Running Efficiently with Robotics

Brendan Murphy

Pembroke High School

Running Efficiently with Robotics

1.Intro

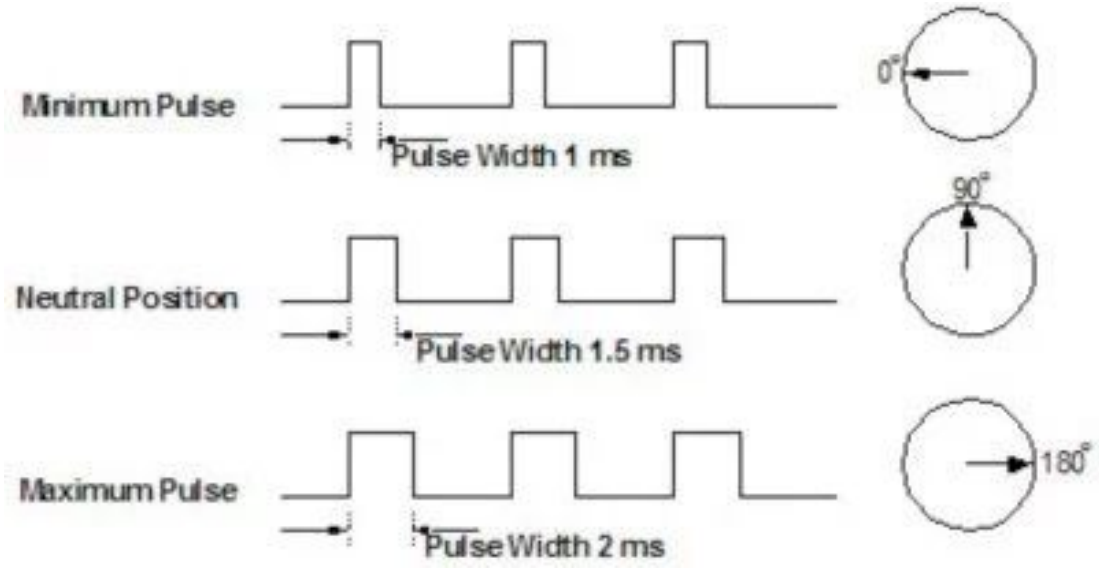
The integrated development of technology into the modern society has released a widespread demand for certain challenges to be met by robotics. Although most developments have been able to meet the standards of society, there is and always has been, a growing demand for more solutions to be paired with these engineering feats. In developing these impressive devices, one major impeder of the mechanical design is the lack of control. In creating a virtual simulation, the code that is used is almost always followed with a mathematical precision that demonstrates the “best case scenario” of the design. This is unfortunately not the case with actual robotics, as precision can be a highly difficult to obtain. The design of such precision motors has thusly made a great impact on the world since their first creation amidst the 19th century.

2.1 Types of Motors

Motors, an iterative development that has come about through the centuries, have varying designs and uses. Precision motors precisely, have two main designs: servo and stepper. These two designs utilize different techniques to create a controlled motion within the motor. Neither of these are necessarily classes of motors, but terms used to describe specific motor designs.

2.2 Servos

Servo motors are a type of actuator, both linear and rotational, that allows for the direct control over the motion. This is achieved through what is described as a closed loop controller, a self adjusting system. In a closed loop system, data is not defined as passing through in a single direction. The information must pass through an amplifier/encoder which will accordingly determine information about velocity and/or position. This data is used to determine the servos output, and thusly create the precise motion within the motor. (7) These controllers are often specified for certain tasks as they are highly sophisticated pieces of equipment compared to most. A particular benefit of the servo over the stepper motor is that it's consumption is based on its motion. When the motor detects that its placement is not in line with its commanded position, the motor will move in order to realign itself. It is at this point that the energy is consumed for the motion of the servo, instead of the continuous energy flow required in a stepper motor. (5)



(5)

The diagram above displays the process of rotating a servo. The servo controler known as the **Pulse Width Module** takes input data from the electrical pulse and relays it as an angle. This angle is then used to direct the rotor placement.

