Innovative Laser Alarm System for Enhanced Home Security and Burglary Prevention

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Abstract
The purpose of this research is to design and develop a laser-based alarm system that produces sound when the laser beam is interrupted, aiming to prevent theft. The research methods include literature study, design, and device development. The results show that this laser-based security system can detect shadow movement using a light sensor and a microcontroller. Therefore, the laser alarm system can be effectively used to detect suspicious movements and provide alerts when the laser beam is disrupted. Further development of this system can be carried out to enhance its reliability and application in various security fields.

1. Introduction

In today's modern era, security has become a crucial factor in human life. In various aspects of life, many individuals and groups go to great lengths to secure their valuable possessions (Ridwan, Moh Anas, Hadi, 2019). Security is especially important when it comes to privacy. Activities carried out by individuals in certain spaces can often be considered private matters(Denis & Sukadi, 2011). Protecting property, loved ones, and personal information is a top priority for both individuals and organizations. Typically, people secure their valuable items using conventional locks, commonly known as padlocks(Denis & Sukadi, 2011). Advances in technology have enabled the development of various innovative solutions to enhance security measures, such as alarm systems. Laser-based alarm systems are one of the technologies gaining popularity due to their simplicity, reliability, and efficiency in detecting suspicious movements.

Laser-based alarm systems transmit a laser beam to a sensor that continuously monitors the integrity of the beam. The security system can detect potential theft of valuable items (Denis & Sukadi, 2011). When the beam is obstructed by movement, the sensor detects this change and triggers an alarm as a warning. This method is highly effective as it enables accurate detection and covers a wide area with minimal equipment.

Home security systems should be one of the essential features for any house aiming to prevent theft and other unwanted disturbances(Denis & Sukadi, 2011). These systems use components such as light-dependent resistors (LDRs), microcontrollers, and buzzers to provide a cost-effective solution for enhancing security in various environments, including residential, commercial, and public areas. Numerous previous studies have focused on developing sensor-based alarm systems.

Designing a simple burglar alarm prototype using two types of sensors demonstrates the potential of a straightforward yet effective home security device (Sumarni et al., 2020). Developing an intrusion detection system based on passive infrared sensors with alarm and real-time text message notifications highlights advancements in security technology (imam mahdi, 2018). This study emphasizes the flexibility of sensor technology in addressing various security challenges. Besides infrared sensors, light-based sensors such as LDRs have also gained attention for their ability to detect changes in light intensity.

Demonstrating the application of optical sensors in burglar alarm systems has shown that changes in lighting can be utilized to detect threats (Muzaki et al., 2011). Additionally, (Susanto et al., 2018)developed an automated learning system using Arduino microcontrollers, highlighting the potential of Arduino in various fields, including security applications. This research also aims to address common challenges in light-based alarm systems, such as sensitivity to ambient light and false alarms.

Implementing a home security system by placing sensors on the house's door leaf, the testing was conducted under dim lighting conditions using an external laser light source to evaluate the system's performance in various environmental scenarios. The significance of this research lies in its contribution to the development of affordable and accessible security technology. With the growing demand for effective security solutions, the development of innovative systems such as laser-based alarms represents a crucial step toward creating safer environments. By integrating modern technology into practical applications, this research aligns with ongoing efforts to enhance security and prevent unauthorized access in residential homes, business premises, and public areas.

Therefore, this research will focus on the design, development, and testing of a laser-based alarm system utilizing LDR sensors and Arduino technology. By addressing existing limitations and introducing new improvements, this study aims to provide a reliable and cost-effective solution to meet the evolving security needs of the current era. Additionally, the flexibility and ease of implementation in different environmental scales are also considered in the development of this laser-based warning system.

This system can be utilized not only for home use but also for various applications, including security in warehouses, industrial facilities, and public spaces. By leveraging microcontroller technology such as Arduino, the system enables integration with other devices, such as surveillance cameras and Internet of Things (IoT) devices, to create a smarter and more integrated security ecosystem. This presents significant potential for further research to enhance the system's efficiency, accuracy, and durability in addressing real-world challenges in this field.

