Interior Light Control System using CC3200 and Android App

Niraliben Yash Jani - 22402416

Supervisor:
Prof. Dr. Goetz Winterfeldt

Introduction

This project presents a smart lighting control system designed for vehicle interiors.
It uses sensors to detect ambient light, a relay to switch lighting, and a rotary sensor to select Auto or Manual mode.

Image Source

Problem Statement

Manual interior light controls in vehicles can be inconvenient and inefficient, especially in changing lighting conditions.

Problems Addressed

- No automation in light adjustment.
- Lack of remote/manual override.
- No visual feedback for user.

Goal

Automate and remotely control interior light for enhanced comfort and safety.

Key Features

Dual Control Modes

- Auto Mode: Relay is triggered based on ambient light levels from the light sensor. Automatically switches interior lights ON in low-light conditions (e.g., nighttime).
- Manual Mode: User controls the relay manually using a rotary angle sensor. Provides direct, user-defined light control without automatic logic.

Wireless Communication (WiFi AP Mode)

- The CC3200 LaunchPad acts as a WiFi Access Point named LightControlAP.
- Enables direct connection between the Android device and the hardware without needing an external router or internet.
- Simple HTTP-based communication (/sensor, /relay, /mode, /override) for mobile app interaction.

Key Features

Android Mobile App Interface

- Built with Jetpack Compose for modern UI design.
- Displays real-time sensor readings: light intensity, rotary value, current mode, and relay status.
- Provides intuitive UI elements for:
  - Toggling modes (Auto/Manual)
  - Monitoring light conditions visually

Relay Override Mechanism

- User can override system logic using the mobile app.
- Activating override allows manual relay control even in Auto mode.
- Deactivating override resumes normal Auto/Manual behavior.
- Useful for situations requiring temporary lighting override (e.g., cleaning, emergencies).

Key Features

Safe & Efficient Energy Use

- Ensures lights are only active when needed:
- Prevents unnecessary battery drain in bright conditions.
- Reduces user distraction by adapting to ambient environment.
- Reliable threshold logic (lightVal < 1800) for safe operation in vehicles.

Modular Hardware Integration

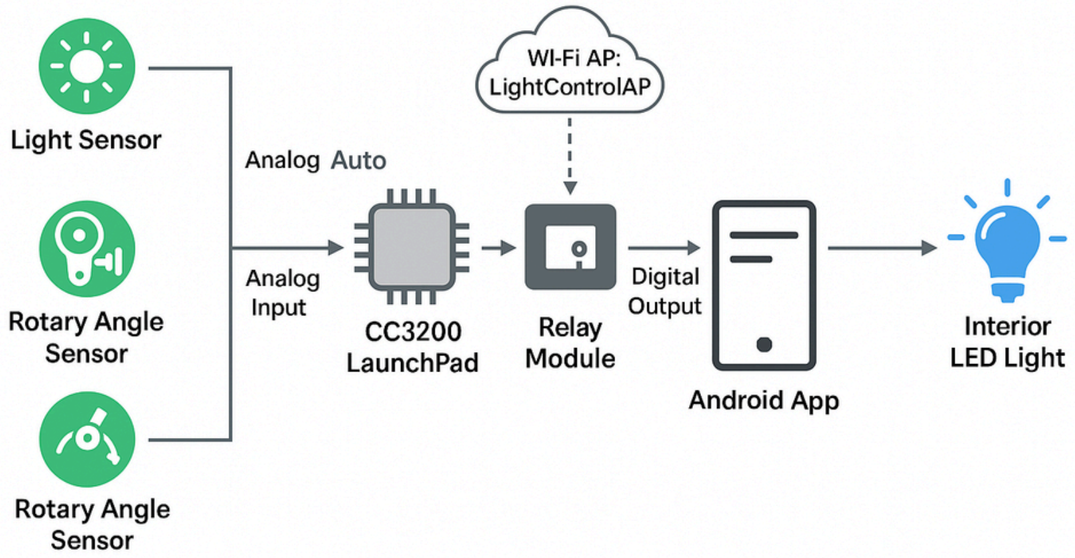
- Fully compatible with standard Grove sensors:
- Light Sensor (Grove Light Sensor v1.2)
- Rotary Sensor (Grove Rotary Angle Sensor)
- Relay Module
- Can be easily extended to include sound alerts, brightness control (PWM), or history logging in future versions.