2.3 Stepper Motors

Stepper motors are often referred to as permanent magnet motors. This is due to the fact that the motor uses a continuous flow of electrical current to create a magnetic field in specific locations of the base. These magnetic fields hold the rotor in place and are shifted when the piece needs to be moved. These motors are either bipolar, meaning that it requires two power sources or a power source that is able to switch polarity, or unipolar, meaning that it only requires one power source. (2) Stepper motors are most commonly appreciated for their low speed high torque values. While most DC motors lose torque (rotational force) with lower speeds, the stepper motor reaches its maximum torque at lower speeds. This makes the Stepper motor the primary motor for precision duties such as camera operation and 3D printing. Unfortunately, like the DC and servo motors, the energy usage of the stepper motor is valued higher and is also independent on load. When in rest, the stepper motor consumes it maximum amount of energy, also known as ‘running hot’. (4) This may sound negative, but in small designs where measured accuracy is required, the stepper is often the best option.

(8)

This image displays the basic design of the stepper motor. Each orange piece represents a different electromagnet and its inverse, both of which are used in the rotation of the central cog.

3.1 Who Cares?

These different motors provide different ways of obtaining precision motion. The uses for such are highly relevant for today's society. Instances, such as the da Vinci surgical system, help provide the public with the modernized developments that have come about within this century.

3.2 Servo Uses

Servos have many practical uses in the modern world. Some such uses include conveyer belts, robotic joints, vehicular brakes, metal and wood working, and automated doors/ other devices. (1) Compared to the stepper, the servo is highly practical in larger case uses and can also be designed in linear motion. This broadens the range of applications of the servo immensely.

3.3 Stepper Uses

The stepper motor can be used mainly for smaller robotics. Because of its constant need for energy supply, the stepper motor is not always the most reliable source for larger tasks. For example, the stepper motor can be used for rotary tables, wire harness construction, and equipment control and positioning. (8) In spite of this, the stepper is highly accurate. Its overall design usually contains a single cog placed in the center of the base. This cog can be measured by the designer to fit any specific angular displacement. Likewise, the device also has the ability to change velocity, like the servo. When considering the codability of the stepper, its ability to provide robotic features and mechanics makes it more practical than the servo.

4. Conclusion

The different types of motors used for precise action are highly relevant in today's society. The average DC motor applies an unsteady amount of rotation to the rotor. This means that when in use the final position is incalculable and imprecise. For machines such as fire

engine ladders and da Vinci surgical systems this is costly. Although both the servo and the stepper have their similar applications they are equally as different from either than that of the DC motor. This is found in both the energy consumption, internal mechanics, and overall usability for certain tasks. Precision in mechanics is highly relevant and in robotics it means much more. In robotics, both servos and steppers are used as joints, each arm/appendage being controlled with direct movements. Other such tasks are required from both, all adding up to the complete design.

Bibliography

1. **"Common Industrial Applications for Servo Motors."** ***Servo Motor Applications - List of Common Industrial Applications for Servos*****. TigerTek, n.d. Web. 01 June 2017.**
2. **Earl, Bill. "All About Stepper Motors."** ***What Is a Stepper Motor? | All About Stepper Motors | Adafruit Learning System*****. N.p., 23 Nov. 2015. Web. 31 May 2017.**
3. **"Introduction to Stepper Motors."** ***Introduction to Stepper Motors*****. Northwestern University, n.d. Web. 31 May 2017.**
4. **Larson, Noble G. "Stepping Motor Control System."** ***DSpace@MIT*****. MIT Artificial Intelligence Laboratory, 01 Feb. 1979. Web. 31 May 2017.**
5. **"Open Loop vs. Closed Loop."** ***ServoCity.com*****. Robotzone, LLC, n.d. Web. 01 June 2017.**
6. **Reed, Francis. "How Do Servo Motors Work."** ***How Servo Motors Work*****. Jameco, n.d. Web. 01 June 2017.**
7. **"Servomotor."** ***Wikipedia*****. Wikimedia Foundation, 25 May 2017. Web. 01 June 2017.**
8. **"Stepper Motor: Basics, Types, Applications."** ***Power Electronics A to Z*****. Power Electronics a to Z, 01 Jan. 2015. Web. 01 June 2017.**