

PERIMETER INTRUSION DETECTIVE SYSTEM USING ARDUINOThiri Naing^{*1}Kyi Kyi Khaing²Tin Tin Nwet³

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Perimeter intrusion detection systems are an integral part of most physical security systems. Perimeter fencing is widely used to isolate and protect public and private places such as airports, military bases, power stations and security related applications. Fence structures merely prevent a percentage of intrusions or postpone them. A higher level of security needed to monitor and investigate activities on or around the university. Perimeter Intrusion Detection System (PID) focusing on the fence intrusions. The system used major components as Arduino board, 8x8 LED display, ultrasonic sensor, 16x2 LCD display module and speaker. The unauthorized person who tries to intrude the university would be sensed, detected and alarm would generate a signal that an intruder was trying to enter the university. The sound level depended on the distance, the nearer the intruder and stronger would be the alarm signal. PID system displayed the distance of the object or personal found in its region on the LCD display. This system was very useful for security applications. Ultrasonic sensor would be searching if there was a motion in its range.

KEYWORDS:

Aurdino UNO, 16x2 LCD, 8x8 LED Matrix, HC-SR04 Ultrasonic Sensor, Speaker

INTRODUCTION

The Internet of Things (IoT) paradigm has recently evolved into a technology for building smart environments. Security and privacy are considered key issues in any real-world smart environment based on the IoT model. The security vulnerabilities in IoT-based systems create security threats that affect smart environment applications. Thus, there is a crucial need for intrusion detection systems (IDS) designed for IoT environments to mitigate IoT-related security attacks that exploit some of these security vulnerabilities. Due to the limited computing and storage capabilities of IoT devices and the specific protocols used, conventional IDSs may not be an option for IoT environments [1].

An intruder detection system (IDS), as discussed in the paper on physical security, is an arrangement of electronic devices for detecting the entry or attempted entry of an intruder and sending an alarm. An intruder detection system (IDS) can involve substitution of electronic surveillance for human surveillance. An effective, long-life IDS is professionally designed, planned, installed, and serviced regularly. Without these minimum standards, an intruder detection system IDS may be vulnerable to circumvention, malfunctioning, and false alarms [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 surveillance at all-time

[4,5,6,7]. This paper proposes a university security system based on Arduino with the use of HC-SR04 Ultrasonic Sensor and LCD display.

BACKGROUND THEORY

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.

Hardware Requirement

The basic components of an **intrusion detection system** are as follows:

Table 1: Lists of hardware requirement

No.	Requirement	Quantity
1	Arduino Board	1
2	Ultrasonic Sensor	1
3	16x2 LCD Display	1
4	8x8 LED Matrix	1
5	Speaker	1
6	Breadboard	1

Ultrasonic Sensor Module

In this paper, HC-SR04 Ultrasonic sensor is used for sensor selection and is determined by the intrusion threat, the operating environment (e.g., indoors, outdoors), and power source constraints. 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. Calculating the distance of the object based on the time taken by ultrasonic wave to return back to the sensor [9]. Since the time and speed of sound is known we can calculate the distance by the following formulae.

$$\text{Distance} = (\text{Time} \times \text{Speed of Sound}) / 2$$

Check the below project to measure the distance of any object and to properly understand the Ultrasonic sensor working. Fig. 1 shows HC-SR04 Ultrasonic sensor and Table 2 shows it range defining diagram described the following. Fig. 2 shows sensor range defining diagram.



Fig. 1 HC-SR04 Ultrasonic sensor

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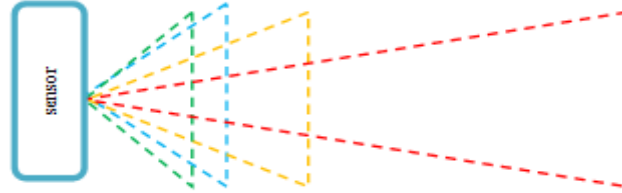


Fig. 2 Sensor range defining diagram

Table 2. 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
4	8x8 Square	121cm - 300 cm

Arduino Board

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Fig. 3 shows the Arduino board.



