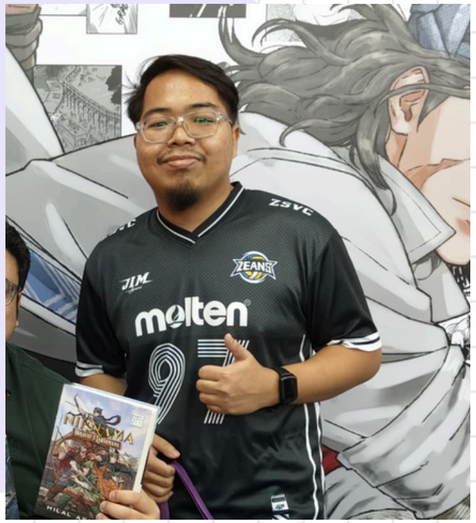
SMARTGLOW: A PID-DRIVEN RGB LIGHT SOLUTION FOR ADAPTIVE LIVING ENVIRONMENTS

MCTA 3104

Mechatronics Control and Automation Lab

GROUP MEMBERS



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INTRODUCTION

This project presents a Smart RGB Lighting System designed to enhance assisted living by enabling users to wirelessly control the color of their room lighting using a mobile Bluetooth app.

By integrating PID control, the system ensures smooth and precise transitions between colors, enhancing visual comfort and personalization. It addresses the challenges faced by individuals with limited mobility who may struggle with traditional lighting systems, offering a user-friendly, accessible, and modern solution to improve independence and quality of life.

PROBLEM STATEMENT

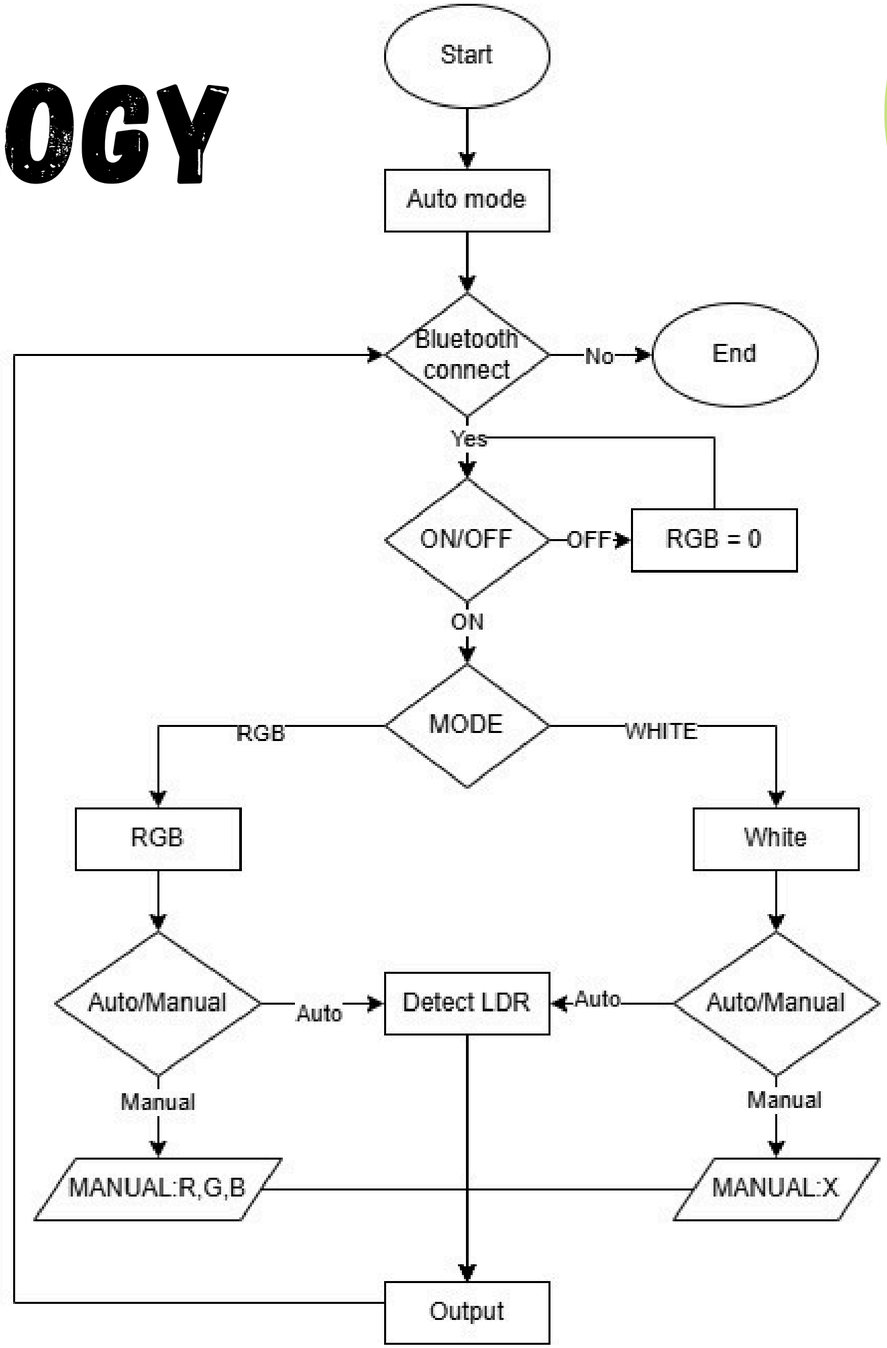
Many IIUM students living in Mahallahs, especially those with physical disabilities or health conditions, face difficulties using traditional wall switches for lighting control. These challenges can reduce their comfort, independence, and quality of life.

