Design and Implementation of an Arduino-Based Security System Using Laser Light

Arianne B. Arjona, Pauline Kaye M. Bautista, Jocelyn E. Edma, Maria Idda Jemima P. Martel,
Erika Dyan N. Octavio, and Neil P. Balba
Lyceum of the Philippines – Laguna

***Abstract*—A study regarding the design and implementation of an Arduino-based security system using laser light was made to help users secure their homes due to increasing crimes. This laser security system is activated once the switch is pressed. Then, if something or someone passed through between the laser light and light dependent resistor, the buzzer will automatically make a sound. During the test, it shows that the prototype is 80 percent successful. The researchers were able to determine and utilize the functionalities of the laser, light dependent resistor, and the Arduino as the microcontroller. Therefore, the researchers conclude that this research is a success.**

***Keywords*—Arduino, light dependent resistor, microcontroller, prototype, security**

INTRODUCTION

Background of the study

A security system is a device designed to detect intrusion and unauthorized access into a building or an area. There are many examples of a security system, a sensor is considered as one of the major components used to create a system for security. In this project, however, the proponents used laser as a major component to provide protection in a certain area. A laser works as a result of resonant effects.

It is a coherent and focused beam of photons—coherent, in this context, means that it is all in one wavelength unlike ordinary light which showers in many wavelengths. With this, a laser can be used as a part of a security system connected to an alarm that when an object goes between the laser and the light dependent resistor (LDR), the alarm will turn on.

A light dependent resistor (LDR) is a component that has a resistance that changes with the light intensity that falls on it. This can be used in light sensing circuits, like the laser security system. This component will be programmed by the Arduino that when the laser path is blocked, it will send a signal to the alarm for it to turn on.

Arduino is an open-source platform used for building electronic projects. It consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (integrated development environment) that runs on a computer, used to write and upload computer code to the physical board.

Problem statement

Nowadays, security can be considered as one of the most necessary things because of increasing crimes. There are many types of security systems that are currently using by most people. Closed-circuit television (CCTV), alarms, etc. but these systems are visible to the naked eyes that will alert intruders to avoid these security systems or to deactivate them.

Objectives of the study

The main objective of this project is to design and implement an Arduino-based security system using laser light.

Specific objectives

- To determine the functionalities of an Arduino, laser, and light dependent resistor;
- To utilize the functions of the laser, light dependent resistor, and Arduino; and
- To create a program that will trigger the alarm once an object blocks the laser path.

Scope and limitation

The Arduino-based security system using laser light has the following scopes:

- This project has the capability to give warning to the people nearby.
- This project is not dependent on the main power source of the area.
- The laser light is hardly seen by the naked eye.

The following are the limitations of the design:

- The laser security system works only if the laser is obstructed. If the intruder passes without obstructing the laser, it is considered as a failure.
- If a certain object crosses the laser path, it will trigger the alarm and will cause a false alarm.
- In order to secure a larger area, we need more lasers and corresponding LDRs.
- The laser security system has an on/off switch, if the owner forgot to turn it on, the intruder can easily pass through or if the owner forgot to turn off the alarm, it will cause a false alarm.
- If two or more laser lights are pointed in one LDR, but only one laser light is blocked, the alarm will not turn on.

Significance of the study

The Arduino-based security system using laser light can give an additional layer of security through a certain area. Apart from a security system, this project can be used in other aspects such as safety. For example, for some machines, once a hand or any body part goes in between the machine, the laser light will be blocked and it will cause the machine to stop. This project can also help other researchers to innovate, develop, and improve present projects.