1.1 Literature Review

Security is a crucial factor in today's life, especially in protecting assets from the threat of unauthorized access. One of the technologies that have been widely developed is the laser-based alarm system. Previous investigations have shown various methods using light sensors and microcontrollers to detect disturbances in security systems.

(Sumarni et al., 2020) created a small and simple anti-theft alarm device based on two sensors that effectively detect disturbances. This research highlights the use of simple yet useful devices for home security.(imam mahdi, 2018) utilized passive infrared sensors to capture human movement, activate the alarm, and send notifications. This system demonstrates the application of integrated technology in smart home security.

The use of light sensors in alarm system development has been studied by (Muzaki et al., 2011).which shows that light sensors can detect changes in light intensity as an indication of potential disturbances. The use of microcontrollers in alarm systems is also becoming more recognized. (Susanto et al., 2018) utilized Arduino to control automatic lights in science learning, providing relevant technical information for the development of other Arduino systems, such as laser alarms.

In this study, the focus of the laser-based alarm system development is the use of Light Dependent Resistor (LDR) to detect changes in laser light. This system is designed using Arduino Uno as the main controller, with additional components like a buzzer to provide sound alerts. The addition of features such as an LDR sensor cover to prevent interference from external light is also an important innovation noted in this research.

2. Research Methods

The research stages presented include needs analysis, design, development, and testing. The needs analysis covers the tools and materials used to develop the laser alarm system based on Arduino Uno. Additionally, the design phase includes the block diagram, wiring design, and flowchart, all of which are crucial to the development process. The development is carried out according to the design by integrating the software and hardware components, which will be tested using a buzzer that sounds when the LDR sensor does not receive the laser light.

In this study, the design of the laser alarm aims to implement Arduino within the security system. The required tools and materials to create the laser alarm system are listed in Table 1.

Table 1. Table tool and material

No.	Tool	Function
1.	Jumper Cables	To connect a device to an arduino
2.	Sensor *LDR*(Light Dependent Resistor)	To catch light from laser
3.	Buzzer	To sound alarm when the LDR sensor does not receive light
4.	Laser Light	To emit light so that it can be received by the sensor LDR sensor
5.	Arduino Uno	To control the running system
6.	USB printer	To connect Arduino to Laptop/PC
7.	Miniatur house	For a place to implement research

The design of the Arduino Uno-based laser alarm system is outlined through a block diagram to ensure that the development process is well-directed, as shown in Fig. 1 . This diagram illustrates that the laser emits a beam, which is received by the LDR sensor. The sensor's output is then processed by the Arduino, which triggers a buzzer to issue a warning when the laser beam is interrupted.

Fig. 1 Block Diagram

The design in Fig. 2 is made according to the block diagram in Fig. 1. In Fig. 2, the Arduino circuit is connected using jumper wires, where the Buzzer is connected to pin 11, the laser lamp is connected to pin 8, and the LDR sensor is connected to pin 9.

The flowchart design in Fig. 3 explains that the program begins with the initialization of the Arduino microcontroller and all associated devices such as the LDR sensor and buzzer. Then, the Arduino Uno will activate the laser emitter to project a laser beam into the monitored area. The LDR sensor will detect the intensity of the light it receives. If the laser beam hits the LDR sensor, it continues normal operation. However, if the laser beam is interrupted, the Arduino will activate the buzzer or alarm in response to the detection of suspicious changes.