Additionally, current solutions available are often not user-friendly, lack personalization, or cause abrupt lighting changes that are uncomfortable. Therefore, a smart, wireless, and adaptive lighting system is needed to make lighting control easier, more accessible, and visually pleasant, tailored to the needs of IIUM students and community members.

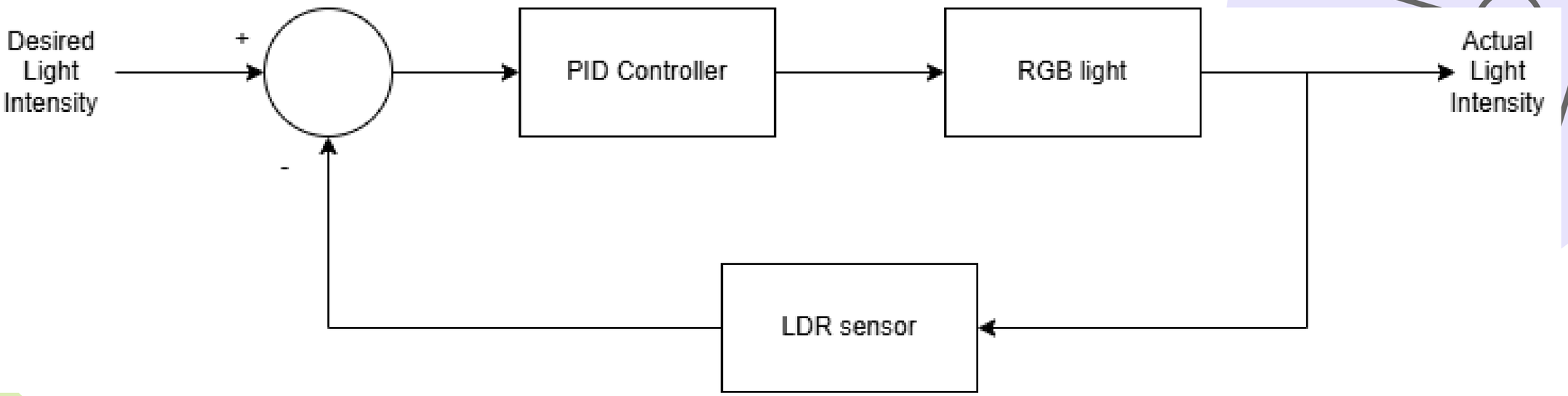
OBJECTIVES

- To integrate PID (Proportional-Integral-Derivative) control for smooth and accurate colour transitions.
- To provide an accessible lighting solution for IIUM students, especially those with limited mobility or disabilities.
- To enhance visual comfort and personalisation in Mahallah rooms or study spaces.

