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Media Release

Torque motors and DC servo motors for robotics applications.

More and more often we see pancake or flat brushless DC motors replacing torque motors in low speed robotic joint and rotary stage applications.

Torque motors are very low profile motors that typically have a hollow bore and a very high number of magnetic poles. They are supplied in kit form as a rotor and stator that can be built directly into the application, with the advantage of reducing the overall size of the machine. However, because of the larger diameter, machining tolerances and a larger air gap (typically 0.5 to 2mm so that the end user can facilitate installation), it is also one of the major disadvantages of torque motors. Just as the resistance of an electrical circuit is given in Ohms law the magnetic flux path from the torque motor's permanent magnets incorporate this "resistive" air gap. Where Current is replaced by magnetic flux, voltage is replaced by magnetomotive force and resistance is therefore relative to permeability.

Torque motors have a large lever arm effect whereby the large diameter creates more torque on the axis (Torque = Force x Radius) and they also feature small electrical time constants. However, the fast switching frequencies required because of the high number of poles and the physical mounting of many magnets on a robust inner ring creates problems with heat and increased rotor inertia. This reduces the motors overall dynamics. The heating effect, similarly in multi-pole linear motors frequently requires the use of water cooling for the motor to operate with acceptable efficiencies.

The frameless structure of torque motors is either an advantage or disadvantage depending on the application environment. There are no ball bearings within the motor representing a wear point, though the lack of any suitable structure to mount feedback devices and protect the powerful permanent magnets from attracting unwanted foreign objects often results in additional engineering to include these features.

In order to get the most from a direct drive torque motor a high resolution encoder is required which is often a very expensive addition. Suppliers will also recommend a high interpolation factor but this leads us into a discussion on resolution v's accuracy, which can only be touched on briefly in this document. If you compare a gearmotor with a direct drive torque motor one gets a very similar result in terms of overall feedback performance. A gearmotor can use a low resolution inexpensive encoder and the quad counts are multiplied by the ratio giving a very high resolution. The gearhead is in effect the equivalent to the interpolation factor, though its backlash is reducing accuracy. For the torque motor the encoder here is electronically interpolated to increase the resolution but this often also multiplies any error, reducing accuracy. In the end more often than not you have similar system performance outcomes only the servomotor will be a less expensive solution.

Thermal, installation, control and price complexities associated with torque motors have recently lead to great interest in a new combination of servo products. More powerful, higher grade, ring style rare earth magnets, low profile inductive encoders built inside the motor frame, short powerful planetary gearheads with new age ceramics and new servo controllers with extremely high bandwidth current regulation, have created an unrivalled solution with respect to power density, dynamics, profile and cost.

…And the answer to the question on everyone's lips.. Yes, they can be run in stall condition with torque control.

This media release is available on the internet at www.maxonmotor.com.au

maxon motor Australia Pty Ltd
PO Box 1961
Hornsby Westfield
NSW 1635
Tel: +61 2 9476 4777
Fax: +61 2 9476 4866
sales.au@maxonmotor.com
www.maxonmotor.com.au

Images: Flat brushless DC motors.