Implementation of Arduino based Object Detection System

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Abstract: Radar is an object detection system that uses radio waves to determine the range, angle or velocity of objects. This work detects objects in the given range using ultrasonic sensor which operate at 40khz frequency and plots them on a graph. Security features like sending a message alert to registered phone number whenever the object is detected using GSM technology is included and a web camera was installed to view the object detected. Since the frequency range used is 40khz which is well within the range of Radio waves (3Khz-300Ghz), the proposed work suits well as a radar system that can be used for security with sms alert.

Keywords: Radar, Arduino, Ultrasonic sensor, GSM, Object detection.

I. INTRODUCTION

Radar is an object-detection system that uses radio waves to determine the range, angle, or velocity of objects. This system was developed secretly for military use by several nations in the period before and during World War II. A key development was the cavity magnetron in the UK, which allowed the creation of relatively small systems with sub-meter resolution. The term *RADAR* was coined in 1940 by the United States Navy as an acronym for **RA**dio **D**etection **A**nd **R**anging.

The modern uses of radar are highly diverse, including air and terrestrial traffic control, radar astronomy, air-defence systems, antimissile systems, marine radars to locate landmarks and other ships, aircraft anti-collision systems, ocean surveillance systems, outer space surveillance and rendezvous systems and missile target locating systems meteorological precipitation monitoring. Object detection system previously implemented by components like arduino and ultrasonic sensor detected using the color differentiation on the graph. But, it won't give any sms alert and video display of the object. Even it won't retrieve attributes like distance and angle at which the object was detected.

II. OBJECT DETECTION SYSTEM

Arduino uno (ATMEGA328) is used for controlling several components like servo motors, Ultrasonic sensor, GSM module. Initially we are transmitting signals from ultrasonic transmitter to hit the object within given surroundings and the echo signal is received by ultrasonic receiver and this signal is sent to matlab through Arduino. Matlab then processes the signal and result can be seen on a plot which relates distance and angle. In course of this, Matlab and Arduino IDE are used.

Arduino IDE is used for Calculating distance and angle, rotating servo motors. Matlab is used for Camera Initialization, reading data from the Arduino and displaying the results on graph in the figure window. Arduino sends the data for both matlab and GSM. It sends data to matlab to process it and to GSM for sending it to be registered via inserted sim card.

Fig.1 illustrates the diagrammatic representation of the connections between the hardware and software components. Web camera is also added to the object which is detected.
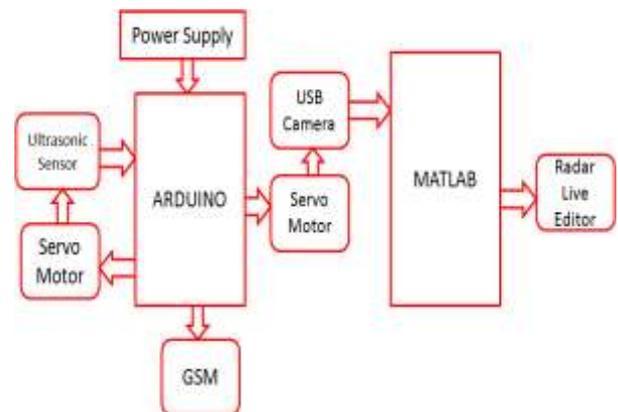

Fig.1. Object Detection System

Arduino is used to control two servo motors, sensors and GSM module so there is a connection between ultrasonic sensor to Arduino, GSM to Arduino and servo motors to Arduino. After collecting the data, to send the data from Arduino to matlab, there is need for connection between Arduino and Matlab. As camera draws power from laptop there is connection between laptop and camera. For GSM there is power supply connection through an adaptor.

III. IMPLEMENTATION

Among arduino pins, 6 pins are used as as signal pins for connecting different components & 4 pairs of source and ground pins on arduino board are also used.

A. Power Supply Connections

- Arduino is drawing power from Laptop using the cable connected between Arduino and Laptop (USB Cable).
- GSM (Global System for Mobile Communication) is drawing power through Adapter which is connected to socket.
- Servo Motors are drawing power from the Arduino Board Directly.
- Camera gets power through a cable connected to the USB pin of Laptop for its flash lights.
- USS (Ultra Sonic Sensor) draws power from the Arduino board itself through the cables connected.

