# Touch Free Switch

Report submitted by


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|---|---|
| **CB.EN.U4ECE21201** | **A.Kiran Sai Pavan** |
| **CB.EN.U4ECE21231** | **M.Manoj Sai** |
| **CB.EN.U4ECE21241** | **P. Venkata Sai Rajesh Kumar** |
| **CB.EN.U4ECE21260** | **T.Karthik Venkat Reddy** |


in partial fulfillment of the requirements for the course

**19ECE384 – Design and Innovation Lab**



**Department of Electronics and Communication Engineering,**
**Amrita School of Engineering,**
**Amrita Vishwa Vidyapeetham, Coimbatore – 641112**


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1. **Motivation**: The touch-free switch mesmerized me with its potential to redefine accessibility and hygiene in public spaces. In today's health-conscious world, minimizing contact points is essential, making touch-free switches not just innovative but indispensable. Exploring the intricate technology behind these switches not only aligns with our passion for electronics and automation but also presents a tangible solution to a pressing real-world challenge. The prospect of contributing to a more accessible, efficient, and hygienic environment through this project fills me with admiration and excitement.
2. **Problem Statement**: In this project, we aim to design and construct a touch-free switch using a synchronous up/down counter circuit. The system will use two IR sensors to detect input signals, four D flip-flops for counting, and four LEDs to display the count. The circuit will increment the LED count when the input to IR1 is 0 and IR2 is 1, and decrement the LED count when the input to IR1 is 1 and IR2 is 0. This project will be implemented using only digital and analog circuits, without the use of microprocessors or Arduino.
3. **Design Procedure**:

Utilize two IR sensors (IR1 and IR2) to detect input signals without physical contact.

IR1 and IR2 will provide digital signals indicating the presence or absence of an object.

**Counting Logic:**

Implement a synchronous up/down counter to manage the LED states.

Use four D flip-flops (74LS74) to store and update the current count.

D FF 1 $D_0 = X_1' * X_2' * Q_b * Q_c * Q_d$

D FF 2 $D_1 = [[(X_1 * X_2) * (Q_a * Q_b)] + X_1' X_2' Q_a'] * Q_c * Q_d$

D FF 3 $D_2 = [(Q_c * Q_d * Q_b) * (X_1 \oplus X_2)] + (X_1' X_2 Q_a' Q_c' Q_d)$

D FF 4 $D_3 = ((X_1' Q_d + X_1) * (X_2' Q_a' Q_b' Q_c'))'$

**Control Logic:**

Design logic gates (AND, OR, NOT) to create control signals for counting.

Up Signal: Activated when IR1 detects a 0 (absence of object) and IR2 detects a 1 (presence of object).

Down Signal: Activated when IR1 detects a 1 (presence of object) and IR2 detects a 0 (absence of object).

**LED Indicators:**

Use four LEDs to display the current count from the counter.

LEDs will light up sequentially from 1 to 4 based on the counter value.

**Counter Operations:**

Increment: When IR1 is 0 and IR2 is 1, the counter increases the count by one, lighting an additional LED.

Decrement: When IR1 is 1 and IR2 is 0, the counter decreases the count by one, turning off one LED.

**Power Supply:**

The circuit will be powered by a +5V DC supply.

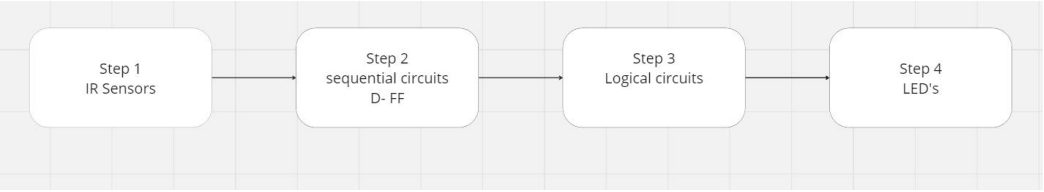
**Timing Considerations:**

Ensure a stable clock signal for synchronous operation of the D flip-flops.