Fig. 3 Arduino UNO board

In this paper, the Perimeter Intrusion Detection was designed and constructed using Arduino microcontroller device. The block diagram for the system is as shown in Fig. 4. 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 ultrasonic 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 speaker will ring with increasing volume as the object coming closer.

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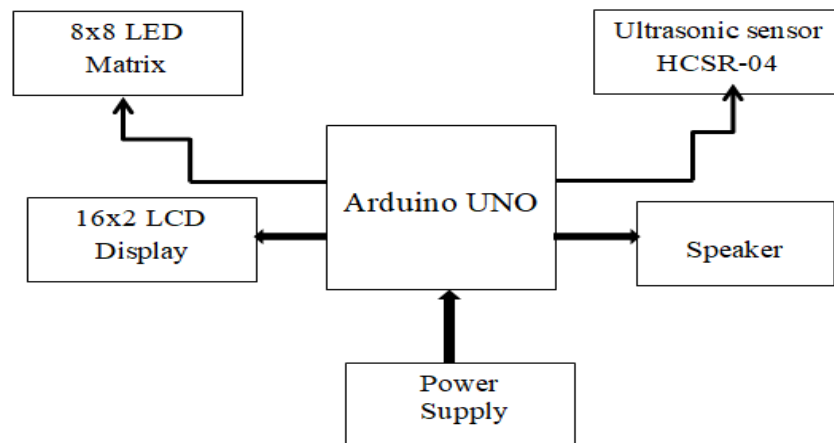


Fig. 4 Block diagram of PID system

HARDWARE IMPLEMENTATION PROCESS

The Security System has a set of (PID) Perimeter Intrusion Detection System. We built the prototype of PID system with Arduino. Ultrasonic ranger sensor, 8x8 ED dot matrix and 16x2 LCD display. The overall circuit diagram of the system is described in Fig. 6.

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. Table 3 shows the pin connection with components and Arduino board.

Table 3. Pin connection with components and Arduino board

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

Pins of LCD are connected with Arduino in this way RS = 2, En = 3, D4 = 4, D5 = 5, D6 = 6, D7 = 7. Pins of 8x8 dot matrix (MAX7219) are connected with Arduino in this way.

CLK = 8; CS = 9; DIN = 10;

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

echoPin = 12;

trig Pin = 10;

Pin of speaker is connected with Arduino pin13. And then ground and Vcc will be given to the circuit. This circuit will detect objects between its detection ranges. 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).

Basic 8x8 LED Matrix Working Systems

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. In Fig. 5, 8x8 LED display will show 4 stages. The alarm will ring with increasing volume as the object coming closer [8].



Fig. 5 Four stages on 8x8 LED display

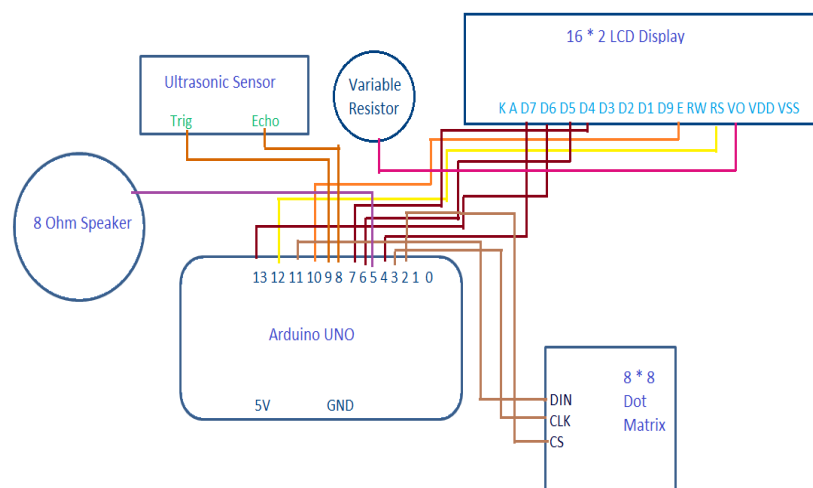


Fig. 6 Circuit diagram of PID system

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 sends 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 further the object, the lower the delay between each frequency. Therefore, it sounds like the frequency changes. Then the cycle is repeated.

