Smart Curtains and Smart Lighting

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Abstract. This project introduces a smart system for automated lighting and curtain control that combines sensors, microcontrollers, and IoT integration. Using Arduino Uno, NodeMCU ESP8266, Light Dependent Resistors (LDRs), and a stepper motor, the system dynamically manages indoor lighting and curtains based on ambient light conditions. Additionally, users can exercise manual control via the Blynk mobile application. The overall goal is to improve energy efficiency, comfort, and user convenience through intelligent light management.

1. Introduction

The demand for smart home automation has grown significantly in recent years due to advancements in IoT and consumer interest in energy-efficient solutions. This project presents a light-responsive system that automatically adjusts indoor lighting and curtain positions, minimizing energy wastage while ensuring optimal illumination. Unlike traditional systems, it provides both automation and manual override, empowering users with flexibility through smartphone-based control.

2. Literature Review

Several studies have explored smart lighting and curtain systems within the domain of IoT-based home automation:

- Smart Lighting Systems: Research on IoT-driven lighting control highlights the potential for energy savings when sensors detect ambient light or occupancy. Commercial solutions such as Philips Hue provide user-friendly control but often at a higher cost.
- Curtain Automation: Prior works on automated curtain systems integrate motorized mechanisms with light sensors, enabling dynamic shading. Some projects extend functionality with voice assistants such as Google Assistant and Alexa.
- Hybrid Approaches: Many experimental studies propose combining lighting and curtain control into one system, but implementation often faces challenges in communication reliability and real-time responsiveness.

This project draws inspiration from such research while focusing on affordability, ease of integration, and seamless IoT connectivity using Arduino and NodeMCU.

3. System Design and Methodology

The proposed system integrates sensor data acquisition, communication, IoT connectivity, and actuation.

3.1 Components Used

The major hardware and software components include Arduino Uno, NodeMCU ESP8266, Stepper Motor (28BYJ-48 with ULN2003 driver), LDR sensors, resistors, jumper wires, power supply, and the Blynk IoT mobile application.

3.2 System Workflow

Figure 1 illustrates the overall workflow of the system.
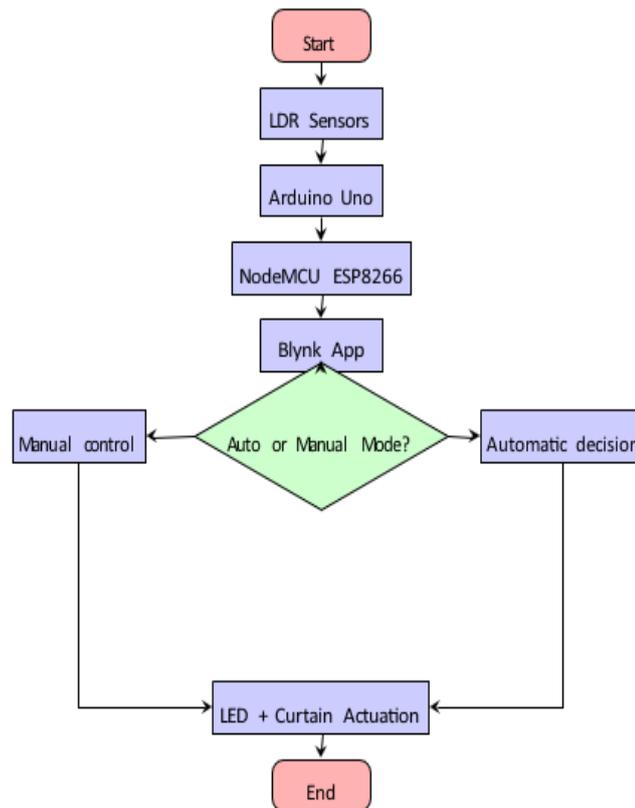
4. NODEMCU ESP8266 and Arduino Uno Code

Figure 1: Overall System Workflow.

4.1 ESP8266

The following is an excerpt from the ESP8266 code listing

```
#define BLYNK_TEMPLATE_ID "TMPL37wx3ihjw"

#define BLYNK_TEMPLATE_NAME "ESP8266"

#define BLYNK_AUTH_TOKEN "hkpdA3dimkCpoOJ2wGzlKtry

#include <SoftwareSerial.h>

#include <ESP8266WiFi.h>

// ... (omitted for brevity)
```

```
// WiFi credentials

char ssid[] = "ZTE_2.4G_Fp2rnJ";

 char pass[] = "hFNY4DT3";

// ... (omitted for brevity)

// Hardware pins

#define LED_PIN D8

// Blynk handler: Stepper clockwise

// ... (omitted for brevity)

int mode = 0;

int manualLEDState = 0;

// ... (omitted for brevity)

//0

manual, 1= auto

const int LDR_THRESHOLD = 50;

// ... (omitted for brevity)
```

4.2 Arduino Uno

The Arduino Uno code handles reading the LDR values and communicating them to the NodeMCU

```
void setup () {

Serial.begin(9600);

}

void loop () {

int ldrLED = analogRead(A0);

int ldrMotor = analogRead(A1);

Serial.print (ldrLED);

Serial.print(",");
```