REVIEW OF RELATED LITERATURE

Related studies

Kant, Sharma, and Singh stated there are lots of applications of Light Amplification by Stimulated Emission of Radiation (LASER) such as 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. [1]

Karri and Lim developed a combination of pixel illumination with its Chroma in YUV color space that will be a very robust and effective way of false alarms in case of swaying objects. [2]

Zhao and Yet discussed about the detection based on an object oriented, statistical multi-feature analysis of video sequences. [3]

Bing, Tun Hung, Gangway, and Tina developed a mobile manipulator which is equipped with cameras at the arm end for purpose of monitoring and this system can increase the safety of the user and efficiency of monitoring. [4]

Synthesis

In relation to the literature that the researchers gathered, there are lots of types of security systems to somehow provide safety for users such as lasers, cameras, sensors, etc. The researchers made use of laser which also has lots of applications according to Kant, Sharma, and Singh. The researchers used an ordinary laser that is directed to the light dependent resistor and when an object passed through between the laser and the light dependent resistor, the buzzer will automatically make a sound. This laser security system can be placed anywhere, especially in places that are liable to suffer from intrusions.

METHODOLOGY

IPO chart and discussion

Input	Process	Output
SPST Push Button switch	• Check if the switch is not pressed, LED 1 will turn on • Check if the switch is pressed, LED 2 will turn on • LDR will turn on • When the alarm turns on, it will check if the switch is pressed, alarm will turn off • LED 1 will turn on • LED 2 will turn off	Arduino Based Security System using Laser Light
Object	• LDR checks if light is detected, alarm remains off • LED 3 and LED 4 will remain off • LDR checks if light is not detected, alarm will turn on • LED 3 and LED 4 will turn on and blink alternately	

Figure 1. IPO chart

The inputs of the project are the single-pole single-throw (SPST) push button switch and any object such as plastics, glass, paper, body parts, etc. If the SPST push button switch is pressed, the LED 2 will turn on as a sign that the LDR is activated and once the laser light is blocked, the alarm will turn on. LEDs 3 and 4 will turn on and blink alternately.

Conceptual framework/theoretical framework

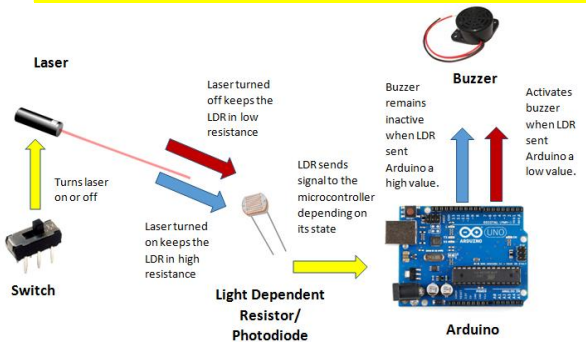

Figure 2. Conceptual framework of the system

The switch turns the laser on or off. The laser light is directed to the photodiode where it will be at high resistance where very low signal is detected by the Arduino which causes the buzzer to remain in the off state, but when there is no light directed to the photodiode or it is cut off by something, the photodiode will be at a very low resistance where the Arduino microcontroller will detect it and activate the buzzer.

Block diagram

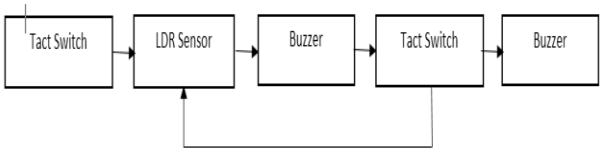

Figure 3. Block diagram

The program will be simulated with five simple steps. First, the user will press the tact switch. Second, the LDR sensor will react if the light is blocked. If yes, the user will go back to Step 1. If the LDR does not detect a light, it will go to Step 3 where the buzzer will turn on. In Step 4, if the user presses the tact switch, it turns off the system, if not, the buzzer stays on.

