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ANALYSIS OF ROTARY UNITS USED IN END EFFECTORS FOR INDUSTRIAL ROBOTS

RPM (rotary positioning module) is an autonomous, functionally and structurally separate module for rotary positioning axes with a fixed integration capacity, determined intelligence, capable of mechanical and management of linking with other modules to functionally higher machine systems. Structure RPM is generally based on the specific requirements imposed on the device while addressed in addition to the minimum of (engine, transmission system, a transformation system, sensors and control system) may contain: flange, clutch, input and output shaft, brake and external sensors.The analysis allows the assessment of properties developed by the RPM and based on the obtained information to modify individual parameters.

Keywords: *analysis, RPM, positioning units*

Introduction

The structure of the arrangement of the components for module RPM depends primarily on the mutual of combination actuator (motor) and gear (reducer). RPM modules we divide according to the location of the engine for direct and indirect. RPM with direct placement engine and gearbox has motor axis and axis gear identical, does not contain a hollow shaft and therefore cannot be over gearbox drag cables or other energy. RPM with indirect placing the engine and transmission does not have motor shaft and gearbox identical, uses secondary transmission (toothed belt, gears) for transmitting torque and power from the engine to the transmission. Gearbox in this case has the majority of the hollow shaft through which it is possible to redeploy cables, inlets energies or the lay shaft on the other axis of the device.

In terms of the use of higher machine systems to the essential requirements and characteristics RPM include: [3]

- input and output speed, gear ratio module,
- the torque, load capacity output flange,
- range of rotational movement to the output,
- speed and fluency rotary movement of the output,
- repeated working accuracy (positioning accuracy),
- overall dimensions,
- dimensions and shape of the mechanical interface.

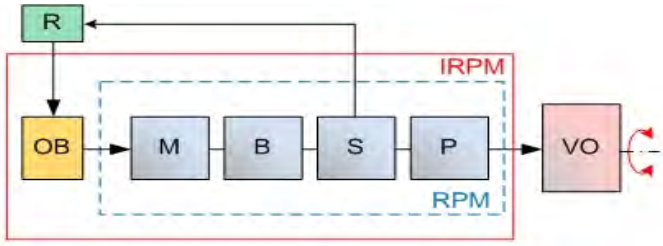
These requirements are also crucial for the equipment deployed in robotic and production facilities, such as rotary axis industrial robots, axis precision manufacturing equipment, rotary axis welding positioners and positioner for machining.

Basic functions RPM

The term rotational axis of the positioning and handling equipment (RPM), we can simply present the node device which functions to conduct directed rotational movement, with the desired speed and accuracy of positioning and shall withstand load changes during the life of the device. This node can be placed kinematic vertically and horizontally, and can be designed as 1 - axis or multi - axis module.

Figure 1 shows the basic configuration of the rotation module (RPM).

The basic module RPM consists of the basic components and the engine, brakes, sensors, reducer, control block and does not have control system with intelligence. Module labelled IRPM - intelligent rotary positioning module includes all components as the RPM with the exception that the management and control block uses some form of intelligence. Intelligence consists chiefly of adaptive control enabling real-time response to changes in the performance of work activities. The changes are based on information collected from sensors (eg. speed sensor, temperature, velocity, acceleration, torque, power, etc.), And the number and type of sensors depends on the specific requirements of the application. [1,6]



Description:
RPM – Rotation Positioning Module
IRPM – Intelligent Rotation Positioning Module
R – Control, OB – Control block
M – Motor, B – Brake, P – Reducer
S – Sensor, VO - Output member (interface)

Fig. 1 Configuring basic rotary module (RPM, IRPM)

Current trends in the design and construction of machinery systems confirm the need for RPM, the RPM is understood as a mechatronic system with defined characteristics and parameters according to the desired RPM module function in the assembly of the machine, to which this module applies. Example deployment RPM in some types of machines and equipment is shown in figure 2. [2,4]

