LASER SECURITY ALARM USING UJT LED FLASHER CIRCUIT

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project titled "**LASER SECURITY ALARM USING UJT LED FLASHER CIRCUIT**" is the bonafide work of "**Shivashankar P** (3122243002105), **Shreya Ashok Kulkarni** (3122243002106) and **Shrinithi K L** (3122243002107)", who carried out the project work under my supervision.

Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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Submitted for project viva-voce examination held on……………………….........

INTERNAL EXAMINER

ABSTRACT

Our project is about the development and construction of Light emitting diode (LED) flash circuit using Unijunction Transistor (UJT). The aim is to create a simple and efficient circuit that produces regular flashes of light using LED. The UJT plays an important role in generating controlled pulses, allowing precise control over the flashing frequency. The circuit design consists of a UJT transistor, an energy source, resistors, capacitors, and LEDs. The resistors and capacitors act as the timing components. The UJT operates in relaxation mode, producing a sawtooth waveform that triggers the LED. By adjusting the timing components, the flashing frequency of the LEDs can be modified to get the desired visual effects for specific applications. The LED flash circuit is effective in delivering consistent and visually pleasing flashes of light. It does not require large power supply and works just fine with low power. Usually, power supply voltages used in UJT flash circuit can be around 5V, 9V or 12V depending on the desired brightness and flashing frequency. To ensure optimal functionality and durability, the project also uses power regulation and protection mechanisms. The UJT flash circuit is customizable and has a wide area of applications, which include police sirens, lamp dimmers, lightning detector, blinkers in toys, decorative lights, signalling systems and much more. The application that we have designed using LED flasher circuit is “SECURITY MANAGEMENT SYSTEM” where we have incorporated LDR and LASER LIGHT to design a LASER SECURITY LED FLASHER”.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

LED – Light Emitting Diode
LDR – Light Dependent Resistor
UJT – Unijunction Transistor
IC – Integrated Chip
SCR - Silicon Controlled Rectifier

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

LED Flashlights have revolutionized the world of portable lighting, offering numerous advantages over fluorescent bulb. LED shown in figure 1.1 stands for "LIGHT EMITTING DIODE" which is a semiconductor device that emits light when electric current passes through it. In LED flashlight LED serves as the primary light source. When an electric current flows through LED it emits bright and focused light. Our project is on LED Flashlight using UJT. The UJT can be effectively utilized in LED Flashlight circuit as control element to regulate the ON/OFF operation of LED.

FIGURE 1.1 Light Emitting Diode

The Unijunction Transistor (UJT) in figure 1.2 is a unique semiconductor device that plays a significant role in electronic circuits as a trigger or control element. The UJT is a three-layer, three terminal device with two bases and an emitter. Its structure consists of a lightly doped N-type material (the emitter) between two heavily doped P-type regions (the bases). The device's name "unijunction" refers to the fact that it has only one type of junction (N-P) compared to traditional transistors, which have two types of junctions (P-N-P or N-P-N). The key feature of the UJT is its ability to exhibit negative resistance characteristics. This means that as the voltage applied to the UJT increases, the current flowing through it initially decreases, and then suddenly increases sharply. This unique behaviour is attributed to the presence of “intrinsic standoff" region in the UJT's current-voltage characteristics. The UJT finds applications in various electronic circuits, including relaxation oscillators, pulse generators, timing circuits, thyristor triggering circuits, and voltage-controlled oscillators. It is often used as a switch or control device due to its inherent triggering capabilities and simplicity. The UJT's operating principle involves biasing the device using an external resistor network. 8 When a voltage is applied to one of the UJT's bases, the device remains in an off state until the voltage reaches a specific threshold. Once this specific threshold is reached, the UJT turns on and conducts current. This triggering behaviour allows the UJT to control other components in a circuit based on voltage levels.

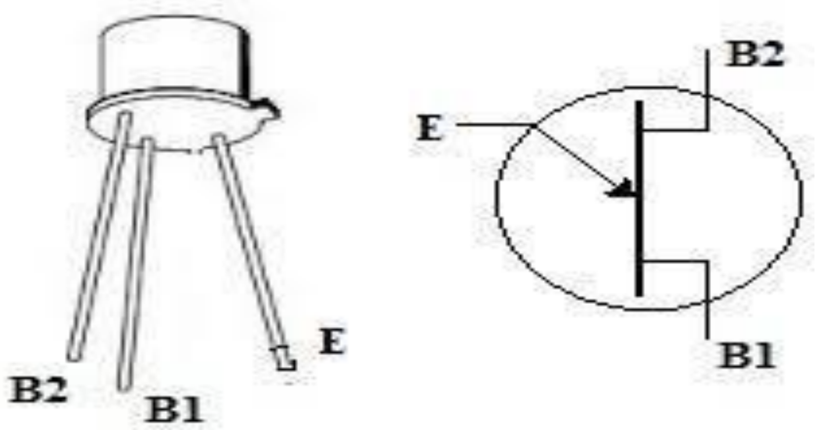

FIGURE 1.2 Unijunction Transistor

The UJT can be effectively utilized in a LED Flash circuit as control element. This transistor controls the flow current to the LED the UJT's triggering mechanism ensures that the LED only lights up when the triggering voltage is present. This prevents unnecessary power consumption and enhances the energy efficiency of Flashlight. The UJT has low power consumption making it suitable or battery-operated devices like flashlights. Thus, it contributes to extending battery life. The UJT's inherent characteristics provide on/off switching of the LED. The UJT's small size and low power consumption make it ideal for compact and portable LED flashlight designs. The reduced space requirements and efficient power usage contribute to the overall portability and convenience of the flashlight.

1.2 PROBLEM STATEMENT:

In an era of increasing security threats to homes, offices, and restricted areas, traditional locks and surveillance systems are no longer sufficient for real-time intrusion detection. Expensive security systems such as CCTV and sensor-based smart devices may not be feasible for everyone due to cost, complexity, and power consumption.

There is a growing need for a low-cost, efficient, and reliable security alert system that can detect unauthorized entry with minimal power and hardware requirements. The system should also be easy to implement using basic electronic components without needing microcontrollers or advanced programming.

1.3. OBJECTIVE:

The objective of this project is to design and develop a simple and low-cost laser security alarm system using:

A Laser beam and LDR (Light Dependent Resistor) to detect obstruction.A Unijunction Transistor (UJT) based relaxation oscillator to generate pulse signals. An LED flasher circuit that visually indicates the breach using blinking light. A buzzer to generate an audible alarm upon interruption of the laser beam.

Key functional objectives:

Detect intrusion through laser beam interruption.

Convert light interruption into an electrical trigger using LDR and transistor logic.

Trigger a visual and audible alert system.

Ensure continuous flashing until manual reset, ensuring the user doesn’t miss the alarm.

