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Review Article

The DC Motor Advantages: Key Benefits and Improvements over AC Motors

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Abstract

Direct current (DC) motors are commonly used because they are inexpensive, highly reliable, and available in a variety of sizes and shapes, making them easy to use and adaptable. Robot manipulators, household appliances, and industrial applications all need speed and position control. PID controllers have grown in importance for the process industries due to their accurate and effective parameter tuning. They are highly dependable, have a straightforward structure, and are stable. Numerous residential, commercial, military, and other systems use electric motors. The characteristics of electric motors vary depending on which kind is used in the right situation. The system that the motor is a part of determines how well it performs. For every part, the right design needs to be selected in order to achieve the best efficiency and performance. Electric motors are used in elevators, jacks, automobiles, trains, printers, home appliances, industrial, civil, and military systems, and robotics. It can be utilized in a variety of settings that pose a risk to human safety, including mine clearance operations, explosive dismantle, and other settings. Examples of these include underwater welding. Reviewing articles about different servo motors is the goal of this study. A thorough comparison of the various motors has also been covered. There has been discussion on the advantages of DC motors over AC motors.

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

I. 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

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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].

II. TYPES OF MOTORS

i. DC Servo Motor

The motor that 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 armor 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.

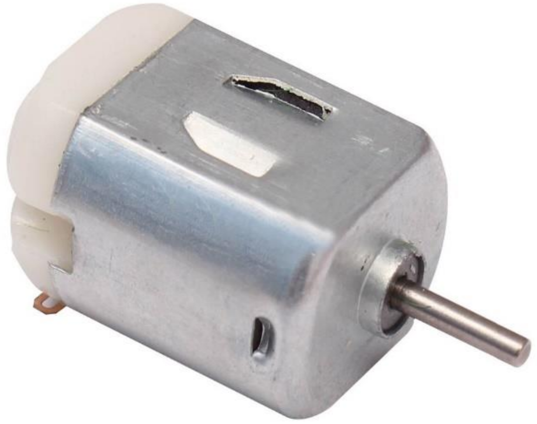

Figure 1: DC Motor

ii. 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.

Figure 2: AC Motor

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iii. 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 services are involved in radio-controlled water, radio-controlled cars, aircraft, robots, toys, and many other applications.

Figure 3: Positional Rotation Servo Motor

iv. 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.

Figure 4: Continuous Rotation Servo Motor

v. 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.

Figure 5: Linear Servo Motor

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vi. 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 [26-339], where Ra is armature resistance, La is inductance, Vb (t) is back EMF, Ea is the input voltage, and m is the angular position.

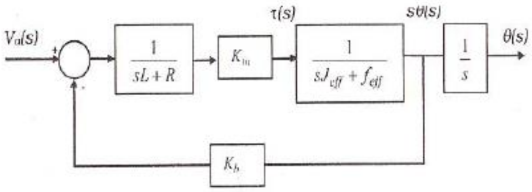

Figure 6: Function and Mathematical Model of Servomotor Systems

III. BENEFITS YOU CAN GET FROM USING DC MOTORS OVER AC MOTORS

i. DC Motors have Higher Starting Torque

For applications like electrical traction, DC motors are favored over AC motors due to their higher starting torque. They are thought to be perfect for handling large weights while starting machinery like cranes and locomotives. Be aware that a variety of DC motors are available with stronger starting torque to suit your needs.

ii. They can Easily Control Speed

DC motors may regulate their speed above or below the rated values, in contrast to the majority of AC motors available in the market. For instance, securely varying the speed is made easy with DC shunt motors. They can therefore be applied to a variety of situations. Because of this, they are perfect for producers who need to adjust their rates of output for different shifts or seasons.

iii. DC Motors do not have Harmonic Effect

The harmonic effect of induction motors is one of their noteworthy features. A harmonic voltage is produced by the induction of non-linear loads, such as discharge lights or saturation magnetic devices, and is expressed as a multiple of the primary frequency of the motor system. The harmonic effect causes noise, warmth, and harmonic current in the rotor of the majority of electric motors. DC motors, on the other hand, are superior as they don't produce harmonics, so you can operate them without worrying about related issues.

iv. The Motors are Easy to Promptly Control

The majority of motors have one thing in common: it's never easy to regulate them quickly and precisely. On the other hand, DC motors are no longer the issue. DC motors, for instance, can be used in situations where quick start, reversing motion, and stopping are necessary for best results.

v. DC Motors are better for Low-Cost Operations

Due to their lower cost, DC motors are preferred by many over other types. This is particularly valid when working with programs that use fractional HP. Since DC motors have been in operation for almost 130 years, there is a significant installed base and an excellent level of maintenance familiarity. As a result, you can be confident that hiring a specialist to quickly and affordably diagnose and fix your DC motor will be easy.

vi. DC Motors have Fewer Rectification and Electronics Needs

Compared to AC inverters, installing a DC motor requires less electronic and rectification on the power electronics system circuit. This implies that the motor can be fitted straight away and used by giving it electricity straight from the power supply.

vii. Easy Speed regulation

The simplicity of speed regulation is one of the main factors that make DC motors attractive for use in both residential and business settings. All you have to do is use a potentiometer to change the voltage terminal. Thus, it is best to choose a DC motor if you require greater speed control [43].

CONCLUSION

I have read a lot of servo motor-related publications for this project. Along with these topics, I went into great length on the various servo motor categories, their uses, their distinctions, and their comparisons [42].

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