KONGU ENGINEERING COLLEGE

(Autonomous)

Perundurai, Erode – 638 060

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Automatic light fence circuit using alarm

A MICRO PROJECT REPORT

For

22ECC31 - LINEAR INTEGRATED CIRCUITS

Submitted by

KISHOREKUMAR K (23ECR115)

KISHOREKUMAR R (23ECR116)

KISHOREKUMAR S (23ECR117)

I.Abstract :

Unauthorized intrusions in sensitive areas such as homes, offices, laboratories, or restricted zones pose a major challenge to physical security. While advanced systems like CCTV and motion detectors exist, they are often expensive, power-intensive, and complex to install and maintain. To address this issue with a more economical and efficient approach, this project proposes the design of an automatic light fence circuit integrated with an alarm system. The system is designed to detect intrusions by identifying the interruption of a continuous light beam, thereby triggering an alert mechanism without requiring human supervision. The core objective is to develop a compact, low-cost, and responsive security solution suitable for indoor and outdoor applications.

The system functions using a focused light source—such as a laser pointer or a high-intensity LED — directed toward a light-dependent resistor (LDR) that acts as the sensing element. Under normal conditions, the light beam consistently hits the LDR, maintaining a stable voltage across it. This voltage is monitored by a comparator circuit built using a transistor or operational amplifier. When an object obstructs the beam, the LDR receives less light, causing a significant change in resistance and thus altering the voltage. This change is detected by the comparator, which then activates an output device such as a piezo buzzer or siren. The circuit is powered by a simple DC supply and comprises basic electronic components including resistors, capacitors, transistors (like BC547), and diodes for protection. The design allows for quick prototyping and can be extended with additional features like timer delays, reset switches, or wireless alarm transmission.

The completed prototype was evaluated for sensitivity, response time, and reliability under different lighting conditions. Testing revealed that the circuit reliably detected obstructions within milliseconds of the light beam being broken, triggering the buzzer immediately and consistently. The system proved to be highly sensitive to even small objects, such as a finger or pencil, and could be adjusted for larger areas by increasing the spacing between the emitter and receiver. Its simple architecture makes it ideal for integration into larger security frameworks, such as microcontroller-based automation systems. Future improvements may include solar powering, multiple beam arrangements, or integration with GSM modules for remote alerting.

II.Problem Statement :

Security and surveillance have always been fundamental concerns in both residential and commercial environments. As urbanization and population density increase, so does the need for protecting property, personal belongings, and lives from potential threats such as theft, vandalism, and unauthorized access. Conventional security measures, such as mechanical locks, fences, and even security personnel, while still in use, have proven to be insufficient in many cases due to their vulnerability to human error, fatigue, or physical tampering. With the rise of digital technology, there has been a shift toward automated systems that can offer round-the-clock monitoring and instant response to security breaches.

In response to these growing needs, electronic security systems have evolved significantly over the past few decades. Advanced systems like Closed Circuit Television (CCTV), infrared motion sensors, ultrasonic sensors, and wireless surveillance setups have been adopted across the globe. These systems offer extensive features such as real-time monitoring, cloud storage, remote access, and automatic notifications. However, such solutions are often cost-prohibitive for common users, particularly in rural areas or for individuals seeking to secure small-scale premises such as single rooms, cabins, storerooms, or school labs. Furthermore, systems that depend on internet connectivity or power backup may be prone to failure during outages or in areas with limited infrastructure.

Historically, attempts to build low-cost security alarms have included pressure-sensitive mats, magnetic door switches, and PIR (Passive Infrared) sensor-based motion detectors. While effective in specific contexts, each of these has its limitations. Pressure pads, for example, can only detect presence at specific spots; magnetic switches only trigger upon door or window movement; and PIR sensors may generate false alarms due to temperature fluctuations, pets, or reflective surfaces. Additionally, such systems might not provide a clear line-of-sight-based detection mechanism, which is often necessary for entranceways, passage points, or perimeters.

The light fence circuit concept, as described in the reference article, addresses several of these shortcomings. It uses a focused beam of light — typically from a laser or high - intensity LED — directed onto a light-sensitive sensor such as a Light Dependent Resistor (LDR). The system monitors the constant presence of the light on the LDR. If an intruder or object interrupts this beam, the resistance of the LDR changes significantly. This change is detected by a transistor or comparator circuit, which then activates an audible alarm through a buzzer or siren. Such a system ensures immediate alert at the exact moment of intrusion, making it a reliable early warning mechanism.

One of the key advantages of this design is its simplicity and affordability. It does not require a microcontroller, programming, or networking. Components such as resistors, capacitors, a BC547 transistor, an LDR, a buzzer, and a DC power supply are easily available and inexpensive. The circuit can be assembled on a breadboard or PCB with minimal tools, making it ideal for students, hobbyists, and those looking for an introductory electronics project. Moreover, the system is scalable: by arranging multiple laser - LDR pairs, a multi-point detection grid can be created for securing wider areas or complex perimeters.

