

GENETIC AND MORPHOLOGICAL APPROACH FOR DESCRIPTION AND SYNTHESIS OF GRIPPING DEVICES OF ROBOTS AND MANIPULATORS

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Abstract

The results of the implementation of the genetic and morphological approach in relation to the gripping devices of industrial robots and manipulators used in robotic complexes and systems are given. The results are illustrated on the examples of the description and synthesis of gripping devices for manipulation with fragile, soft, non-rigid and glass objects with the application of various environments and fields in power path.

Keywords: gripping device, robot, genetic code, genetic and morphological approach, power path

1. INTRODUCTION

For an automatic manipulation of objects of different forms sizes and properties in robotic systems and complexes for various productions important executive bodies are the gripping devices (GD) [2,7-11].

At present a large number of different GD implementations are created that is caused by a considerable modification of the robotized operations and objects (details, subjects, products) with which robots work in various operating conditions [7,9,10]. A variety of GD is classified according to the following signs [1,6,7]: way of object control; principle of operation; type of object basing; level of specialization; working range of the extent of the gripping object; availability of auxiliary devices and mechanisms; number of working positions (gripping parts); type of management; principles of GD fastening to a hand of an industrial robot or a manipulator.

2. PROBLEMS

According to one of the carried-out functions GD belong to a certain type of gripping mechanisms and, in particular, grip sockets since they have to provide reliable control of an object while manipulating due to the application of the gripping power of an object to static for elimination of tear or strictly regulated in order not to damage the object. In other words, as in the grip sockets, the necessary condition should be provided - the required gripping power.

Therefore, GD have such power paths from a power source and an actuator as in the gripping mechanisms [4,5] that enable while describing and synthesizing the GD to apply the theory of genetic and evolutionary synthesis [12] at various levels of the structural organization (fig. 1).

According to the genetic and morphological approach to the description and synthesis of the gripping mechanisms the transfer of movements, forces and energy to the gripping elements can be described at the chromosomal level in the form of morphological model (matrix) of elementary power paths – parental chromo-

somes (pair of input and output force) for objects such as bodies of revolution in a cylindrical coordinates [5]:

$$M_m = \begin{bmatrix} F_{a1} \\ F_{r1} \\ F_{r1} \\ F_{r1} \\ F_{r1} \\ M_{a1} \\ M_{r1} \\ M_{r1} \\ M_{r1} \\ M_{r1} \end{bmatrix} \Rightarrow M_{EX} \begin{bmatrix} F_{a2} \\ F_{r2} \\ F_{r2} \end{bmatrix}$$

It gives 12*4=48 options, and unless the direction of forces and the moments at the input are considered, which isn't so important for DG drives, options will become twice less.

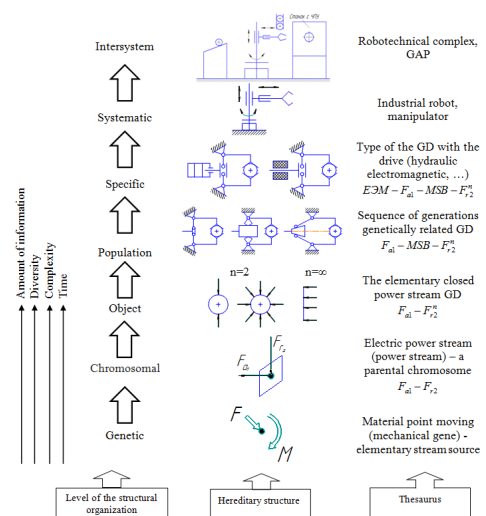


Fig. 1. Genetic model of the structural organization and evolution of complicated robotic systems and complexes in the flexible automated manufacturing

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The graphic representation of the power paths in the GD is shown in fig. 2.

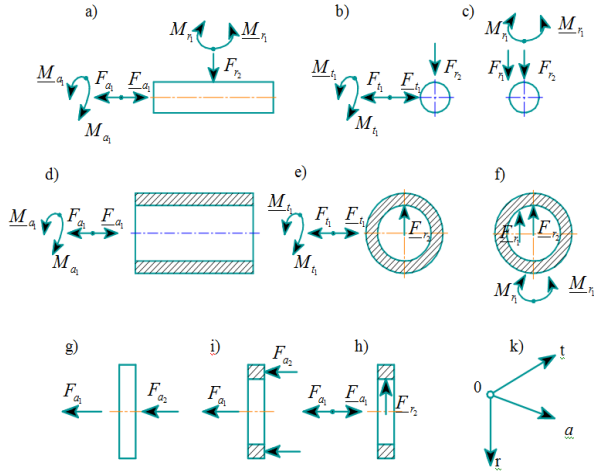


Fig. 2. Options of possible power paths in gripping devices for a manipulation of solid cylindrical (a-c) and hollow cylindrical (d-f) details, solid disks(g) and rings (i-h) in cylindrical coordinates of art (k)

3. SOLVING THE PROBLEM IN THE EXAMPLES

For a manipulation by fragile, soft, non-rigid and glass objects in addition to mechanical solid-state inverters, liquid, viscous, and air environments, and also magnetic and electromagnetic fields should be used [5,11].