Truth Table

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | $X_2$ | Qa | $Q_b$ | $Q_c$ | $Q_d$ | $Q_a'$ | $Q_b'$ | $Q_c'$ | $Q_d'$ |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Design Flow




**Step 1 :- IR Sensors**

**Components :** 2 IR sensors

**Function:** detects the motion and give digital output

**Specifications:** input voltage is varies from 3.3v to 5v, it Active IR sensor

**Step 2 :- Sequential Circuits**

**Components :-** D Filpflops

**Function:** acts as an electronic memory component

**Specifications:** Supports 5-V VCC Operation and Low Power Consumption

**Step 3 :- Logical Circuits**

**Components :-**

AND Gates(IC7408,7411)

OR Gates(IC7486)

XOR Gates

NOT Gates

**Function:** acts as a building block for digital circuits

4. **Budget**:

| S.No | Components | Quanity | Cost/Unit(in Rupees) | Total(in Rupees) |
|---|---|---|---|---|
| 1 | 74HC175D (Quad D - FF) | 1 | 15 | 15 |
| 2 | IR sensors | 2 | 35 | 70 |
| 3 | 2 i/p xor Gate (Ic7486) | 2 | 15 | 30 |
| 4 | Not Gate (IC7404) | 2 | 13 | 26 |
| 5 | 2 i/p OR Gate (IC7486) | 3 | 10 | 30 |
| 6 | 3i/pAND Gate (IC7411) | 4 | 27 | 108 |
| 7 | 2i/p And Gate (IC7408) | 3 | 20 | 60 |
| 8 | Breadboard | 4 | 40 | 160 |
| Total | | | | 499 |

5. **Design Schematic**:

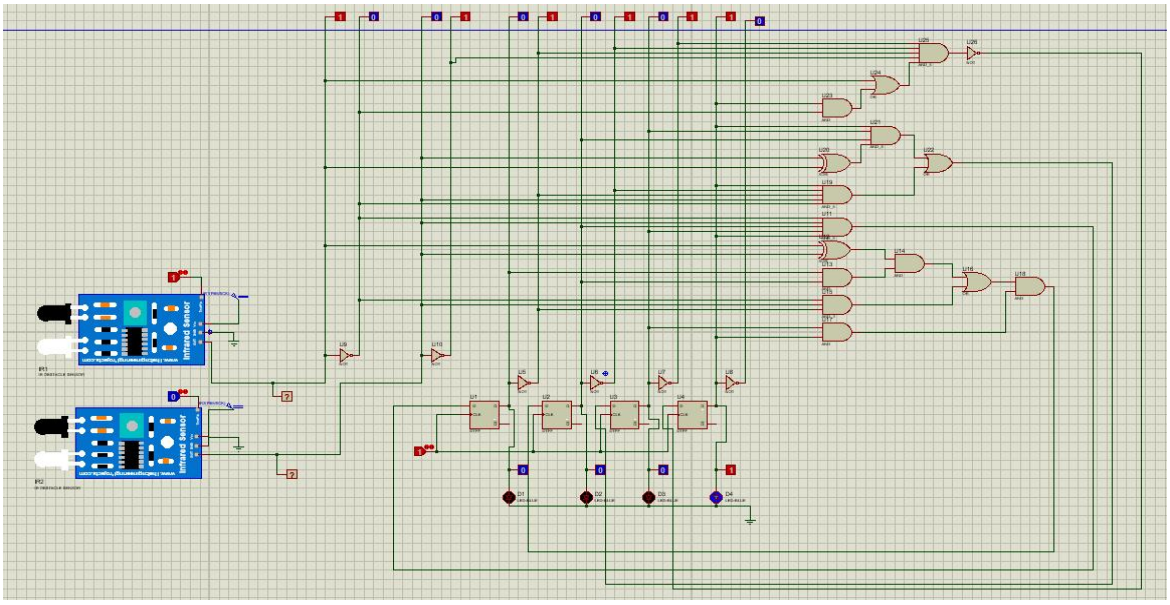


*Fig.1. Touch free switch simulation*

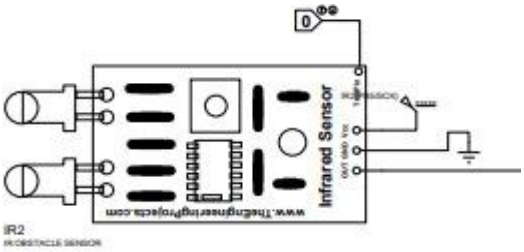



*Fig.2.IR Module schematic*

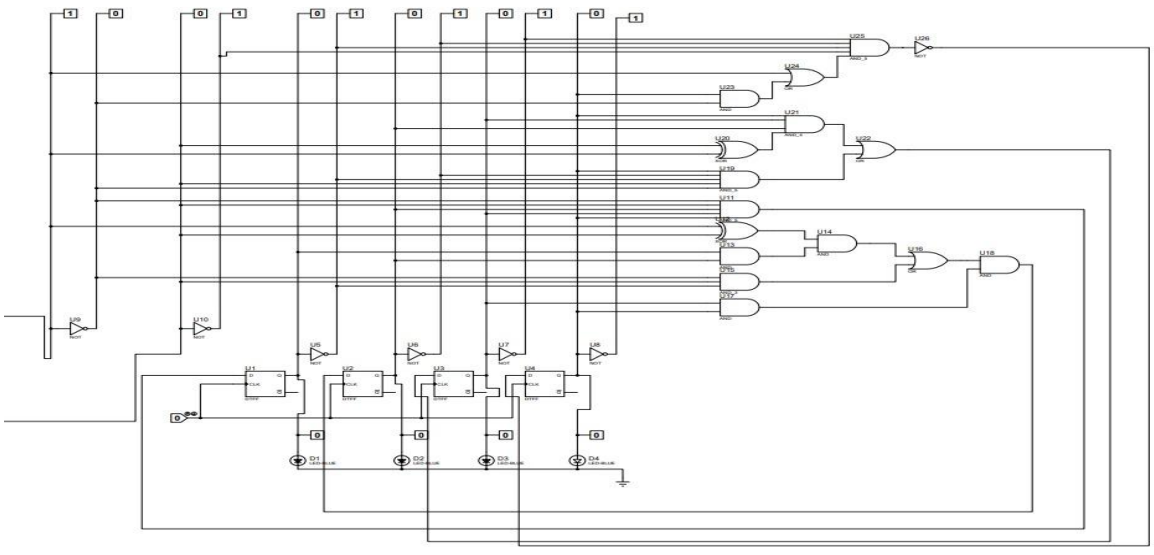


*Fig.3.Counter schematic*

6. **Simulation Results / Discussion**: Please indicate the results of your simulation,

The simulation of the touch-free switch using a synchronous up/down counter exhibited excellent performance and reliability. The IR sensors accurately detected the presence and absence of an object, converting these signals into digital inputs for the counter. When IR1 registered a 0 (absence of object) and IR2 registered a 1 (presence of object), the counter incremented, resulting in an additional LED being illuminated. Conversely, when IR1 registered a 1 (presence of object) and IR2 registered a 0 (absence of object), the counter decremented, causing one LED to turn off. This consistent behavior validated the correctness of the control logic and the counting mechanism, as the state changes were accurately reflected by the LEDs.

The simulation confirmed the robustness and precision of the circuit. The stable clock signal ensured synchronized updates to the D flip-flops, facilitating smooth operation of the counter without glitches. The LEDs provided an immediate and clear visual indication of the current count, making the system straightforward to monitor and verify. Overall, the simulation results demonstrated the successful implementation of the touch-free switch, showcasing the efficiency and reliability of the design using IR sensors and digital components to achieve the desired functionality.