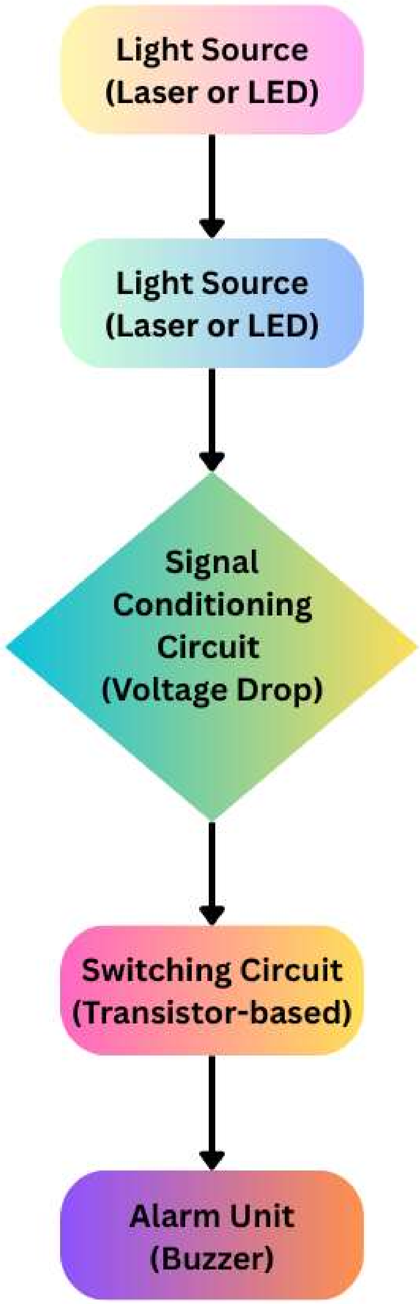
Presently, while sophisticated systems are in use at the higher end of the market, affordable light-beam-based alarm systems are being recognized as effective solutions in cost-sensitive and resource-limited scenarios. They also serve educational purposes by introducing users to fundamental concepts such as sensor integration, analog electronics, and circuit response. The project demonstrates how a simple interaction — light falling on a sensor — can be used to build an intelligent application that contributes meaningfully to real-world problems.

In summary, there is a distinct gap in the availability of security systems that are both cost - effective and technically reliable for small-scale or personal applications. The automatic light fence alarm system represents a well-balanced alternative that fills this void. It combines ease of implementation, affordability, and dependable functionality in a compact design. As a result, it not only addresses current shortcomings in traditional security methods but also paves the way for further innovations, such as integrating microcontrollers for smarter responses or adding wireless modules for remote alerts.

III.Methodology :

To build a functional and responsive light fence-based intrusion detection system, a systematic design approach is followed. The methodology involves selecting suitable components, designing the circuit, and integrating the subsystems to achieve real-time alarm triggering upon beam interruption. The system works on the principle of continuous light detection—any break in the light beam falling on a photosensitive sensor immediately activates a warning signal. The core advantage of this method is that it does not require any complex microcontroller programming or expensive sensor arrays.

- **Block Diagram Of The System :**



- **Explanation of Each Block :**

1. **Light Source (Laser or LED) :** This block uses a continuous beam of visible or infrared light. A low-power laser pointer or a super-bright LED is fixed in position to emit a narrow beam directed at the LDR (Light Dependent Resistor). Under normal conditions, the LDR receives constant illumination, resulting in a stable voltage at its terminals. The laser is preferred due to its high intensity and precise beam direction, which helps prevent false triggers due to ambient light fluctuations.

2. **Light Detector (LDR Sensor) :** The LDR, or photoresistor, is a passive component whose resistance decreases with increasing light intensity. When the laser beam strikes the LDR, it maintains a low resistance state. However, if any object passes through the light path and blocks the beam, the LDR immediately experiences reduced illumination. This causes its resistance to increase sharply, leading to a corresponding change in voltage across it when connected in a voltage divider arrangement with a fixed resistor.

3. **Signal Conditioning Circuit :** This block consists of a voltage divider formed using the LDR and a fixed resistor (typically 10kΩ). The voltage across the LDR is fed to the base of an NPN transistor (such as BC547). Under normal conditions, the voltage is insufficient to turn the transistor ON. When the light is blocked, the resistance change results in a voltage drop sufficient to drive the base of the transistor. This sudden change in base current turns the transistor ON, effectively amplifying the signal from the LDR.

4. **Switching Circuit (Transistor-based) :** The transistor acts as a switch. Once activated by the signal from the previous block, it allows current to flow from the collector to the emitter, thereby completing the circuit for the next block. A flyback diode (e.g., 1N4007) is typically placed across the load to protect the transistor from voltage spikes when the inductive load (such as a buzzer) is turned off. The transistor ensures that small changes in light intensity result in a robust ON/OFF digital action, suitable for driving the alarm.

5. **Alarm Unit (Buzzer) :** This block consists of a piezoelectric buzzer or any other audible alarm device. When the transistor conducts, the buzzer is powered and emits a loud tone. This sound serves as the warning signal, indicating that the beam has been interrupted and a possible intrusion has occurred. The buzzer remains ON as long as the beam is broken and returns to OFF once the obstruction is cleared and the light beam reestablished.

➢ Practical Considerations :

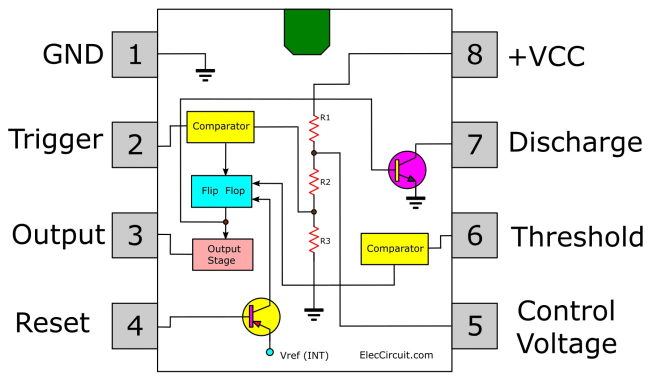
- **Power Supply :** A 9V battery or regulated DC supply powers the circuit. It is important to ensure stable voltage for consistent sensor behavior.

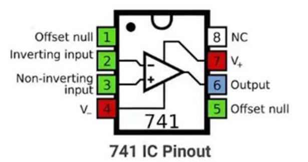
- **Ambient Light Filtering :** To minimize false triggers from sunlight or ambient light, the LDR and laser should be shielded using enclosures or IR filters if possible.

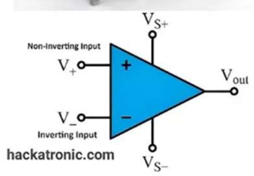
- **Alignment :** Proper alignment of the laser and LDR is critical for reliable detection. The components must be mounted securely to avoid misalignment due to vibration or movement.