Software Procedure of the system

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

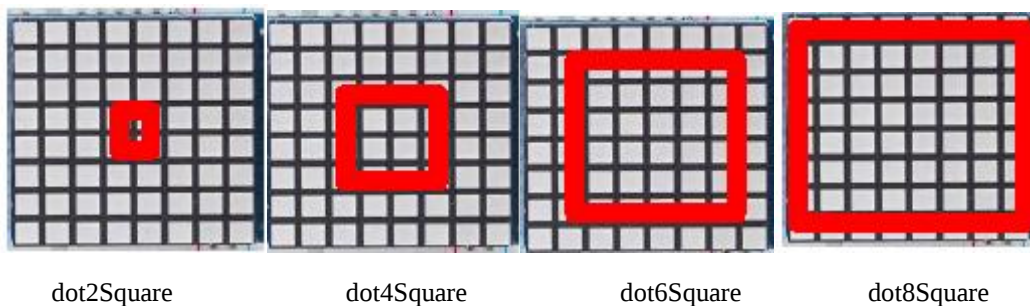
If in the range of 60 cm, 8x8 display will show dot4Square.

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

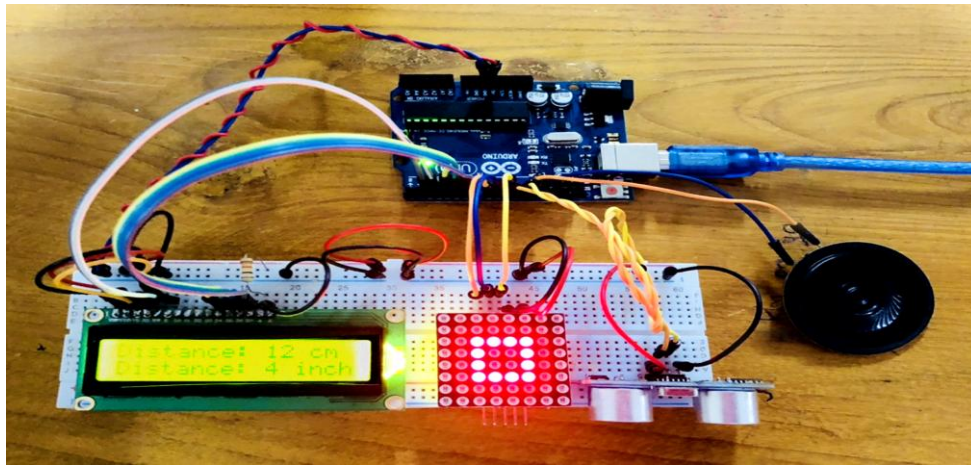
If in the range greater than 120 cm, 8x8 matrix displays will show dot8Square matrix which means nothing is approaching towards the center.

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.



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. Fig. 7 describes the intruder is found and very close to the campus.

*Fig. 7 Output display of PID system*

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CONCLUSION

The Arduino-based perimeter intrusion detection (PID) system by using Ultrasonic sensor (HCSR-04) is designed by both hardware and software controlled. PID system is highly preferable not only for the university but also anywhere security issues are needed. This security is included for University/ Home/ Bank/ Office and for the purpose of safety; everybody wants to take proper measures to prevent intrusion. The system develops a novel approach that automatically detects intruder and produces a warning alarm, display on the LCD. We found that the maximum loudness of our speaker is about 4000Hz. So, we define that from 2000Hz of sound will alarm when the intruder is at the outermost range to 4000Hz of alarm song will ring when the intruder is nearest of the sensor. So, if the object is coming near, sound of alarm increase volume and delay time of alarm will be lesser or alarm will ring faster.

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