Multiple Laser Alarm System using Arduino Uno

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Abstract

Contemporarily, illegal activities such as theft, intrusion, and robbery are frequent in the community. Security systems identical to door locks and alarms are used to mitigate such crimes. In this paper, the researchers propose using a multi-laser alarm system by mainly using Arduino Uno board. Like laser systems common in action films, the project makes use of multiple lasers to detect motion on the location. The device is programmed to produce noise when all the LDR receive zero light from the lasers. The researcher thinks of using multiple lasers to increase the detection of human movement. For an instance, placing one laser in lower places and the latter to a higher height. Cats or rolling rubber ball can trigger the lower laser, but humans can trigger both lasers at the same time. The details of the system and its code is described. Results shows that the system works on a variety of objects.

Keywords: Arduino Uno, laser, light dependent resistor, buzzer, LEDs

I. INTRODUCTION

Security is one of the most important factors to consider today. Every technology develops day by day in this world and some of the technologies are used to crimes. The team decided to create an alarm security system as the project to improve safety.

Alarm systems today are in the form of electronics and such systems are to detect, determine and deter criminal activities. It can detect invasions, fire, or any changes to its surrounding. Mostly it detects possible threats and notify the authorities about the events that take place.

The laser-alarm security system is a device designed to detect intrusion or unauthorized entry into an area. One of the major components used to create a security system is the sensor. The sensor measured the action of the electrical equivalent and processes, and the signal can be sent and interpreted quickly. The purpose of the sensor on the security is to detect the events or change in its environment and send the information to the other electronics components. Laser is also one of the major components in this project, without the laser the project will fail. The laser provides a protection to the area, and it works as a result to resonant effect.

Laser alarm security system can be used in many ways; around the house, safety locker, and it can act as an additional layer of security. Aside from security purposes, it can be also setup to check if pets or babies crossed out of the boundary. Installing at home a laser alarm security system means to protect your home and valuables and to keep your family safe from break-in. Arduino Uno is a low-cost electronics device with a simple hardware and software. It able to read inputs light on a sensor, a finger on a button and turn into output – activating a motor, and publishing something online. Arduino Uno is made of a programmable board, and it allows us to write and upload code to the microcontroller.

Nowadays, security system can be considered as one of the most necessary things because of the increasing crimes on action. In this pandemic, there are a lot of crimes are happening this include stealing of things in some places like on the business location, home equipment's and more. Security system is a line of defense for keeping your property and valuable safe. This type of alarm system can alert you if something bad is going down, which it keeps both property and valuables safer. There are many types of security system that are currently using by most people like with the use of CCTV, alarm of the broken glasses, but this alarm system is visible to the naked eyes that will alert the intruders to deactivate them.

Objectives of the Study

The objective of this research is to design and construct a simple security system using Arduino that will be used to detect intrusion or unauthorized entry into an area. The design of the alarm system will use laser beam as light. The alarm system will perform a multi-area system with the use of monitoring and a keypad matrix. This study aims to understand how the Arduino Uno works together with the laser and LDR, to make use of Arduino, laser and LDR to create an alarm system, to generate a program that will activate the alarm when unauthorized motion is detected.

Review of Literature

The light emitted by a laser varies greatly from that produced by a torch. It is special in three aspects. To begin with, it is more practical. As a result, lasers can be used to cut through tough materials. Second, laser light has a much smaller spread than ordinary light. Surveyors may use the laser to draw straight lines and calculate distances. Finally, laser light has only one color or wavelength, whereas ordinary light has a range of colors [1].

LASER has a broad range of uses, according to Kant, Sharma, and Singh, including optical disk drives, laser printers, and barcode scanners; fiber-optic and free-space optical communication; laser surgery and skin treatments; cutting and welding materials; military and law enforcement devices for marking targets and measuring range and speed; and laser lighting displays in entertainment. Laser lighting displays in entertainment, as well as military and law enforcement equipment for marking targets and measuring range and speed [2].

