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INDUSTRIAL ROBOTS IN MODERN MACHINE-BUILDING INDUSTRY

Machine-building industry is one of the most important and complex manufacturing industry. It involves the design, production, and operation of machinery. Engineering deals with the construction of industrial machinery for the metallurgy, oil, chemical and other industries, heating and cooling systems, transport systems, air, space and watercrafts, robotics, medical devices, weapons, and others.

The introduction of industrial robots in today's engineering production allows doing full complex automation of all processes, raising the efficiency of human resources application, providing step-by-step reduction of application and even exclusion of hand, heavy and unskilled labor.

Industrial robot is a computer-controlled machine, which has movement functions with a high degree of freedom similar to human arms and hands and is able to move autonomously on the basis of sense and perceptions.

Industrial robots are important components of automated flexible manufacturing systems (FMS). They can increase productivity. Typical applications of robots include welding, painting, assembly, selection and installation, pick and place, packaging, product inspection, and testing; all these are accomplished with high reliability, endurance, speed, and accuracy [4].

Industrial robots are classified according to the following criteria (Table 1):

Table 1

Classification of Industrial Robots

Criteria	*Types*
Functional and structural capabilities	automatic, biotechnical, interactive
Purpose	universal, target, special
Mechanical structure	Cartesian / gantry, cylindrical, spherical / polar, SCARA, articulated, parallel
Type of production	casting, welding, forging, painting, transport and assembly
Coordinate system of manipulator's arm	rectangular (flat and spatial), polar and cylindrical, spherical, angular (flat, cylindrical and spherical)
Nominal load	super lightweight, lightweight, middleweight, heavy weight, super heavyweight
Type of drive	with electromechanical actuators, pneumatic actuators, hydraulic actuators, combined drives

Type of program	hard programmed, flexible programmed, adaptive, intelligent
Nature of control	positional, contour and combined

1. According to functional and structural capabilities and purpose industrial robots are divided into automatic, biotechnical and interactive manipulators.

– automatic robots are the first major class of robots. They are characterized by the fact that the management of actions occurs without direct human intervention. The human operator only set-ups, start-ups and controls the system. Automatic robots can be software, adaptive and intelligent;

– biotechnical robots are the second major class of robots. Human operator is involved in control. Biotechnical robots are classified into three types according to the control methods: team, copying and semi-automatic control;

– interactive manipulators are the third large class of robots. The partial participation of the human operator in the administration is their main feature. A human operator's interaction with a computer is expressed in such forms as: automated, supervisor and dialog control.

2. According to the purpose all industrial robots are divided into the following groups:

– universal, designed to perform several operations on different technological equipment;

– target, designed to perform one or more operations on the main technological equipment of various models;

– special, designed to perform only one type operations [3, p. 6].

3. The major categories of industrial robots by mechanical structure are:

– Cartesian / gantry robot;

– cylindrical robot;

– spherical / polar robot;

– SCARA robot;

– articulated robot;

– parallel robot.

4. According to the type of production all industrial robots are divided into: casting, welding, forging, painting, transport and assembly and so on.

5. According to the coordinate system of manipulator's arm all industrial robots are divided into: rectangular (flat and spatial), polar and cylindrical, spherical, angular (flat, cylindrical and spherical) [5].

6. According to the nominal load all industrial robots are divided into:

– super lightweight (0.08; 0.16, 0.32; 0.40; 0.50; 0.63; 0.80; 1.0 kg);

– lightweight (1.25; 1.60; 2.0; 2.50; 3.2; 4.0; 5.0; 6.3; 8.0; 10.0 kg);

– middleweight (12.5; 16.0; 20.0; 25.0; 32.0; 40.0; 50.0; 63.0 80.0; 100.0; 125.0; 160.0 ; 200.0 kg);

– heavy weight (250; 320; 400; 500; 630; 800; 1000 kg);

– super heavyweight (1250 and more) [1].

7. The major categories of industrial robots by the type of drive are:

– robot with electromechanical actuators;

– robot with pneumatic actuators;

– robot with hydraulic actuators;

– robot with combined drives.

8. According to the type of program all industrial robots are divided into:

– hard programmed robots are industrial robots without device for quickly change program;

– flexible programmed robots are industrial robots with the device for quickly change program;

– adaptive robots are industrial robots which carry out their activities on the basis of information about the objects and phenomena of the environment; this information is obtained in the process;

– intelligent robots are industrial robots that are able to plan their behavior according to the task, quality criteria, their own state and the state of the environment [2].

9. The major categories of industrial robots by the nature of control are positional, contour and combined [3, p. 6].

The technical indicators of industrial robots include:

– nominal load;

– work space (the space in which the executive mechanism of robot is located);

– service area (part of the workspace, where the industrial robot performs its work);

– the number of degrees of mobility (depends on the design of the driving mechanism);

– velocity of the manipulator links;

– the working body positioning error and the working body trajectory error.

This classification is designed for constant use, easy search and selection of the most rational alternative robot based on the ranking of all factors mentioned in this article.

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