Schematic diagram

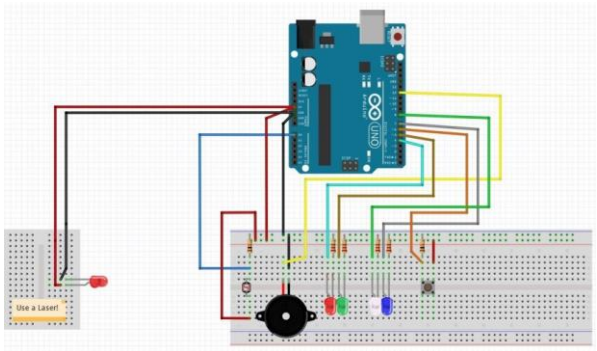

Figure 4. Schematic diagram

Design requirements

Hardware specifications

The proponents prepared a detailed process for the hardware specifications that discusses the process of laser security system. Prototype development is composed of the hardware system that home security system can operate by using lasers. Arduino Uno was used for the prototype development in order to process every signal and condition undergoing in the project. Then, the schematic diagram of laser displays what is used.

Software specifications

The proponents used C language to program the Arduino Uno for software design development. The C language was used to utilize and write the program in the microcontroller of the prototype design and the researchers also used the program to compile and simulate the program. The LDR or light dependent resistor measures whether there is light present or absent from the laser. The program was set to detect signal from the light dependent resistor that was to be processed by the microcontroller in order to send a signal to the buzzer whether to activate or deactivate. Automatic operation is dependent on the light dependent resistor.

Flow chart (Pseudo chart)

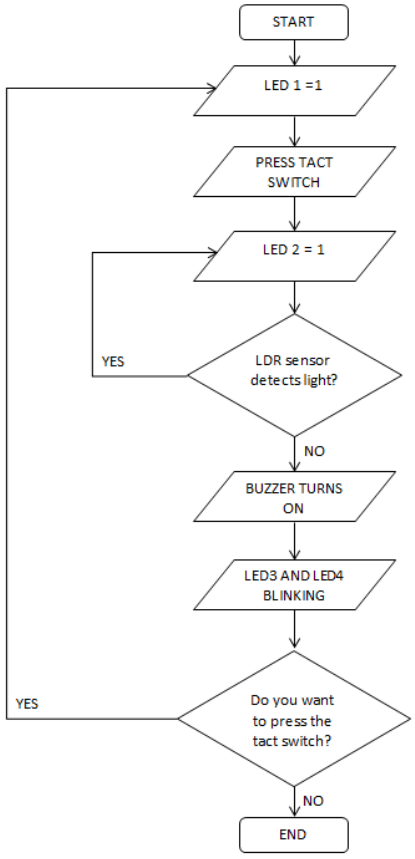

Figure 8. Flow chart

Figure 8 illustrates and explains how the system works. It also represents the important role of each progression to execute the system all in all. It is seen that the user will press the tact switch so that the LDR will sense if the light is on or off. If the LDR senses that there is a light, the buzzer turns on. The buzzer makes a sound if an object passes between the LDR sensor and laser.

Algorithm discussion and illustrations

Step 1: Press the tact switch
Step 2: LDR sensor detects light?
Step 3: If yes, then go back to Step 2
Step 4: If no, buzzer turns on
Step 5: Press the tact switch?
Step 6: If yes, then go back to Step 2
Step 7: If no, buzzer continues with its sound

Standards used

Arduino Uno

The major component used in the system is the Arduino Uno microcontroller which has both analog and digital input and output pins. This microcontroller has its own programming language and user interface.

Light dependent resistor (LDR)

The LDR has a resistance that vary depending on the input signal. This component gives analog output from its analog input.

Laser

A device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.

DATA AND RESULTS

General overview of the program

The proponents mainly used the Arduino as a microcontroller, the light dependent resistor (LDR) as a sensor, and the laser that is pointed at the center of the light dependent resistor. The program made use of algorithms that served as a main function of the code such as a loop.

Functions

The goal of the project, *Arduino-based security system using laser light*, is to create an exact and precise output. The project can be used in houses or certain areas to provide additional security.