Examples of the use of air environment under pressure p with the implementation of various power paths are shown in fig. 3.

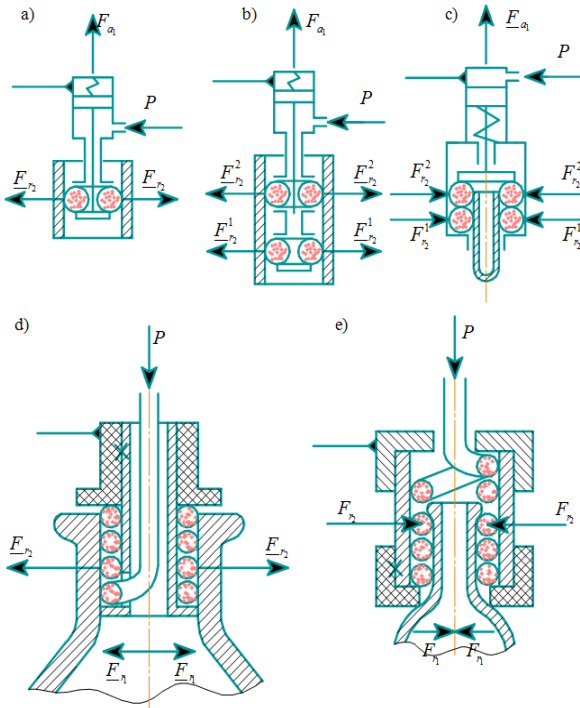


Fig. 3. Schematic circuits of gripping devices for fragile and non-rigid objects and their corresponding parental chromosomes: a, b) $F_{a1} - F_{r2}$; c) $F_{a1} - F_{r2}$; d) $F_{r1} - F_{r2}$; e) $F_{r1} - F_{r2}$

According to the patent of Ukraine № 32431 in the DG the power path is realized with one output (fig. 3, a) and

two outputs (fig. 3, b) - $F_{a1} - (F_{r2}^1 - F_{r2}^2)$ for gripping the object from the inside by means of hollow toroidal rubber gripping elements at their collapsing. In the DG the power path is realized according to the same patent (fig. 3, c).

According to the patent of Ukraine № 68761 in the DG power path $F_{r1} - F_{r2}$ is realized with one entrance and multiposition gripping of an object from the inside (fig. 3, d) at air supply under pressure p in a process of canted coil pipe. The same principle of the object gripping outside is realized in the DG according to the patent of Ukraine № 63969 in the form of a power path $F_{r1} - F_{r2}$.

Instead of the air environment for the gripping of low-rigid details electromagnetic fields can be used (fig. 4, a-c) [6].

According to the patent of Ukraine № 43614 (fig. 4, a) and № 44205 (fig. 4, b) with electromagnets in the DG power path $F_{r1} - F_{r2}$ is realized, and according to the patent of Ukraine № 45139 – power path $M_{r1} - F_{r2}$. In the DG with the bending cameras of the firm “Simrit” the power path $F_{r1} - F_{r2}$ is realized.

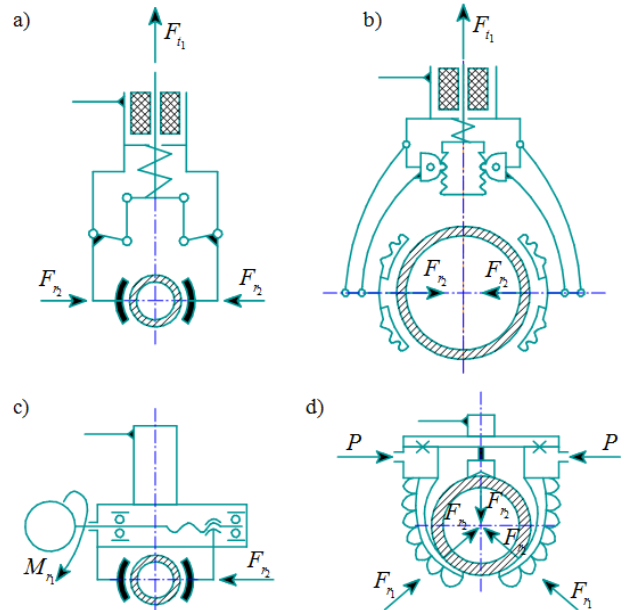


Fig. 4. Schematic circuits of gripping devices for rigid, fragile, non-rigid objects and their corresponding parental chromosomes: a, b) $F_{t1} - F_{r2}$; c) $M_{r1} - F_{r2}$; d) $F_{r1} - F_{r2}$

CONCLUSION

It is shown that genetic and morphological approach can be applied successfully not only to the description and synthesis of gripping mechanisms, but also for the gripping devices of industrial robots and manipulators, using as parental chromosomes power (energy) paths between two material particles [4,5].

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