System Architecture Overview

This smart interior lighting control system uses sensor-based automation and mobile connectivity to enhance user comfort and energy efficiency inside vehicles.

Core Components

- **Light Sensor (A1)**
  - Detects ambient brightness in the vehicle.
  - Data is sent to the CC3200 microcontroller.
- **Rotary Angle Sensor (A2)**
  - Allows selection between Auto and Manual mode.
  - Determines user preference for automated or manual control.



System Architecture Overview

- **Relay Module (D4)**
  - Acts as a switch to turn the interior light ON/OFF.
  - Controlled by CC3200 based on logic or manual command.
- **CC3200 LaunchPad**
  - Central processing unit of the system.
  - Operates in WiFi Access Point mode (LightControlAP).
  - Hosts a RESTful HTTP server to expose sensor data and accept control commands.
- **Android App**
  - Connects to CC3200 over WiFi.
  - Displays real-time data: light level, mode, relay state, rotary value.
  - Allows user to override relay, toggle modes, and monitor system behavior.

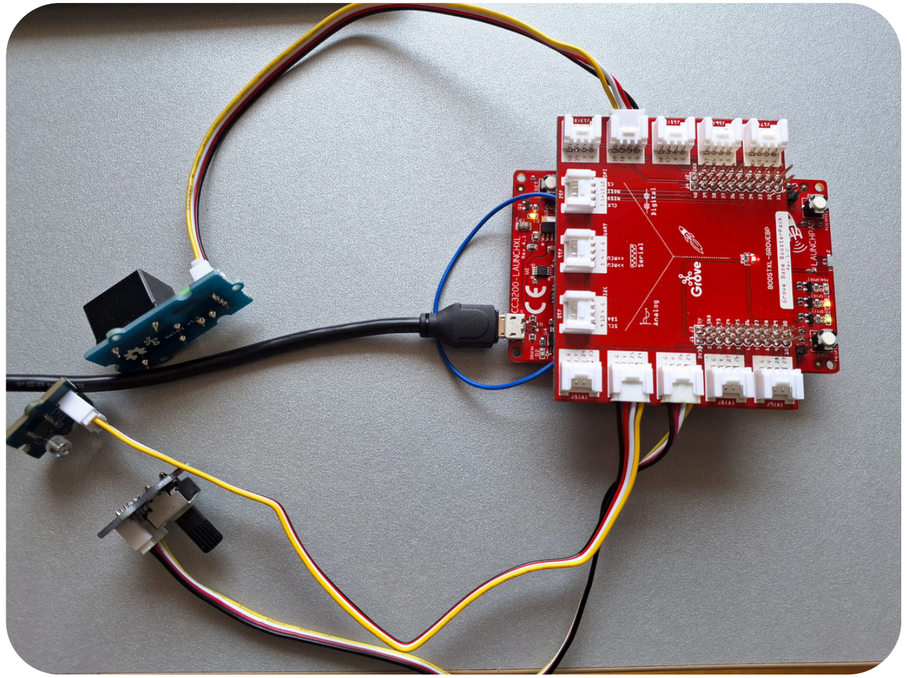
Communication Flow

- Sensors send analog signals to the CC3200.
- CC3200 processes input and decides the relay state.
- Android app communicates via HTTP (e.g., /sensor, /relay?state=on).
- Relay toggles light based on Auto/Manual logic or override commands.

Hardware Connections

- Light Sensor → J6(A) (analog input)
- Rotary Sensor → J7(A) (analog input)
- Relay Module → J14(D) (digital output)
- 5V and GND connected to sensors
- CC3200 operates in Access Point Mode

A simple breadboard setup with Grove connectors is used for prototyping



Energia Firmware Logic

- Reads light and rotary sensor values.
- Determines Auto or Manual mode based on rotary input.
- Activates relay when brightness threshold is crossed.
- Supports override commands from Android App via REST API.

