Project II: Laser Security System

Introduction

With development of new technology, new methods of security are being explored in order to protect valuables in the setting of any space such as home offices, banks etc. One such methods utilizes a laser system, and this method has proven to be very effective in increasing security. It is used in many applications from advanced home security systems to lockers in banks. “LASER” is an abbreviation that stands for Light Amplification by Stimulated Emission of Radiation. It is a device that emits light based on the stimulated emission of electromagnetic radiation. The system works when the laser emits a narrow beam of light and detects an intruder by sensing the reflected light wave from the intruder themselves. A laser diode and module are used to detect the presence of an intruder. When an intruder is detected, an alarm system is activated and a buzzer goes on, thereby alerting the human security in the space. Furthermore, as an additional step to the security system, a green-light and red-light LED is used to indicate the presence of an intruder. The green light is on when the laser diode and module can detect the emitted light rays. When the detection loop is broken, it indicates the presence of an intruder and the LED turns to red light while also ringing the buzzer at the same time. This project builds the entire laser security system using all the hardware components to detect intruders in a high security location.

Components

- Hardware
    - Arduino Uno R3
    - Laser Diode
    - LDR Module
    - LED lights
    - Breadboard
    - Jumper wires
    - Resistors
    - Buzzer
- Software
    - Arduino IDE

Each of the components and their roles to the project are described below:

The Arduino Uno R3 is a microcontroller board based on the ATmega328P. It features 14 digital input/output pins, 6 analog inputs, and a USB 2.0 type-B connection for programming and power. The board operates by reading inputs (like light on a sensor), processing the data, and controlling outputs (like turning on an LED). It's widely used for prototyping and educational purposes in electronics and programming.

Figure 2.1: Arduino Sensor

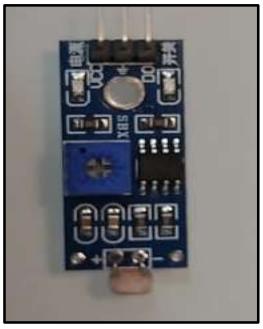


Figure 2.2: LDR Module

An LDR (Light Dependent Resistor) module detects light levels by changing its resistance based on the intensity of light, forming a voltage divider circuit that produces a variable voltage corresponding to the light intensity. This voltage can be read by an analog-to-digital converter on a microcontroller, such as an Arduino. LDRs are useful in IoT-based security applications, such as intrusion detection by monitoring changes in light levels,

A laser diode is a semiconductor device that emits coherent light through a process of stimulated emission. When a forward voltage is applied, electrons and holes recombine in the p-n junction, releasing photons. The internal structure includes reflective surfaces that amplify the light, producing a coherent, monochromatic beam. Laser diodes are used in applications like communication and optical storage.

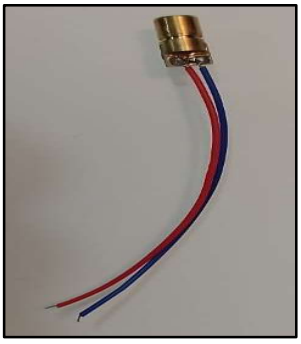
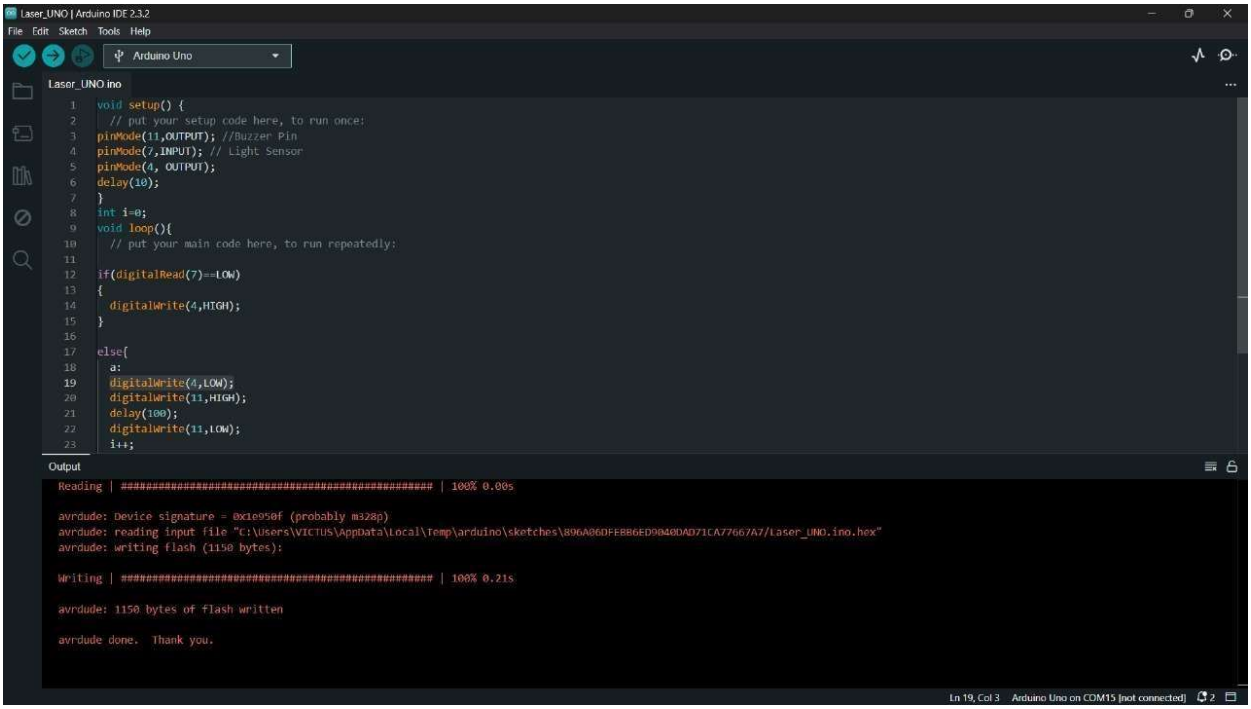


