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Review Article

A Look at the Different Types of Servo Motors and Their Applications

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Abstract
Direct Current (DC) motors are widely used because they come in many shapes and sizes, so their application is quite easy and flexible, and they have high reliability and low cost. Speed and position control are required in industrial applications, robot manipulators and home appliances. Because of the accurate and efficient tuning of parameters for PID controllers, they have become very important for the process industries. They have a simple structure, good stability, and high reliability. Electric motors are used in many homes, industrial, military, and other systems. Electric motors have properties that depend on the type of motor selected for the appropriate application. The performance of the motor depends on the system of which it is part. The appropriate design must be chosen for each part to obtain the best performance and the highest efficiency. Elevators, jacks, cars, trains, printers, home appliances, industrial, civil, and military systems, as well as robots, all use electric motors. It can be used in different applications, such as underwater welding, and in other places that are dangerous to humans, such as the operation of mine-removal, explosive dismantling, and others. The aim of this research is to review papers related to various servo motors and also the comparison between the different motors has been discussed in detail.

Keywords: Servo Motor, PID Controller; Transfer Function, Matlab.

INTRODUCTION

Electric motors are used in many homes, as well as industrial, military, and other systems [1 - 3]. Electric motors have properties that depend on the type of motor selected for the appropriate application [4 - 6]. The performance of the motor depends on the system of which it is part [7 - 9]. The appropriate design must be chosen for each part to obtain the best performance and the highest efficiency. Control systems have been proven by experiments to have a need for them within many industrial applications due to the effect they have when they are part of the system. It is classified into traditional, expert, and optimum. Conventional improves the performance of linear systems and is widely used because it is simple and cheap compared to others [10 - 14]. The expert relies on previous experience in its design and is used with linear systems, and its performance is better than the traditional one [15 - 18]. Elevators, jacks, cars, trains, printers, home appliances, industrial, civil, and military systems, as well as robots, all use electric motors. It can be used in different applications, such as underwater welding, and in other places that are dangerous to humans, such as the operation of mine-removal, explosive dismantling, and others [19 - 21]. An electric motor was chosen within the specifications. It will be mentioned later and represented mathematically by a conversion function and simulation. There are three cases, including its results without controllers, again and again with a conventional controller, and a third with expert systems [22 - 25]. The simulation results prove the importance of using controllers to improve the performance of the system's work efficiently and accurately with high response. The current simulation aims to identify the capabilities of the computer program Matlab as a computer program. Previous experiences and the current time periods have proven the possibility of simulating different systems. Through work, a special model must be developed, and according to the researchers' specialization, it is necessary to identify the possibilities of its use first, the accuracy of working with it, and take its results into account. Electric motors of various types have been simulated using the Matlab program. PID controller to compare with different systems, such as linear systems. The results confirmed the previous statement that traditional power systems improve the performance of cell systems. The results also confirmed the need for expert systems to improve the performance of linear systems. The difference between the current work and previous works is the emphasis, on the one hand, on the capabilities of the computer program to simulate engine-based systems in different applications by representing them mathematically. The operation for comparing different cases in order to obtain the best performance. In order to obtain the appropriate design that enables the operation of a highly efficient and responsive system, fast and high accuracy in performance. The steps will also be indicated later in the research papers. The limits of the research included understanding the process of operating the engine in different ways and working conditions. Also, the research contribution is designing algorithms for control theories, including traditional ones. The operation of control systems to control the engine was also implemented [41].

DC Servo Motor

The motor which is used as a DC servo motor generally has a separate DC source in the fields of winding and armature winding. The control can be archived either by controlling the armature current or field current. Field control includes some advantages over armature control. In the same way, armature control includes some advantages over field control. Based on the applications, the control should be applied to the DC servo motor. The DC servo motor provides very accurate and fast response to start or stop command signals due to the low armature inductive reactance. DC servo motors are used in similar equipment and computerized numerically controlled machines.

AC Servo Motor

An AC servo motor is an AC motor that includes an encoder and is used with controllers for giving closed loop control and feedback. This motor can be placed with high accuracy and also controlled precisely as required for the applications. Frequently, these motors have higher designs of tolerance or better bearings, and some simple designs also use higher voltages in order to accomplish greater torque. A motor mainly involved in automation, robotics, CNC machinery, and other applications requires a high level of precision and useful versatility.

Positional Rotation Servo Motor

A positional rotation servo motor is the most common type of servo motor. The shaft's o/p rotates at about 180 degrees. It includes physical stops located in the gear mechanism to stop turning outside these limits to guard the rotation sensor. These common servos are involved in radio-controlled water, radio-controlled cars, aircraft, robots, toys and many other applications.

Continuous Rotation Servo Motor

A continuous rotation servo motor is quite related to the common positional rotation servo motor, but it can go in any direction indefinitely. The control signal, rather than setting the static position of the servo, is understood as the speed and direction of rotation. The range of potential commands causes the servo to rotate clockwise or counterclockwise as preferred, at varying speeds depending on the command signal. This type of motor is used in a radar dish. If you are riding one on a robot, you can use one as a drive motor on a mobile robot.

Linear Servo Motor

The linear servo motor is also similar to the positional rotation servo motor discussed above, but with an extra gear to alter the o/p from circular to back-and-forth. These servo motors are not easy to find, but sometimes you can find them at hobby stores where they are used as actuators in higher model airplanes.

