Motion control made easy

Day 1 Orientation

Topics of discussion:

- System operation
- Stability and tuning
- Programming example

Motion control systems are used throughout industry to generate precise mechanical moves. Every second of every day they can be found working diligently, charting and executing the courses of cutting tools, sensors, markers, and innumerable other devices. Naturally applications for such systems are very wide and cover many fields of technology.

Motion control has changed dramatically over the past two decades. Today it is possible to construct a control system out of readily available building blocks, in total contrast with the situation 20 years ago, where most components had to be built by the designer. As a result, the system designer today does not have to be a motion control expert; in fact, most designers are not even electrical engineers.

System operation

The elements of a motion control system, illustrated in Figure 1, include a motor (which converts electric current into torque), an amplifier (which supplies the current), a position sensor, and a controller. Figure 2 shows the functional operation of these elements.

Consider first the motor which generates rotary torque in proportion to applied current. The torque, once it overcomes friction, accelerates the motor. To decelerate the motor, the polarity of the current is reserved, producing an opposing torque.

Motor current is supplied by the driver or amplifier. This device produces a current *I* in proportion to the applied voltage *V*.

The motion controller acts as the brain of the system. Besides performing control functions, it generates the command signal to the amplifier. The position sensor, considered the eyes of the system, produces an output that is fed back to the "brain" or controller. Many systems use optical encoders, which generate electric pulses in proportion to the rotation. By counting encoder pulses, the controller can figure out motor position.

To get a better feel for closed-loop control, refer to Figure 2 and follow the path of the nominal position input *R*. The controller compares the position feedback signal *C* with *R* to form the position error *E*. The error is then filtered (also part of the controller) producing a voltage signal *V* to drive the amplifier which generates motor current *I*. The resulting change in motor position is measured by the sensor, and the process begins again.

To see how it all works together, consider a case where the motor has to move

Closed loop control system

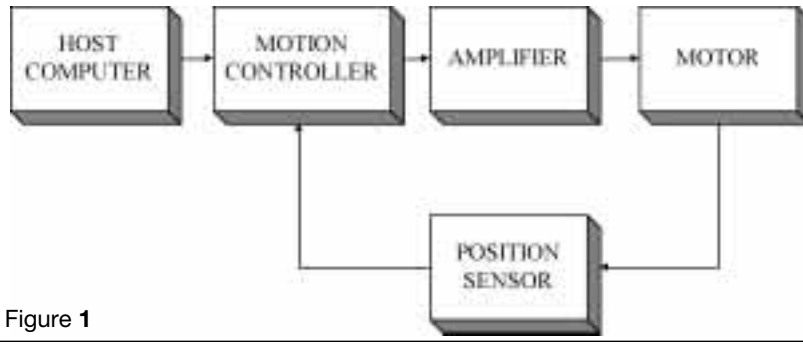

Figure **1**

Functional diagram

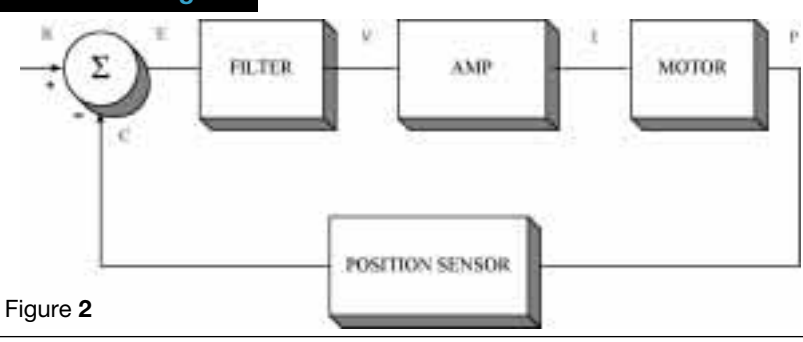

Figure **2**

See ad on page A000 in the 1999 PTD Handbook.

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