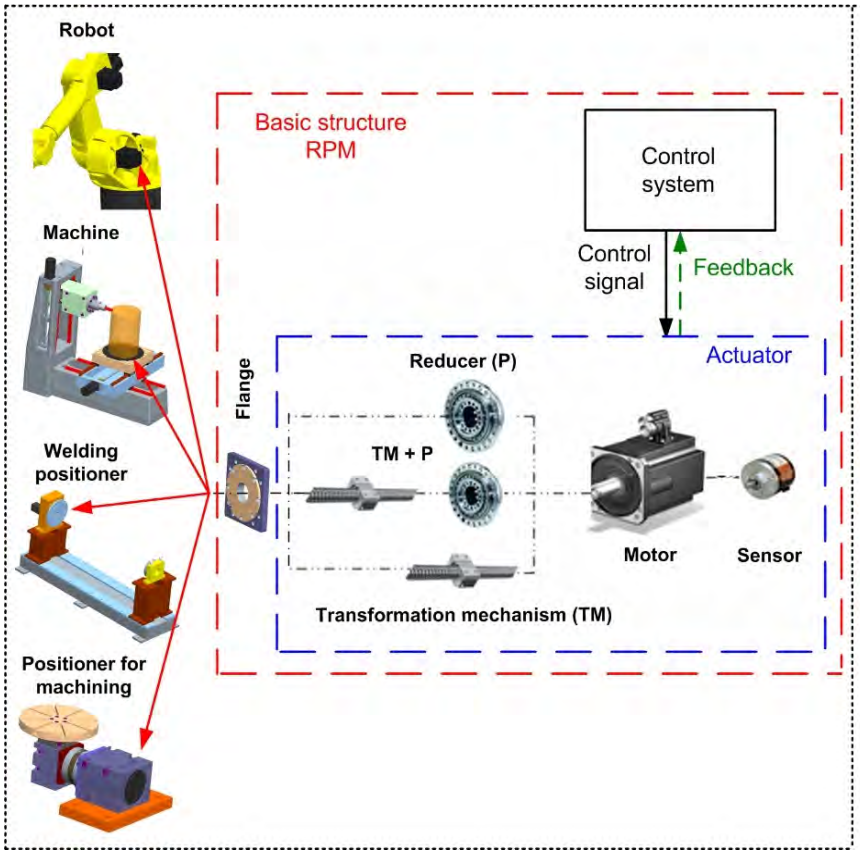


Fig. 2 Deployment of RPM in machinery and equipment

Analysis properties modules for robotic end effectors

Possibilities deployment reducers in rotary axis industrial robots are dependent on the kinematics robots and type range, which is depends on load capacity end effectors robot. The results of analysis of the range, focused on the size torque required to the realization motion in individual nodes of robots (according to kinematic of robots) are shown in figure 3. [5]

Kinematics RTT - Cylindrical robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Yes	Yes	Yes
2 - axis	Not	Yes	Yes	Not
3 - axis	Yes	Yes	Not	Not

Kinematics RRT - Spherical robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Yes	Yes	Yes
2 - axis	Not	Yes	Yes	Not
3 - axis	Yes	Yes	Not	Not

SCARA robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Yes	Yes	Yes
2 - axis	Not	Yes	Yes	Not
3 - axis	Yes	Yes	Not	Not
4 - axis	Yes	Yes	Not	Not

Parallel robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Yes	Yes	Yes
2 - axis	Not	Yes	Yes	Yes
3 - axis	Not	Yes	Yes	Yes

Kinematics RRR - Angular robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Not	Yes	Yes
2 - axis	Not	Not	Yes	Yes
3 - axis	Not	Not	Yes	Yes
4 - axis	Not	Yes	Yes	Yes
5 - axis	Yes	Yes	Not	Not
6 - axis	Yes	Yes	Not	Not

DUO - arm robot				
Node of robot	Size of torque moment (Nm)			
	0-10	10-50	50-100	100-250
1 - axis	Not	Yes	Yes	Yes
2 - axis	Not	Yes	Yes	Yes
3 - axis	Not	Yes	Yes	Not
4 - axis	Not	Yes	Yes	Not
5 - axis	Not	Yes	Yes	Not
6 - axis	Not	Yes	Yes	Not
7 - axis	Yes	Yes	Not	Not
8 - axis	Yes	Yes	Not	Not
9 - axis	Not	Yes	Yes	Not
10 - axis	Not	Yes	Yes	Not
11 - axis	Not	Yes	Yes	Not
12 - axis	Not	Yes	Yes	Not
13 - axis	Not	Yes	Yes	Not
14 - axis	Yes	Yes	Not	Not
15 - axis	Yes	Yes	Not	Not

Fig. 3 Sizes torque moment in the nodes robots

A manner similar, was carried out the analysis on speed of rotation, accuracy, repeatability and range of motion for different kinematics of industrial robots.

Another suitable area deployment precision reducer is in the end effector of the robot (the micro movements and technological head).In the effectors, where are required micromovements is necessary to take into account the smaller serializability such production and the need to adapt to specific customer requirements. In the industry robotics, focusing on analysis of effectors passed 15 companies with a total of 20 facilities where found 32 knots appropriate for the possible deployment of RPM modules. Based on the analysis of these nodes, we can say the biggest prerequisite for the deployment of lower size range reducers (average body reducer from Ø 30 to 80 mm), tab. 1.

Tab. 1

Analysis size range modules for the end-effector robot

Type of equipment	Analysis performed						Applications by size in (%)
	Number of Companies	Number of equipment	Type of equipment/ number (piece)		Number of nodes	Type of node/ number (piece)	Size range of module (ø30-110 mm)
End effector	5	20	Micro - mechanisms	12	32	Rotary unit 20	Ø 30 – 7 % Ø 50 – 21 % Ø 60 – 24 %
			Technological head	28		Drive module 12	Ø 70 – 22 % Ø 80 – 17 % Ø 110 – 9 %

Through the implemented analysis gave the following values (parameters) that is used to the end effector of industrial robots:

- torque moment: 10 – 250 Nm,
- speed of rotation: 5 – 180 ot/min,
- accuracy: 0,005° - 0,1°,
- repeatability: 1 – 60 arcsec,
- range of motion: 90 – 360°.

Conclusion

An analysis of deployment options of rotating units in various industrial robots kinematics we investigated the possible potential deployment of rotary units. The analysis is addressed mainly the last - end nodes industrial robots, as well as end-effectors these robots. The task was to determine the basic parameters of the nodes robots, which are necessary for the proper identification of a size range of rotary units. Based on the implemented analysis can be adapted to develop new modules RPM to suit the needs of the market.

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