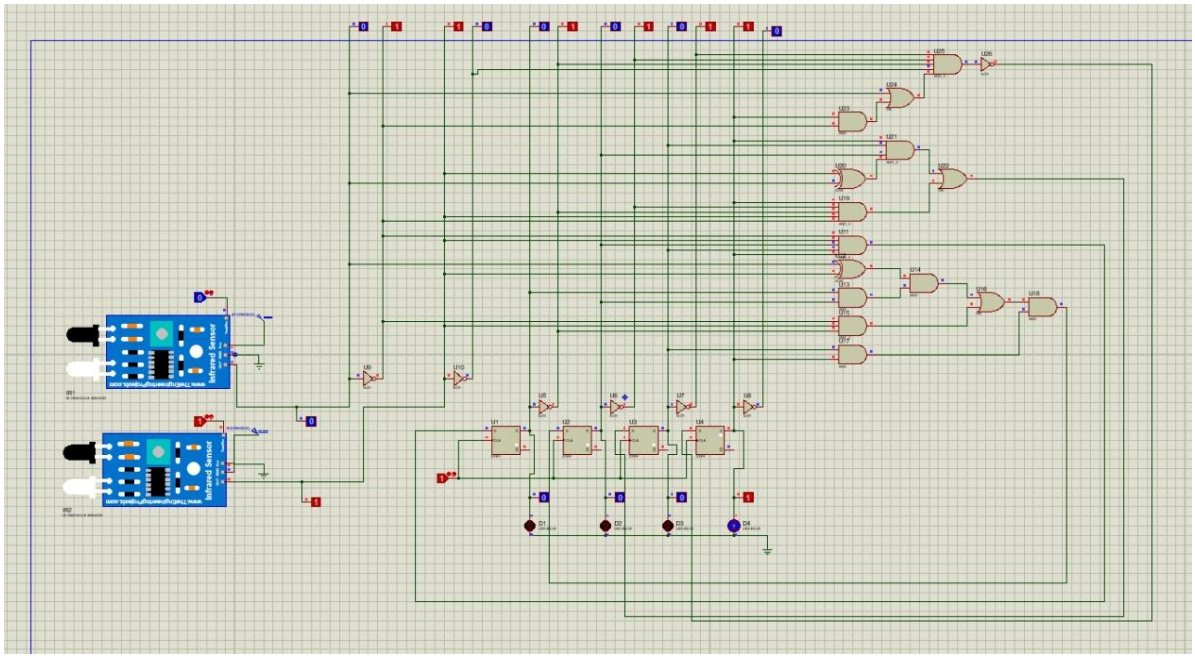


***Fig.4.Touch Free Switch simulation result 1***

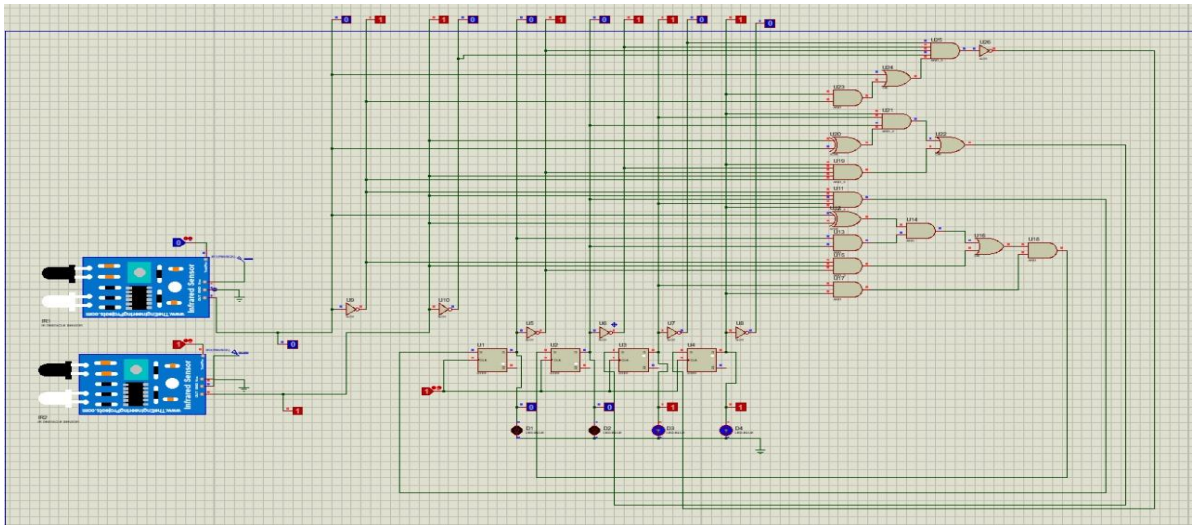


*Fig.5.Touch Free Switch simulation result 2*

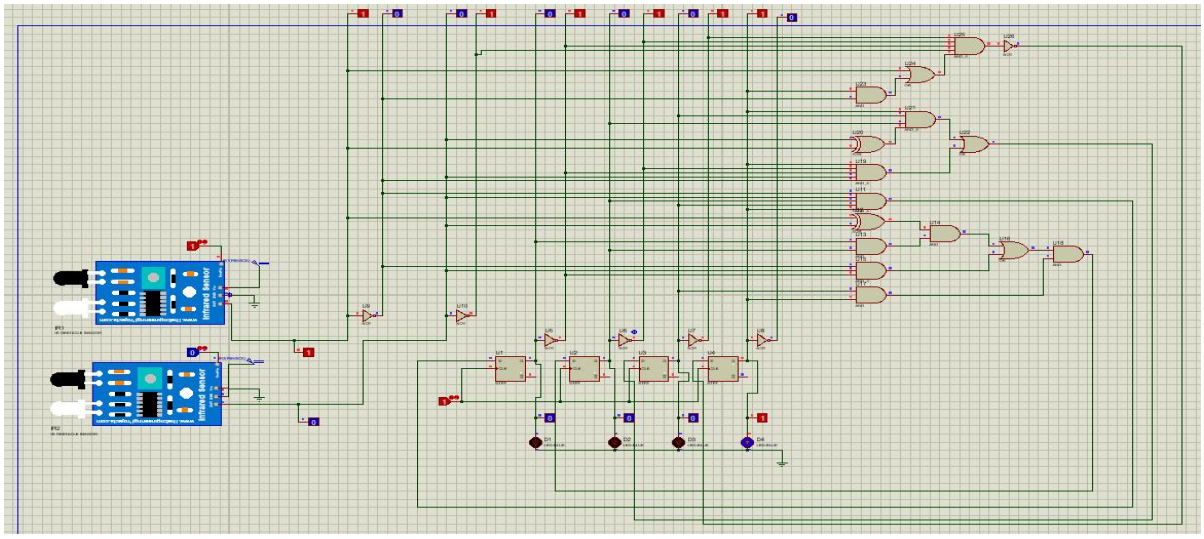


*Fig.6.Touch Free Switch simulation result 4*

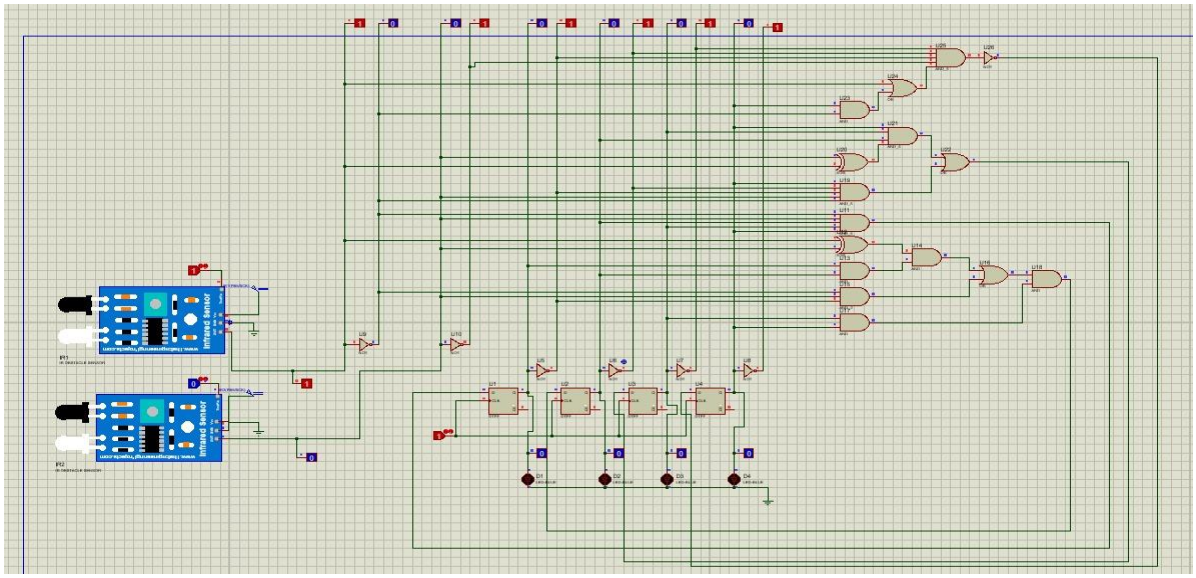


*Fig.7.Touch Free Switch simulation result 4*

