Arduino-Based Home Perimeter Intrusion Detection System with Ultrasonic Sensor

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ABSTRACT: This paper presents a simple and effective design of home perimeter intrusions detection (PID) system that is tested on Arduino IDE environment. The system uses major components as Arduino board, 8x8 LED display, ultrasonic sensor, 16x2 LCD display module and speaker. The unauthorized person who tries to intrude the house will be sensed, detected and alarm will generate a signal that an intruder is trying to enter the house. The sound level depends on the distance, the nearer the intruder and stronger will be the alarm signal. This work can be used for many surveillance and security related applications.

Keywords: Aurdino, 16x2 LCD, 8x8 LED dot matrix, Ultrasonic Sensor

1.INTRODUCTION

Internet of Things has emerged as one of the most promising technologies for the future [1,2]. This field is actively researched, and different solutions have been proposed to address the challenges in this area, such as limited amount of energy and cost-efficiency [3]. One of the most discussed topics in IoT is the Home Automation, developing an inexpensive and safe system for indoor use has been a widely researched area which has brought advances in technology and availability of small, flexible, and smart systems.Guided by the concepts of IoT we develop an intelligent security system designed to give surve illance at all time [4,5,6,7].
Perimeter Intrusion Detection Systems (PIDS) are systems used in an external environment to detect the presence of an intruder attempting to breach a perimeter. This paper proposes a smart home security system based on arduino with the use of HC-SR04 Ultrasonic Sensor and LCD display.

2.BACKGROUND THEORY

Home Security System has a set of Perimeter Intrusion Systems .PID system displays the distance of the object or personal found in its region on the LCD display. This system is very useful for security applications. Ultrasonic sensor will be searching if there is a motion in its range.

2.1 Ultrasonic Sensor Module:

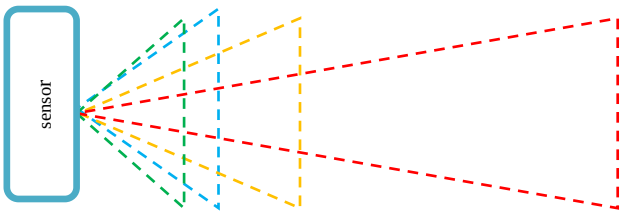
Ultrasonic sensor HC-SR04 is used here to detect the presences of any person at the door. The sensor module consists of ultrasonic transmitter, receiver and the control circuit. Ultrasonic Sensor consists of two circular eyes out of which one is used to transmit the ultrasonic wave and the other to receive it.Figures of ultersonic sensor and it Range Defining Diagram described the following.

Calculating the distance of the object based on the time taken by ultrasonic wave to return back to the sensor. Since the time and speed of sound is known we can calculate the distance by the following formulae.

Distance = (Time x Speed of Sound) / 2

Check the below project to measure the distance of any object and to properly understand the Ultrasonic sensor working.

Sensor Range Defining Diagram



Range defining for 8x8 Matrix

No.	Square	Range
1	2x2 Square	2cm - 30 cm
2	4x4 Square	31cm - 60 cm
3	6x6 Square	61cm - 120 cm
	8x8 Square	121cm - 300 cm

3. PROPOSED SYSTEM

In this paper Home Perimeter Intrusion Detection was designed and constructed using Arduino microcontroller device. The block diagram for the system is as shown in fig 1. The design is in six modules; power supply, ultrasonic sensor, 16x2 LCD device,8x8 led dot matrix,speaker and Arduino UNO modules. While the Arduino UNO forms the main control element, the ultersonic ranger sensor senses the intruder to be measured and send it to Arduino UNO. And then If the sensor detects something gets closer to the sensor, it will send a feedback to the processing unit. LCD display will display the distance of the intruder.8x8 LED display will show 4 stages.. The speraker will ring with increasing volume as the object coming closer.

4. HARDWARE IMPLEMENTATION PROCESS

Home Security System has a set of (PID) Perimeter Intrusion Detection System. We built the prototype of PID system with Arduino.Ultrasonic ranger sensor,8x8 led dot matrix and 16x2 LCD display.The overall circuit diagram of the system is described in fig 2.

4.1 Pin Connection with Components and Arduino Board

We change Pin No. in connection with components and Arduino not to be complex in connecting wires. Pin connections are shown in below table except the Power and GND pins

No.	Pin No. of Arduino	Pin of Components	Components
1	12	RS	16x2 LCD Display
2	10	E	
3	7	D4	
4	6	D5	
5	13	D6	
6	4	D7	
7	3	CLK	8x8 Matrix
8	2	CS	
9	4	DIN	
10	9	Trig	Ultrasonic Sensor
11	8	Echo	
12	5	Speaker	Speaker

4.2 System Operation

When an object comes in the range of the motion sensor, the Arduino is interrupted by the matrix and the Arduino sends signal to 8x8 LED matrix display and lights up all LEDs. When an object comes in the range of the ultrasonic sensor, the Arduino calculates the distance to that object. Then it send it to LCD to display the distance and a particular message. The distance is mapped into 4 ranges to display it on 8x8 LED matrix display. When there is no object, the outermost LEDs blink. As the object comes closer, the LEDs will become solid row without blinking. When the object comes too close to the sensor, the innermost LEDs will blink. The distance is mapped into a variable in the range ‘1’ to ‘10’ while ‘10’ being the

furthest and '1' being the nearest. When the object is near, the Arduino do some processing and determines which frequency to make for the speaker, and the speaker makes sound. The furtherer the object, the lower the delay between each frequency. Therefore, it sounds like the frequency changes. Then the cycle is repeated.