METHODOLOGY



PID CONTROLLER



PID Tuning Values:

Kp = 1.0: Responds to current error

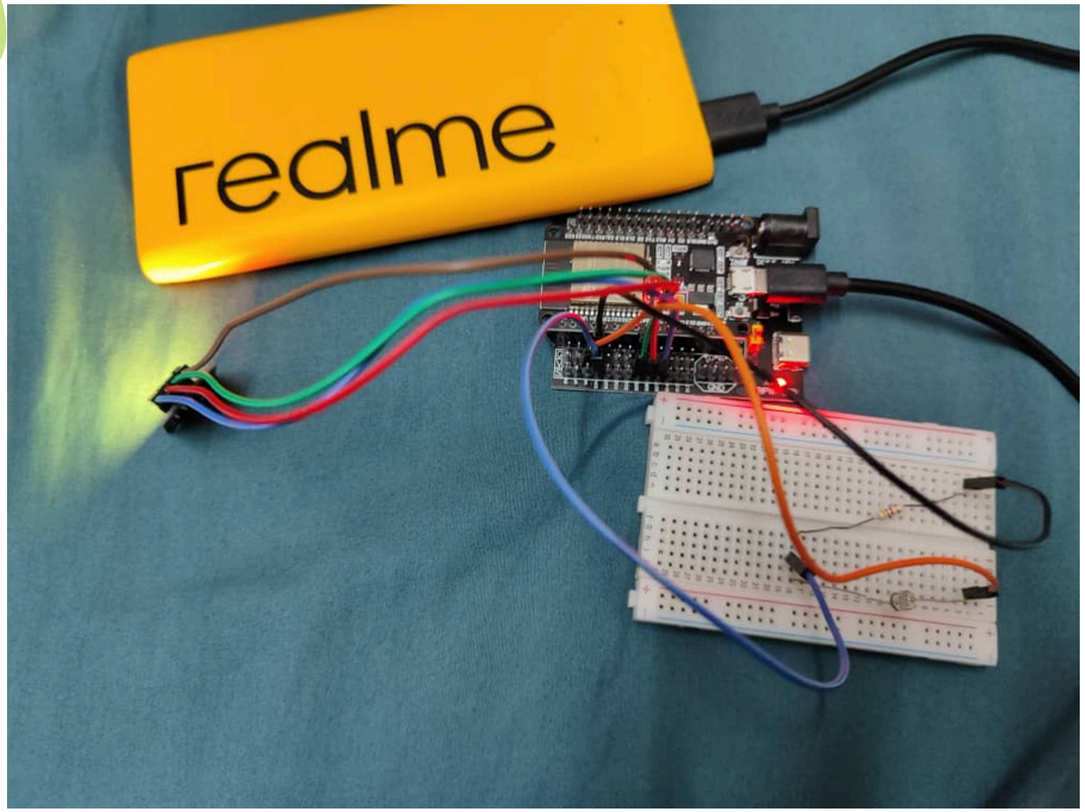
Ki = 0.1: Eliminates steady-state error

Kd = 0.05: Smooths response to avoid overshoot

Target Color: RGB (100, 200, 148)

```
22:10:51.536 -> LDR: 0 | R:100 G:200 B:148
22:10:51.574 -> LDR: 0 | R:100 G:200 B:148
22:10:51.639 -> LDR: 0 | R:100 G:200 B:148
22:10:51.674 -> LDR: 0 | R:100 G:200 B:148
22:10:51.749 -> LDR: 0 | R:100 G:200 B:148
22:10:51.781 -> LDR: 0 | R:100 G:200 B:148
22:10:51.870 -> LDR: 0 | R:100 G:200 B:148
22:10:51.917 -> LDR: 0 | R:100 G:200 B:148
```

