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Arduino Based Ultrasonic Radar System using Matlab

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Abstract: ***Radio detection and ranging, that is, RADAR is a radio wave technique to determine the scope of the object, angle or speed. It is object detection technology. It is used to detect aircraft, ships, spacecraft, missiles, motor vehicles, weather formation and terrain. The proposed "Ultrasonic Radar System" uses an ultrasonic module that includes an ultrasonic transmitter and receiver as well as an AVR microcontroller ATmega128. 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. Here, the objective is to design an ultrasonic radar system by plotting its graph with the help of Matlab to identify the location of the object and its angle in the unauthorized area.***
Keywords: Radar, Principle of Radar, Ultrasonic Module, Matlab, Arduino.

I. INTRODUCTION

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 7 time. Therefore, the ultrasonic radar system is designed for unauthorized object detection. The system can monitor a limited range of areas and uses the buzzer to 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. It is also connected to a LCD screen to monitor the detection status. The radar continuously monitors the environment and checks the echo of the ultrasonic sensor. As soon as the object is detected, the detected data is processed and sent to the authority, and the alarm detects the object.

II. PRINCIPLE OF RADAR

The technology of Radar was developed by countries during World War II. The term radar was first introduced by English. Radar's modern use is highly diversified, including air and traffic control, radar astronomy, air defense systems, anti-missile systems; marine radar positioning other ship, aircraft and meteorological precipitation monitoring, 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.

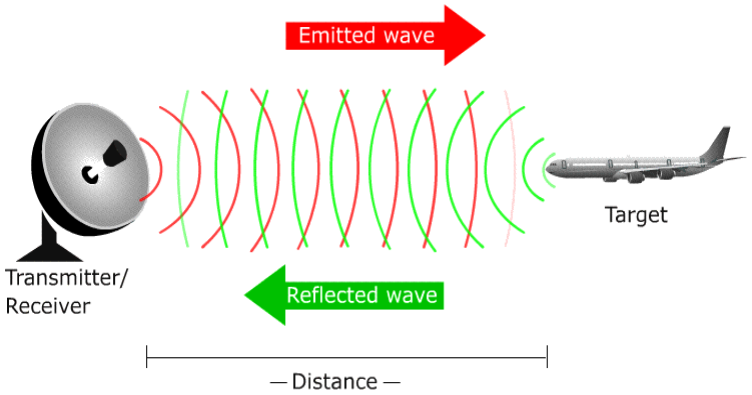

Fig 1: Radar System

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 a undefined directions. The signal which is reflected back to the transmitter makes

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the radar work. 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.

III. ULTRASONIC MODULE

Ultrasonic distance measurement module HC-SR04 provides 2cm to 400 cm non-contact measurement function, ranging accuracy of up to 3mm. The module consists of an ultrasonic transmitter, a receiver and a control circuit.

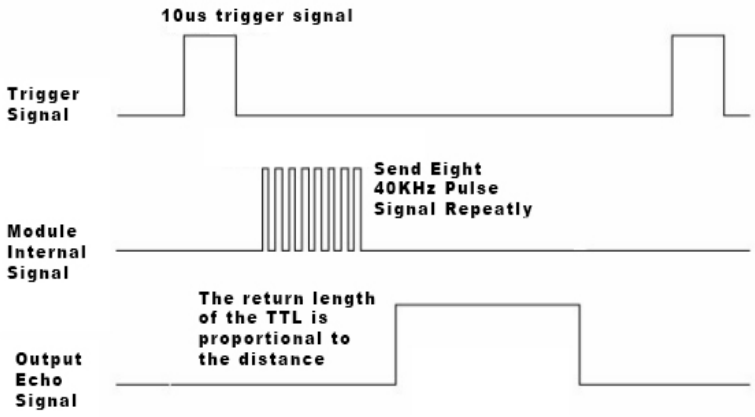

Fig 2: HC-SR 04 Timing Diagram

The basic working principle
Use IO to trigger at least 10s high signal,
The module automatically sends 8 40 kHz and detects whether there is a pulse signal return.
If the signal returns, through the high level, the high output IO duration is from sending the ultrasonic wave to the return time. Test distance = (high level x sound velocity (340m / sec) / 2