According to Dong, Giakoumidis, Juma, Tretyakov and Mavridis, elderly people and people with disabilities have it hard to live encountering fast moving objects. Therefore, they made use of a Laser motion detection to alert people of an incoming object. In this case, they used vibration signal to the individual's neck [3].

Aside from detecting fast moving objects, laser can also be used to secure places where nobody is allowed to enter. A protection and warning system that uses laser light and a light sensor is known as a laser-based security system. Our homes, offices, banks, lockers, and other valuables are all secured by security systems from intruders and unauthorized entry. There are various types of security systems available, with laser-based security systems being one of the most important and successful. A laser security system may be used as a standalone system that emits a sound or creates a noise when it senses some suspicious behavior, or it can be incorporated into a wider security and home automation system that can send messages, call the owner etc. [4].

When an invisible LASER beam is disturbed, a Warning or SIREN work. This is a very typical scenario nowadays. The LASER beam protection device is used by many people to protect their homes, workplaces, stores, warehouses, and other places. Not only buildings and premises are protected with such invisible LASER beams, but many valuable objects such as watches, diamonds, valuable antique items in museums, and many other items are as well [5].

According to Singha and Maji, this type of laser system consumes less power to the whole laser system, which is expensive. It can also be installed in homes easily; you can install it yourself [6].

Like Singha's laser system, Ayad Mohammed's laser fence is a mechanism that can detect objects passing the line of sight between the laser source and detector. His alarm makes use of camera, which will focus to the sight of unauthorized entry. The system runs on a program using the C# language and visual basic to evaluate the system [7].

People do not have to worry about the cost of these laser security systems. They are affordable and easy to produce and install, they might be able to make it themselves. According to the team of Rai, it consists of few components and can be placed to small areas, yet it covers long distances. Crimes are imminent today which is why their team created this "Low-Cost Laser Light Security System in Smart Home" affordable by anyone [8].

Lockers and locker rooms can be protected with an LDR-based alarm system. A light source or laser light source is fixed above the sensor in a closed casing in such a system, and the LDR sensor is connected to an alarm mechanism. When an unethical attempt is made to gain access to a locker or locker room, the laser light is activated, which stimulates the LDR sensor, triggering an alarm. This project shows a similar alarm mechanism, but instead of using a product-style casing, the circuit was built on a breadboard to demonstrate the concept. This project's security system uses LDRs, but any other sensor, such as a smoke sensor, magnetic (Hall) sensor, or temperature sensor, can be used to turn it into a fire alarm system, motion detection system, or heat/fire alert system [9].

Another example of laser security system is Islam and Sarkar's LASER based security system. Their system utilized LASER to detect intruders. A wireless sensor network is connected and used to communicate to the authorities of the restricted place. They have Lasers and LDRs attached to Arduino board in which the board is programmed to make decisions whether to buzz the alarm or call a number depending on the activated lasers [10].

II. METHODOLOGY

Input	Process	Output
LDR	• Detects continuous light from laser beams. • If light source is blocked, alarm will turn on. • LED 3 & 4 blinks rapidly.	Laser Alarm Security System using Arduino.
Push Button Switch	• If not pressed, the device is on standby with LED 1 lit • If pressed again, the device detects light and the LED 2 lit. • If the alarm turned on, press the button again to reset to standby.	
Laser	• Laser emits light to the LDR when connected to power source.	

Figure 1. IPO chart

The project's inputs are Push Button Switch, LDR, and Laser. When the device connects to a power source, all the components connected to the device will activate except LED2. LED1 lights up green, which means the device is in neutral state. When LED 2 is red and blinking, it means an object blocked the light source and the alarm will turn on. When the push button is pressed, the alarm and LED2 will turn off and the device is back to its neutral state.

