = [0 0 0 0 0 0]; y1 = [100 0 50 86.60 86.60 50];
for i=1:length(x0);hold on;
plot([x0(i),x1(i)],[y0(i),y1(i)] ,'Color', [0.603922 , 0.803922 , 0.196078],'LineWidth',2);
end
```

```
%Draw Sonar default datafor i=1:180
hold on;
[x, y] = pol2cart(i*0.0174532925, 100);h(i) = plot([0,x],[0,y],'g','LineWidth',1);end
%define serial  port s1 = serial('COM13');s1.BaudRate=9600; fopen(s1);
%Draw Sonar Datawhile(1)
data = fscanf(s1); [th, r] = strtok(data);
th = real(str2num(th));r = str2num(r); set(h(th),'color','r');
[x0, y0] = pol2cart(th*0.0174532925, 100);[x, y] = pol2cart(th*0.0174532925, r); set(h(th),'XData',[x0,x]);
set(h(th),'YData',[y0,y]);
m = plot([0,x0],[0,y0],'r','LineWidth',3);drawnow
delete(m);end
```

VII. ADVANTAGES & DISADVANTAGES OF ULTRASONIC RADAR SYSTEM

The main advantages are that it can be used in stationary and moving mode. It has two directional modes and beam spread can incorporate many targets. It can often select fastest target, or best reflection. It is very reliable. The main disadvantages in this, timer- radar can take up to 2 seconds to lock. Radar has wider beam. Its range

Only 200 ft. range. It cannot detect if deceleration is greater than one.

VIII. RESULT & ANALYSIS

The result of the ultrasonic radar system is shown in the Fig 4. The analysis of object detection is done with the help of Matlab. The graph shows the two shaded regions i.e., red and black regions. Here, the black part shows that there is no object detected and the red part shows that there is an object in that particular region. With the help of this, we can also trace the position and angle of that object.
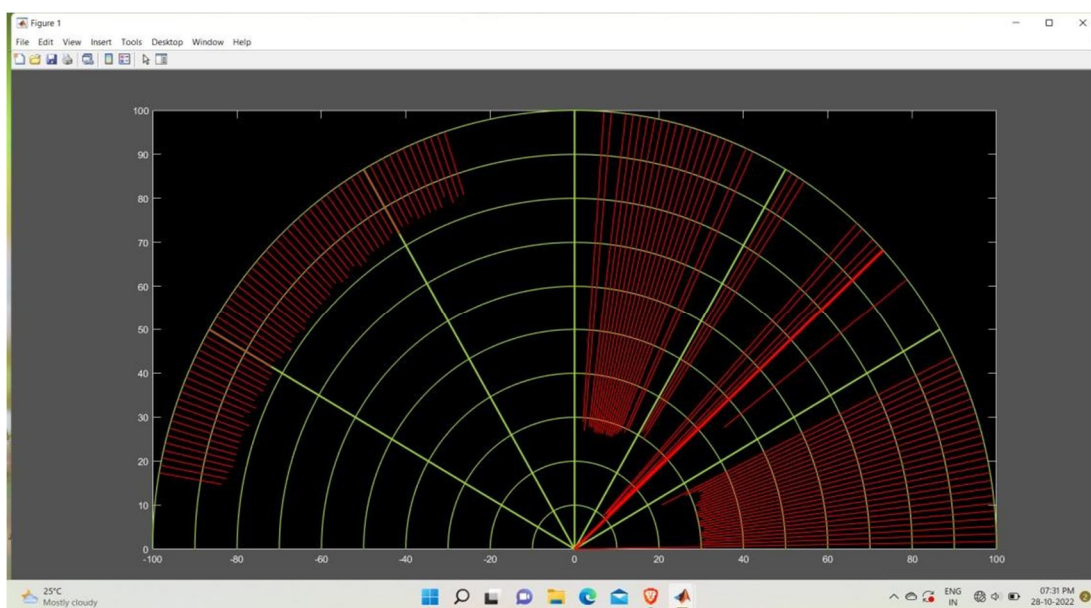

Fig 4: Graphical Representation of Radar

IX. CONCLUSIONS

This project has been developed to come up with an efficient way for detecting and notifying objects which presents a low cost and low power system for the security of an unauthorized area by the help of radar system. As we have designed a short-range radar therefore our research was specified and limited. The future modification may include addition of cameras, smart phones, etc. This is good radar system for security if image recognition system will be added so that image of object can be detected. Usage of a 360 degrees rotating servo motor can make the system more efficient. With the help of Artificial intelligence, using wireless radar communication detection of object takes place with the traces of sound by the object in any unknown area.

X. ACKNOWLEDGMENT

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