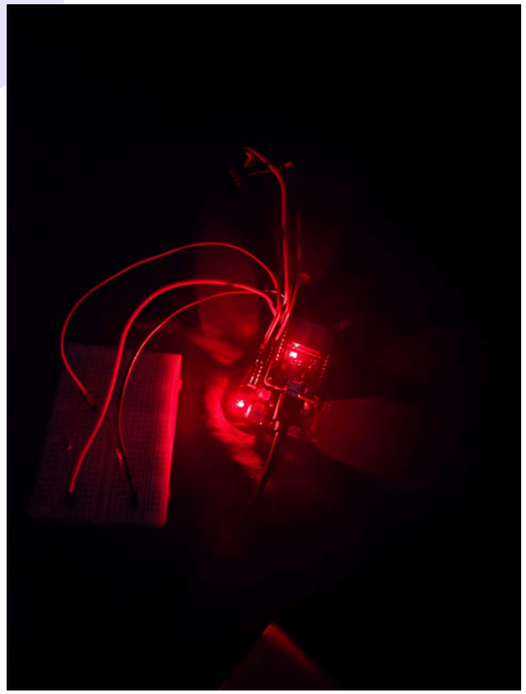
CIRCUIT



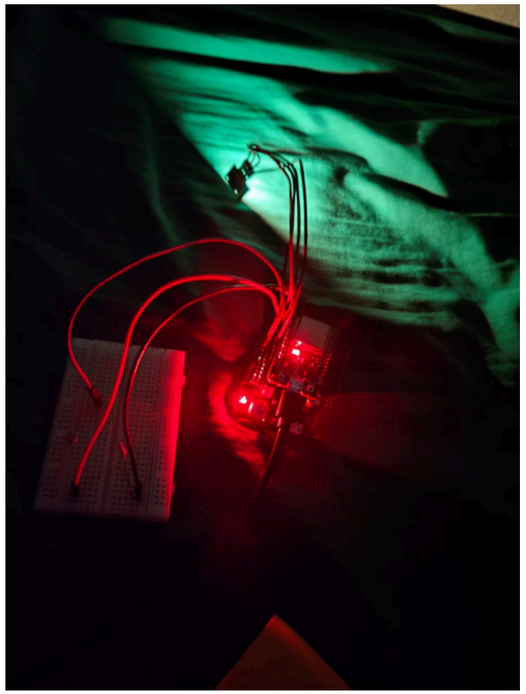
FINAL PRODUCT

RESULT

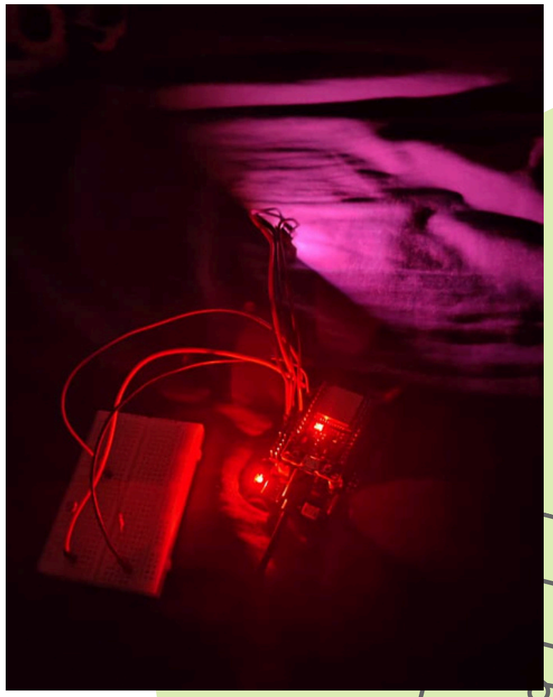
LIGHT OFF



RGB AUTO