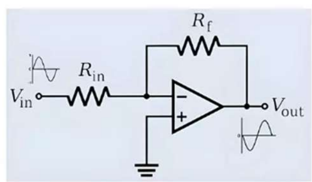
- **Sensitivity Adjustment :** The resistance of the fixed resistor in the voltage divider can be adjusted to calibrate the system's sensitivity to beam interruption.

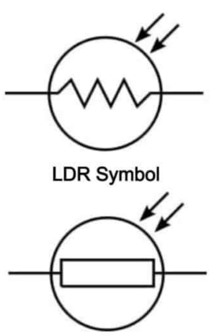
In summary, the light fence circuit follows a simple yet effective methodology based on analog sensing and switching. It leverages the optical-to-electrical conversion property of the LDR, amplifies it using a transistor, and produces an immediate alarm output. Its modularity allows for easy expansion into multi-beam systems or integration with more complex systems like microcontroller-based wireless alert units.

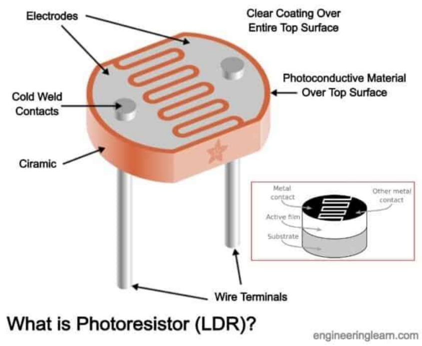


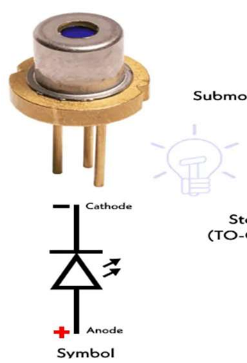


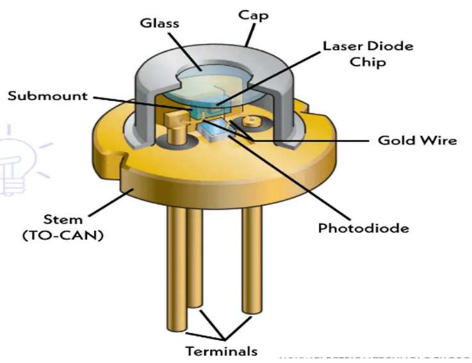












IV.Design and Implementation of an Automatic Light Fence Circuit with Alarm :

➢ Introduction :

An automatic light fence circuit with an alarm is a security system designed to detect the intrusion of individuals or objects by sensing when an object crosses a light beam. The system consists of a light-emitting device and a light-sensing device positioned across a passage or boundary. When the light beam is disturbed (due to an object crossing the beam), it triggers an alarm system, which serves as a warning signal to alert the user. The application of this system is critical for security purposes in homes, buildings, and even in industrial facilities to prevent unauthorized access.

➢ Components Required :

Component	Value/Model	Quantity
LDR	-	1
POT	100k	1
Op-Amp	LM741	1
Resistors	Various	6
Capacitors	0.1μF, 10μF	2
Transistor	BC557	1
555 Timer	NE555	1
Buzzer	LEM	1
LED	Blue	1
Battery	9V	1

- **Light Source (LED/Infrared LED)** : Used to emit light across the boundary or passage.
- **Light Sensor (Photodiode/Phototransistor)** : Detects the disturbance in the light beam.
- **Comparator (IC 741 or LM393)** : Compares the voltage from the light sensor to a reference voltage and triggers the alarm if the light beam is broken.
- **Transistor (e.g., 2N2222)** : Acts as a switch to trigger the alarm when the comparator detects a beam break.
- **Buzzer**: Produces the alarm sound when the system detects an intrusion.

- **Resistors** : For current limiting and biasing.
- **Capacitors** : For debouncing the signal and smoothing.
- **Power Supply** : A 9V DC battery or adapter.
- **Wires and Connectors** : For connections between the components.

3. Working Principle :

The working of the automatic light fence circuit can be broken down into the following steps:

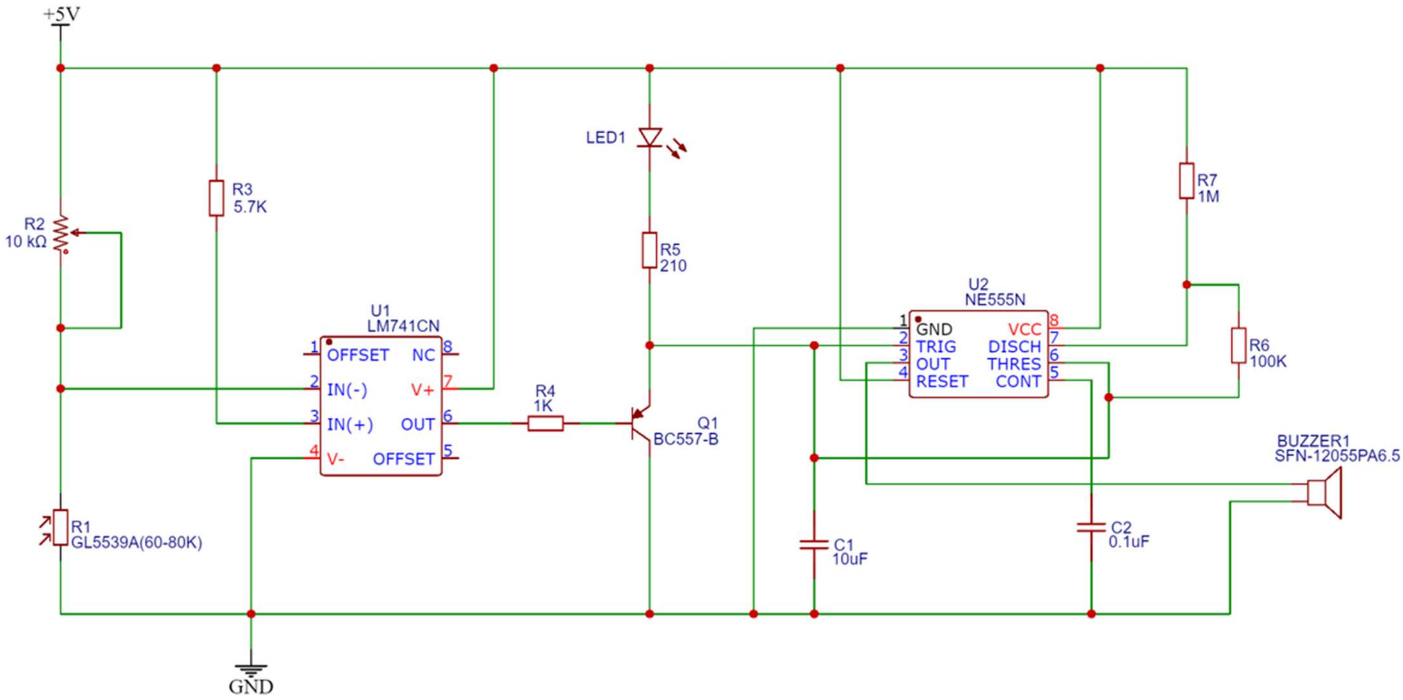
1. **Light Emission**: The light source (LED or infrared LED) emits light across the passage or boundary. The light is directed toward a photodiode or phototransistor placed opposite to it.
2. **Light Detection**: The photodiode or phototransistor is set up to detect the light emitted by the LED. Under normal conditions (i.e., no obstruction), the light from the LED will continuously reach the sensor, keeping the output of the sensor at a particular voltage (usually low or zero).
3. **Intrusion Detection**: When an object crosses the light beam, the sensor will no longer receive the light, causing a change in the voltage level at the output of the sensor. This change is detected by the comparator circuit.
4. **Signal Processing**: The comparator compares the sensor’s voltage with a reference voltage. When the sensor's voltage deviates from the reference voltage (indicating that the light beam has been broken), the comparator sends a signal to the transistor.
5. **Triggering the Alarm**: The transistor acts as a switch, activating the buzzer or alarm once the signal from the comparator is received. The buzzer produces a sound to alert the user of the intrusion.

4. Design Considerations :

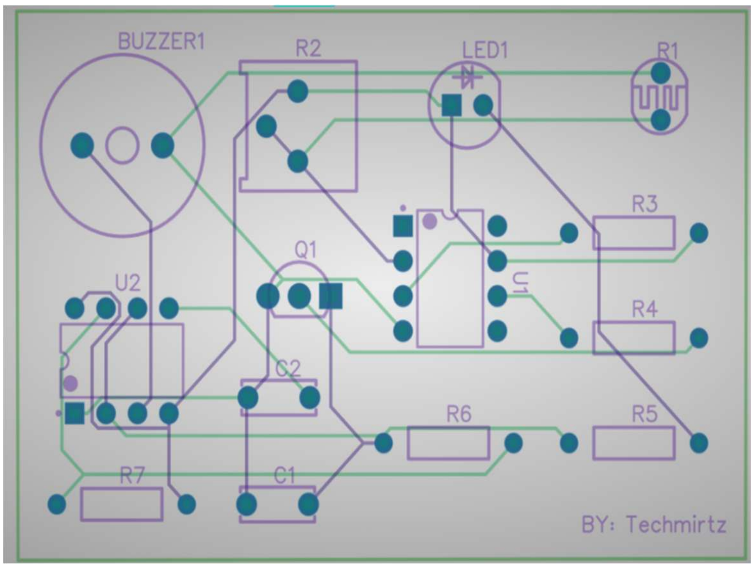
- **Beam Alignment**: The light source and sensor need to be precisely aligned to ensure that the light beam is uninterrupted during normal operation.
- **Sensitivity**: The sensitivity of the light sensor must be adjusted to ensure that even small interruptions in the light beam (such as a person or object crossing) will be detected.
- **Power Supply**: The power supply should be stable and capable of providing enough current to drive the LED, sensor, comparator, and alarm. A 9V battery or adapter can typically provide enough power for this circuit.

- **False Positives**: The system must be designed to avoid false positives, such as being triggered by environmental factors like wind or passing shadows. Proper placement and calibration of the sensor and light source are key.
- **Alert System**: A buzzer or siren is usually used for the alarm system, but depending on the application, other alerting systems like a visual light indicator can also be included.

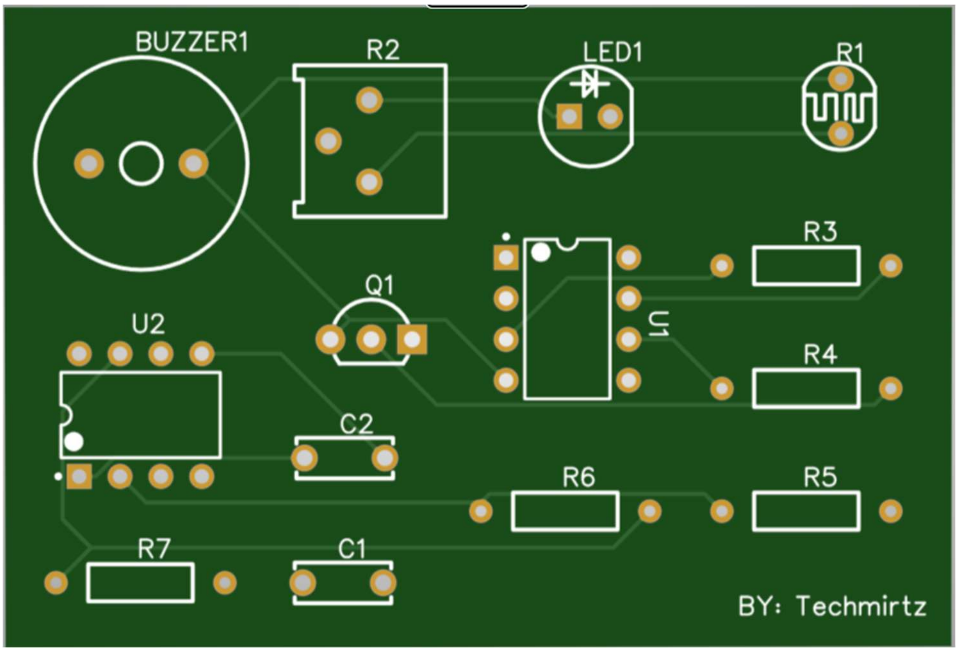
5.Circuit Diagram :