Conceptual Framework

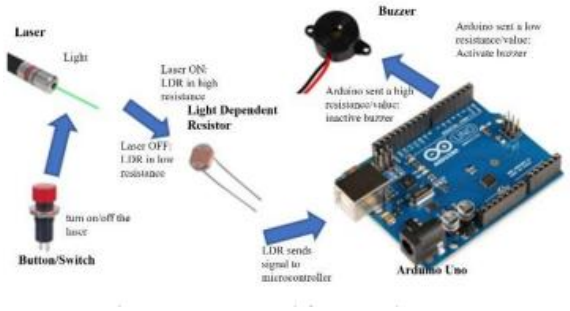

Figure 2. Conceptual Framework System

This figure shows the process on how the whole system will work. The function of the switch is to turn on or off the prototype. The laser is directed to the LDR sensor where it can detect a high or low resistance. LDR sends a signal to the microcontroller and the Arduino sends signal to buzzer. When the laser is on, the LDR will detect a high resistance and the Arduino causes the buzzer to remain off state. But if there is no light is directed to the sensor, or it is cut off by some object or people, the sensor will send a low resistance where the Arduino will detect, and the buzzer will activate.

Block Diagram

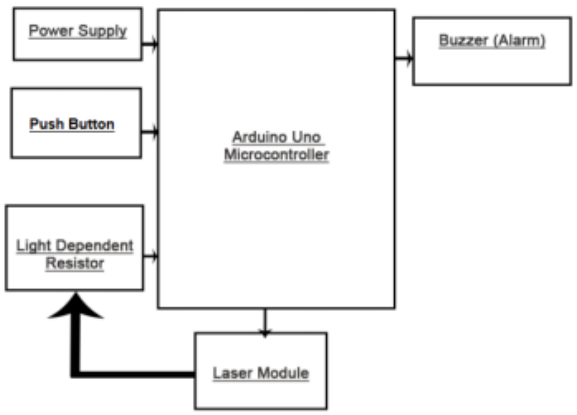

Figure 3. Block Diagram

Figure 3 shows the Block Diagram of the device. The power supply will give power to the Arduino to run the other electronic components such as the laser beam module, the LDR, Push

Button Switch, LEDs, and Buzzer. Therefore, all the components are powered on and the buzzer is beeping. However, it is off when the laser beam points toward the Light Dependent Resistor. If someone passes the laser beam removing the light to the LDR, it will result to the buzzer beeping. This is when the push button comes in use. You must press the push button to turn off the alarm.

Schematic Diagram

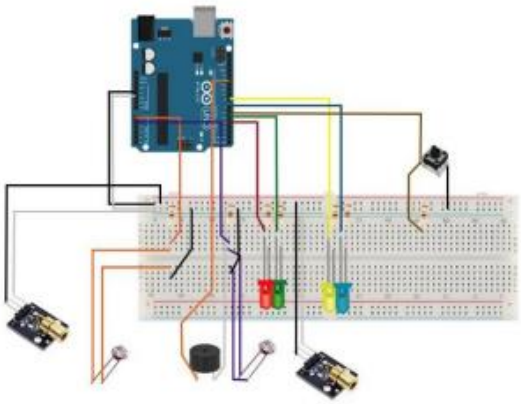

Figure 4. Schematic Diagram

Figure 4 presents the schematic diagram of the system. It shows the connection of wirings in the system. The black wire connects to 5v and board, which connects the components to the power source. The white wire is the ground. Red wire for Red LED, which connects to Digital Pin 4, green to pin 5, yellow to pin 8, Blue to pin 7, and brown to pin 6 which is connected to the push button. The buzzer is connected to pin 12. The LEDs and LDRs have resistors used in between the connections.

Design Requirements

Software specification

The team used C++ language and Arduino IDE to program the Arduino Uno for software design. The C++ language was used to write the code in the Arduino or microcontroller of the prototype design. The team also used both programming tool to compile and simulate the program. The program was set to deliver signals to every component and the program is set to detect signals from the LDR and processed by the microcontroller to send another signal to the buzzer. The whole operation in output will depends on the light dependent resistor. Development of the automation system.

Hardware specification

The prototype development is also composed of hardware that security system will operate by using two or more laser. The Arduino Uno was used to complete the development of the prototype and Arduino Uno is used to process every signal or connection to every component and condition of the project.