B. Between Arduino and GSM Module

Transmitter and receiver pin of GSM module are connected to the receiver and transmitter pins (3,2) of Arduino board respectively. In GSM module receiver pin should be active because GSM is receiving data from arduino So 2nd pin of arduino which acts as transmitter of arduino is connected to the receiver pin of GSM module. Any information to be sent from GSM module to arduino, then transmitter of GSM module should be connected to receiver (3rd) pin of arduino. In this work there is no need of this second case that is activation of transmitter pin in GSM module.
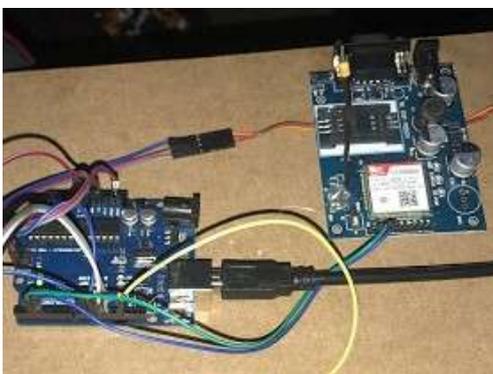

Fig. 2 Connecting arduino and GSM module

C. Between Arduino and Sensor

Basically, there are 4 pins in Ultrasonic Sensor i.e., V_{CC}, GND, trigger and echo pins. The V_{CC} and GND pins are connected to the source and ground pins on arduino but the trigger pin is connected to 12th pin on arduino & echo pin is connected to the 11th pin on arduino board.
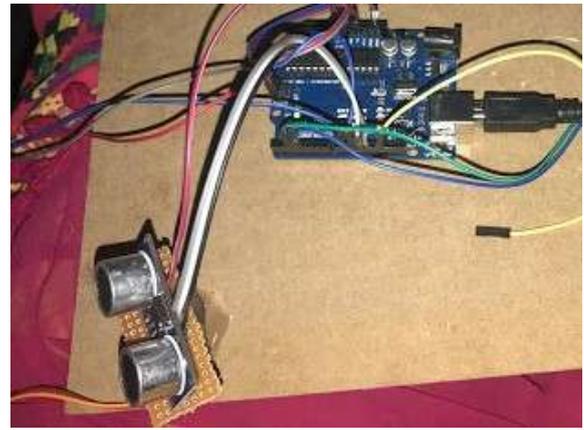

Fig.3. Connecting Sensor to Arduino

D. Between Arduino and Servo Motor

There are 3 pins on Servo motor - V_{CC}, GND and signal pin. The V_{CC} and GND pins are connected to the source and ground pins on arduino but the signal pin of one servo motor is connected to 9th pin on arduino and signal pin of another servo motor is connected to the 10th pin on Arduino board.

E. Software –Matlab & Arduino IDE

Arduino IDE is used for calculating distance and angle, rotating servo motors. Matlab is used for camera initialization, reading data from the arduino and displaying the results on graph in the figure window. Initially, arduino code is dumped into the microcontroller using the arduino IDE software. Then the data is read from the arduino into the matlab software. By using the figure window and the code in the matlab, the results are observed

IV. RESULTS

With the whole setup, program code is dumped into the arduino by clicking in the compile and run as in fig. 4

Fig. 4. Arduino program process

Now, LED's on Arduino board blinks and the component LEDs switches ON indicating the power supply is connected to all components. Blinking LEDs make sure of the connections established as shown in Fig 5
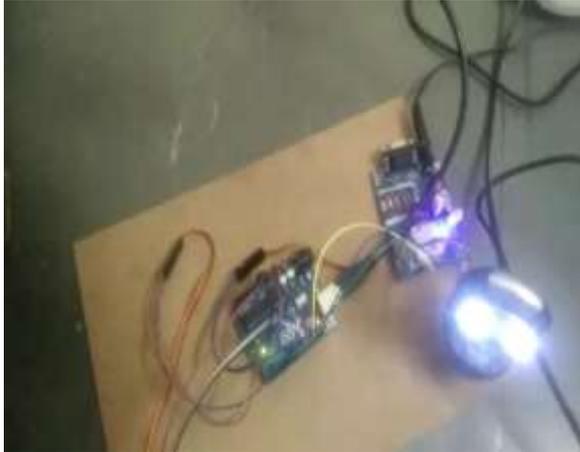

Fig.5. LEDs Indication of Establishment of Connections

Now as this is done, run the MATLAB code by clicking on the run button and then click on the 'change folder' as shown in the fig. 6.
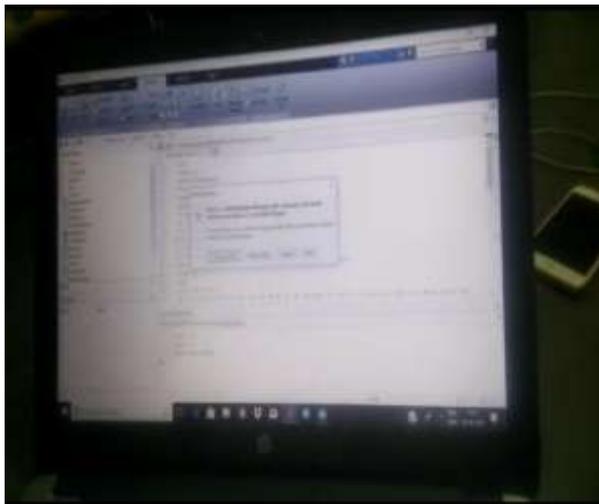