## 7. **Implementation / Prototytping results**:

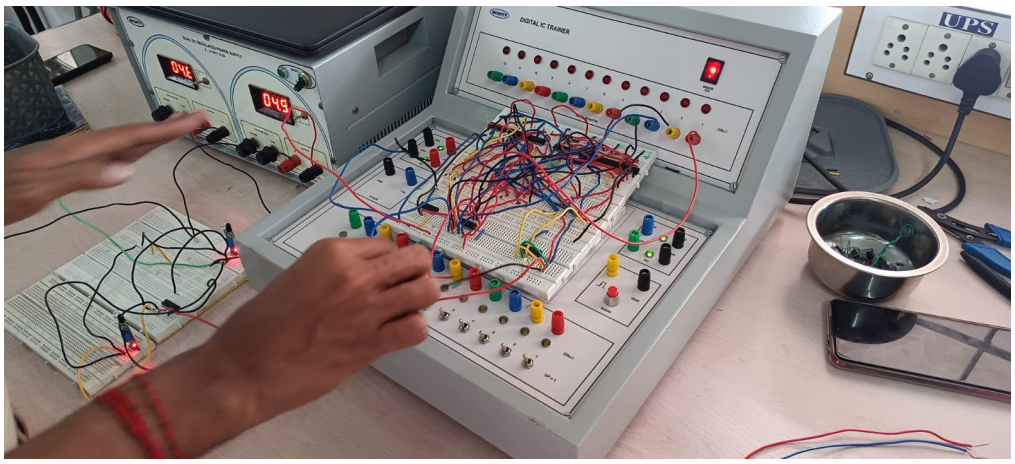



***Fig.8.Breadboard connection of the Prototype***

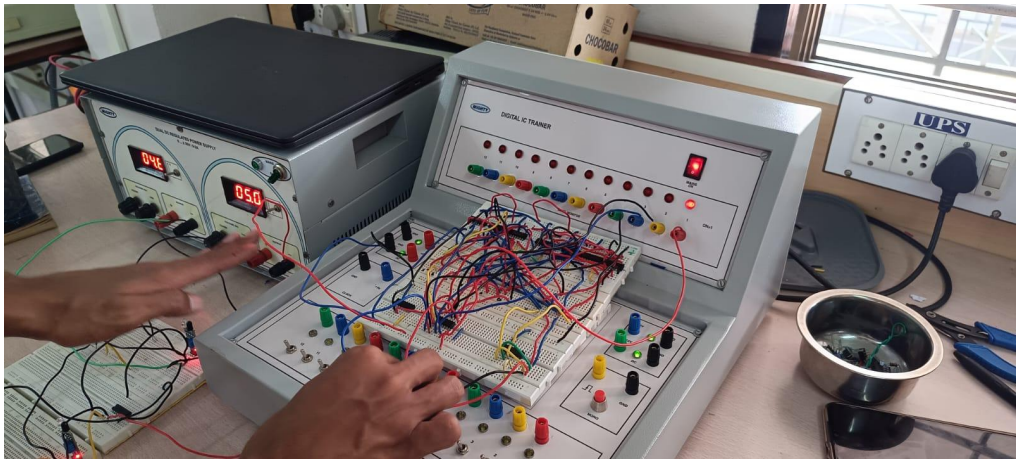



***Fig.9.Glow of LED***

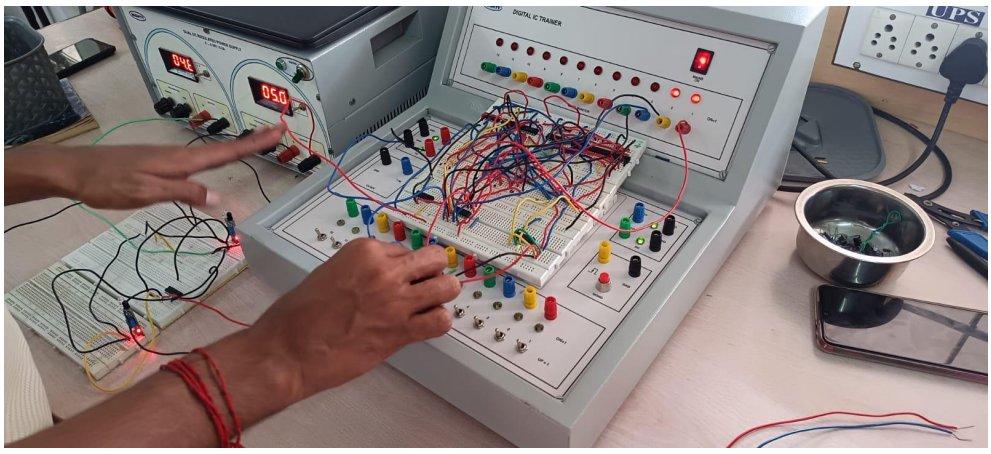



***Fig.10.Glow of LED***

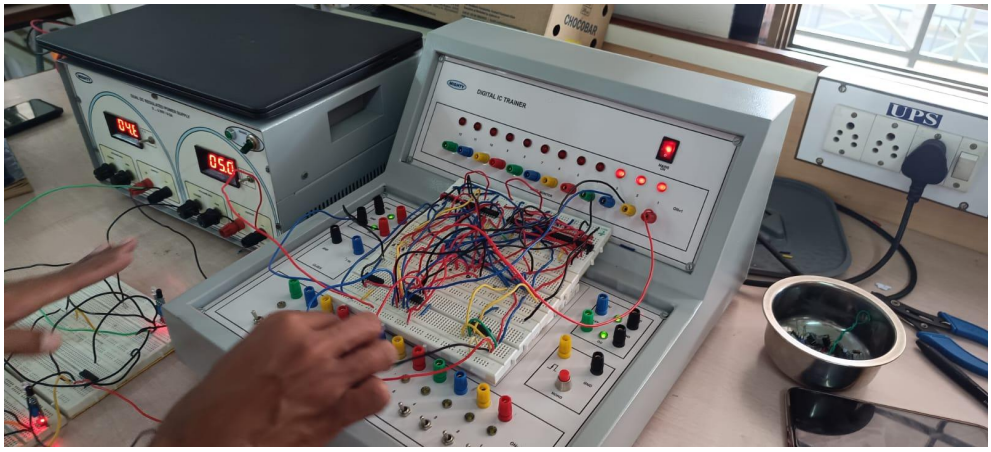



***Fig.11.Glow of LED***

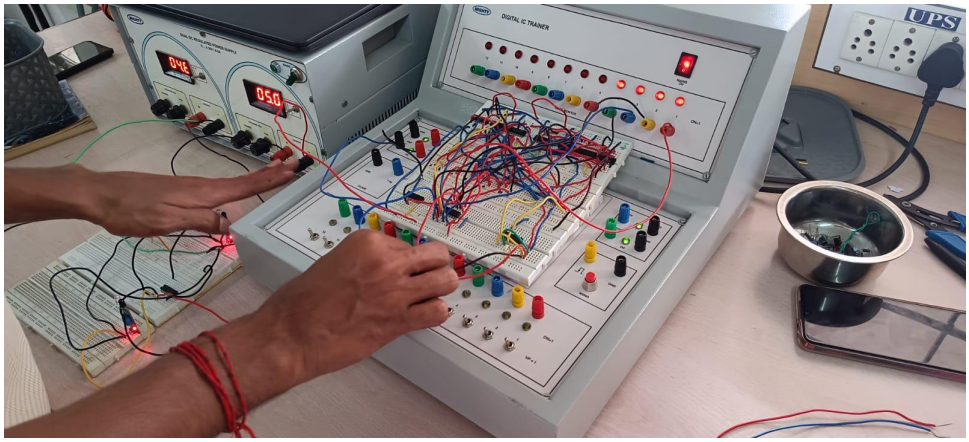