Endpoints:

- `/sensor` – Return system state in JSON
- `/relay?state=on|off` – Override relay
- `/mode?state=auto|manual`
- `/override?state=exit`

Android App UI Design

Features:

- Top bar with title, WiFi icon, and theme toggle
- Real-time light and relay monitoring
- Mode toggle (Auto/Manual)
- Manual relay control (Override)
- Light condition visualization (color-coded)
- Car image and system status messages

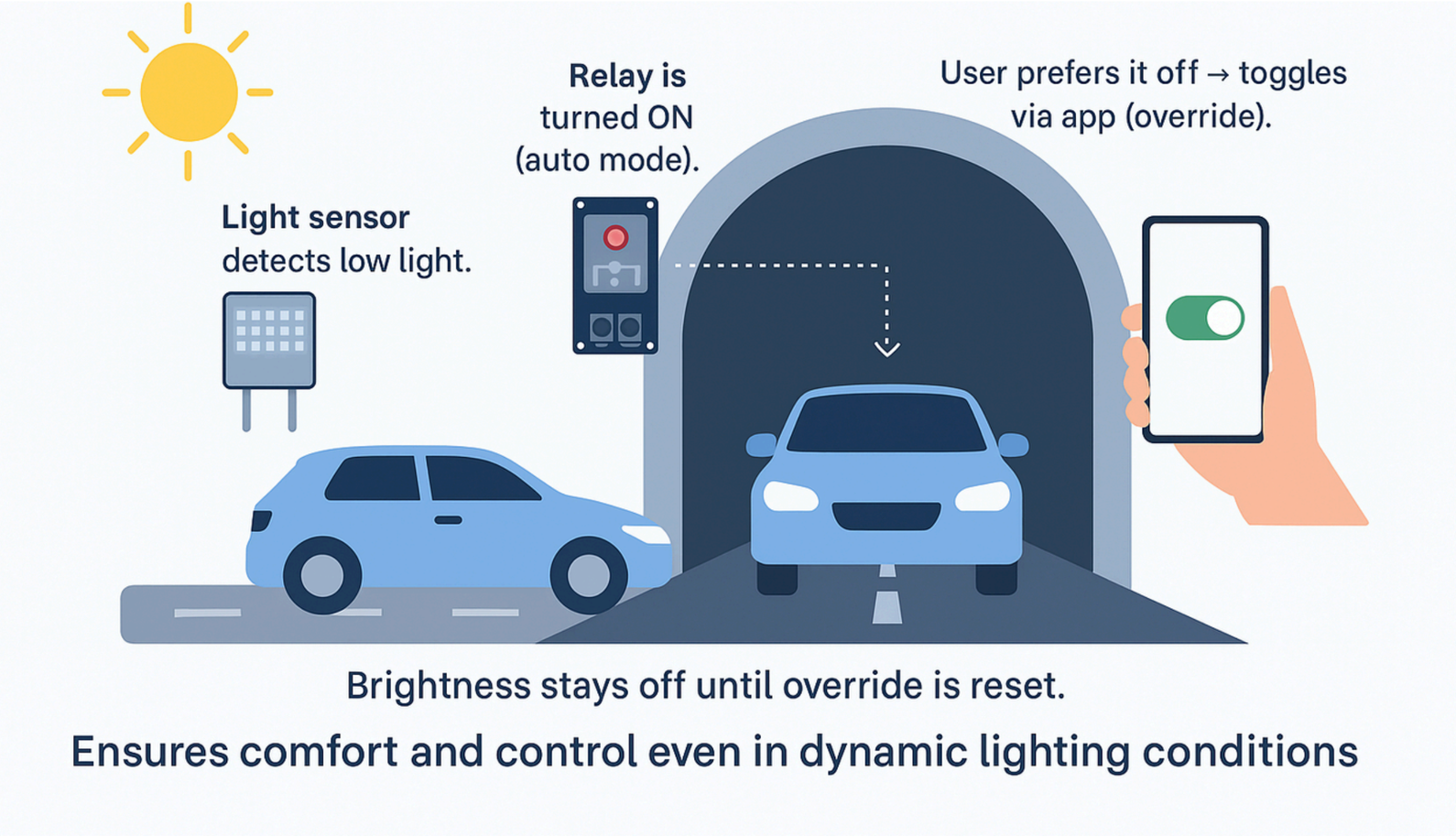
Android Networking Logic

Core Functionality:

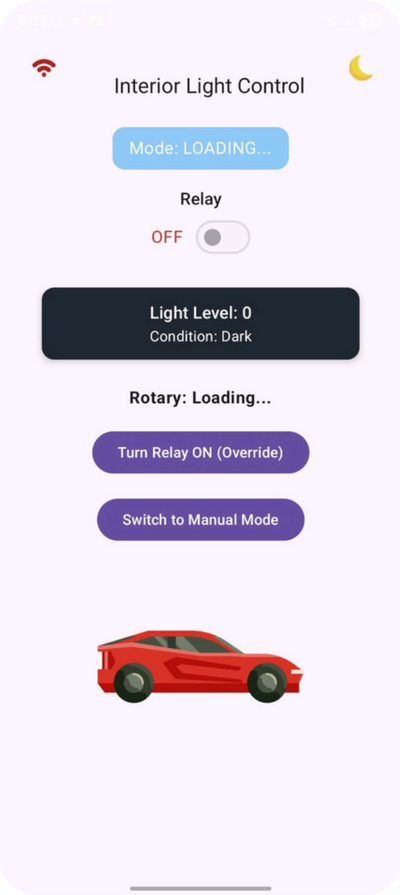
- Sends periodic HTTP GET requests to `http://192.168.1.1/sensor`
- Parses JSON to update UI: mode, relay, light, rotary, override
- Sends commands (relay/mode/override) based on user interaction
- Graceful error handling and WiFi status indicators