Function and Mathematical Model of Servomotor Systems

A motor is a machine that converts electrical energy into mechanical energy. The motor consists of a fixed part and a fixed rotating part that contains electrical energy. It is represented by current and voltage, and the rotating part has kinetic energy. It is represented by torque and speed. Fig. 1 represents a motor system [26 - 39], where Ra is armature resistance, La is inductance, Vb (t) is back EMF, Ea is the input voltage, m is the angular position

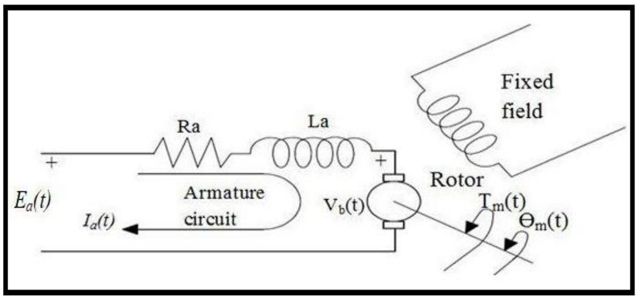

Fig.1 (a): Servomotor system

Fig. 1 (b): Servomotor system diagram

The Difference between DC Servo Motors and AC Servo Motors

The Power Source is the major key difference between DC and AC Servo motors. The AC servo motors depend on an AC power source while the DC Servo motors depend on DC power source (like Batteries). The AC servo motors performance is dependent upon voltage as well as frequency while the DC servo motors performance mainly relies upon voltage alone. The major differences between the AC and the DC Servo motor are discussed here on the basis of important real-world factors such as efficiency, speed & torque adaptability, size, operational stability, noise, maintenance, and output power. The following table explains the key differences between AC Servo motor and DC Servo motor [40].

Table-1: explains the key differences between AC Servo Motors and DC Servo Motors.

Characteristics	AC Servo Motor	DC Servo Motor
Efficiency	Low (about 5-20%)	High
Speed & Torque	Adaptable to strong torque and high-speed working condition.	Adaptable to a limited torque and speed
Stability	Less stability issues	More problems of stability
Noise	No radio frequency noise	Brushes cause radio frequency noise
Operation	Have stable and smooth operation	Noisy operation
Weight & Size	Lighter weight and small in size	Heavy weight and large in size
Repair and Maintenance	Since no commutators, less maintenance is required	Because of commutation process, regular maintenance is needed
Output Power	Deliver low power normally between 0.5 watt and 100 watts.	Provide high power

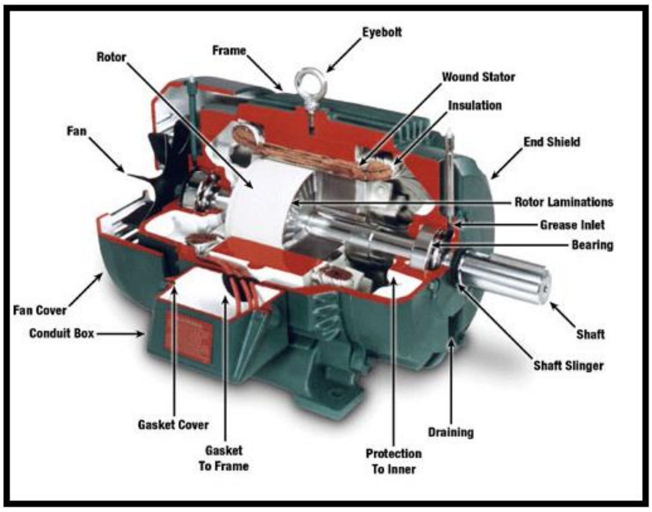

Fig.1 (c): DC Servomotor system

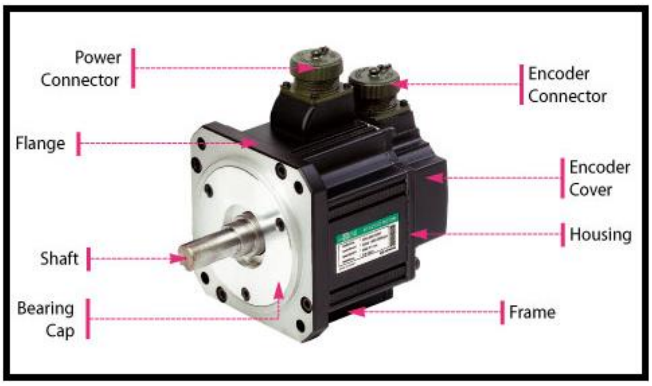

Fig.1 (d): AC Servomotor system

A comparison between stepper and servo motors

Servo Motor	Stepper Motor
It operates in a closed-loop.	It operates in an open-loop.
It has an internal feedback system. So less prone to error.	It has no feedback system. So more prone to error.
Servo motors are costly as compared to stepper motors.	Stepper motors are less costly as compared to servo motors.
Not as small.	Small size
Servo motors provide lower torque in comparison with steppers.	Stepper motors provide a high amount of torque at low speeds.
Servo motors provide very high torque at higher speeds.	Stepper motors provide very low torque at higher speeds.
Servo motors require an encoder and a gearbox for more accurate control.	There is no need for an encoder.
The speed of the servo motor is higher than the stepper motor.	The speed of the stepper motor is lower than the servo motor.
Servo motors tend to pulsate or vibrate in a standstill position.	There will be no vibration or pulsation in stepper motors at a standstill position.

Conclusion

In this research, I have reviewed many papers related to servo motors. I have also discussed the various categories of the various servo motors and their applications, their differences, and their comparisons, which are also discussed in detail.

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