

## Module 3 : Actuators for robots

### Lecture 8 : Actuators for Robots & Examples-Part II

#### Objectives

In this course you will learn the following

- Stepper motors.
- Performance characteristics of steppers
- Hydraulics and pneumatics systems and actuators

#### STEPPER MOTORS

Unlike conventional motors, stepper motors move through steps (of 0.9, 1.8.. degrees) in response to electric pulses applied to them. By sending them a train of n pulses one could make them move through multiples of the above angle. This permits one to dispense with encoders. Steppers do miss steps if the load is in excess. Stepper motors can be generally classified as

- Variable reluctance motors ( soft steel rotor)
- Permanent Magnet (PM) stepper motor
- Hybrid Stepper Motor

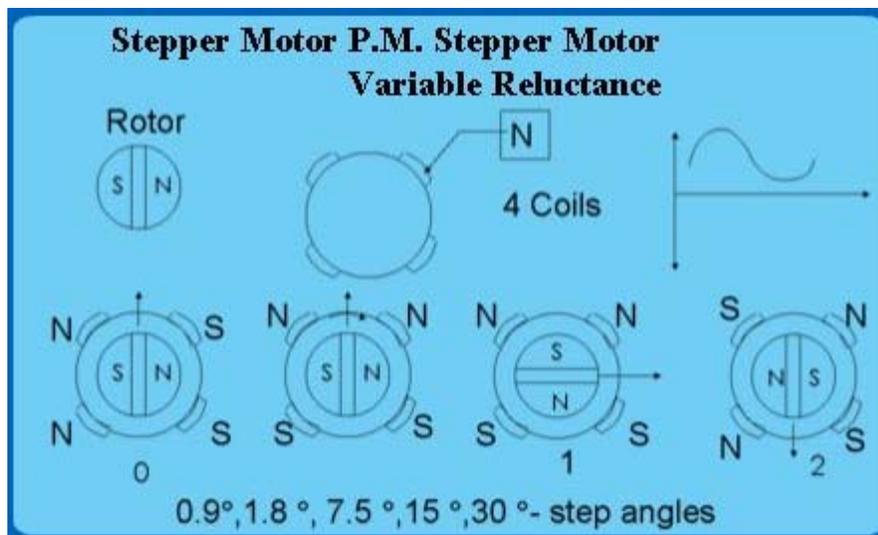


Figure 8.1.1

The rotor consists of a magnet and the stator poles will depend on voltages / pulses applied to it. The poles of stator and rotor will either be attracted or repelled depending upon the configuration of the poles in stator as shown in Fig. 8.1.1. It is obvious that an electronic circuit is to be used to set the stator poles to the desired polarity. As these "poles" rotate the rotor moves in steps. The steps available are 0.9, 1.8, 7.5, 15, 30 degrees.

## Performance characteristic of stepper motors

- The torque Vs Speed graph is shown below Fig. 8.1.2
- Pull in torque (inner curve) is the torque required to start and accelerate without losing steps.
- Pull out torque (outer curve) is the maximum torque that can be applied at a given step-rate without losing steps.

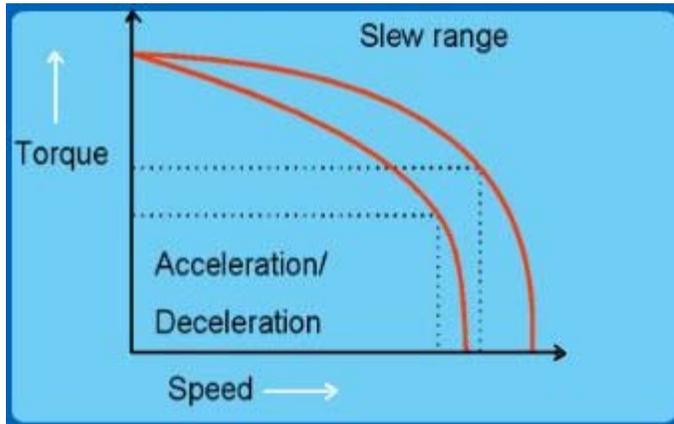


Figure 8.1.2

Holding torque is defined as to hold the load in particular position as shown below Fig. 8.1.3.