IV. WORKING OF ULTRASONIC RADAR SYSTEM

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.
Test distance = (high time × speed of sound (340M / s)) / 2
Distance cm = echo pulse width in µs / 58
Distance in inches = echo pulse width in µs / 148
Finally, the distance calculated based on the pulse width of the echo signal is sent to the LCD segment and the range is displayed in centimeters. This ultrasonic range finder can measure the distance of 2.5 meters, the accuracy of 0.1 cm.

V. ARDUINO

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, 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 a AC-to-DC adapter or battery to get started.

VI. MATLAB AND ITS CODING

The matrix-based MATLAB language is the world's most natural way to express computational mathematics.

```
clc; clear all;
%Customize graph
figure('units','normalized','outerposition',[0 0 1 1]);
```

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```
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 data
for i=1:180
hold on;
[x, y] = pol2cart(i*0.0174532925, 100);
h(i) = plot([0,x],[0,y],'g','LineWidth',1); %#ok<SAGROW>
end
%define serial port
s1 = serial('COM4');
s1.BaudRate=9600;
fopen(s1);
%Draw Sonar Data
while(1)
data = fscanf(s1);
[th, r] = strtok(data);
th = real(str2num(th)); %#ok<*ST2NM>
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
fclose(s1); %#ok<*UNRCH>
```

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.

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VIII. RESULT & ANALYSIS

The result of the ultrasonic radar system is shown in the fig 3. The analysis of object detection is done with the help of Matlab. The graph shows the two shaded regions i.e., red and green regions. Here, the green part shows that there is no object and the red part shows that there is an object in that particular region using this we can also trace the position and angle of that object.

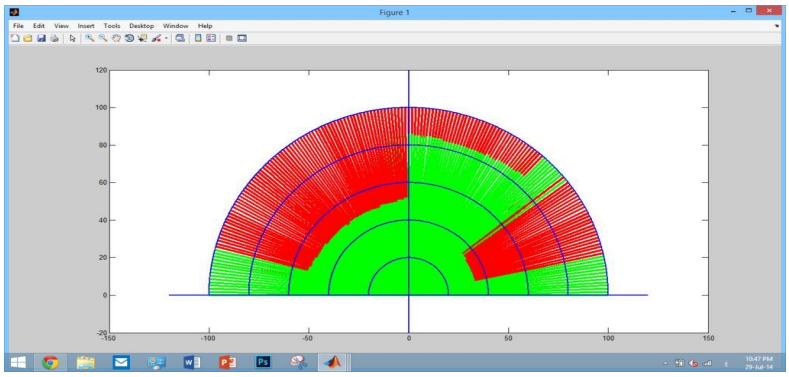

Fig 3: Graphical Representation of an object detection

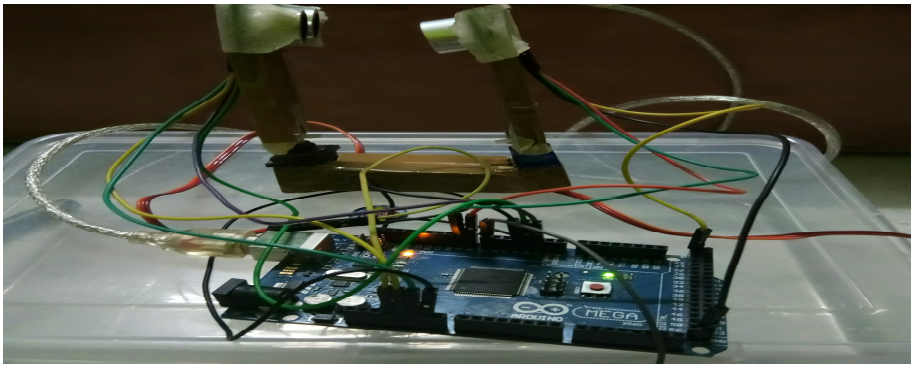

Fig 4: Model of Arduino based Ultrasonic Radar System

IX. CONCLUSIONS

The paper presents a low cost and low power system for the security of an unauthorized area by the help of radar system. 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.

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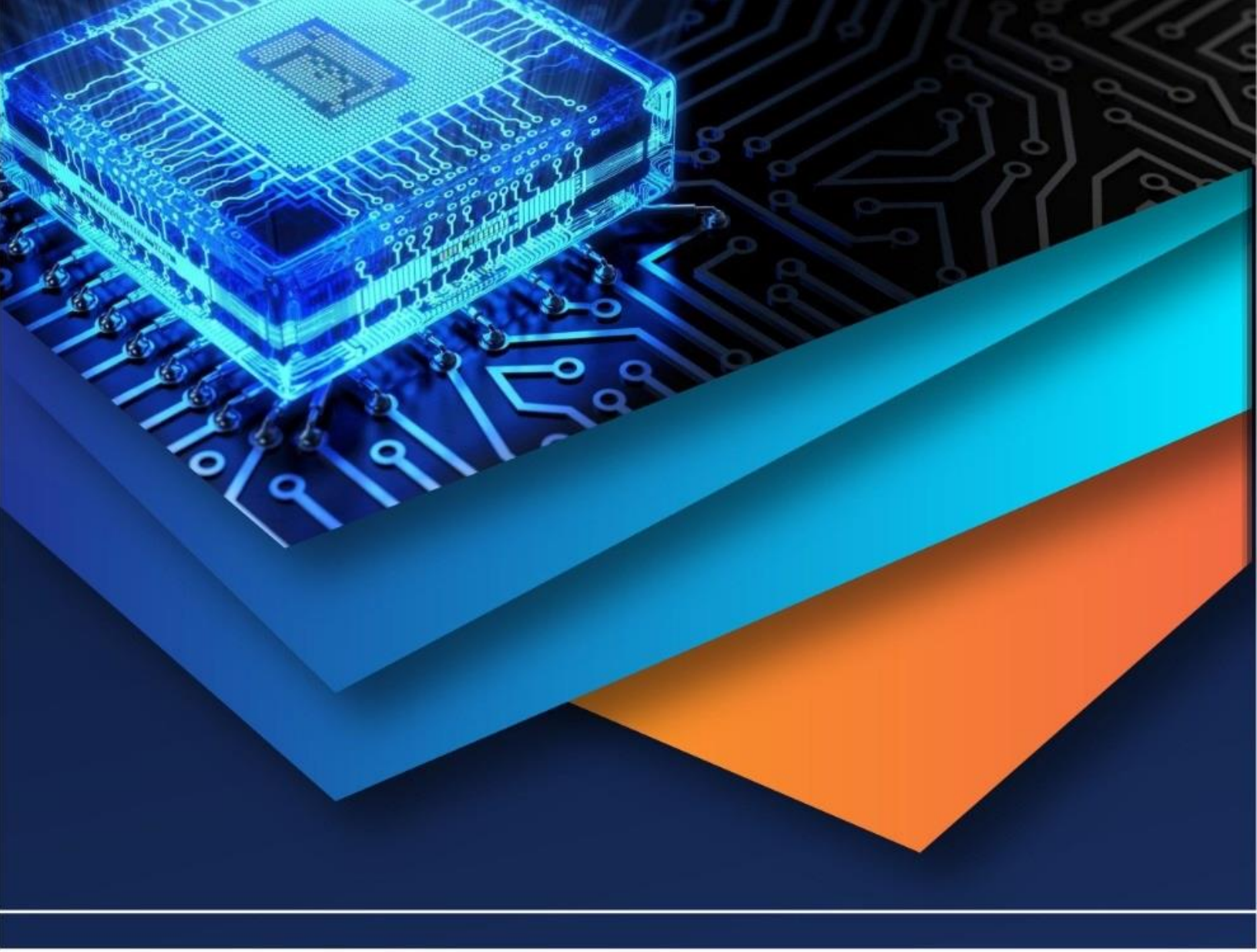

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