1.4. SCOPE OF THE PROJECT:

The presented light-sensing alert system can be further enhanced and adapted for various practical applications. In the future, this basic model can be integrated with microcontrollers (like Arduino or ESP32) for smarter automation, enabling wireless notifications (such as SMS or app alerts) when light conditions change. Sensitivity adjustment circuits can be added to allow flexible operation in different environments, from bright outdoor areas to dim indoor spaces. Moreover, the system can be expanded to include solar power for sustainable energy use, making it highly suitable for remote areas. With additional features like sound customization, light intensity logging, and IoT connectivity, this project can evolve into a more advanced security or monitoring system useful in industrial, residential, and agricultural sectors.

1.5 ORGANISATION:

The table of contents outlines a comprehensive technical report focused on the design and implementation of an LED flasher circuit. It begins with preliminary sections such as the abstract, lists of tables, figures, symbols, and abbreviations, setting the stage for the detailed content that follows. Chapter 1 introduces the project, presenting the problem statement, objectives, scope, and structure of the report. Chapter 2 provides a literature review that includes background information on LED flasher circuits, featuring examples such as a simple blinking flasher and a design using a unijunction transistor (UJT), along with a discussion of their components. Chapter 3 shifts to the software implementation of the proposed circuit, covering the introduction, proposed design, simulation results, and the detailed workings of various sub-circuits including base, LDR, RC, and SCR circuits. Chapter 4 addresses the hardware implementation, describing the actual construction, wiring connections, and casing design of the circuit. The report concludes in Chapter 5 with a summary of findings and recommendations for future work, followed by a references section listing the consulted sources.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The LED flasher circuits play a significant role in various applications, ranging from decorative lighting to signalling systems. These circuits are designed to make LEDs blink in a periodic manner, turning them ON and OFF at regular intervals. The functionality of such circuits relies on the use of oscillators, which generate square wave signals, causing the LED to flash repeatedly. Over the years, multiple designs have been developed to achieve this effect, with varying complexity and component requirements.

This literature review explores different approaches to building LED flasher circuits, highlighting the most common techniques used, including the utilization of the 555 timer IC, simple transistor-based designs, and the use of Unijunction Transistors (UJTs). Each approach has its advantages, such as ease of implementation, flexibility in control over flashing speed, and power efficiency. The review also addresses the role of key components such as capacitors, resistors, and transistors, which are crucial for adjusting the blinking frequency and ensuring reliable circuit performance. By examining these different methods, this review aims to provide a comprehensive understanding of the various LED flashing circuits and their applications, along with the challenges and considerations involved in their design and implementation.

2.2 LED Flasher

LED Flasher is a simple circuit which will blink the LEDs in regular period. This circuit can be used for decoration purpose or can be used for a signalling purpose and many more. A LED flasher circuit is a circuit which flashes the LED- meaning turns it ON-OFF, ON-OFF, ON-OFF. The555timer chip is a very versatile IC, because when connected correctly, it can create pulses of current at specific time intervals decided by the resistor-capacitor (RC) network. When a 555 timer creates pulses in this way, the LED doesn't stay constantly on. It only turns on at a pulse and then shuts off after the pulse has passed. And it does this in a never-ending cycle, which creates the flashes of light. To make the 555-timer chip create pulses, it must be placed in a stable mode. A stable mode simply means that the 555 timer has no stable state. It switches constantly between high and low, or on and off. This is why this mode is also called oscillator mode, because it uses the 555 timer an oscillator, which creates square wave signals. The 555 timer is made to be configured as a stable multi-vibrator. The potentiometer which is connected to the timer should be present and also to adjust the blinking or flashing speed of the LEDs. [6]

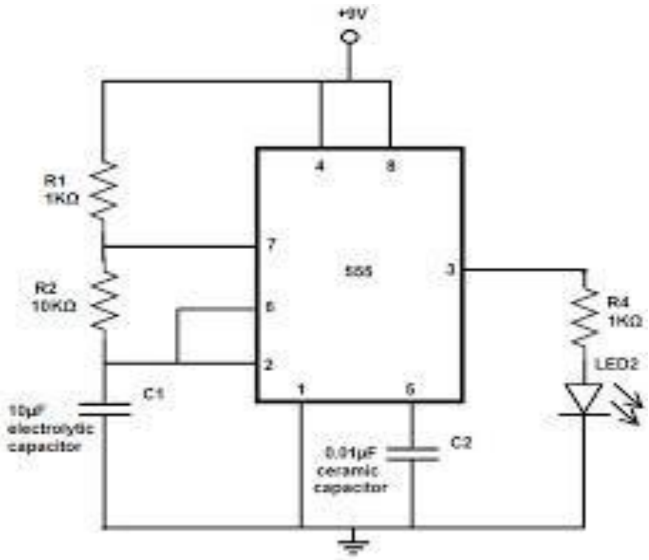

FIGURE 2.2 LED Flasher using IC

2.3 Simple Blinking LED Flasher circuit

This simple led flasher blinker circuit made by using two NPN BC547 transistors and some resistors and capacitors. The speed of blinking can be changed by changing the value of capacitors C1 and C2. This led flasher circuit is very easy and simple and there is no IC used. [5]

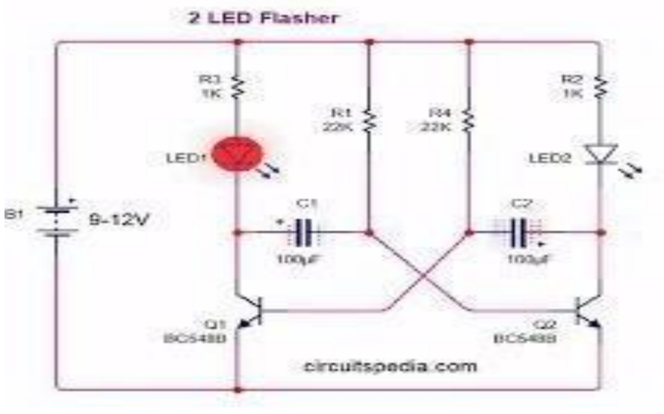

FIGURE 2.3 Simple blinking LED Flasher

Use 9V or 12V battery or adaptor for this circuit. Both NPN transistors you can use of BC547, 548 or 2N2222. This circuit can be operated using DC 6 – 12V Supply. This circuit basically works on the charging and discharging of capacitors.

2.4 LED flash circuit using a UJT

An LED flash circuit using a UJT (Unijunction Transistor) as the triggering device is designed. [1] The circuit is required to produce a periodic flashing effect on an LED with adjustable frequency and duty cycle. It should drive the LED to turn on and off repeatedly at a controlled frequency, allowing the user to adjust the frequency and duty cycle for the desired flashing effect. The circuit should operate reliably and consistently over different input voltages and temperatures, while minimizing power consumption. It should be designed with simplicity and cost-effectiveness in mind, using readily available components. Safety measures should be incorporated to ensure reliable operation and adhere to electrical standards.