Cost Analysis

Material	Cost
LDR	PHP70.00
Jumper Wires	PHP50.00
5v Buzzer	PHP45.00
Laser (per item)	PHP85.00
Arduino UNO	PHP150.00
Breadboard	PHP70.00
Push Button	PHP30.00
LED	PHP20.00
TOTAL	**PHP520.00** *+ price of additional lasers*

Main Components

Arduino Uno

The Arduino Uno board is the primary component of the device. It is a micro controller, which has analog and digital function, as well as input and output pins. It is programmable using the Arduino IDE and this is where the code for the program of the device will be written.

Laser

The device responsible for producing light to the LDR. This is the light source that is being detected by the LDR.

Light Dependent Resistor

Light Dependent Resistor or Photoresistor, is a passive electronic component and it is a resistor that has a resistance which detects a light intensity.

Buzzer

Emits sound and will be the alarm for the project.

III. RESULTS AND DISCUSSIONS

Overview of the project

The main components are Arduino Uno which is the microcontroller, and the code was uploaded, laser pointer is set to the center of the LDR, buzzer which create a noise or alarm, and the light dependent resistor which is the sensor. The program that was set is the main function for the project.

```
const int triggeredLED = 7;
const int triggeredLED2 = 8;
const int RedLED = 4;
const int GreenLED= 5;
const int inputPin = A0;
const int inputPin1 = A1;
const int buzzerPin = 12;
const int armButton = 6;

boolean isArmed = true;
boolean isTriggered = false;
int buttonVal = 0;
int prev_buttonVal = 0;
int reading = 0;
int reading1 = 0;
int threshold = 0;

const int lowrange = 2000;
const int highrange = 4000;

void setup(){
  pinMode(triggeredLED, OUTPUT);
  pinMode(triggeredLED2, OUTPUT);
  pinMode(RedLED, OUTPUT);
  pinMode(GreenLED, OUTPUT);
  pinMode(armButton, INPUT);
  digitalWrite(triggeredLED, HIGH);
  delay(500);
  digitalWrite(triggeredLED, LOW);
    calibrate();
    setArmedState();
}

void loop(){
  reading = analogRead(inputPin);
  reading1 = analogRead(inputPin1);
int buttonVal = digitalRead(armButton);
if ( (buttonVal == HIGH)&&(prev_buttonVal == LOW))
  {
    setArmedState();
    delay(500);
  }
  if ((isArmed) && (reading < threshold)) {
    if (reading1 < threshold){
    isTriggered = true;}
  }
  if (isTriggered) {
    for(int i = lowrange; i<= highrange; i++){
      tone(buzzerPin, 220, 450);
    }
    for(int i = highrange; i >= lowrange; i--){
      tone (buzzerPin, 196, 250);
    }
    digitalWrite(triggeredLED, HIGH);
    delay(50);
    digitalWrite(triggeredLED, LOW);
    delay(50);
    digitalWrite(triggeredLED2, HIGH);
    delay(50);
    digitalWrite(triggeredLED2, LOW);
    delay(50);
  }
  delay(20);
}

void setArmedState() {
  if (isArmed) {
    digitalWrite(GreenLED, HIGH);
    digitalWrite(RedLED, LOW);
    isTriggered = false;
    isArmed = false;
  } else {
    digitalWrite(GreenLED, LOW);
    digitalWrite(RedLED, HIGH);
    tone(buzzerPin, 220, 450);
    delay(200);
    tone(buzzerPin, 196, 250);
    isArmed = true;
  }
}

void calibrate() {
  int sample = 0;
  int baseline = 0;
  const int min_diff = 200;
  const int sensitivity = 50;
  int success_count = 0;
 digitalWrite(RedLED, LOW);
 digitalWrite(GreenLED, LOW);

 for (int i=0; i<10; i++) {
   sample += analogRead(inputPin);
   digitalWrite(GreenLED, HIGH);
   delay(50);
   digitalWrite(GreenLED, LOW);
   delay(50);
 }
 do {
   sample = analogRead(inputPin);
   if (sample > baseline + min_diff) {
     success_count++;
     threshold += sample;

     digitalWrite(GreenLED, HIGH);
     delay(100);
     digitalWrite(GreenLED, LOW);
     delay(100);
   } else {
     success_count = 0;
     threshold = 0;
   }
 } while (success_count < 3);
 threshold = (threshold/3) - sensitivity;
 tone(buzzerPin, 196, 250);
 delay(300);
 tone(buzzerPin, 220, 450);
}
```