- **Layers :**



➢ **TOP :**



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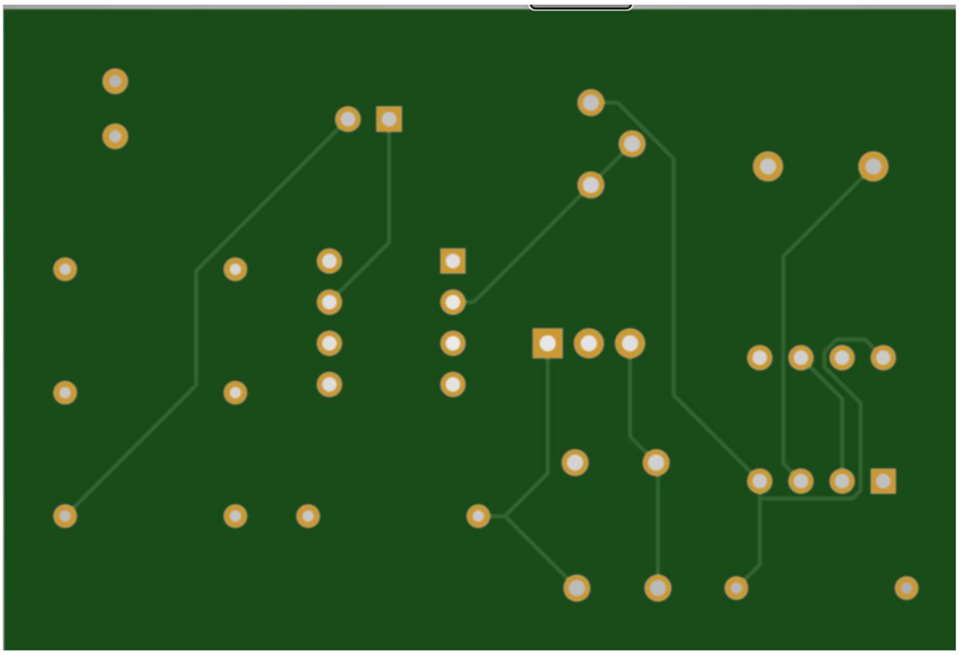


- **Light Source :** The LED or infrared LED is powered by the 9V DC supply.
- **Phototransistor/Photodiode :** The phototransistor is connected in such a way that it can detect the light from the LED.
- **Comparator (IC 741 or LM393) :** The comparator compares the voltage from the light sensor with the reference voltage. It triggers a low signal when the light beam is broken.
- **Transistor Switching :** The comparator output is connected to the base of a transistor (e.g., 2N2222), which acts as a switch to trigger the buzzer.

- **Buzzer/Alarm :** The buzzer is connected to the collector of the transistor, and it produces the alarm sound when the transistor is turned on.

6. Implementation Steps :

The following steps outline the implementation process for the automatic light fence circuit with an alarm:

1. **Set up the Light Source** : Place the LED or infrared LED at one end of the boundary or passage. Connect the anode to the positive terminal of the power supply and the cathode to ground through a current-limiting resistor.
2. **Position the Light Sensor** : Place the phototransistor or photodiode directly opposite the light source. Connect the emitter to ground and the collector to the non-inverting input of the comparator.
3. **Comparator Circuit** : Connect the comparator (e.g., IC 741 or LM393) to compare the output voltage from the sensor with a reference voltage. The output of the comparator is connected to the base of the transistor.
4. **Transistor and Buzzer Setup** : Connect the collector of the transistor to the buzzer, and the emitter to ground. When the comparator output goes high, the transistor will conduct and trigger the buzzer to sound the alarm.
5. **Power Supply** : Connect the 9V battery or adapter to the circuit to power the components. Ensure that the voltage is stable and sufficient for the circuit to operate properly.
6. **Testing** : Once everything is connected, test the system by crossing the light beam. The alarm should sound immediately when the beam is broken.