2.5 COMPONENTS AND ITS DESCRIPTION

2.5.1 Unijunction Transistor (2N 2646): A Unijunction Transistor (UJT) is a three-terminal semiconductor device [2]. The main characteristics of UJT is when it is triggered, the emitter current increases re-generatively until it is limited by emitter power supply. [a] Due to this characteristic feature, it is used in applications like switching pulse generator, saw-tooth wave generator etc... UJT 2N 2646 transistor is a 3-terminal semiconductor device that contains only one junction & it behaves like an electrically controlled switch. This UJT or uni-junction transistor cannot be used as a linear amplifier however it is widely used in triggered oscillators, free-running oscillators, and pulse generation circuits of low frequencies.

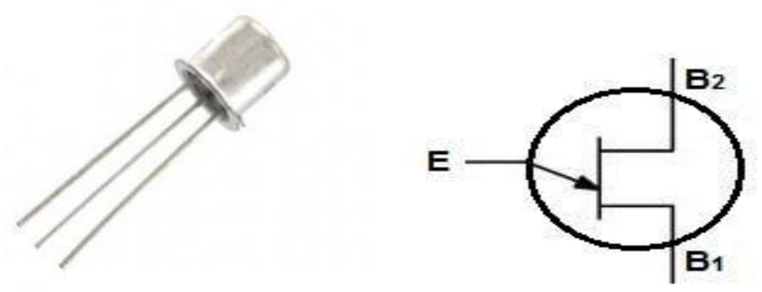

FIGURE 2.5.1Unijunction Transistor

2.5.2 Capacitor:

A capacitor is a device that stores electrical energy in an electric field by accumulating electric charges on two closely spaced surfaces that are insulated from each other. It is a passive electronic component with two terminals.

FIGURE 2.5.2 Capacitor

2.5.3 Battery:

An electric battery consists of electrochemical cell. When a battery is supplying power, its positive terminal is the cathode and negative terminal is anode. A 9V battery is a type of battery commonly used in various electronic devices. It is named 9V because it has a nominal voltage of 9 volts. These batteries are often rectangular in shape and have a Snap-on connector at the top for easy insertion into devices.

FIGURE 2.5.3 Battery

The 9V battery is composed of six small 1.5V cells connected in series. Each cell typically consists of a zinc negative electrode and a manganese dioxide positive electrode, with an electrolyte separating them.

2.5.4 Alternate Components:

ORIGINAL COMPONENT	TYPE/FUNCTION	ALTERNATE COMPONENTS
BC547	NPN Transistor	2N2222, 2N3904, S8050
2N2646	Unijunction Transistor	2N6027, 2N6028, 2N6029
555 TIMER IC	Timer IC (U3)	NE555, LM555, TLC555
SCR **(UNMARKED)**	Silicon Controlled Rectifier	2N5060, C106, BT169
PHOTORESISTOR (PR1)	Light-dependent resistor	GL5528, VT935G, NSL-19M51
BUZZER (U2)	Piezo Buzzer	PKM13EPYH4000, CEM-1203(42), ABT-408-RC
LEDS (D1-D6)	Indicator LEDs	Any 5mm Red LED: LTL-307EE, HLMP-3301
CAPACITORS (C1, C2, C3)	Electrolytic/Ceramic	C1: 22µF (e.g., Kemet, Nichicon); C2: 10nF; C3: 0.1µF
RESISTORS (R1–R6, ETC.)	Resistors (varied)	Standard carbon film resistors; value-matched substitutes
RESET_BUTTON	Momentary Pushbutton	Alps SKHH, Omron B3F, generic tactile switches

TABLE 2.5.4 List of Alternate components

2.6 SUMMARY

The literature review delves into various methods and components used in the design of LED flasher circuits, which are commonly applied in decorative lighting and signaling systems. These circuits function by making LEDs blink at regular intervals, typically using oscillators to generate square wave signals. A significant portion of the review focuses on different circuit design techniques, including the popular 555 timer IC-based approach, which utilizes an astable configuration to produce continuous pulses that cause the LED to flash. The review also discusses a simple LED flasher circuit built using two NPN transistors (like BC547), capacitors, and resistors—offering an easy and cost-effective design without the need for an IC. Another method involves using a Unijunction Transistor (UJT), particularly the 2N2646, to create an adjustable LED flash circuit known for its simplicity, reliability, and efficiency. The review highlights the role of key components like capacitors for timing control, batteries for power supply, and UJTs for switching, emphasizing their importance in achieving desired performance and ensuring circuit stability under varying conditions. Overall, the review provides a comparative insight into different LED flasher circuit designs and their respective advantages.

CHAPTER 3

SOFTWARE IMPLEMENTATION OF THE PROPOSED CIRCUIT

3.1 INTRODUCTION:

The software used for this project is Falstad Circuit Simulation . Falstad is a free circuit simulation website where circuits can be designed using the required components and the output of the proposed circuit can be seen. The animated simulation from the Falstad makes the user understand the flow of current in his circuit and helps to rectify the error in their circuit. Irrespective of many paid software simulations, this is still serving to be a free and open to all and go through simulation platform. This platform also provides circuit simulation for some of the basic circuits from which we can understand about some of the common circuits which are predominantly used in today's world.

3.2 PROPOSED CIRCUIT (LASER SECURITY LED FLASHER) :

The proposed circuit in figure 3.2 is subdivided into different subcircuits that is provided in the figure 3.4.1,3.5.1,3.6.1,3.7.1.