General interface

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

boolean isArmed = true;
boolean isTriggered = false;
int buttonVal = 0;
int prev_buttonVal = 0;
int reading = 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);
int buttonVal = digitalRead(armButton);
if ((buttonVal == HIGH) && (prev_buttonVal == LOW))
{
  setArmedState();
  delay(500);
}

if ((isArmed) && (reading < threshold)){
  isTriggered = true;}

if (isTriggered){

   for (int i = lowrange; i <= highrange; i++)
  {
    tone (speakerPin, i, 250);
   }

   for (int i = highrange; i >= lowrange; i--)
   {
     tone (speakerPin, i, 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(speakerPin, 220, 125);
  delay(200);
  tone(speakerPin, 196, 250);
  isArmed = true;
}
}
```

```
void calibrate(){

  int sample = 0;
  int baseline = 0;
  const int min_diff = 200;
  const int sensitivity = 35;
  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(speakerPin, 196, 250);
  delay(200);
  tone(speakerPin, 220, 125);
}
```

Figure 10. C.1 code

The first part of the code are the components being assigned to each pin of the Arduino Uno. After that, under the void setup is the output of the LEDs on the first part where the LDR is not yet activated. The next part of the code is the void loop which is assigned to the function of the project. This part is where the 'if-else' used that if the laser light is blocked, the alarm will turn on and the other LEDs that were turned off will turn on, else, nothing happens. The code for the LED that turns on during the alarm is under the void set ArmedState. Under the void calibrate is the calibration of the LDR, this is where sensitivity can be adjusted.

Table 1. Data and results

Test	Expected Output	Actual Output	Remarks
Paper:			
1	Alarm turns on	Alarm turns on	Successful
2	Alarm turns on	Alarm turns on	Successful
3	Alarm turns on	Alarm is off	Unsuccessful
4	Alarm turns on	Alarm turns on	Successful
5	Alarm turns on	Alarm turns on	Successful
Plastic:			
1	Alarm turns on	Alarm turns on	Successful
2	Alarm turns on	Alarm turns on	Successful
3	Alarm turns on	Alarm turns on	Successful
4	Alarm turns on	Alarm is off	Unsucessful
5	Alarm turns on	Alarm turns on	Successful
Glass:			
1	Alarm turns on	Alarm is off	Unuccessful
2	Alarm turns on	Alarm turns on	Successful
3	Alarm turns on	Alarm turns on	Successful
4	Alarm turns on	Alarm turns on	Successful
5	Alarm turns on	Alarm turns on	Successful
Hand:			
1	Alarm turns on	Alarm turns on	Successful
2	Alarm turns on	Alarm is off	Unsuccessful
3	Alarm turns on	Alarm turns on	Successful
4	Alarm turns on	Alarm turns on	Successful
5	Alarm turns on	Alarm turns on	Successful

Data shows that in each item used for blocking, it has one unsuccessful result due to the quickness of the blocking. Despite this, four out of five of the actual output is the same as the expected output. In percentage, this project can be considered as 80 percent successful.

Table 2. Data and results

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

Five out five of the actual outputs were the same as the expected output. This can be considered as a 100 percent successful.

CONCLUSION

In this project, the proponents were able to determine and utilize the functionalities of the laser, light dependent resistor, and Arduino Uno. The combination of these components can create a laser security system. The Arduino Uno is where the code is uploaded. The code that the proponents have created contains the functions of each component that is needed for the project. In understanding the functions of the components, the proponents were able to design and implement an Arduino-based security system using laser light.

RECOMMENDATIONS

The proponents recommend the following based on findings:

- A laser security system can enhance the security system installed in an area.
- This project can also provide safety to other people in terms of other aspects.

The researchers recommend the following for further improvement of the system:

- Improve the content of the system by making it automated.
- Use more efficient LDRs that can handle large amounts of the intensity of light received.
- It is better to improve the electrical components for future researchers regarding this topic to increase its accuracy in detecting motion and also, to widen its range.

REFERENCES

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