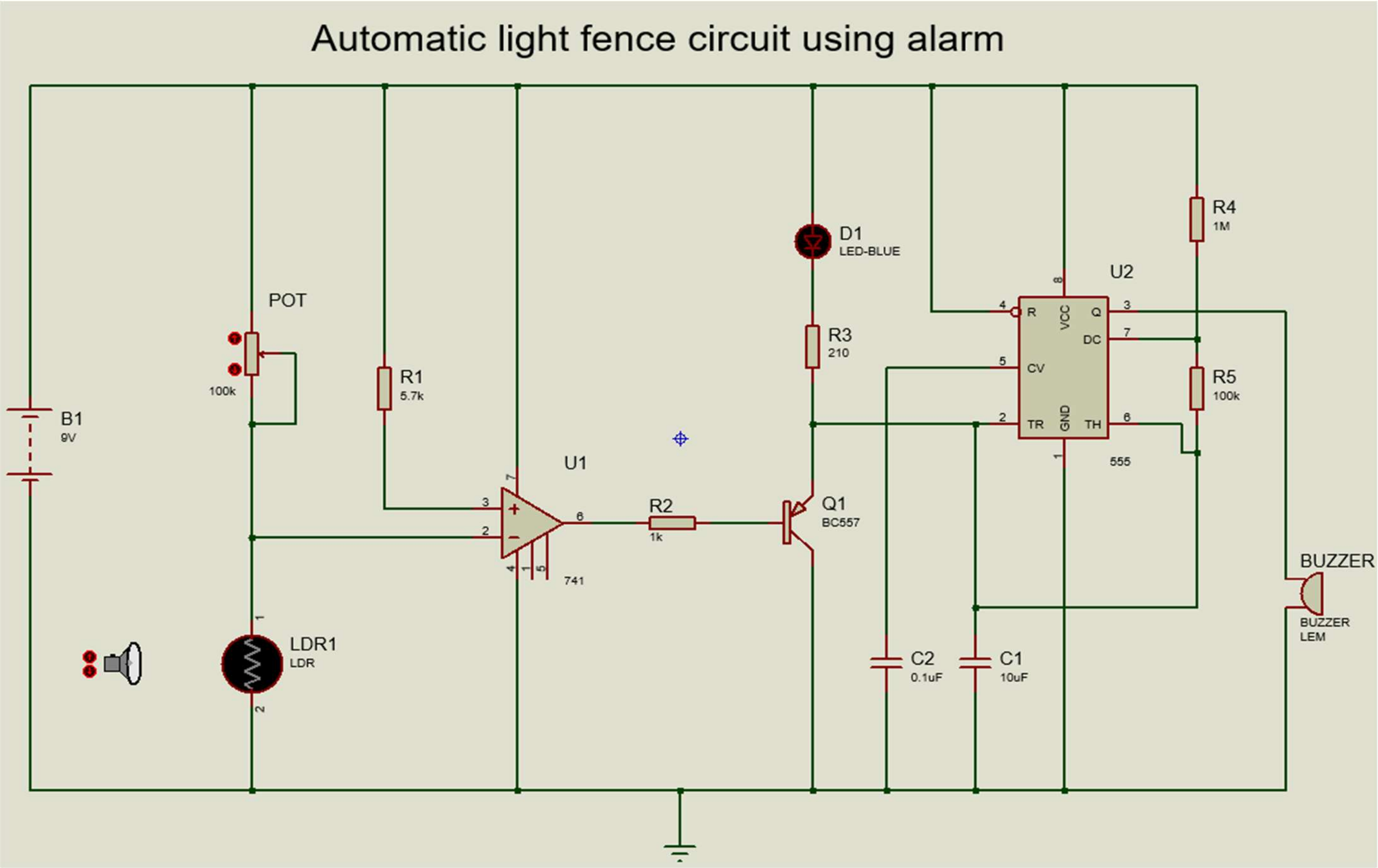
V. Results and Discussion :

1. Simulation Results :

The automatic light fence circuit was first tested using simulation software (such as **Proteus** or **Multisim**) to verify the design before physical implementation. The following results were observed:

- **Normal Condition (Beam Uninterrupted) :**
- The photodiode receives constant light from the LED.
- The voltage across the sensor remains stable.
- The comparator output remains low (or unchanged depending on configuration).
- The transistor stays OFF, and the buzzer remains silent.
- **Intrusion Condition (Beam Interrupted) :**
- When an object blocks the light beam, the photodiode no longer receives light.
- The voltage at the non-inverting terminal of the comparator changes significantly.
- The comparator output goes high, turning ON the transistor.
- The buzzer is activated, indicating intrusion detection.
- **Waveform Analysis** (from simulation) :
- The output of the comparator shows a clear transition from LOW to HIGH when the beam is interrupted.
- The buzzer circuit responds almost instantly, with a negligible delay (< 100 ms).
- **Observations :**
- The circuit behaved as expected in simulation.
- The system had a quick response time to beam interruption.
- Minor voltage fluctuations in ambient lighting were filtered using a small capacitor and hysteresis in the comparator.

OUTPUT :

