Servo Motor SG90 Overview

The SG90 is a small, lightweight, and inexpensive servo motor commonly used in robotics and DIY electronics projects. It can rotate to a specified angle within a range of approximately **0° to 180°**, making it ideal for applications requiring controlled movement like opening doors, steering, or pan-tilt mechanisms.

Key Features:

- **Weight:** ~9 grams.
- **Torque:** Around 1.8 kg/cm (sufficient for light applications).
- **Operating Voltage:** 4.8V to 6V.
- **Signal Control:** Operates via **Pulse Width Modulation (PWM)** signals.

How Servo Motors Work

The SG90 is a **position-controlled device**. It has three main components:

1. **DC Motor:** Provides rotational power.
2. **Gear Reduction System:** Reduces speed and increases torque.
3. **Control Circuit:** Receives PWM signals and adjusts the motor's position accordingly.

The motor's position is determined by the width of a pulse sent via the **signal pin**. This is known as **Pulse Width Modulation (PWM)**.

PWM Signals and Pulse Widths

A servo motor responds to the width of pulses in the PWM signal sent to its control pin. The pulse width determines the servo's position:

Key PWM Parameters:

1. **Frequency:**
    - Standard PWM signals for servos operate at **50Hz** (period = 20ms).
2. **Pulse Widths:**
    - The SG90 responds to pulses ranging from **1ms to 2ms** within the 20ms period:
        - **Minimum Pulse (~1ms):** Rotates the servo to 0°.
        - **Neutral Pulse (~1.5ms):** Moves the servo to 90° (middle position).
        - **Maximum Pulse (~2ms):** Rotates the servo to 180°.

3. **Angle Control:**
    - The width of the pulse is directly mapped to the servo's angle:
        - **1.0ms → 0°**
        - **1.5ms → 90°**
        - **2.0ms → 180°**

How Everything Works

1. **PWM Signal Input:**
    - A PWM signal is sent to the servo's control pin (via a microcontroller like an Arduino).
    - The pulse width within the 20ms period specifies the desired angle.
2. **Internal Circuitry:**
    - The control circuit inside the servo measures the duration of the pulse.
    - It compares the pulse width to the desired angle and generates a corresponding control signal for the DC motor.
3. **Position Feedback:**
    - The servo contains a **potentiometer** connected to its output shaft.
    - The potentiometer measures the current position and provides feedback to the control circuit.
    - If the position doesn't match the desired angle, the control circuit adjusts the motor's rotation to correct it.

Servo Control Pins

The SG90 has three pins for operation:

1. **VCC:** Power input (4.8V–6V).
2. **GND:** Ground connection.
3. **Signal:** Input for PWM signals to control the angle.

Why Minimum, Neutral, and Maximum Pulses?

- **Minimum Pulse (1ms):** Represents the smallest angle the servo can achieve (0°).
- **Neutral Pulse (1.5ms):** Positions the servo in the middle (90°). It’s often used as the starting or default position.
- **Maximum Pulse (2ms):** Represents the largest angle the servo can achieve (180°).

Key Points About SG90 and PWM:

1. **Why Pulse Width is Important:**
    - The servo interprets the length of the pulse as a position. A wider pulse moves the servo to a higher angle.
2. **Why 50Hz Frequency?**
    - The servo motor requires a steady pulse train at a low frequency to function correctly. The 50Hz frequency ensures the motor has time to stabilize after each signal.
3. **Why Include Feedback?**
    - The internal feedback ensures precise positioning, allowing the servo to adjust itself to the desired angle.

Why Is One Pulse Enclosed in 20ms?

The 20ms period includes:

1. **Active Time:** The pulse width (1ms–2ms) determines the position.
2. **Idle Time:** The remaining ~18ms ensures stability and prevents overheating or overdriving the motor.

Does It Work with DC Power?

- **No Direct DC Input:** The servo motor requires a PWM signal for position control.
- **Passive Components:** Without PWM, the motor would simply run to the maximum or minimum physical limits based on its design.

[How does a Servo Motor Work and How to Interface it with ESP32?]

[All about SG90 Servo Motor: Precision Control and How to Use It]

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