Figure 5. Code

The first part of the code declares the components to their respective pins, Boolean variables, and integer variables. In the void setup, the codes written are the operational function of each declared components in the first part. The LEDs are set as an OUTPUT while the Push Button as an INPUT. It has calibrate command, which calibrates or tests the device's components if all are working properly or not. The codes

inside void calibrate turns on and off the LEDs to check their operation, and the alarm will buzz two times. The command "setArmedState" is the standby mode or the neutral mode of the device. In this phase, the device will not alarm until to press the push button then the device will start. In void loop, these codes will run if the device is on. Once the button is pressed, the device is out of standby mode and starts to detect light from the lasers. The device is programmed to alarm when both lasers are triggered. When the alarm turns on, the LED3 and LED4 will turn on alternately. Pressing the push button once again will reset the device to setArmedState or standby mode.

Table 1. Data and Result

Test	Expected Output	Actual Output	Remarks
Hand:			
1	BUZZER ON	BUZZER ON	Successful
2	BUZZER ON	BUZZER ON	Successful
3	BUZZER ON	BUZZER ON	Successful
4	BUZZER ON	BUZZER ON	Successful
5	BUZZER ON	BUZZER ON	Successful
Paper:			
1	BUZZER ON	BUZZER ON	Successful
2	BUZZER ON	BUZZER OFF	Unsuccessful
3	BUZZER ON	BUZZER ON	Successful
4	BUZZER ON	BUZZER ON	Successful
5	BUZZER ON	BUZZER ON	Successful
Glass:			
1	BUZZER ON	BUZZER OFF	Unsuccessful
2	BUZZER ON	BUZZER ON	Successful
3	BUZZER ON	BUZZER ON	Successful
4	BUZZER ON	BUZZER ON	Successful
5	BUZZER ON	BUZZER ON	Successful
Rubber:			
1	BUZZER ON	BUZZER ON	Successful
2	BUZZER ON	BUZZER ON	Successful
3	BUZZER ON	BUZZER ON	Successful
4	BUZZER ON	BUZZER ON	Successful
5	BUZZER ON	BUZZER ON	Successful

The table shows that there are unsuccessful trials when objects paper and glass block the laser. The unsuccessful trial on paper is because it is too thin which causes the light to pass through, the researchers opted to use a thicker paper. The same applies to the glass wherein the light passes straight through the glass. Successful trials were due to the light bending on the curves of the glass.

Table 2. Data and Result

Test	Expected Output	Actual Output	Remarks
1	Buzzer off	Buzzer off	Successful
2	Buzzer off	Buzzer off	Successful
3	Buzzer off	Buzzer off	Successful
4	Buzzer off	Buzzer off	Successful
5	Buzzer off	Buzzer off	Successful

The prototype produces a probability of 100 percent certainty during the five actual trials done by the researchers. The actual output is the same as expected outputs.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Laser alarm system provides us security against crime and theft day by day. Using this type of system, it can help to lessen or avoid robbery, theft and crime at business place, home, school and even in the company. The combination of all the components such as LDR, Arduino Uno, laser, buzzer, LEDs, button, and a

programming software can make a laser alarm system. By understanding all the function of the equipment, codes, and programming language that was use, the team was able to create, design and implement a multiple laser alarm system using Arduino Uno.

Recommendations

The researchers created a multiple laser alarm system and recommended on some improvement for future research studies. A better laser and LDR to enhance the durability and longevity of the light source; include architecture to the system; Give a try adding more lasers and longer jumper wires to enhance its detection and laser pattern complexity; Add a module to send notifications of possible intrusion to the owner's mobile phone.

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