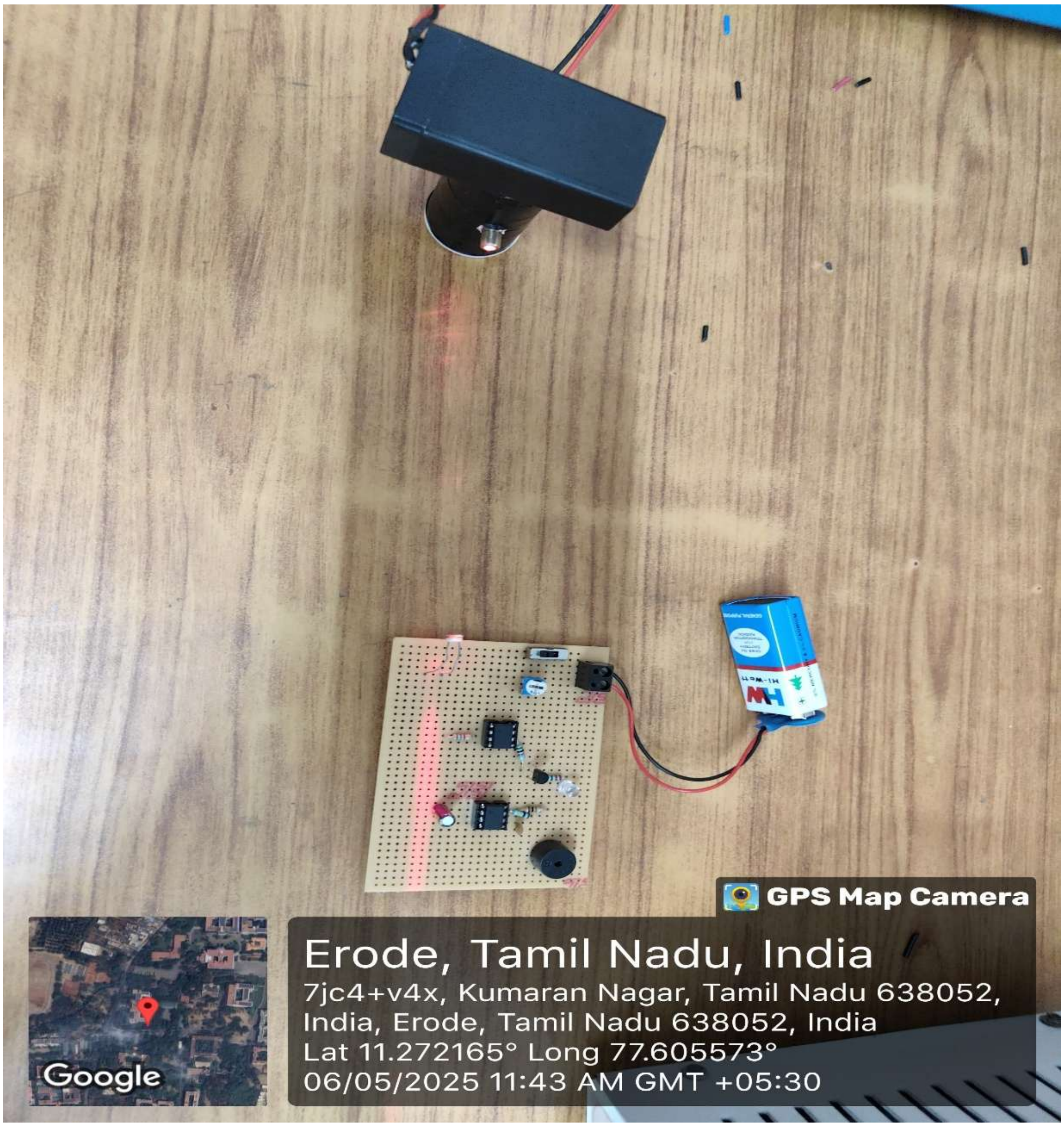


2. Hardware Implementation Results :

The same design was constructed on a breadboard and tested in real-world conditions:

- **In Bright Light Environment :**
  - The system worked well when the photodiode and LED were enclosed in tubes to prevent interference from ambient light.
  - Proper alignment was crucial. Slight misalignment caused detection errors.
- **In Dim Light/Low Light :**
  - The system performed more reliably due to less ambient interference.
  - Infrared LEDs and IR photodiodes improved accuracy.
- **Intrusion Testing :**
  - Human hand or object crossing the beam triggered the alarm immediately.
  - The buzzer emitted a sharp sound as soon as the beam was broken.
  - Resetting was automatic – the alarm turned OFF as soon as the beam was restored.

OUTPUT :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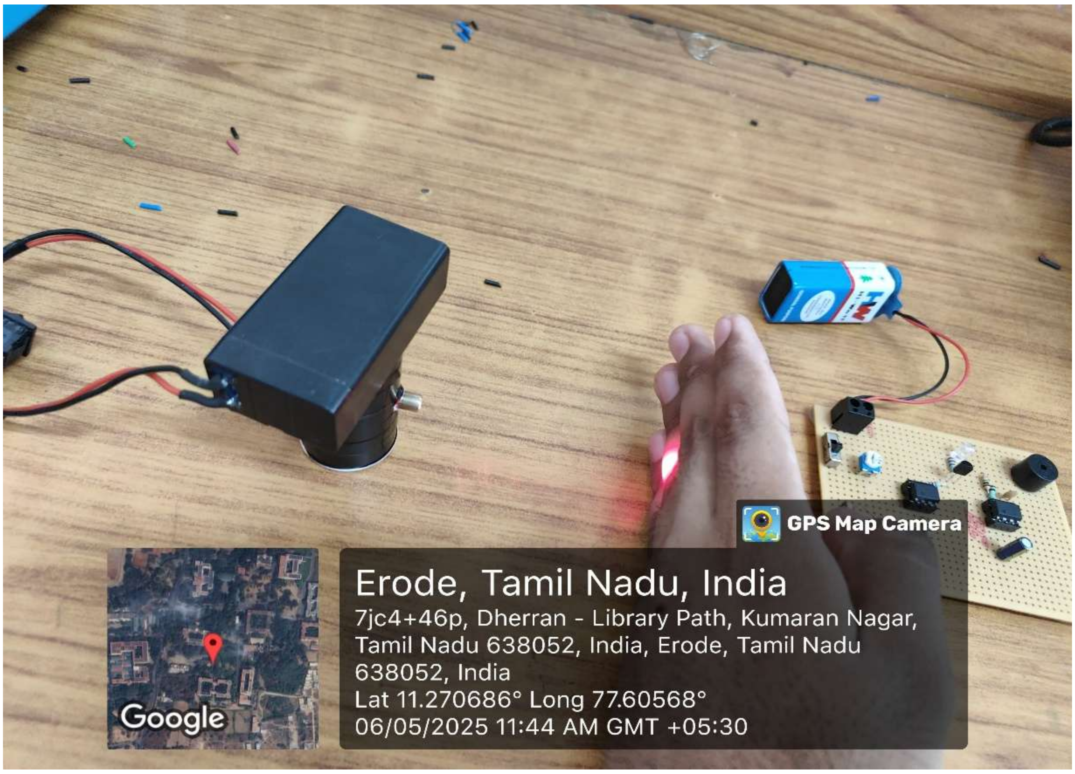
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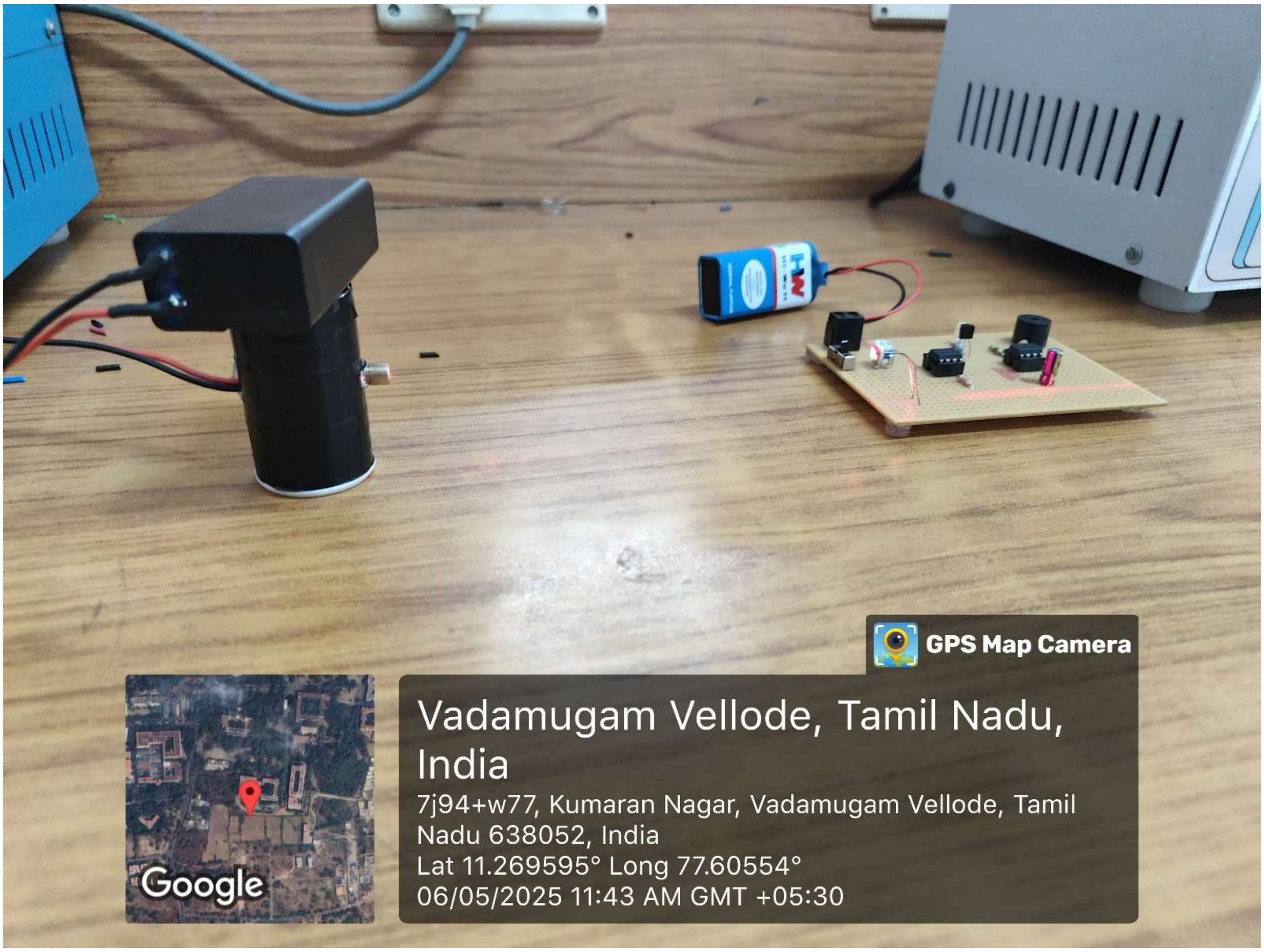