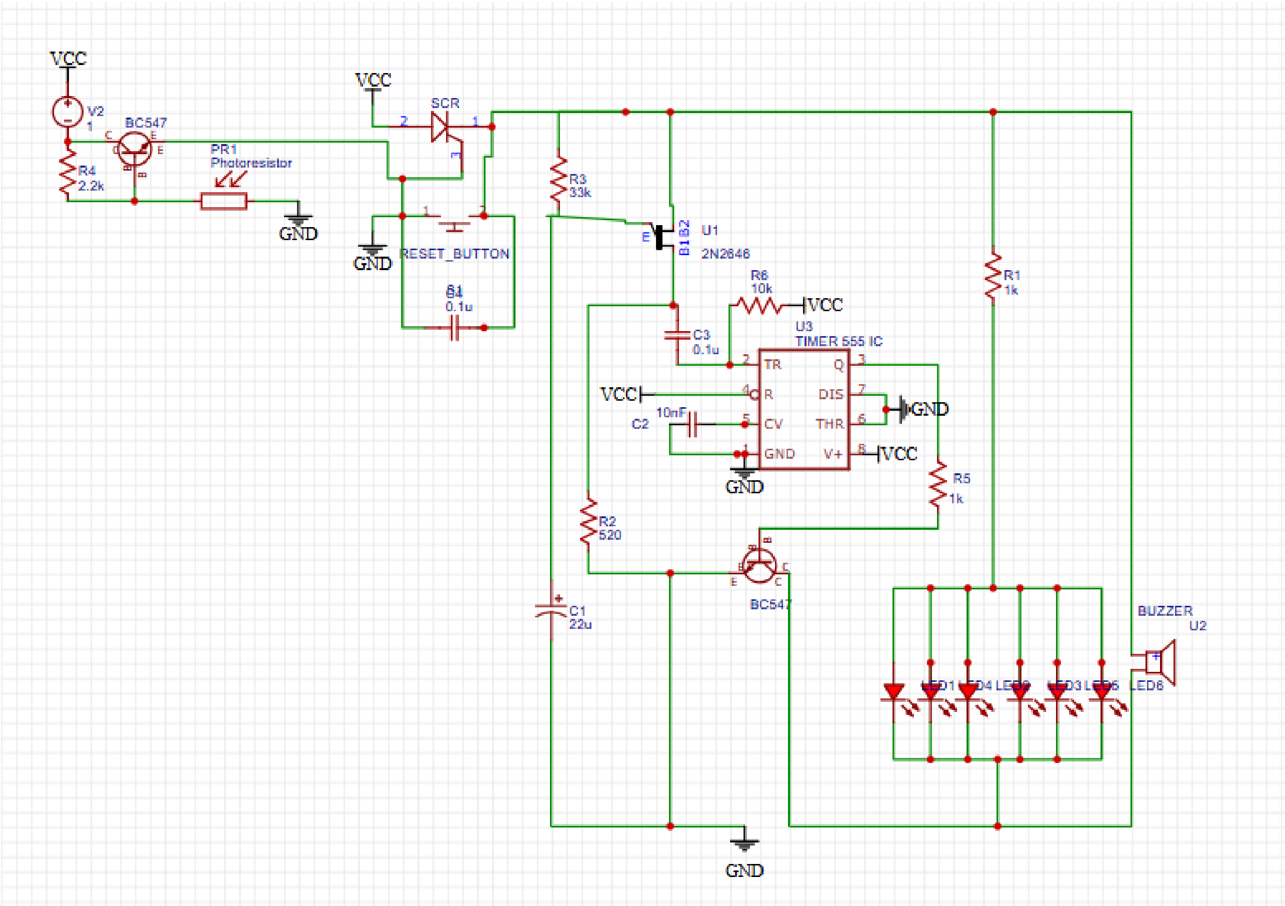

FIGURE 3.2.1 CIRCUIT DIAGRAM

3.3 Simulation snapshots (LED FLASHER CIRCUIT):

1. The 33 k resistor (REFER CIRCUIT IN FIGURE 3.4.1) controls the charging rate of the 22 mu F capacitor.

2. When the 22 mu F capacitor gets fully charged it triggers the UJT into ON state.

3. The voltage at which this happens is called peak point voltage.

4. The LED glows until the capacitor gets fully discharged.

5. Once the capacitor gets fully discharged this triggers the UJT to OFF state.

6. This consecutive switching ON and OFF (FIGURE 3.3.1) of the UJT gives rise to a pulsating signal. [4]

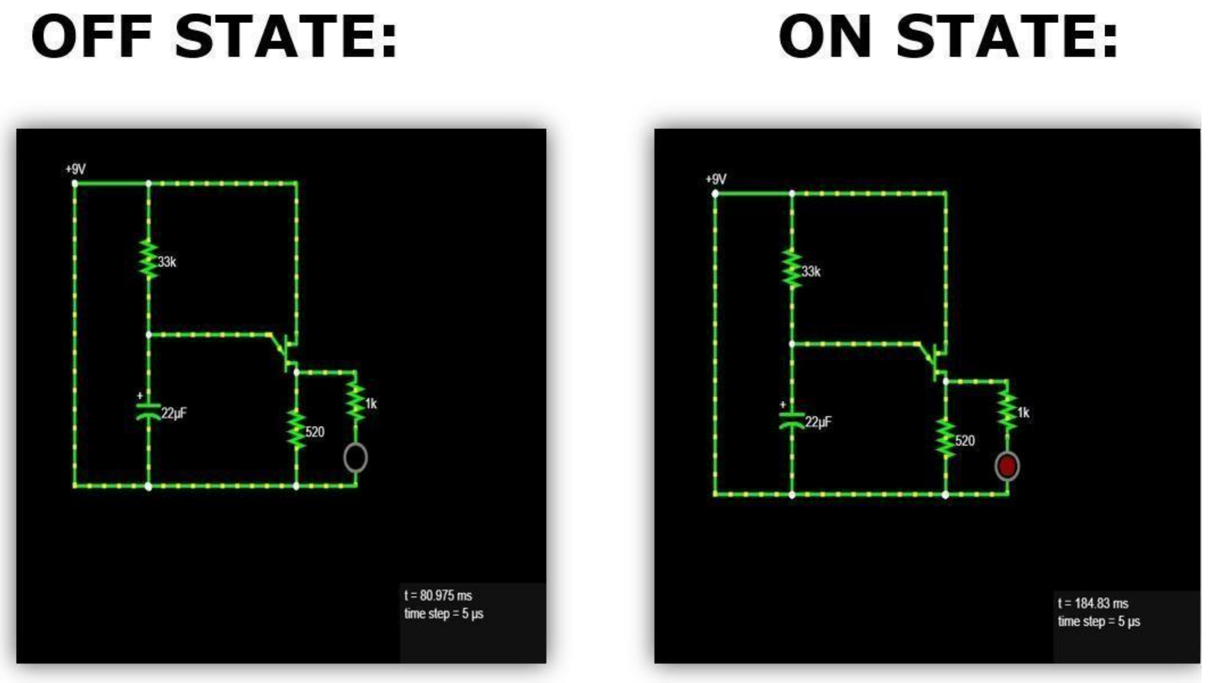

FIGURE 3.3.1 ON AND OFF STATE

3.4 Base circuit:

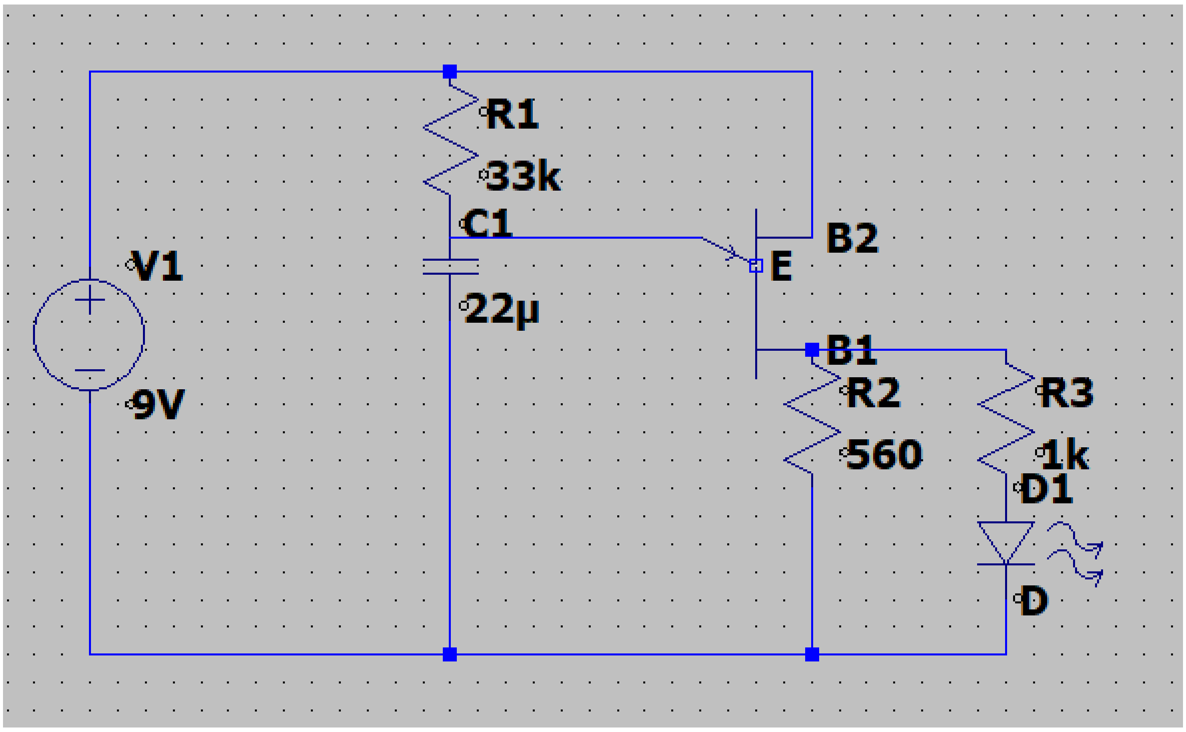

FIGURE 3.4.1 UJT LED FLASHER CIRCUIT

3.5 LDR circuit

The LDR part of the circuit (3.5.1) works using the voltage divider bias of BJT[c]. When the laser is focused, light exposure of the LDR is high which reduces it's resistance. The voltage drop across the LDR also decreases. Since the LDR is connected across the Emitter base junction of the BJT, the voltage across the LDR affects the