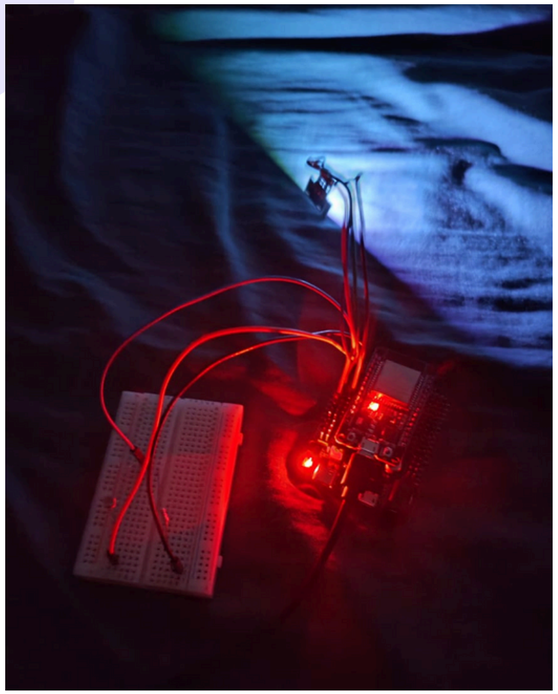


MANUAL RGB

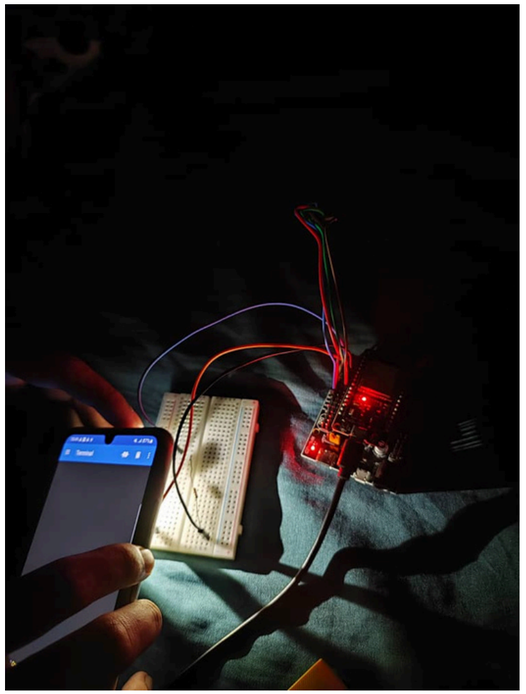


RESULT

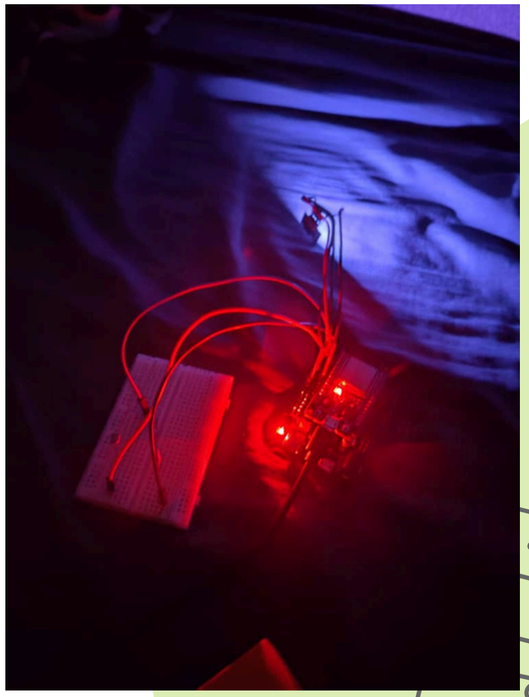
WHITE LIGHT



WHITE AUTO



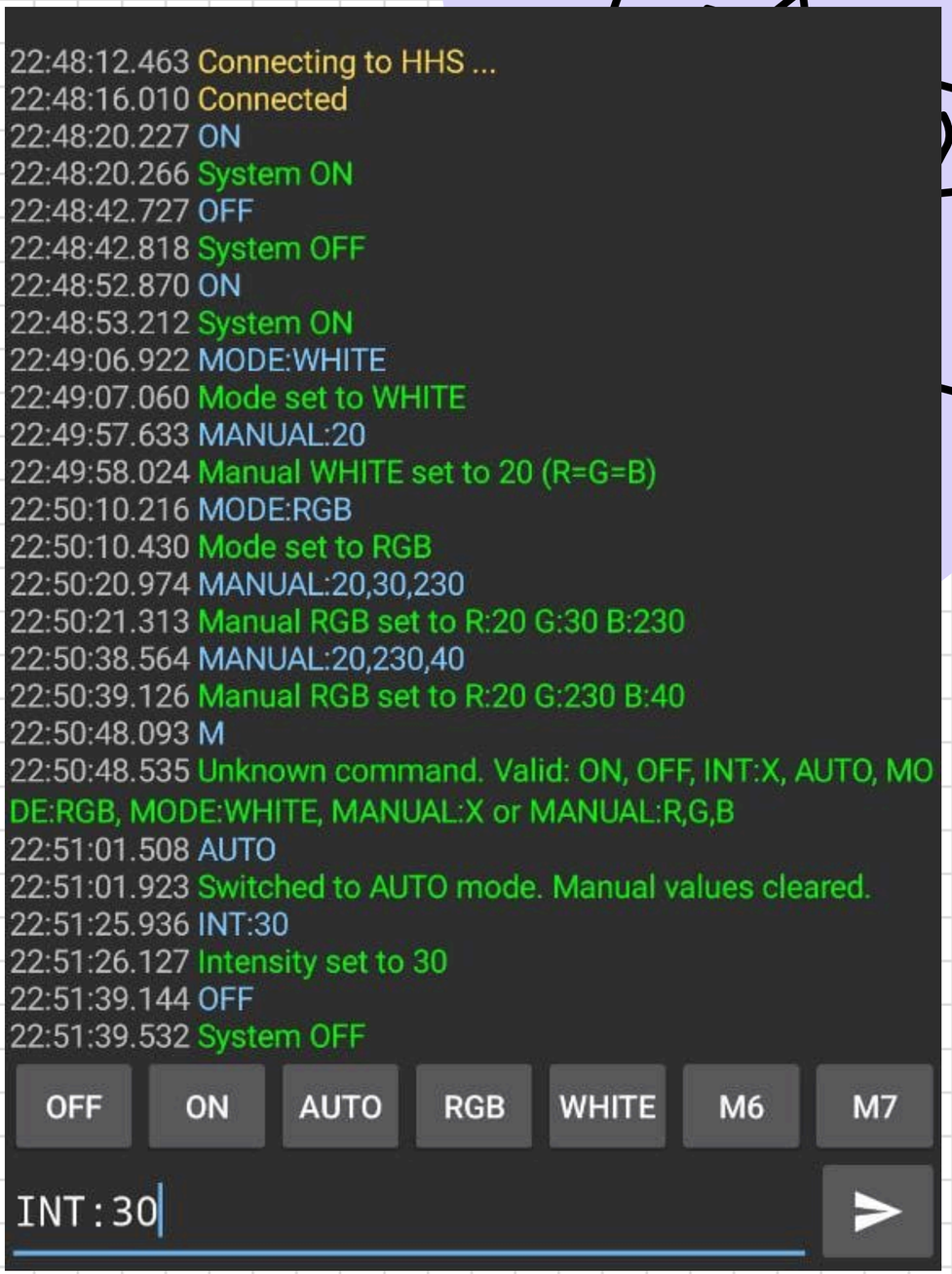
SET INTENSITY



INTERNET OF THINGS

Serial Bluetooth Terminal

Kai Morich



EFFECT OF VARYING PID VALUES

Test 1 (Kp = 2.5, Ki = 0.8, Kd = 0.0)

Target Color: RGB (220, 30, 200)