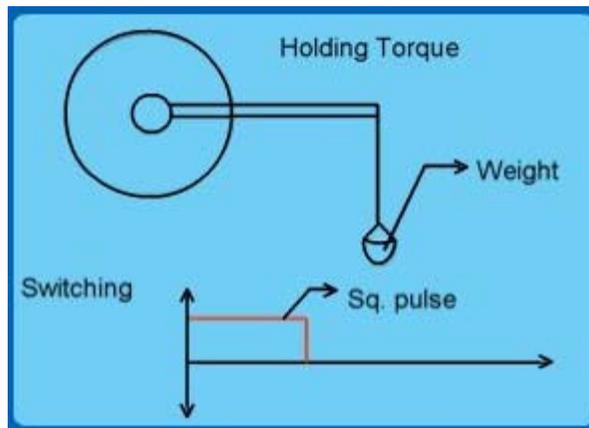


Figure 8.1.3

## Hydraulic and pneumatic systems and actuators used in manipulators

Hydraulic piston and cylinders are essentially preferred to lift and move heavy loads. A high pressure positive displacement pump is used to push oil into the cylinder. Valves are used to regulate the flow and thereby obtain different speeds(Refer Figure 8.2.1).

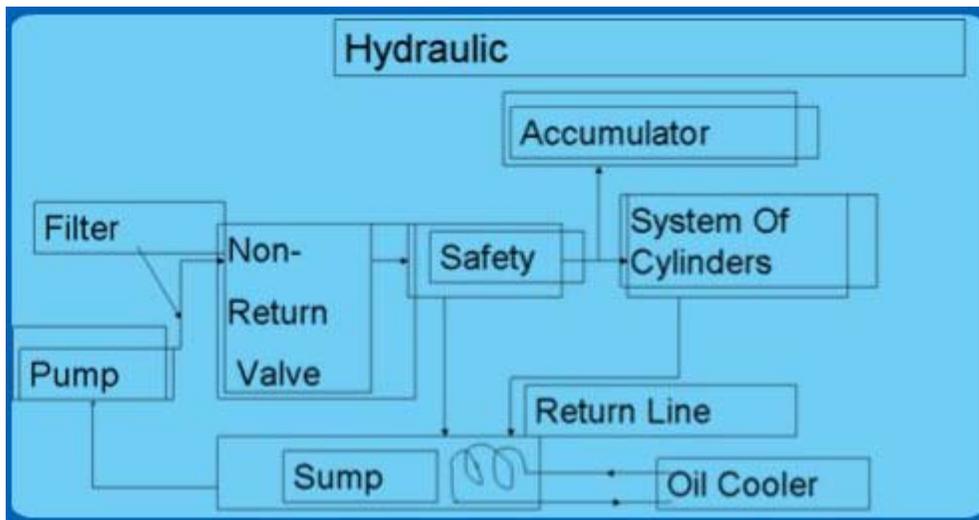


Figure 8.2.1

Such hydraulic pumps are of rotary and reciprocating type. Some reciprocating type pumps have adjustable squash plate mechanism which permits variable displacement of the piston.

Pneumatic systems use air instead of oil. Since air is compressible the action of these is significantly different from that of hydraulic cylinders. Hydraulic and pneumatic cylinders are of single acting and double acting type with smooth cushioning at end of stroke. (Rodless pneumatic cylinders also exist) .

These systems uses directional control valves (DCVs) with different modes of operation such as manual or solenoid operated. Flow control valves are used to control the speed of actuators. Servo valves are used in the systems for better control of speed.

Pneumatic ally operated manipulators execute sequential motions, one cylinder completes its motion before the next one moves. Valves like pressure sequence valves, solenoid operated valve, pilot operated valve are used for this purpose.

## Recap

In this course you have learnt about

- Variable reluctance, Permanent magnet & hybrid stepper motors
- Torque Verses speed characteristics of Stepper motor
- Hydraulic & Pneumatics systems governing equations

Congratulations, you have finished Lecture 8. To view the next lecture select it from the left hand side menu of the page