**Project Title:** ECRL (Eye Comfort Reading Light)  
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**Final Project Progress Update**

Since our last submission, we conducted intensive system-level testing using simulated environmental lighting. The aim was to validate LED control logic under rapidly changing conditions and boundary behaviors. As anticipated, the overall system architecture held up well, but we identified and resolved several subtle logic flaws that could have undermined the system’s robustness.

**New Logic Implementations and Refinements**

1. **Ratio-Stabilized Downscaling for Bright/Dark Modes**  
   To ensure stability in sudden light transitions, both **Too Bright** and **Too Dark** conditions now:
   * Apply proportional downscaling to both LEDs,
   * Iteratively preserve the output color ratio within a defined band (±2% of target),
   * Terminate when either LED reaches a practical cutoff (≤5).

This prevents unbalanced states (e.g., yellow-only or white-only light) from persisting in low-light edge cases.

1. **Hybrid Bootstrap in Comfort Band**  
   To address stagnation where LED intensity remains at zero even when ratio correction is needed, we implemented a conditional bootstrap:
   * When an LED’s value is zero, a minimal startup value is injected (5% of max),
   * This allows ratio corrections to initiate properly and avoids LED starvation.
2. **Precision Adjustment Logic Preserved**  
   All proportional calculations maintain the original logic:

adjust = 0.1 \* abs(currentYellowRatio - targetYellowRatio) \* maxLEDIntensity;

This ensures that changes remain smooth, reversible, and dynamic based on the actual deviation.

1. **Comfort Band Logic Encapsulation**  
   The final version uses a structured, simulation-based optimization to retain full autonomy in deciding the best action based on environmental readings and previous LED states.

**Challenges Addressed in Final Phase**

1. **Stuck LEDs at Low Intensity**  
   Scaling alone occasionally left one LED at a minimal level without extinguishing it. We introduced conditional thresholds (≤5) to force true zero output, avoiding residual glow and flicker.
2. **Sudden Light Drop Misinterpretation**  
   The original algorithm responded to external light loss by *increasing* LED output to maintain balance. With simulated action selection, the system now reduces output if that leads to better ratio correction.