4.3 Automatic Mode Logic

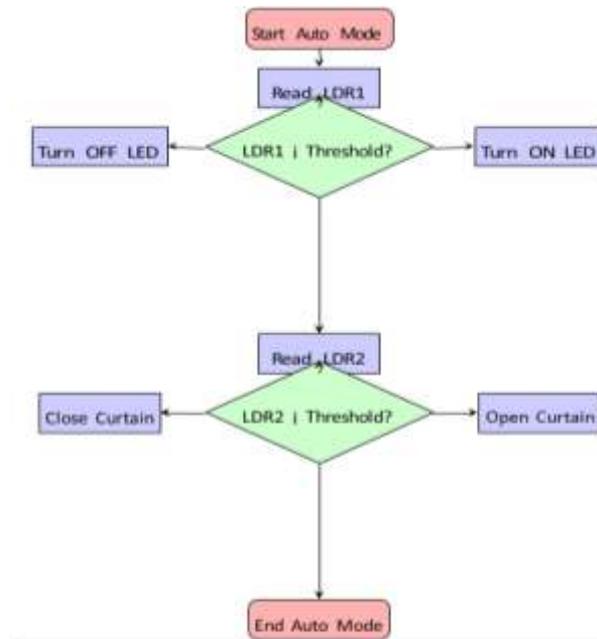In automatic mode, decisions are made based on sensor thresholds (Figure 2).

Figure 2: Automatic Mode Control Flow.

4.4 Manual Mode Logic

When the user selects manual mode, control is passed directly from the Blynk app (Figure 3).
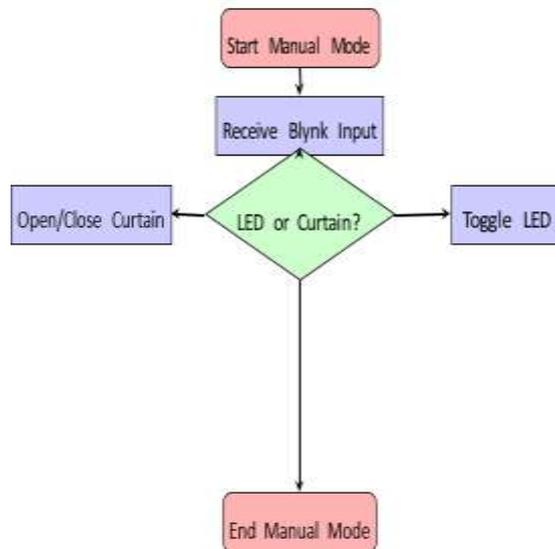

Figure 3: Manual Mode Control Flow.

5. Experimentation and Testing

The system was tested under different light conditions to fine-tune LDR thresholds. Results show reliable light detection, stable Wi-Fi communication, and smooth motor performance. Manual overrides remained responsive, ensuring consistent user control.

6. Implementation

The proposed system was implemented using affordable microcontrollers and sensors. Key hardware components include the stepper motor for curtain actuation and the NodeMCU ESP8266 for IoT integration.

6.1 Stepper Motor

The curtain actuation was carried out using a 28BYJ-48 stepper motor, which provides precise control for opening and closing the curtains. Figure 4 shows the motor used in the prototype.

Figure 4: 28BYJ-48 Stepper Motor used for curtain actuation.

6.2 NodeMCU, ESP8266

The NodeMCU ESP8266 served as the Wi-Fi-enabled controller for transmitting sensor values to the Blynk IoT platform. It also enabled real-time user interaction through the mobile application. Fig. 5 shows the NodeMCU used in this project.
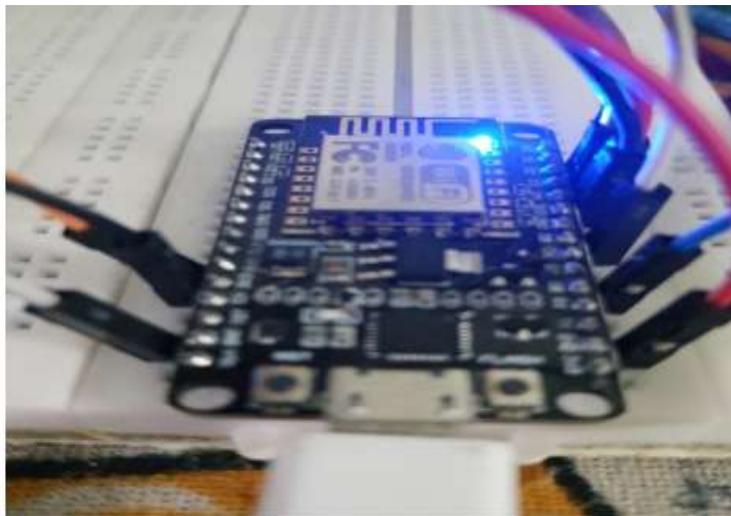

Figure 5: NodeMCU ESP8266 Module Connected on a Breadboard.

7. Applications

The proposed system has broad applications in:

- Residential Homes: Energy saving and convenience in daily routines.
- Offices: Natural light management to reduce artificial lighting.
- Hospitals: Enhancing patient comfort with optimal lighting.

- Hospitality: Personalized automation for guest experiences.

8. Conclusion

This project demonstrates a cost-effective and efficient smart lighting and curtain system using Arduino and NodeMCU integration. It enhances energy efficiency and user convenience through IoT connectivity, offering both automation and manual control. Future developments may include voice assistant integration, machine learning for predictive automation, and scalability for commercial use.

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