***Fig.12.Glow of LED***

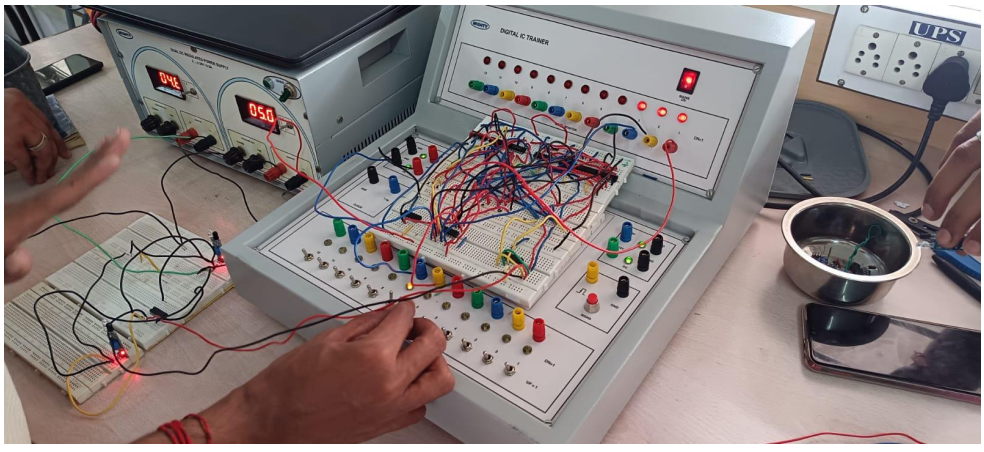



***Fig.13.Glow of LED***

8. **Discussion & Conclusions**:

Our goal in this project was to use a synchronous up/down counter circuit, D flip-flops, and infrared sensors to design and build a touch-free switch. The simulation's findings showed that, depending on whether an object was present or not, the touch-free switch effectively increased and decreased the number of LEDs. When IR1 detected a 0 (no object) and IR2 detected a 1 (object present), the up signal was triggered, and the down signal was triggered when IR1 detected a 1 (object present) and IR2 detected a 0 (no object).

The main goal of developing a touch-free switch was accomplished in order to reduce the number of physical contact points. This is especially important in the health-conscious world of today, where keeping hygiene requires minimizing touch surfaces. The circuit only used digital and analog circuitry to function properly; microprocessors or Arduino were not used. The LEDs gave a clear visual representation of the count state, and the efficient use of four D flip-flops to store and update the current count was demonstrated.