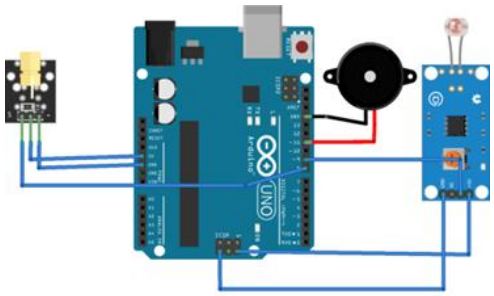

Fig. 2 Design Arduino Uno

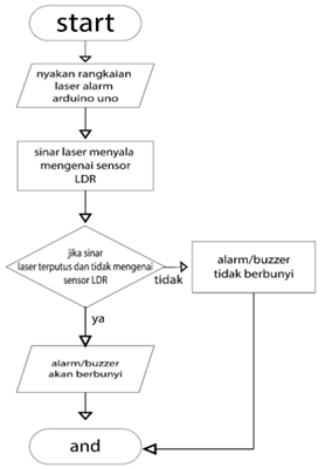

Fig. 3 Flowchart

The creation of the Arduino Uno-based laser alarm circuit is made according to Fig. 2. At this stage, the laser light will directly face the LDR sensor so that the LDR sensor receives light from the laser lamp. The buzzer will be activated when the LDR sensor does not receive light from the laser lamp.

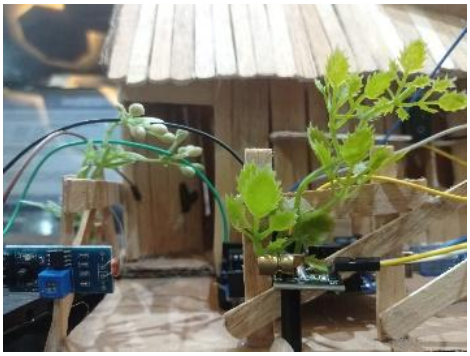

Fig 4. Laser alarm circuit

The program used to declare and configure variables for each pin to be used on the Arduino Uno, where the buzzer is connected to pin 11 as an output and the LDR sensor is connected to pin 9 as an input, is shown in Fig. 5.

```
1   void setup() {
2     // Konfigurasi pin
3     pinMode(11, OUTPUT); // Buzzer di pin 11
4     pinMode(7, INPUT);   // Tombol/sensor di pin 7
5   }
```

Fig. 5 Configuring and declaring pins for each variable

The program on the Arduino is then used to control the system according to the instructions created based on the flowchart in Figure 3.

```
6
7   void loop() {
8     // Periksa apakah tombol/sensor pada pin 7 aktif
9     if (digitalRead(7) == HIGH) {
10      unsigned long startTime = millis(); // Catat waktu mulai
11      while (millis() - startTime < 10000) { // Ulangi selama 10 detik
12        digitalWrite(11, HIGH); // Nyalakan buzzer
13        delay(100);             // Tunggu 100 ms
14        digitalWrite(11, LOW);  // Matikan buzzer
15        delay(100);             // Tunggu 100 ms
16      }
17    }
18    digitalWrite(11, LOW); // Pastikan buzzer mati setelah selesai
19  }
20
```

Fig. 6 Controlling the system according to the instructions

So, overall, this code activates the laser and reads the value from the LDR sensor. If the LDR value is LOW, it will turn off the buzzer; otherwise, it will activate the buzzer. However, it should be noted that to fully understand the purpose and function of this program,

3. Result and Discussion

Table 2 shows the results of the laser alarm circuit based on Arduino Uno. Based on the tests conducted, it successfully controls the buzzer through the Arduino Uno system. The buzzer will activate when the LDR sensor does not receive light from the laser lamp.

Table 2. Test Results

No.	Test Type	Testing	Test Result
1.	Testing sensor *LDR*	Using cover	The sensor is not easily disturbed by other light
		Don't use a cover	The sensor is disturbed and the alarm does not sound
2.	Laser Testing	Using an external laser	The alarm sensor still running
3.	Light	Using a laser with low light	The alaram goes on

The results of several tests, as shown in Table 2, explain that when the LDR sensor is covered, it is less likely to be disturbed by other light sources. Conversely, if the LDR sensor is not covered, it will be susceptible to interference, causing the buzzer not to respond. Additionally, tests using an external laser showed that the LDR sensor and buzzer continued to operate normally. The next test, using the laser alarm with dim light, caused the LDR sensor to receive less light, which resulted in the buzzer sounding.

4. Conclusions

Thus, the test results show that the use of a cover on the LDR sensor, the use of an external laser, and dim light can affect the performance of the sensor and alarm as expected, as explained earlier.

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