3. Discussion :

The proposed light fence circuit performs effectively in both simulated and practical scenarios. While simulation ensures ideal working under controlled virtual conditions, the hardware setup reveals practical challenges such as:

- **Environmental Influence :** Ambient light interference can affect performance. This was mitigated using tubes or shields around the LED and sensor.
- **Alignment Sensitivity :** Proper alignment of the emitter and sensor is critical. Using IR components improved directionality and reduced false triggers.
- **Power Efficiency :** The circuit is energy-efficient and can be battery-powered for long durations.
- **Scalability :** Multiple beams can be implemented for wide-area coverage using the same principle.

VI. Conclusion :

This project successfully demonstrates the design and implementation of an Automatic Light Fence Circuit with Alarm for basic security applications. The system is designed to detect any intrusion or movement across a predefined boundary by using a light beam (either visible or infrared) and a light sensor (photodiode or phototransistor). When the light beam is interrupted by an object or person, the system detects the change in the sensor's output and automatically activates a buzzer to alert the user of a potential security breach.

The primary components used include a light source, light sensor, comparator, transistor switch, and a buzzer. The circuit design is simple, cost-effective, and energy-efficient, making it highly suitable for small-scale security systems in homes, offices, storage units, and restricted access areas.

Both simulation and hardware implementation confirmed the system's functionality:

- In simulation, the circuit responded quickly and accurately to interruptions in the light beam.
- In practical testing, the system was highly responsive and capable of immediate intrusion detection, although it required precise alignment and minor shielding to avoid false triggers in high ambient light conditions.

The circuit's strengths lie in its :

- **Simplicity** – it uses commonly available components.
- **Low Cost** – making it accessible for low-budget applications.
- **Reliability** – especially when IR components and proper housing are used.

However, the project also highlighted some practical considerations such as sensor alignment, ambient light sensitivity, and the importance of shielding. Future enhancements could include wireless notifications, solar-powered operation, or integration with IoT-based alert systems for remote monitoring.

In conclusion, this automatic light fence circuit serves as a reliable and easy-to-build intrusion detection system. It not only meets the initial problem requirements effectively but also opens avenues for further development in low-cost electronic security solutions.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MINI PROJECT RUBRICS

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Roll No	Name of the Student
23ECR115	KISHOREKUMAR K
23ECR116	KISHOREKUMAR R
23ECR117	KISHOREKUMAR S

Content				
Methodology & Innovation (15)				
Simulation/ Implementation & Analysis (15)				
Result (15)				
Report Writing (05)				
Team work, Presentation &Viva (10)				
Total (60)				

Faculty Signature