- Very fast response, but overshoots.
- Color flickers and becomes unstable.
- Strong influence of Kp and Ki without damping.

```
21:20:13.751 -> LDR: 0 | R:95 G:254 B:91
21:20:13.783 -> LDR: 0 | R:93 G:254 B:92
21:20:13.872 -> LDR: 0 | R:92 G:254 B:92
21:20:13.918 -> LDR: 0 | R:91 G:254 B:93
21:20:13.951 -> LDR: 0 | R:90 G:254 B:94
21:20:13.983 -> LDR: 0 | R:89 G:254 B:94
21:20:14.072 -> LDR: 0 | R:88 G:254 B:95
21:20:14.118 -> LDR: 0 | R:87 G:254 B:95
21:20:14.151 -> LDR: 0 | R:86 G:254 B:96
21:20:14.190 -> LDR: 0 | R:86 G:254 B:96
21:20:14.273 -> LDR: 0 | R:85 G:254 B:96
21:20:14.320 -> LDR: 0 | R:84 G:254 B:97
21:20:14.366 -> LDR: 0 | R:84 G:254 B:97
21:20:14.398 -> LDR: 0 | R:83 G:254 B:97
21:20:14.430 -> LDR: 0 | R:83 G:254 B:97
21:20:14.518 -> LDR: 0 | R:83 G:254 B:98
21:20:14.551 -> LDR: 0 | R:82 G:254 B:98
```

Test 2 (Kp = 0.4, Ki = 0.02, Kd = 0.6)

Target Color: RGB (80, 255, 100)

- Slow transition, minimal overshoot.
- System settles smoothly but takes time.
- Kd helps to reduce oscillations.

```
21:20:13.872 -> LDR: 0 | R:92 G:254 B:92
21:20:13.918 -> LDR: 0 | R:91 G:254 B:93
21:20:13.951 -> LDR: 0 | R:90 G:254 B:94
21:20:13.983 -> LDR: 0 | R:89 G:254 B:94
21:20:14.072 -> LDR: 0 | R:88 G:254 B:95
21:20:14.118 -> LDR: 0 | R:87 G:254 B:95
21:20:14.151 -> LDR: 0 | R:86 G:254 B:96
21:20:14.190 -> LDR: 0 | R:86 G:254 B:96
21:20:14.273 -> LDR: 0 | R:85 G:254 B:96
21:20:14.320 -> LDR: 0 | R:84 G:254 B:97
21:20:14.366 -> LDR: 0 | R:84 G:254 B:97
21:20:14.398 -> LDR: 0 | R:83 G:254 B:97
21:20:14.430 -> LDR: 0 | R:83 G:254 B:97
21:20:14.518 -> LDR: 0 | R:83 G:254 B:98
21:20:14.551 -> LDR: 0 | R:82 G:254 B:98
21:20:14.583 -> LDR: 0 | R:82 G:254 B:98
21:20:14.626 -> LDR: 0 | R:82 G:254 B:98
21:20:14.720 -> LDR: 0 | R:82 G:254 B:98
21:20:14.756 -> LDR: 0 | R:81 G:254 B:98
21:20:14.788 -> LDR: 0 | R:81
```

Ln 24, Col 37 ESP32 Dev Module on COM12

DISCUSSION

Functions

- Wireless control for easy lighting changes
- Smooth color transitions using PID for visual comfort
- RGB and White modes for personalized or functional lighting
- Adaptive brightness based on light sensor

Improvement

- Create more user-friendly app
- More sensors: Motion and temperature sensor
- Save energy: Auto dim or off when no one in the room
- Add voice control

CONCLUSION

This project successfully demonstrates a Smart RGB Lighting System that:

- Offers wireless, user-friendly control
- Provides smooth, comfortable lighting transitions
- Supports multiple lighting modes
- Enhances independence and quality of life for individuals with limited mobility

With some improvements like adding an app, voice control, and color temperature adjustments, it can become an even more effective and accessible lighting solution.