Smart Bio-Adaptive Street Lighting System

Emotion + Environment + Smart Lighting Integration

BY- DEV GUPTA

OVERVIEW

A bio adaptive street lighting system that automatically adjusts intensity, color temperature, and direction of street lights based on real-time pedestrian emotion, crowd density, weather, noise levels, and even wildlife presence using edge AI and biosensors. The system aims to enhance public safety, reduce light pollution, and promote eco-sustainability, all while being autonomous.

PROBLEM STATEMENT

Our public lighting systems are outdated. They are unaware of the people they serve and unresponsive to the environment they exist in. In a world where smart, adaptive technology is everywhere our streets are still lit by one size fits all solutions.

Traditional street lights waste energy.

No response to noise or pollution in current systems.

PROJECT OVERVIEW

This project aims to build a next-generation streetlight that doesn't just turn on and off. It thinks, feels, and responds to the world around it.

- Uses AI and a camera to detect human emotions (like happy, sad, angry).
- Includes sensors to detect:
  - Motion (people nearby)
  - Sound (sudden noise or disturbances)
  - Air quality (pollution levels)
- Smart LEDs change their color and brightness based on emotions, noise, and environment.

KEY FEATURES

- **Emotion Detection using AI-**Uses a camera and DeepFace AI to recognize human emotions like happy, sad, angry, or neutral. Lighting changes based on detected mood to enhance comfort and safety.
- **Adaptive RGB LED Lighting-**LED colors and brightness adjust automatically based on emotion, environment, and activity. Creates a more personalized and soothing public space.
- **PIR Motion Detection-**Detects when someone is nearby and turns on or brightens the light. Helps conserve energy when no one is around.
- **Noise-Triggered Light Alerts-**Listens for loud sounds like shouting, crashes, or disturbances.
  Triggers a brighter light or color change to draw attention and improve safety.
- **Pollution-Based Dimming-**Monitors air quality using gas sensors. Lights dim or change color when pollution levels are high, acting as a subtle public warning.

Component List

- Raspberry Pi 5.
- Raspberry Pi Camera Module v2 or any Webcam.
- WS2812B RGB LED Strip.
- HC-SR501 PIR Motion Sensor.
- KY-038 or LM393 Microphone Sound Sensor Module.
- MQ-135 Gas Sensor.
- 12V Power Supply
- Breadboard and jumper wires

Other Supporting Materials and Optional Add-ons

- Resistors (for LED and sensor safety)
- MOSFET or Transistor (to drive LED strip)
- MicroSD Card (32GB or more for Raspberry Pi OS and code)
- DHT11 or DHT22: For adding temperature and humidity.
- GPS Module: To track streetlight location (in full-scale smart city use).
- ESP8266/ESP32: If you want to make sensor nodes wireless.
- Add solar + battery backup.

WORKING DEMO

- Happy Face → Yellow Light
- Angry Face → Red Light
- Sound Spike → Flashing Red
- Motion → Bright White
- Pollution → Dimmed Lighting

ADVANTAGES AND INNOVATION

- Emotion-aware lighting is innovative
- Reduces energy consumption
- Enhances public safety
- Adds intelligence to existing infrastructure
- Easy to scale for smart city applications

DISADVANTAGES

- AI-based emotion detection (DeepFace) can be inaccurate in low light or poor angles.
- Sensors (e.g., MQ135, sound sensors) need calibration and can give false readings.
- Environmental factors (rain, wind, noise) can affect sensor accuracy.
- Camera-based emotion detection may not work well with face masks or occlusions.
- Higher setup cost compared to traditional or solar street lights.
- Consumes more power due to continuous camera, sensors, and LED operation.
- Scaling this system across a city is expensive.

THANK YOU