switching of BJT. When there is an obstacle in the path of the laser, the light falling on LDR decreases and the resistance increases hence increasing the forward bias voltage of the Emitter base junction and switching ON the BJT. This output of the BJT triggers the SCR.

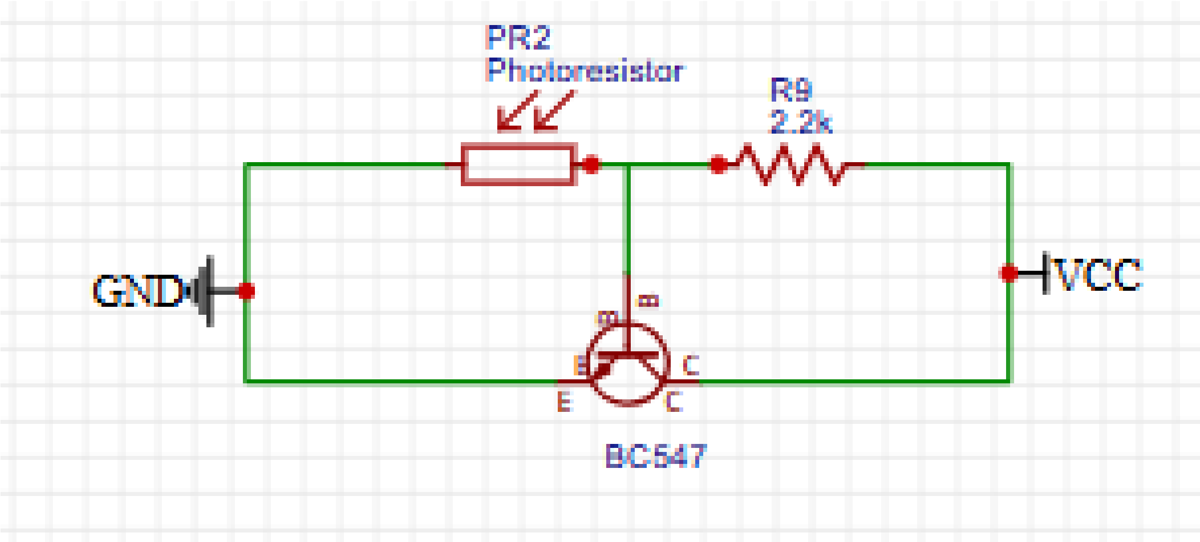

FIGURE 3.5.1 LDR CIRCUIT

The table given below shows how light conditions affect the transistor through the LDR and resistor voltage divider.

Light Condition	LDR Resistance	Base Voltage of BC547	BC547 State	Collector Output
Light	Low	High	ON	LOW
Dark	High	Low	OFF	HIGH

TABLE 3.5.1 LDR Logic Table

3.6 IC Circuit

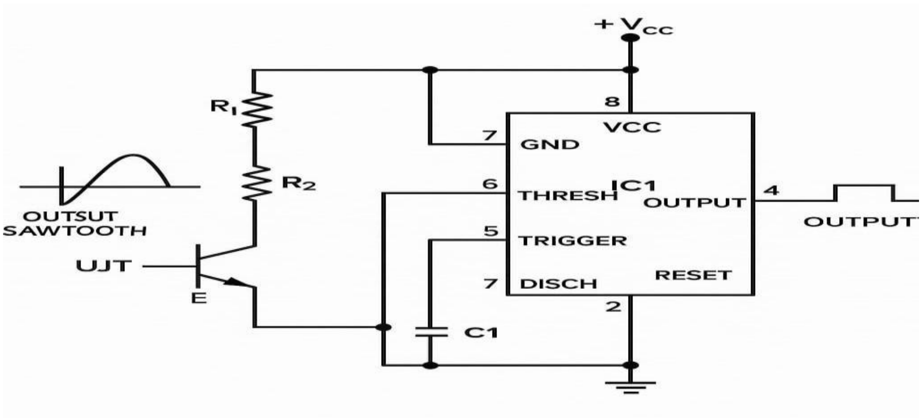

FIGURE 3.6.1 555 TIMER IC

3.7 SCR AS A SR LATCH:

The collector of the LDR 's transistor is connected to the gate terminal of the SCR, so that the switching ON and OFF of the SCR can be controlled by the output of the LDR circuit. The cathode of the SCR is connected to the UJT circuit. For setting the SCR to ON state the Gate recieves a positive voltage from the collector of the LDR circuit. For resetting the SCR a manual reset push button is connected from the gate to ground.

