Features of Industrial Robots

An industrial robot is a complex, technical system consisting of several subsystems operating within the robot's physical make-up. Each of these subsystems performs its own carefully defined functions and contributes to the overall function of the industrial robot. Three of the more important of these subsystems include (a) kinematics, (b) the control system, and (c) the drive.

Kinematics

Kinematics refer to the spatial arrangement, according to the sequence and structure, of the axes of movement in relation to each other. There are four basic types of movement that an industrial robot may have: (1) cartesian, (2) cylindrical, (3) polar, and (4) jointed-arm. Figure 1 illustrates these four types of movement and their applications.

Cartesian Co-Ordinate Robot. The Cartesian co-ordinate robot is one that consists of a column and an arm. It is sometimes called an x-y-z robot, indicating the axes of motion. The x-axis is lateral motion, the y-axis is longitudinal motion, and the z-axis is vertical motion. Thus, the arm can move up and down on the z-axis; the arm can slide along its base on the x-axis; and then it can telescope to move to and from the work area on the y-axis. The Cartesian co-ordinate robot was developed mainly for arc welding, but it is also suited for many other assembly operations [4:15].

Cylindrical Co-Ordinate Robot. The cylindrical co-ordinate robot is a variation of the Cartesian robot. This robot consists of a base and a column, but the column is able to rotate. It also carries an extending arm that can move up and down on the column to provide more freedom of movement. The cylindrical co-ordinate robot is designed for handling machine tools and assembly (4:16).

Polar Co-Ordinate Robot. The polar co-ordinate, or spherical co-ordinate robot consists of a rotary base, an elevation pivot, and a telescoping extend-and-retract boom axis. These robots operate according to spherical co-ordinates and offer greater flexibility. They are used particularly in spot welding [5:25].

Jointed-Arm Robot. The jointed-arm robot resembles a human arm. It usually stands on a base on which it can rotate, while it can articulate at the "shoulder" joint, which is just above the base. The robot can also rotate about its "elbow" and "wrist" joints. With the swiveling and bending at the wrist, six degrees of freedom can be obtained. The jointed-arm robot is the most popular form for a robot and is capable in welding and painting work [4:17].