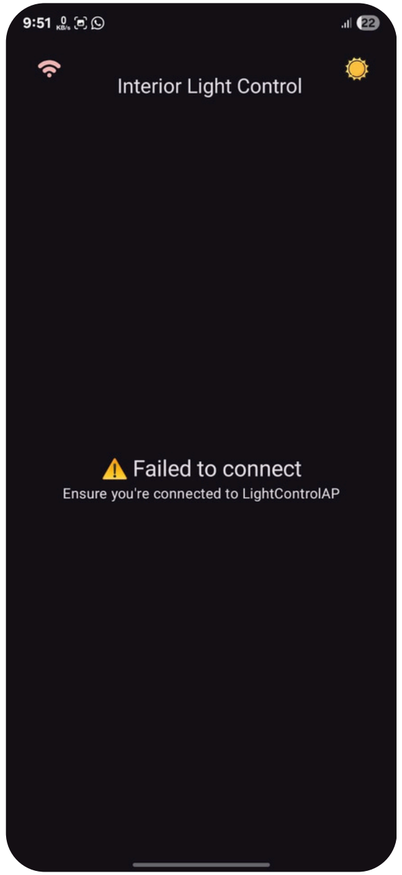
Use Case Scenario

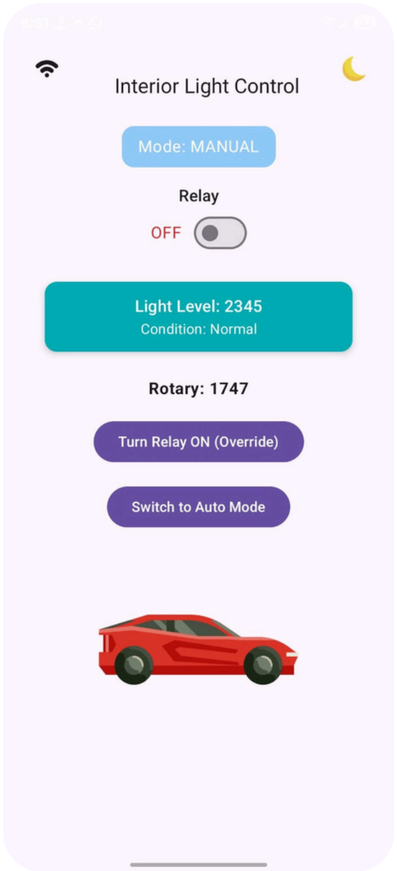
Scenario: A car enters a dark tunnel

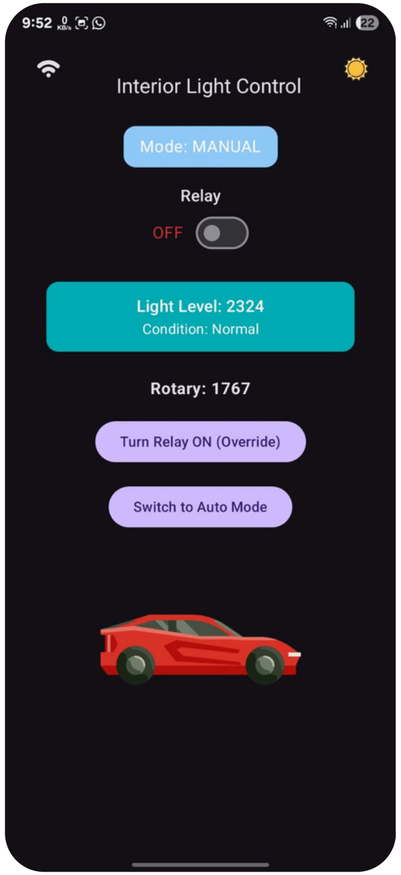


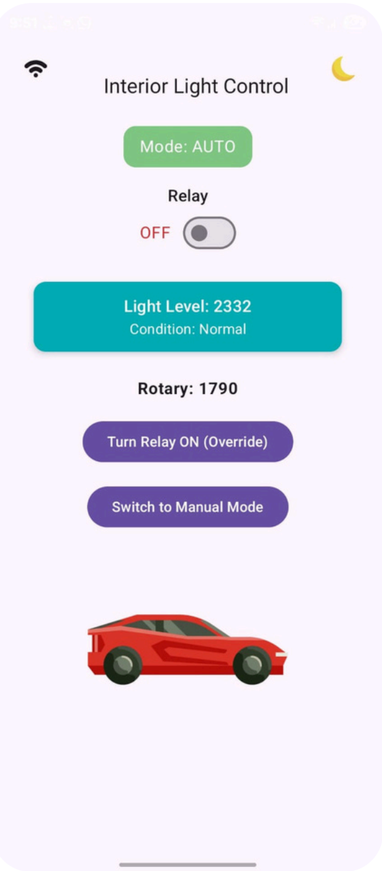
Screenshots











Advantages

- Simple and effective automation for vehicle interiors
- No need for cloud or third-party servers
- Easy to use Android app interface
- Fully offline-capable (WiFi AP)
- Reusable for other smart light scenarios

Limitations & Challenges

Limitations:

- WiFi AP limits phone's internet access
- Manual rotary control may be imprecise
- No persistent memory

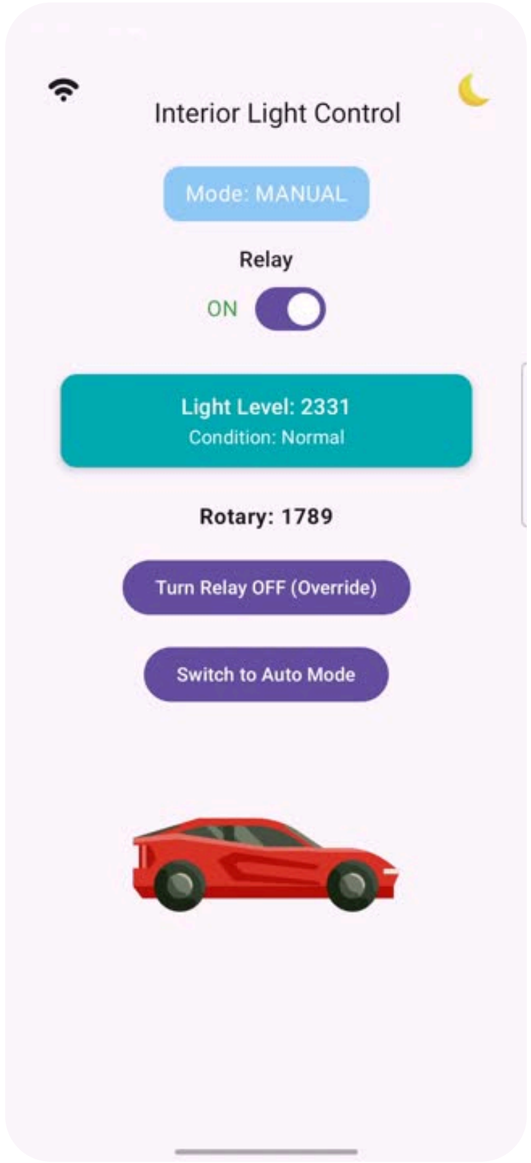
Challenges Faced:

- Android-CC3200 connection instability
- Parsing analog sensor values correctly
- UI responsiveness in Compose

Future Improvements

- Add LED brightness control via PWM (already supported in firmware)
- Bluetooth communication fallback
- Add scheduling feature in app

Demo Video


Interior Light Control
Mode: MANUAL
Relay
ON
Light Level: 2331
Condition: Normal
Rotary: 1789
Turn Relay OFF (Override)
Switch to Auto Mode

Thank You

A reliable and practical project integrating embedded systems with mobile UI to provide an intelligent lighting solution.

Technologies Used: Energia (C/C++), Jetpack Compose (Kotlin), WiFi communication