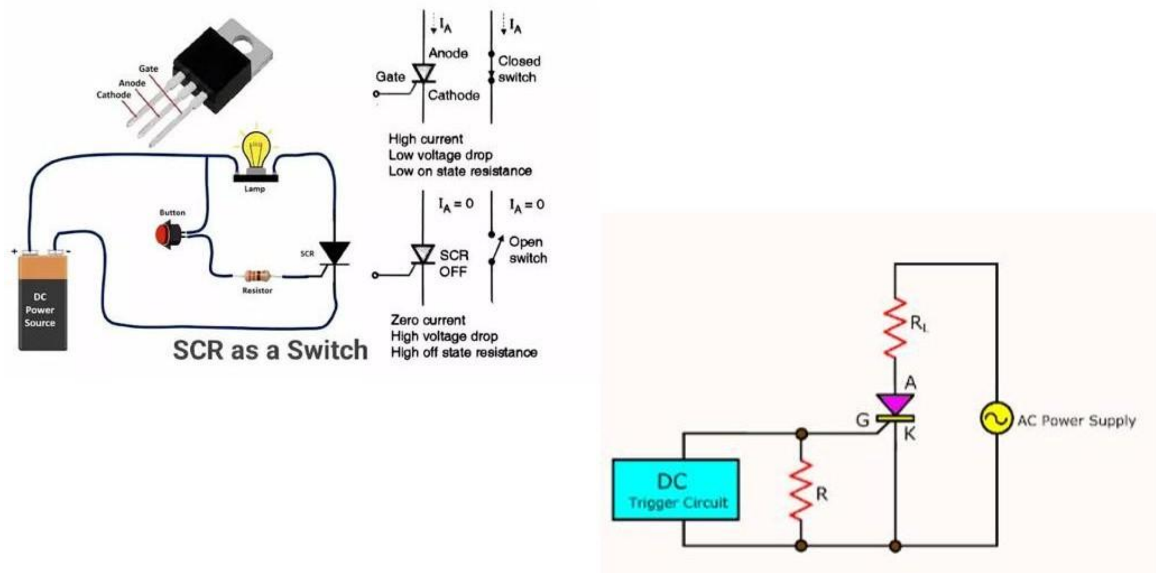

FIGURE.3.7.1 SCR AS SR LATCH

Figure 3.7.1 is the basic SCR circuit that functions as SR latch that is used to reset the circuit.

BC547 Collector Output	SCR Gate Input	SCR State	Output (Alarm)
LOW	No Trigger	OFF	OFF
HIGH	Triggered	ON	ON

TABLE 3.7.1 SCR Triggering Logic Table

3.8 SUMMARY:

This project implements a light-interrupt based security system using discrete components, primarily a photoresistor (LDR), transistors, a 555 Timer IC, and indicators like LEDs and a buzzer. The system detects an interruption in a light beam (e.g., laser or ambient light), triggering an alarm to notify unauthorized access or intrusion.

Working Principle:

1. Light Detection:

- A photoresistor (LDR) forms a light-sensitive voltage divider.

- In normal conditions (light falling on LDR), the resistance remains low, keeping the transistor biased accordingly.

2. Triggering Mechanism:

- When the light beam is interrupted (object passes), the resistance of the LDR increases.

- This change triggers a 2N2646 UJT (Unijunction Transistor), which initiates a pulse.

3. 555 Timer Activation:

- The UJT output triggers a 555 Timer IC configured in a monostable mode.

- When triggered, the 555 Timer produces a high output for a specific time interval.

4. Output Indication:

- The timer output drives a transistor, which energizes a buzzer and lights up an array of LEDs as a visual and audible alert.

5. Reset Mechanism:

- A manual reset button is provided to stop the alarm once the situation is handled.

CHAPTER 4

HARDWARE IMPLEMENTATION OF PROPOSED CIRCUIT

4.1 INTRODUCTION:

The bread board connection of the components of the proposed circuit is given below in figure 4.1.1.

