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Stepper Motors versus Servo Motors

The following will compare the differences between Stepper and Servo Motors, and when each technology is most appropriate for use in specific applications.

Closed-Loop vs. Open-Loop:

Stepper Motors are generally operated under open-loop control. Commands determine the specified movement of the Stepper Motor. In rare instances, Stepper Motors can stall or lose steps, due to resonance issues or unexpected force. While it is a rare occurrence, the possibility is a drawback for Stepper Motor technology. Stepper Motors can operate in a closed-loop configuration. However, this results in a costly system design.

Servo Motors offer constant positional feedback. Constant feedback eliminates the potential for stalling, and allows the motor to correct any positioning discrepancies. The closed-loop configuration that Servo Motors offer allows the motor to generate faster speeds and up to three times the torque than their Stepper counterparts.

Speed and Power:

At high speeds, Stepper Motors typically have poor torque characteristics. Through microstepping, torque can be improved. However, unless Stepper Motors are used in closed-loop mode, they do not perform as well as Servo Motors.

Comparing similar sizes, Servo Motors can generate speeds and power anywhere between two and four times the speed of a Stepper Motor. Servo Motors operate under constant position feedback (closed-loop), allowing for higher speed and greater reliability. Servo Motors perform under a closed-loop system, allowing the Servo Motor to attain higher peak torque capabilities.

Required Maintenance and Reliability:

Stepper Motors are brushless so they are not prone to wear and require no maintenance.

Servo Motors are available in brush-type or brushless options. Similar to steppers, brushless Servo Motors do not require maintenance. However, brush-type Servo Motors generally require a change of brushes every 5,000 hours.

Accuracy and Resolution:

Stepper Motors generally produce 200 full steps, 400 half steps, and up to 25,000 microsteps per revolution. The specified location is not always achieved, due to the Stepper Motor's open-loop nature, especially when operating under a load. To attain a smooth motion, microstepping is often used; however, it often results in less positional accuracy.

Servo Motor resolution is dependent upon the type of encoder used. Most encoders produce between 2,000 and 4,000 pulses per revolution, while some can produce up to 10,000 pulses per revolution. Servo Motors can maintain positional accuracy due to their closed-loop operation.

Selecting a System:

Stepper Motors are commonly recommended for applications that are cost-sensitive and low maintenance. Steppers provide stability and flexibility; they do not fluctuate in positioning, especially under dynamic loads, and can be run in open or closed-loop configurations. If run within their specifications, no encoders are needed.

Servo Motors are recommended for high-speed (typically greater than 2,000 RPM) and high-torque applications requiring dynamic load changes. Servo Motors require higher maintenance and a more complex setup, but do not create vibration and/or resonance issues like Stepper Motors may.