Figure 2.2:
Laser Diode

Code

The Arduino code that is used for the system to run is shown in the figure below:



Block Diagram

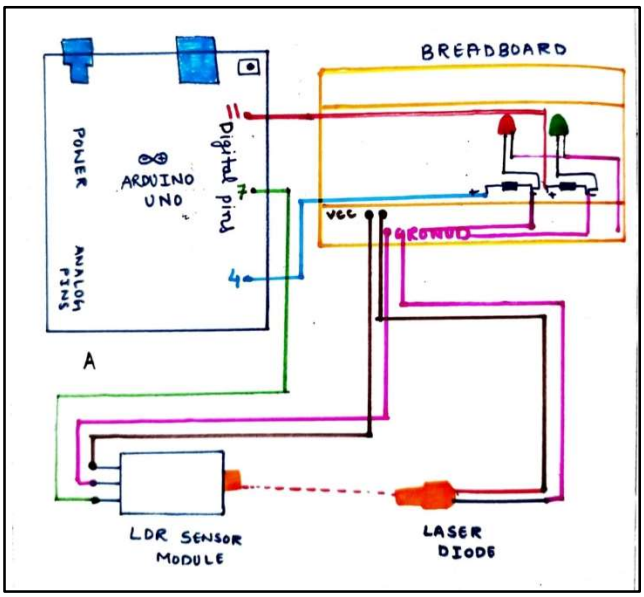


Figure 2.3: Block Diagram

Connections

The major components of the project involve Laser diode, LDR module, LEDs (red or green), buzzer, and Arduino Uno R3. With the help of a breadboard, all these components are connected. The LDR Sensor Module involves three pins: the Vcc, ground and output pin. The Vcc and ground are connected to the breadboard and the output pin is connected to pin 7 of the Arduino Uno R3 board. Similarly, the laser diode consists of positive and negative terminal. The positive terminal is connected to the Vcc of the breadboard and the negative terminal is connected to the ground of the breadboard.

Furthermore, there are two LEDs that are used in the project. Each LED represents the working condition of the system: the red LED indicates presence of an intruder whereas the green LED is the normal state of the system. The positive terminal of the red LED is connected to the negative terminal of the resistor. The positive terminal of the resistor is connected to the fourth pin of the Arduino Uno R3 board. The negative of the red LED is grounded. Similarly, the positive terminal of the green LED is connected to the negative terminal of the resistor. The positive terminal of the resistor is connected to the eleventh pin of the Arduino Uno R3 board. The negative of the green LED is grounded.

There is also a buzzer connected in order to alert the user in case of intruder presence. The positive terminal of the buzzer is connected to the positive terminal of the resistor and the negative terminal is grounded. Overall, the components above connected in this particular manner provide the successful functioning of the system.

Hardware Connection

The above-mentioned components are connected as shown below:

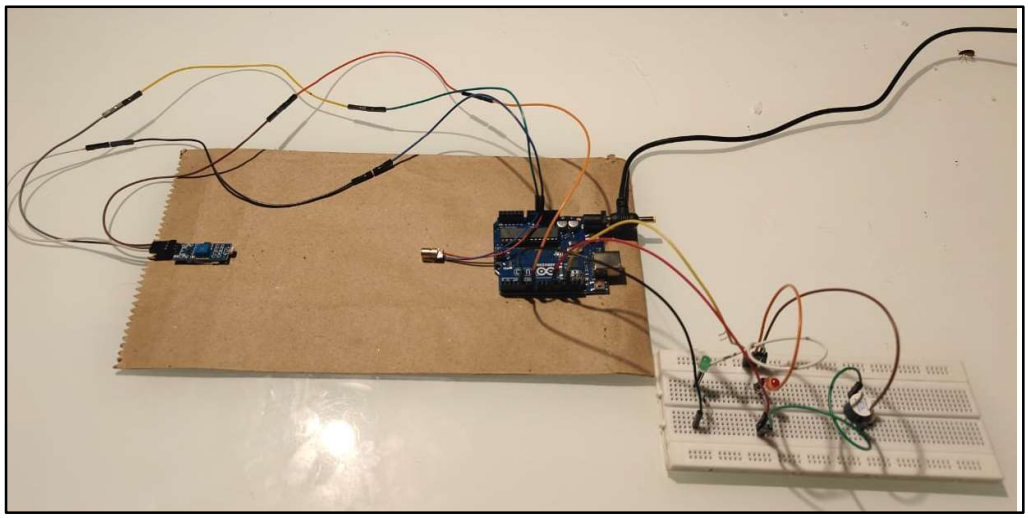


Figure 2.4: Hardware Connection

Result

The code is uploaded onto the Arduino Uno board and the hardware circuit is connected to a laptop with the help of a USB Type-B wire. In order to check if the system is able to detect intruders accurately, a few objects were placed in the range of the sensor and the output is monitored. The objects are placed in different locations and the objects are of different size in order to ensure proper functioning of the system.

The figure below shows the system when the light is ON:

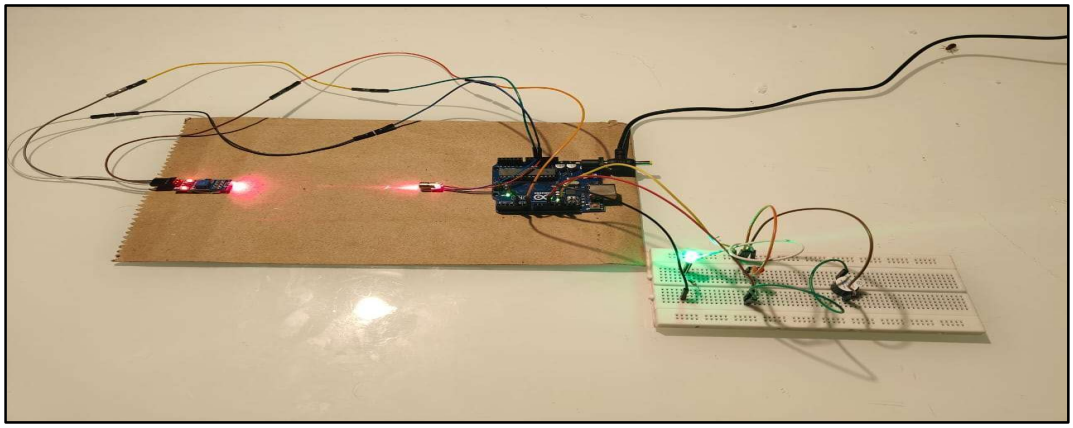


Figure 2.5: Light is ON

The below image shows the system when an object intervenes with the light:

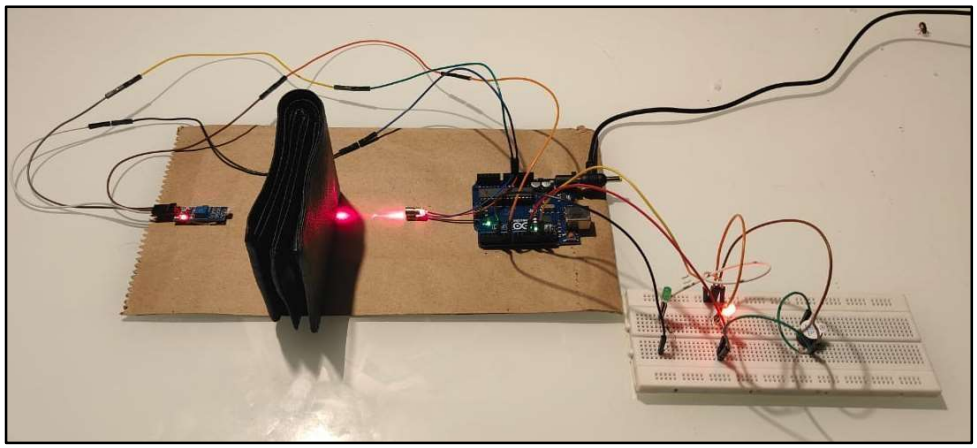


Figure 2.6: Object intervenes

Along with the output LED turning red, a buzzer also turns on.

Conclusion

Overall, the laser system successfully detects objects in its range with the help of a laser module and diode and also alerts the owner with an LED system as well as a buzzer system. Since the light waves travel through fog, smoke, etc., it makes it ideal for security applications in defence systems as well. Furthermore, the system is very cheap to make and also integrates very easily with other bigger application systems. All these features allow the system to be used in a wide range of applications. However, the system does pose its own disadvantages that need to be developed upon. For example, the laser security system only works when an intruder breaks the laser light. Now since the laser light is very narrow, if the intruder is skilled enough to pass the area without disturbing the laser, the system can be considered as a failure. Furthermore, this system covers a very small area of protection. In order for there to be high level security or security over a large area, a number of lasers and other components need to be used, which can amp up the total cost of the system, while still holding the same disadvantages. Therefore, this system needs to be modified in order for it to be a more reliable system of security. All in all, this project summarises the uses, applications, working, advantages and disadvantages of a laser security system.