

How Does the Servo Know Where It Is When It Powers Up?

User: How does the servo know where it is when it powers up?

Assistant: When a standard hobby servo motor powers up, it does not inherently know its current position because standard hobby servos lack position feedback or memory. Here's a detailed explanation:

1. Default Behavior at Startup

- Most hobby servos do not have internal position memory. When powered up, they will remain in their last position (physically) unless explicitly commanded to move by a control signal.
- Upon receiving a control signal (PWM), the servo moves to the specified position.

2. Control Signal at Startup

- If a servo receives a PWM signal immediately upon powering up, it will move to the position specified by that signal.
- Example: If the control signal corresponds to a 90 position, the servo will rotate to 90 regardless of its actual starting position.

3. External Position Feedback

- Standard hobby servos do not have an encoder or feedback mechanism that reports their current position back to the controller.
- If the system needs to "know" the position after startup, the servo must be moved to a known reference position (e.g., fully closed or open) as part of an initialization process.

4. Initialization Routine

A common approach is to include an initialization routine in the software to ensure the servo starts from a known position:

- Power up the servo.
- Send a command to move it to a known reference position, such as 0 or 90.
- From that point onward, track its position based on the commands sent.

Example Code for Initialization:

```
```python
Initialize servo to a known position (e.g., 0 degrees)
set_angle(0) # Move servo to the starting position
```
```

5. Advanced Servos with Feedback

- Some advanced servos (e.g., digital servos or servos with encoders) have internal memory or feedback sensors that allow them to:
 - Detect their position relative to an internal reference.
 - Provide position feedback to an external controller.
- These are more expensive and typically used in robotics or industrial applications.

User: OK. I'm still a bit confused. If I run the servo to 90 degrees, then the power goes off and comes back on again and tell it to go to 45 degrees, is that an absolute position?

Assistant: Great question! Here's the precise answer:

When power is restored, if you command the servo to go to 45 degrees, it will move to 45 degrees relative to its current understanding of position based on the PWM signal.

Why This Happens

1. ****Servo Basics****:

- Hobby servos do not track their physical position.
- They only move based on the PWM signal sent to them. For example:
 - A PWM signal corresponding to 45 degrees will always instruct the servo to rotate to what it interprets as 45 degrees, regardless of its actual position.

2. ****Your Scenario****:

- Initially, the servo starts moving toward 90 degrees.
- At 45 degrees (halfway there), power is lost. At this point, the servo has no memory of where it physically stopped.
- When power is restored, the servo does not know it is physically at 45 degrees. It assumes no prior state.
- Upon receiving the command to go to 45 degrees, it reinterprets "45 degrees" as an absolute target position and moves to what it calculates as 45 degrees based on the new PWM signal.

Key Takeaways:

- Servos are absolute-positioned relative to the control signal (PWM), not their actual physical state.
- Power loss interrupts all motion and wipes any tracking of the servo's physical position.
- A fresh command after power is restored will always move the servo to the position defined by the new PWM signal.

User: I'm confused. You said that the servo has no memory of its position after a power loss. But the potentiometer provides that information, doesn't it?

Assistant: You're absolutely right to point that out! Let me clarify this crucial detail about how the potentiometer works in a servo motor and why it still appears as though the servo "loses" its position after a power loss.

The Role of the Potentiometer

The potentiometer is a key component in the servo's internal feedback loop. It continuously reports the current position of the servo's output shaft as a voltage. Even after a power loss:

- The potentiometer's position remains mechanically tied to the output shaft.
- When power is restored, the potentiometer still reflects the correct physical position of the servo.

Why Servos Seem to Forget Their Position

Despite the potentiometer providing accurate position feedback, the control circuit of the servo doesn't retain any information about:

- The last commanded position (from the PWM signal).
- Whether the current position matches the intended target.

When power is restored:

1. The servo's control circuit resets to a default state.
2. It waits for a new PWM signal to tell it where to go.
3. The potentiometer doesn't communicate its position externally - it only informs the servo's internal control loop.

User: Not now. Your explanation is now very clear. Thanks!

Assistant: You're very welcome! I'm glad the explanation is clear now. If you ever have more questions or need assistance in the future, feel free to ask. Good luck with your projects, and happy building!