Chapter 12
Stepper Motor

ABSTRACT

A stepper motor is a digital device which is like a computer that runs on pulses. It can be directly connected with digital computer unlike D.C. motor for which A/D or D/A converters are needed. In fact, stepper motor is an electric motor which moves or rotates in series of small discrete steps. A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. In this chapter, the authors discuss the stepper motor. It starts with the definition of stepper motor, its basic function, and principle of working. They then discuss the types and construction of stepper motor. Finally, this chapter concludes with the applications of stepper motor.

In this chapter, we discuss about stepper motor, its construction, working principal, and applications. A stepper motor is a digital device which is like a computer that runs on pulses. It can be directly connected with digital computer unlike D.C. motor for which A/D or D/A converters are needed. In fact, stepper motor is an electric motor which moves or rotates in series of small discrete steps. A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. It receives a rectangular pulse train as an input and responds by rotating its shaft to a certain number of degrees. This rotation is dictated by the number of pulses in the pulse train. As a consequence, the rotation of stepper motor has several direct relationships to the applied input pulse train. For instance:

- First, sequence of applied pulses is directly related to the direction of motor shafts rotation,
- Second, the speed of motor shafts rotation is directly related to the frequency of input pulses, and
- Finally, the length of rotation is directly related to the number of input pulses applied.

We first discuss some definitions that will help us to understand the construction and working principal of stepper motor.

Pole: The pole is defined as one of the regions in a magnetized body in which the magnetic flux density is concentrated. For instance, the two-phase stepper motor has 2 poles for each phase on the stator and 2 poles on the rotor. In order to increase the number of steps per revolution of the motor, several more poles can be added to both stator and the rotor.

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Step Angle: Step angle is the number of degrees a rotor will turn per step. The step angle is calculated as:

$$Step\ Angle = \frac{360^\circ}{N},$$

where, N is the total number of poles for all phases together.

Torque: In the stepper motor, when the magnetic fluxes of the stator and rotor are displaced from each other, a torque is developed. This torque, which is produced by the stepper motor, depends on several factors namely:

- The stepper motor drive type and design
- The current in the windings
- The step rate

12.1 CONSTRUCTION OF STEPPER MOTOR

A stepper motor basically consists of yoke, stator and a rotor. The yoke is made up of cast iron. The stator is made up of silicon steel having poles, while rotor of the stepper motor also has poles. It is important to note that stator have always two greater poles than rotor. Figure 1 shows the construction of stepper motor.

We now discuss the general working principal of stepper motor.

Figure 1. Stepper motor