Universidad de Guadalajara

Centro Universitario de Ciencias Exactas e Ingenierías

Seminario de problemas de programación de sistemas embebidos I19893 – D01

Activity 5

PWM Generation with ESP32 Using a Potentiometer and an LED

Prof. Martínez Sandoval, Daniel Giovanni

Students:

Cabrera Gómez, Sergio Nicolas

Code: 222328115

Davalos Magaña, Jonathan Israrel

Code: 219339068

Martinez Flores, Cassandra Frine

Code: 218456125

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Abstract This document presents the design and implementation of a pulse-width modulation (PWM) system using an ESP32_Dev Module, a potentiometer, and an LED. The duty cycle variation is achieved by reading the potentiometer's analog input, allowing real-time brightness control of the LED. The implementation is carried out in the Arduino IDE environment.

Keywords ESP32, PWM, Arduino IDE, Potentiometer, Brightness Control, Pulse-Width Modulation.

Introduction Pulse-width modulation (PWM) is a technique used to control the power delivered to electronic devices. In this project, a system is implemented that allows the duty cycle of a PWM signal to be varied using a potentiometer as input, enabling real-time brightness adjustment of an LED.

Related Work Various studies have explored PWM generation with microcontrollers such as Arduino and PIC. The advantage of the ESP32 lies in its ability to generate high-resolution PWM signals and its ease of programming through the LEDC module.

Theoretical Framework PWM is a technique where a digital signal varies its duty cycle to control the power delivered to a device. In the ESP32, PWM is generated using the LEDC peripheral, which allows defining the frequency and resolution of the duty cycle. The potentiometer's analog reading is converted to a digital value and mapped to adjust the PWM duty cycle.

Methodology The system development follows these steps:

- Configuration of the ESP32 and connection of the components.
- Reading the potentiometer's analog value.
- Mapping the read value to an appropriate PWM range.
- Applying the calculated duty cycle to the LED.

Materials and Methods

Components Used:

- ESP32-WROOM-32
- 10kΩ Potentiometer
- High-brightness LED
- 330Ω Resistor
- Breadboard and connecting wires

Circuit Design The potentiometer is connected to the ESP32's analog input GPIO34. The LED is connected to the digital output GPIO32 through a limiting resistor. The PWM signal generated at GPIO32 controls the LED's brightness.

Software Implementation The code was developed in Arduino IDE and contains the following functions:

- **setup()**: Initializes serial communication and configures the LED pin as an output.

- **loop()**: Reads the potentiometer value, converts it to voltage, and calculates the PWM duty cycle.

Key Lines of Code Explained

- **Potentiometer Reading and Voltage Conversion:**

```
potVa = analogRead(ppot);
  volt = potVa * (voltR / 4095.0);
```

This section of the code converts the analog reading into a voltage value based on the ESP32's ADC range.

- **PWM Duty Cycle Calculation:**

```
int brillo = map(potVa, 0, 4095, 0, 255);
```

The read value is scaled to a range of 0 to 255 to define the LED's intensity.

- **Applying PWM to the LED:**

```
analogWrite(pled, brillo);
```

This command adjusts the duty cycle based on the calculated value, allowing control of the LED's brightness.

Results and Discussion The system functioned stably, enabling progressive brightness control of the LED in response to the potentiometer's rotation. The system's response was verified to be immediate and proportional to the potentiometer adjustment.

Conclusion The effectiveness of PWM in controlling electronic devices was demonstrated. The ESP32 implementation allowed efficient PWM handling with minimal processing load.

References

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