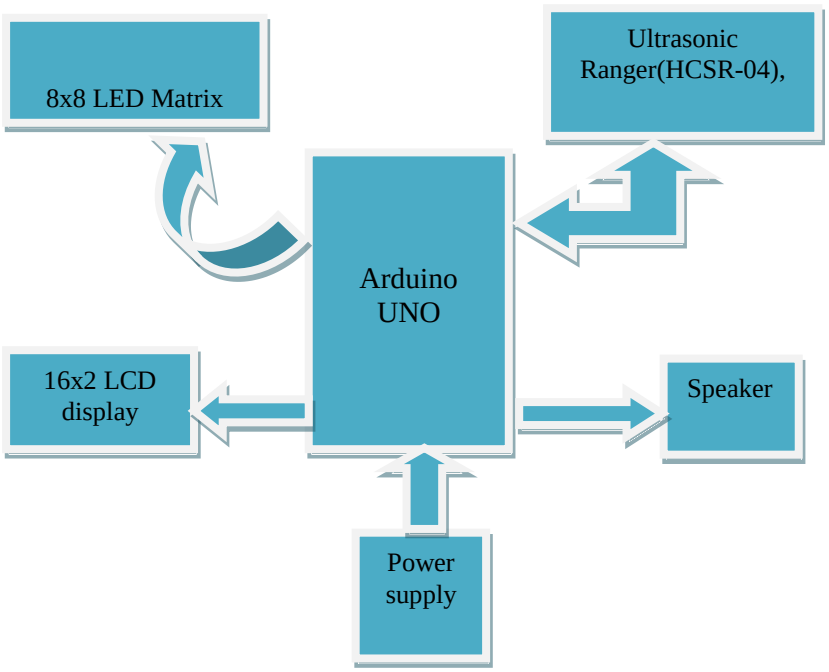


Figure 1. Block diagram of arduino based home PID system

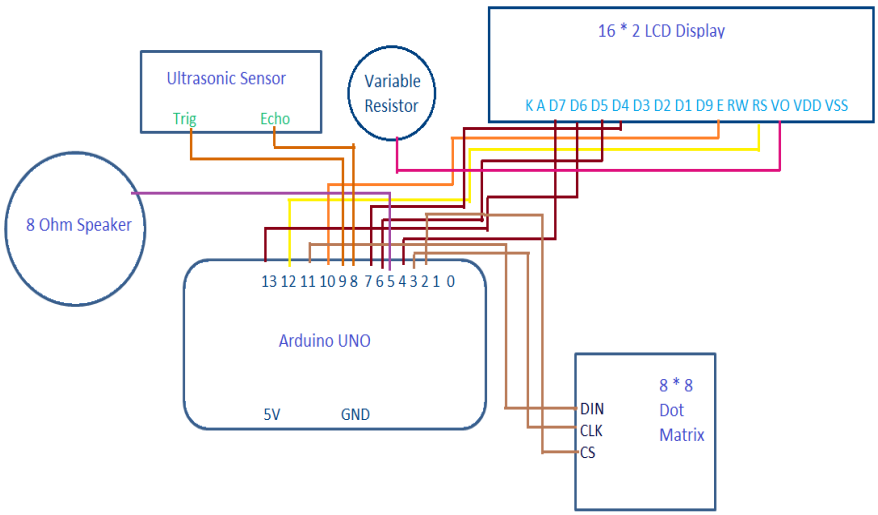


Figure 2.The whole circuit diagram of the system

5. SOFTWARE PROCEDURE FOR CONTROLLING THE WHOLE SYSTEM FUNCTION

Four separate different condition for displaying 8x8 matrix.If the intruder I in the range between 2 and 30centimeters, 8x8 matrix display will show dot2Square.

If in the range of 60 cm, 8x8 display will show d0t4Square.

If in the range of 120 cm,8x8 display will show dot6Square.

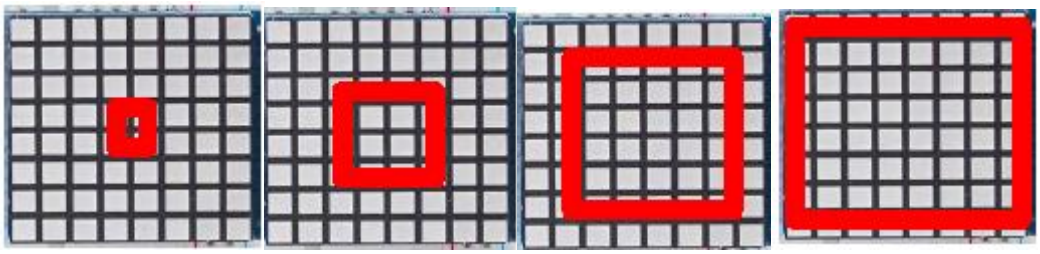
If in the range greater than 120 cm, 8x8 display will show dot8Square matrix which means nothing is approaching towards the center.