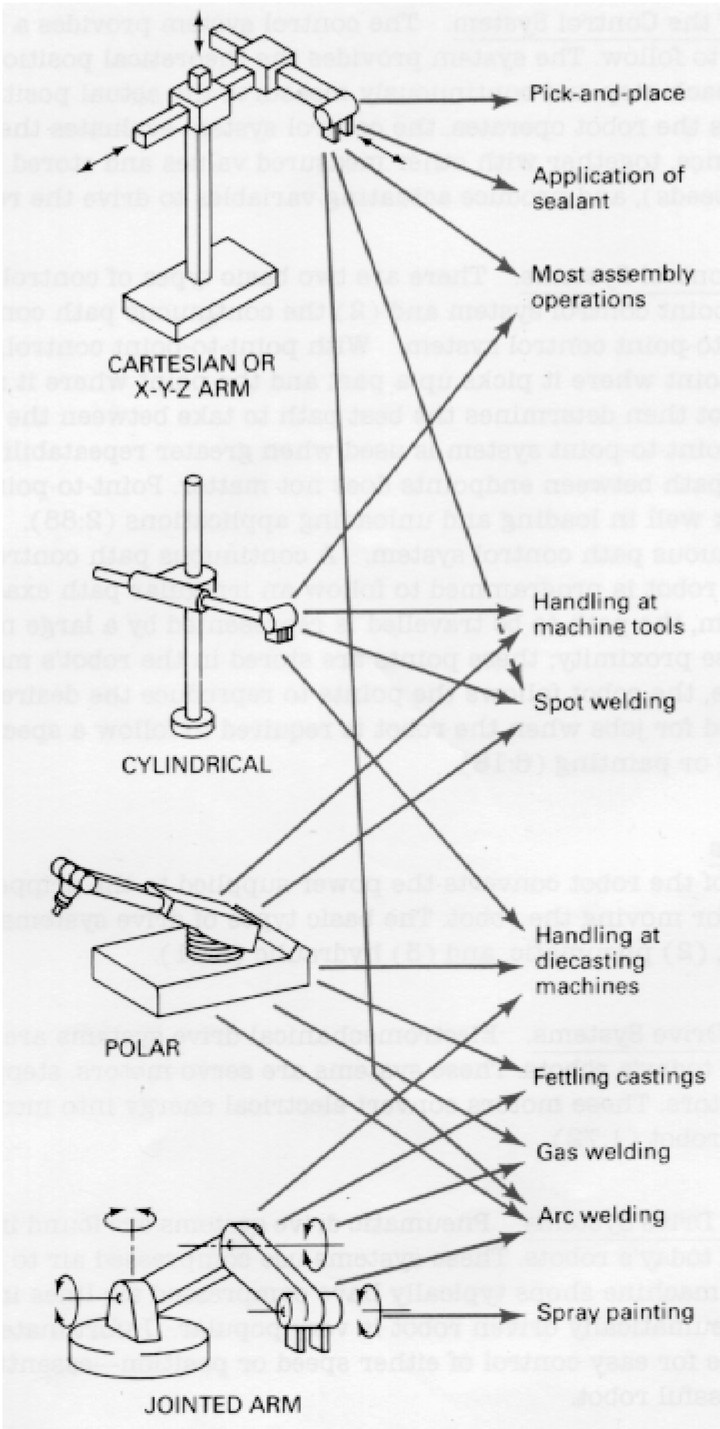

Figure 1. Four basic types of robot configurations and their factory applications.

Control Systems

The control systems of an industrial robot determine its flexibility and efficiency, within the limits set beforehand by the design of the mechanical structure.

Purpose of the Control System. The control system provides a logical sequence for the robot to follow. The system provides the theoretical position values required for each step and continuously measures the actual position during movement. As the robot operates, the control system evaluates the theoretical/actual difference, together with other measured values and stored data (e.g., theoretical speeds), and produces actuating variables to drive the robot.

Types of Control Systems. There are two basic types of control systems: (1) the point-to-point control system and (2) the continuous path control system.

- *Point-to-point control system.* With point-to-point control, the robot records the point where it picks up a part and the point where it releases that part. The robot then determines the best path to take between the two points [6:49]. The point-to-point system is used when greater repeatability is required, or when the path between endpoints does not matter. Point-to-point control systems work well in loading and unloading applications [3:88].
- *Continuous path control system.* A continuous path control system is one in which the robot is programmed to follow an irregular path exactly. Inside the control system, the path to be travelled is represented by a large number of points in close proximity; these points are stored in the robot's memory. In the working cycle, the robot follows the points to reproduce the desired path. The system is used for jobs when the robot is required to follow a specific path, such as in welding or painting [14:18].

Drive

The drive of the robot converts the power supplied to the grippers into kinetic energy used for moving the robot. The basic types of drive systems include (1) electrical, (2) pneumatic, and (3) hydraulic [14:31].

Electrical Drive Systems. Electromechanical drive systems are used in about 20 percent of today's robots. These systems are servo motors, stepping motors, and pulse motors. These motors convert electrical energy into mechanical energy to power the robot [2:72].

Pneumatic Drive Systems. Pneumatic drive systems are found in approximately 30 percent of today's robots. These systems use compressed air to power the robots. Since machine shops typically have compressed air lines in their working areas, the pneumatically driven robot is very popular. Unfortunately, this system does not make for easy control of either speed or position—essential ingredients for any successful robot.

Hydraulic Drive Systems. The most popular form of the drive system is the hydraulic system because hydraulic cylinders and motors are compact and allow high levels of force and power, together with accurate control. A hydraulic actuator converts forces from high pressure hydraulic fluid into mechanical shaft rotation or linear motion. Hydraulic fluid power is more cost effective for short-stroke, straight-line positioning requiring high forces, controlled acceleration, and repetitive motion. No other drive system packs as much power into such a small package; no other drive is as safe or as resistant to harsh environments.

Information Sources

(Not included)