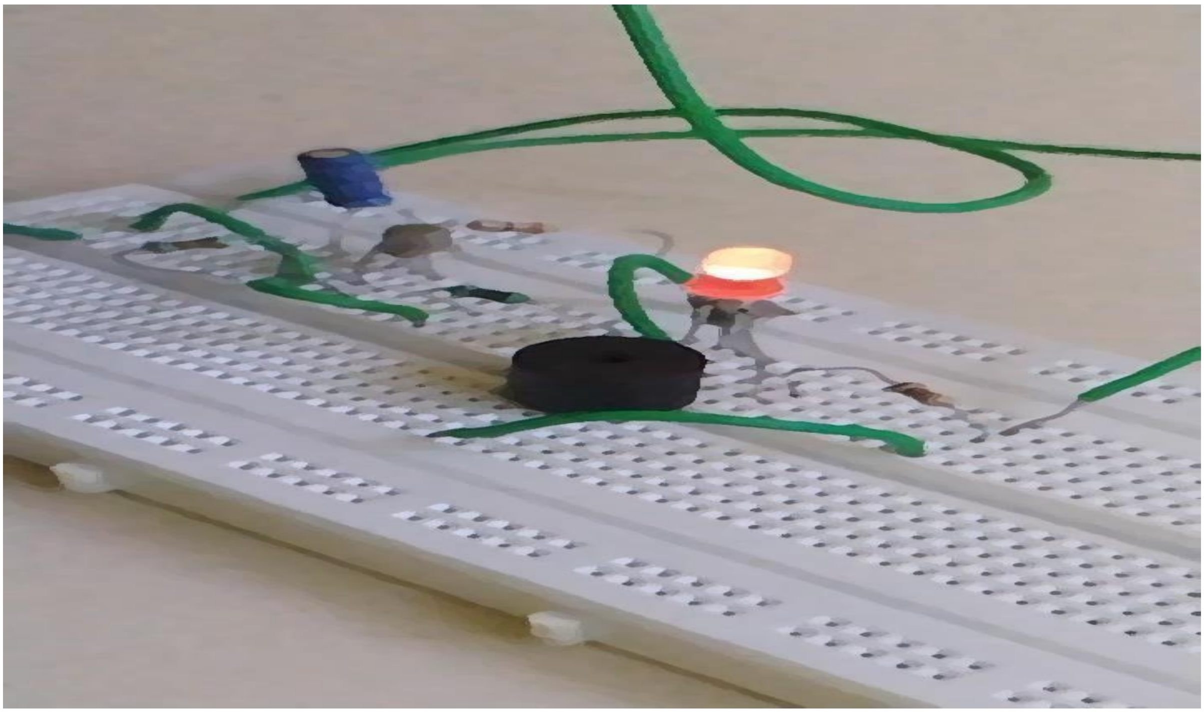

FIGURE 4.1.1 Bread Board Connections

The LED flashlight circuit consists of a UJT, an LED, a power source (such as a battery), and a resistor-capacitor (RC) timing network. The UJT acts as a control element to regulate the on/off operation of the LED. The UJT is biased using the RC timing network. The network includes a resistor and a capacitor connected to the UJT's base terminals. The resistor charges and discharges the capacitor, determining the timing of the UJT's triggering. When the power is turned on, the UJT is in an off state. The capacitor in the timing network starts charging slowly through the resistor. As the capacitor charges, its voltage gradually increases. Once it reaches a specific threshold determined by the RC timing network, the triggering voltage is applied to the UJT. When the UJT receives the triggering voltage, it switches on. In this state, it allows current to flow from the power source through the UJT and the LED. With the UJT on, current passes through the LED, causing it to illuminate. While the UJT is on, the capacitor in the timing network begins to discharge through the resistor. This process continues until the voltage across the capacitor drops below the UJT's threshold.

Once the voltage across the capacitor falls below the threshold value, the UJT switches off. In this state, it becomes high resistance, interrupting the current flow. With the UJT off, the current to the LED is cut off, causing it to turn off. The capacitor now starts charging again, and the process repeats allowing the LED flashlight to be turned on and off as desired.

4.2 PCB CONNECTIONS

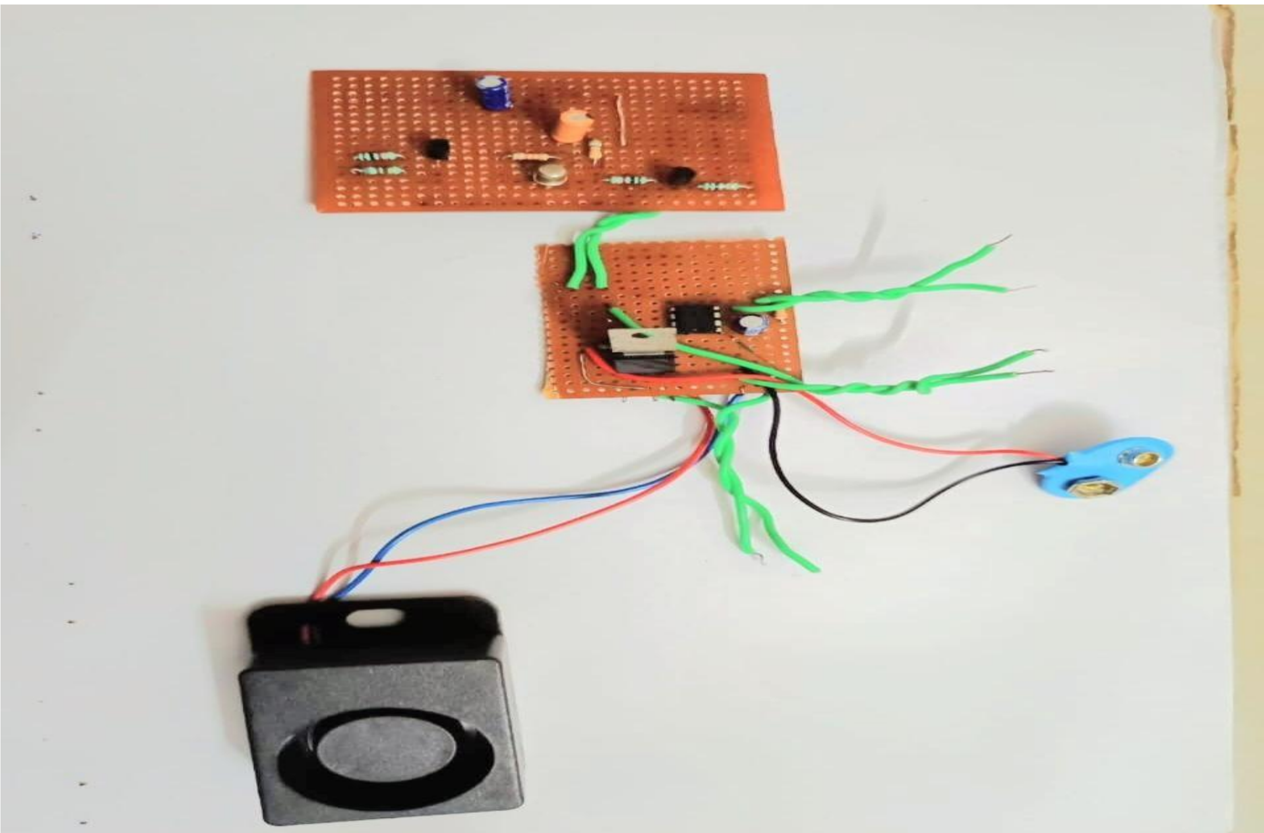

FIGURE 4.2.1 PCB Connections

The components are soldered in PCB in the figure 4.2.1, also known as Printed Circuit Board.

