Programming environment:

VS Code + PlatformiO

Deciding factors:

PlatformIO IDE is a powerful and feature-rich development environment for a larger project that uses the Arduino framework but supports a wider range of microcontroller platforms and development boards, helps maintain better project structure and code maintainability by allowing for proper C++ conventions (separate .h and .cpp files), and offering more efficient debugging and tooling.

Logic description:

1. Setup (setup())

- Initializes **serial communication** for debugging.
- Configures **GPIO pins** for button, relay, LED, and battery voltage monitoring.
- Sets **button interrupt** to wake the device on a press.
- Enters **sleep mode immediately** after initialization.

2. Main Loop (loop())

- Wakes up on button press and processes it (handleButton()).
- If device is ON:
    - Checks battery voltage every 5 seconds.
    - Toggles relay at the set frequency.
    - Updates LED indicator.
- If device is OFF, it enters sleep mode after 500ms.

3. Button Handling (handleButton())

- Uses debounce logic to ensure stable button readings.
- Short press toggles the device ON/OFF.
- Long press:
    - Adjusts the relay toggle frequency.
    - If the button remains pressed, keeps changing frequency at set intervals.

4. Changing Relay Frequency (changeFrequency())

- Cycles relay toggle frequency between 1s and 10s.
- Automatically reverses direction when reaching limits (10s -> 9s -> ... -> 1s -> 2s ...).
- LED briefly flashes to indicate a frequency change.

5. Relay Toggling (toggleRelay())

- Switches the relay ON/OFF at set intervals.
- Prints status to serial monitor for debugging.

6. Battery Monitoring (checkBatteryVoltage())

- Reads voltage using an analog pin.
- Converts ADC value to actual voltage using a voltage divider.
- If voltage < 3.0V, sets lowBatteryDetected = true and starts rapid LED blinking.

7. Sleep Mode (enterPowerSavingMode())

- Disables ADC to reduce power consumption.
- Uses SLEEP_MODE_PWR_DOWN to enter sleep.
- Execution halts until button press wakes it up.

8. Wake-up Handling (exitPowerSavingMode())

- Re-enables ADC after waking up.
- Ensures the system resumes normal operation.