Fig.6 Matlab Window

Click on the change folder option and wait for the result to be displayed in the figure window. Result is displayed in the figure window showing angle and distance of the object detected.
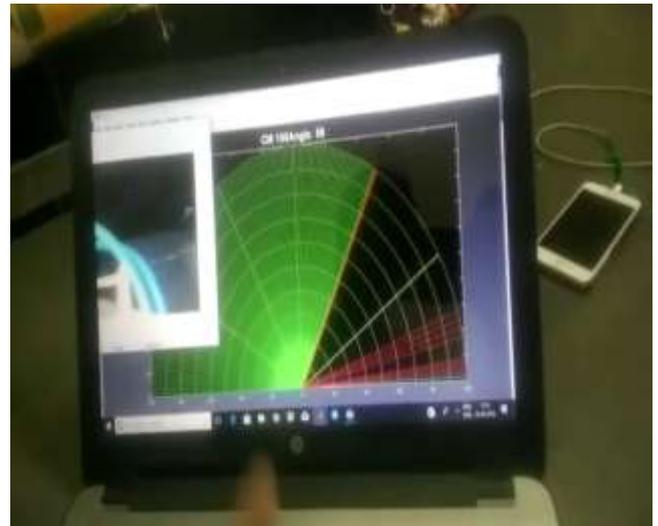

Fig.7. Result displaying the distance

When the object is not present, by default value of 100cms is displayed as shown in the above figure. Once the object is detected, the lines are changed to red in color as directed in the code written in MATLAB. Whenever the object is detected, red lines are displayed and the readings of angle and distance is changed.
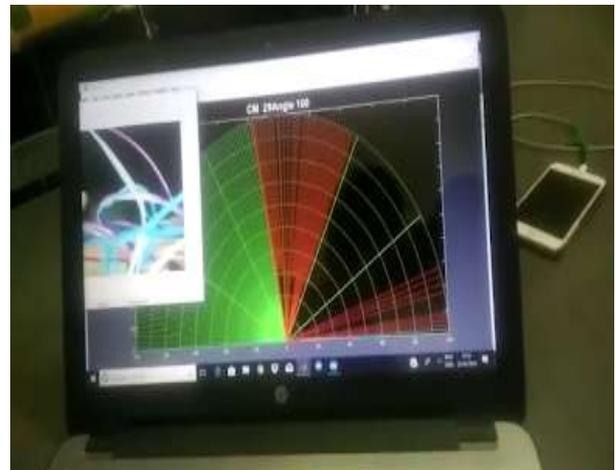

Fig.8. Detection of Target

The servo motor keeps rotating and ultrasonic sensor mounted on top of the servo motor is also rotated from +180 to -180 degrees. Also, the webcam which is mounted on top of another servo motor rotates in sync with the other servo motor and displays the video, which helps us in looking at the object that is detected through the other window.
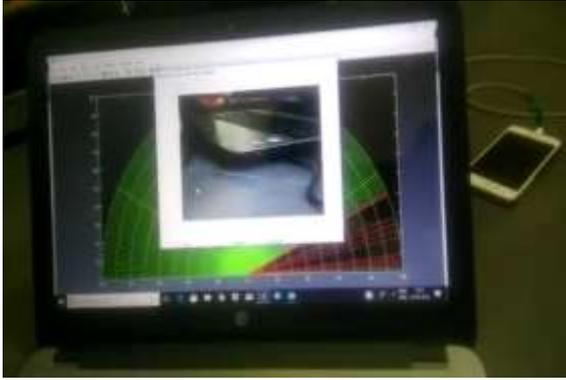
The output of the webcam is as shown in fig.9

Fig.9.Webcam Output

Through this live video module, intruder is directly recognized and thereby can be taken necessary action according to the situation. This video camera runs in the range of 0 to 180 degrees. SMS alert to the registered mobile number is received as shown in fig.10

Fig.10.SMS alert to registered mobile

In this way, we can directly know the security breaches at our finger tips.

V. CONCLUSION

Object detection using ultrasonic sensor which operate at 40khz frequency is implemented and respective graph is plotted. Security features like sending a message alert to registered phone number whenever the object is detected using GSM technology is included and a web camera is installed to view the object detected. This system can see through the medium consisting of fog, snow, rain, darkness, clouds etc. Radar signal can penetrate and see through insulators. It can track parameters of object or target viz. range, angular position, location of target, velocity of target.

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