4.3 OUTER CASING DESIGN

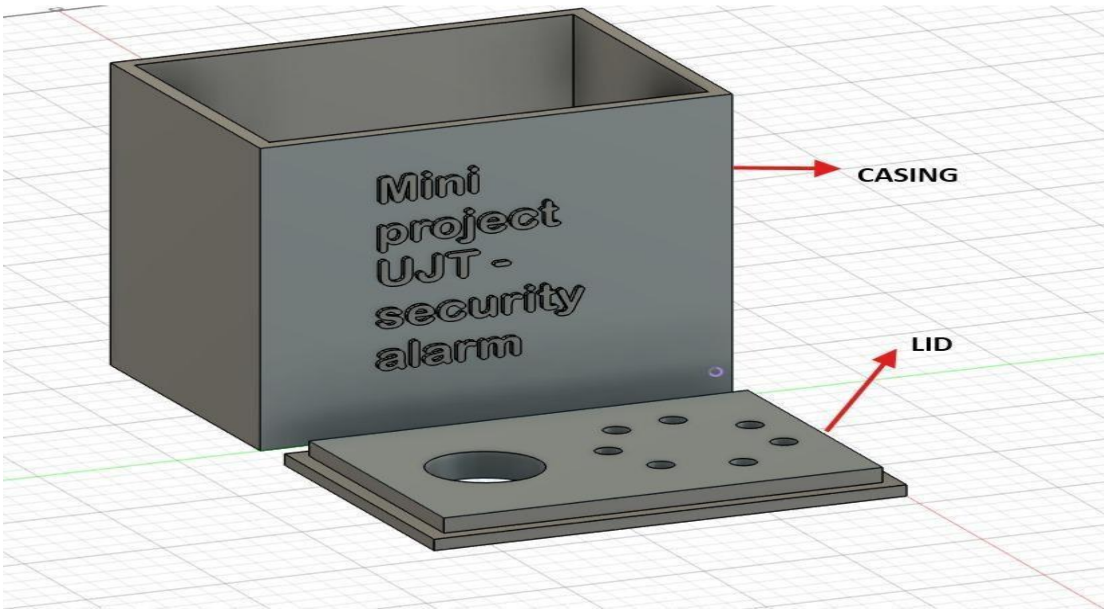

FIGURE 4.3.1 FUSION 360 MODEL

The outer casing in figure 4.3.1 is designed using fusion 360 and even autocad is an alternate software that can be used to design it .The 3D printing process using Fusion 360 begins with designing the model by creating 2D sketches and converting them into 3D solids using extrusion and other modeling tools. Features like holes, fillets, and shells are added to refine the design. Once completed, the model is exported as an STL file, which is then imported into slicing software such as Ultimaker Cura. In the slicer, settings like layer height, infill percentage, supports, and print speed are adjusted before generating a G-code file. This G-code is then transferred to a 3D printer, where the model is printed layer-by-layer after bed leveling and filament loading, resulting in a precise and functional physical prototype.

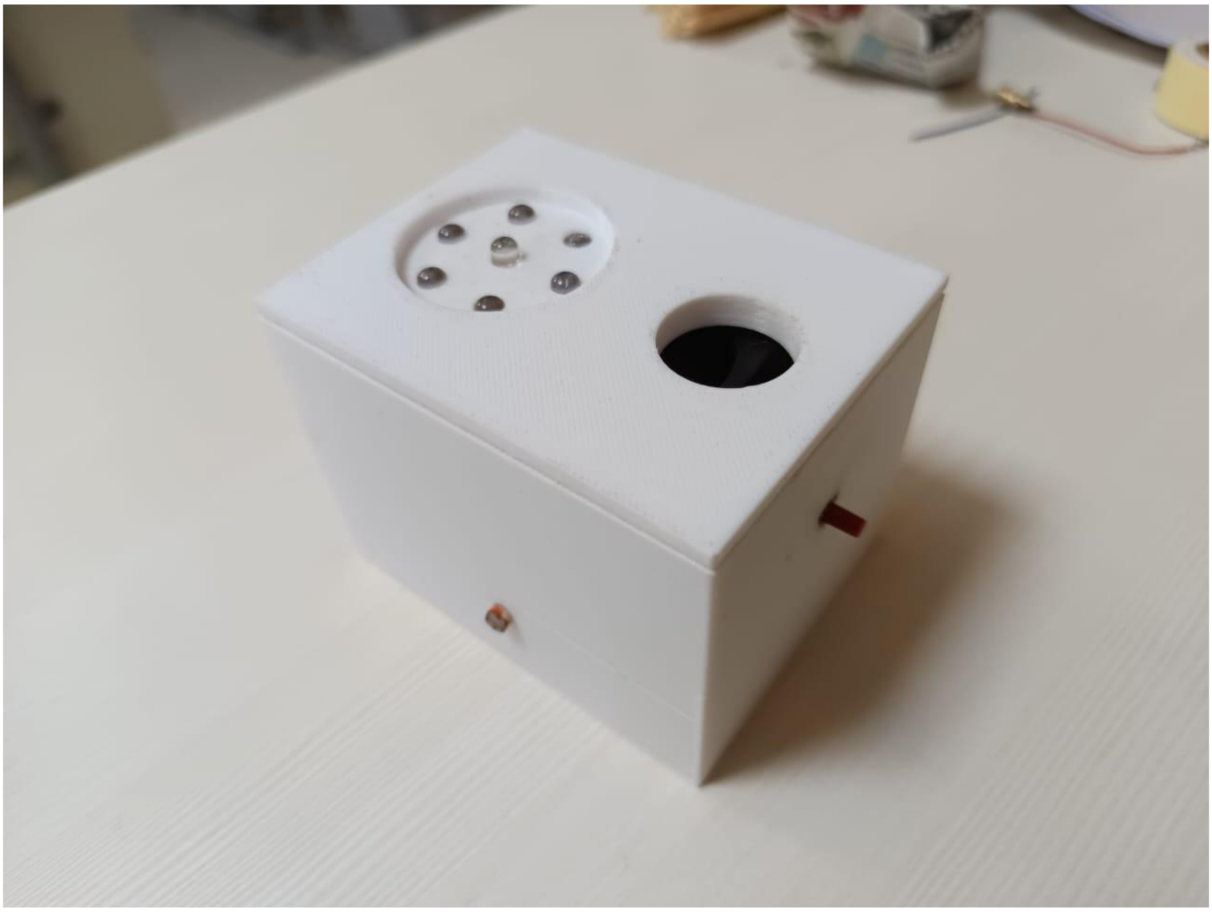

FIGURE 4.3.2 FINAL PROTOTYPE

The figure 4.3.2 is the final prototype of the Laser Security alarm using UJT LED flasher circuit.

4.4 SUMMARY

The chapter details the development process of a UJT LED flasher circuit used in a laser security alarm system. Initially, the circuit is assembled on a breadboard, where key components such as a Unijunction Transistor (UJT), an LED, a power source, and a resistor-capacitor (RC) timing network are connected. The UJT functions as a switching element, controlled by the RC network. When powered, the capacitor charges through the resistor until a threshold voltage is reached, triggering the UJT to turn on and allow current to flow through the LED, causing it to light up. As the capacitor discharges, the voltage drops, and once it falls below the threshold, the UJT switches off, turning off the LED. This on-off operation continues in a loop, enabling a flashing effect. After successful testing on the breadboard, the components are permanently soldered onto a Printed Circuit Board (PCB) to form a stable and compact version of the circuit. Finally, a custom outer casing is designed using Fusion 360 and prepared for 3D printing. The result is a fully functional and enclosed prototype of the laser security alarm, as demonstrated in the final prototype image.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 CONCLUSION

In conclusion, LED flasher circuits offer a practical and versatile solution for a variety of applications such as decorative lighting, indicators, and signaling devices. This review covered different methods of designing LED flashers using components like the 555 timer IC, NPN transistors, and Unijunction Transistors (UJTs). Each configuration has its own advantages—whether it's the timing precision of the 555 timer, the simplicity of a transistor-only circuit, or the flexibility offered by UJTs. Understanding these circuit designs provides a solid foundation for creating efficient and reliable flashing systems with adjustable parameters like blinking speed and duty cycle.

5.2 FUTURE WORK

For future work, further improvements can be made by exploring microcontroller-based flashing systems, which offer programmable timing and more complex light patterns. Additionally, incorporating light or motion sensors can make the circuits more interactive and energy-efficient. Research into low-power components and integration with renewable energy sources could also expand the use of LED flashers in sustainable and remote applications.

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