We test that maximum range of our Ultrasonic sensor estimated is 300 cm and angular coverage is around 15 degree.

For measuring the distance between sensor and object function :

Declaring variable “duration” for assigning the value of the time travelled by the ultrasound between sensor and the object.Library function “pulseIn” is used to trigger the sensor to emit ultrasound.We get the value of time travelled by the ultrasound between sensor and the object by this method. If we want the distance of the object, we have to multiply by the velocity of sound which is 34300 centimeters per second and 1.3503 inches per second.

In this case, we have to divide the velocity by 2 in order to have the value for velocity of echoing sound wave.



dot2Square dot4Square dot6Square dot8Square

Pins of LCD are connected with Arduino in this way rs = 12, en = 10, d4 = 7, d5 = 6, d6 = 13, d7 = 4;

Pins of 8x8 dot matrix (MAX7219) are connected with Arduino in this way.

CLK = 3;
CS = 2;
DIN = 4;

Pins of ultrasonic range detector are connected with Arduino in this way.

echo Pin = 8;
trig Pin = 9;

Pin of speaker is connected with Arduino pin 5.

And ground and Vcc will be given to the circuit.

This circuit will detect objects between its detection range. The speaker will generate sound after one complete loop when the object is in the nearest range. (L4 = 0cm to 10cm)

The speaker will generate sound after three complete loops when the object is in second nearest range. (L3 = 10cm to 20cm)

The speaker will generate sound after six complete loops when the object is in third nearest range. (L2 = 20cm to 30cm)

The speaker will generate sound after nine complete loops when the object is away starting from fourth nearest range. (L1 = 40cm to away)

6. RESULT and DISCUSSION

After hard working, all the parts are connected as circuit design. Then we upload the programming code as we compiled in the Arduino and we get positive result. At last we see that it works properly according to our design. The following two figures (fig 3, fig 4) are described the intruder is found and very close to the campus.

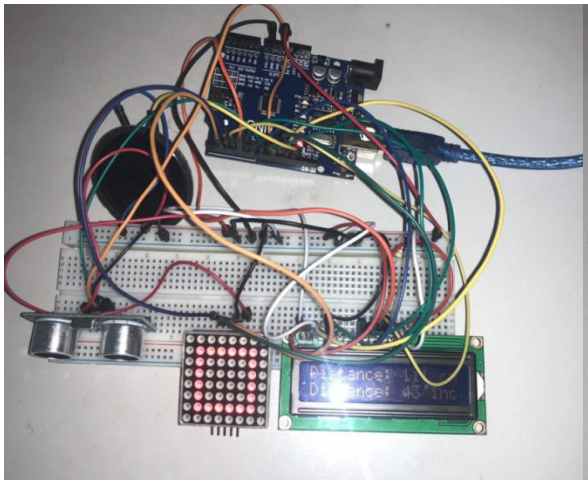


Fig 3:Home PID System while the Intruder is found

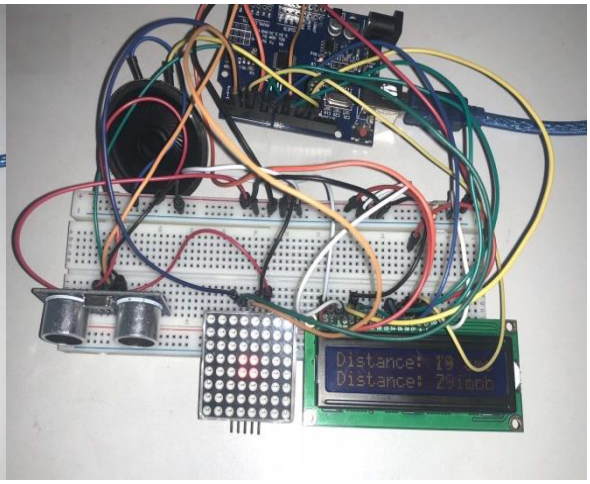


Fig4: Home PID System while the Intruder is too close

After designing the circuit we still had a lot of challenges ahead. In the above picture it is shown that in a home there is the system is applied for security purpose. When a moving object is moving in the sensor range it take that as system input signal. When getting the input signal , alarm sound is generated, alarm signal on 8x8 LED Matrix will display blinking dotted square and display the distance from the intruder on 16x2 LCD

7.Conclusion and Future scope

The arduino-based perimeter intrusion detection (PID) system by using Ultrasonic Ranger (HCSR-04) is designed by both hardware and software controlled.Home security system is highly preferable not only for home but also anywhere security issues are needed. This security is included for Home/ Bank/ Office and for the purpose of safety; everybody wants to take proper measures to prevent intrusion.

Around the globe human intruder system is one of the challenging systems to design due to the development of technology in the modern world. Deploying intruder system in high security areas such as military borders is difficult and expensive. The proposed system develops a novel approach that automatically detects intruder and produces a warning alarm ,display on the LCD.

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