Technical Article

Understanding brushless-DC Motor Systems, Part 1

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Quick – what are the three motor types? The most common answer that I hear is "brushed-DC motors, stepper motors and brushless-DC motors," which is basically a knee-jerk reaction to the question. Some of the more intrepid motor-drive experts I know might say "single-phase AC input, multiphase AC input or DC input," categorizing each motor by its input mechanism rather than the specific motor type. I will admit, this is a pretty clever answer. There is certainly no shortage of different possible groupings in the taxonomy of motors, ranging from the use of position sensors to the supply voltage to the driver implementation; some engineers may be tempted to try to answer in these ways, even though the response doesn't always fit into three distinct categories. In this technical article, I'll address a new way to look at motor classification.

I have recently become fascinated with the idea that we should classify motors by their function. Many applications use different kinds of motors depending on the whim of the designer, but the same motor solution may not even be applicable in a different application that uses the same kind of motor. If that sentence gave you a headache (my communications colleague assured me that it had this effect on her), let me give you a better example: you can implement a pan-tilt-zoom (PTZ) camera axis with a stepper motor, a brushless-DC motor or even a brushed-DC motor. A brushless-DC motor is also the most common motor type in a ceiling fan (see Figure 1). But you can't use the same brushless-DC motor solution for both of these end-equipment types. A ceiling fan driver circuit, however excellent its performance, would be a horrible choice for a PTZ camera, and result in a product that just doesn't work. Why do I know this? Intuitively, I recognize (as you probably do as well) that the "function" of a ceiling fan motor and the "function" of a PTZ camera motor are very different, even though both are using a brushless-DC motor. There must be a property of motor functionality from an application perspective that can help establish a different classification of motor types.

Figure 1. A PTZ Camera versus a Ceiling Fan

So what are these motors actually doing? The function of a ceiling fan is to spin at a constant **speed** to circulate air in a room. The function of a PTZ camera is to move the camera to a certain **position** and hold it there. I can add a third example in to the mix – a cordless power drill. The user controls the drill's **torque** by pressing the trigger, perhaps to drill a bit through a wall stud. These motors have very distinct implementations; thus, my answer to "What are the three motor types?" is an emphatic "Speed, torque and position." Take a look at Figure 2 and Table 1 below.

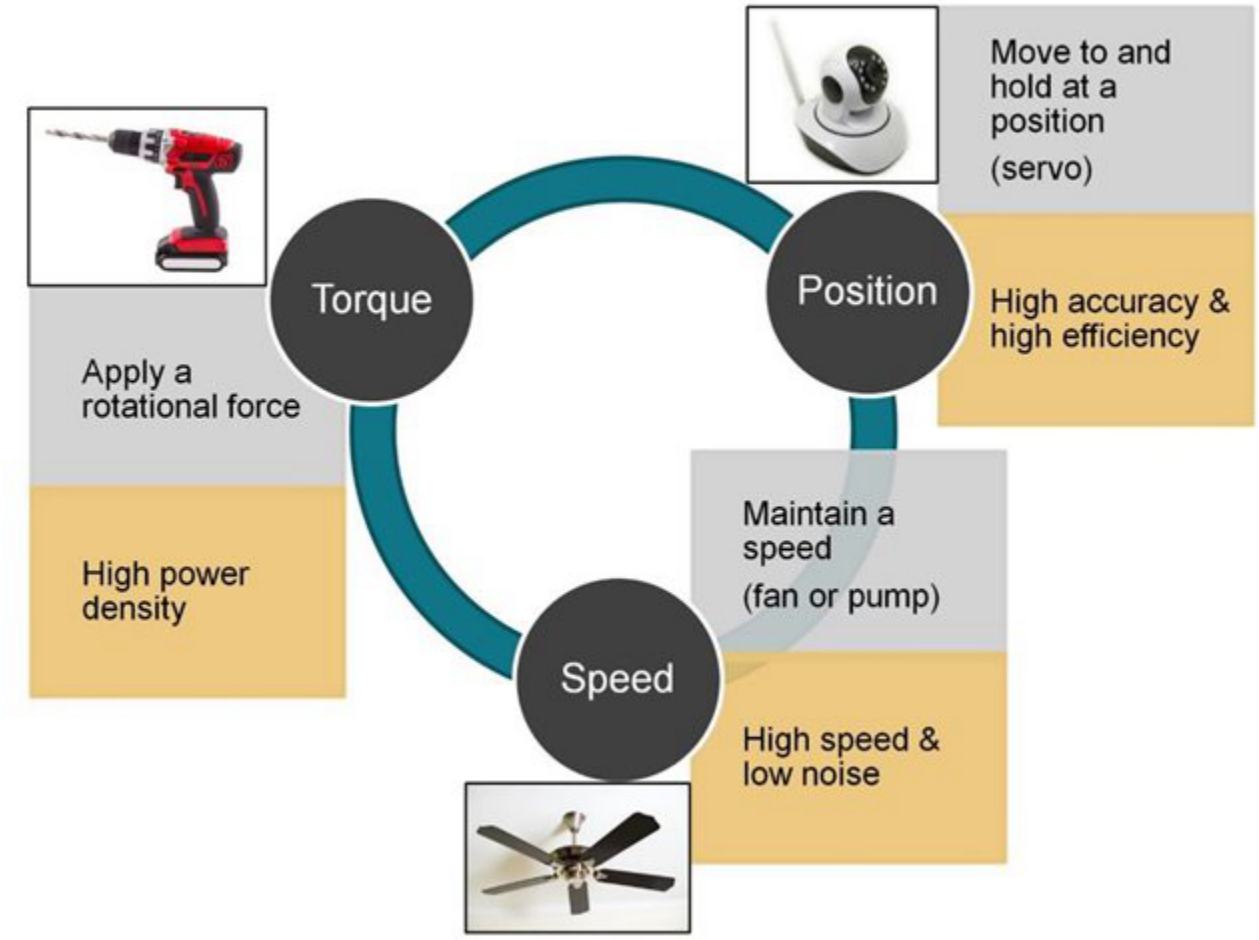

Figure 2. Speed, Torque and Position

Table 1. Summary of Speed, Torque and Position

Type	Example	Load	Top priority	Sensorless capability
Speed	Ceiling fan	Air or fluid	High speed and low noise	Easy
Torque	Power drill	Solid	High power density	Very hard
Position	PTZ camera	Solid	High accuracy and efficiency	Extremely hard(1)

(1) I won't say impossible, but this one is very close to impossible. Since a position control system operates primarily at zero speed, there is no back-electromotive force to sense, and therefore no sensorless signal to close the loop.

Let's talk more about speed, torque and position in the Understanding brushless-DC motor systems, part 2 technical article.

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