

3. Practical aspects of the polymodel approach to the synthesis of mechatronic modules of packaging equipment

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Introduction. The poly-model approach to the synthesis of mechatronic modules for packaging equipment allows us to flexibly and efficiently design and manufacture packaging machines that meet the changing needs of the market and provide high performance, reliability and cost-effectiveness.

Materials and methods. The research materials are robotic systems based on electric drives. The study of mechatronic systems is based on the theories of mechanics, electronics, automation, computer science and uses methods of analytical modelling, experimental research, numerical modelling, system and hierarchical approaches, as well as computer simulation.

Results and discussion. In order to describe the interrelationships between different variants of mechatronic modules construction of packaging equipment, it is proposed to use an alternative-graph formalisation, which shows different variants of system elements construction (Fig.1). Let G_j – graph, defining variants of composition and interrelations of possible nodes of mechatronic modules; $G_j^* \in G_j$ – subgraph defining one of possible variants of nodes realisation with their interconnections.. Its arcs reflect the interrelations between the nodes. The formalisation of problems with mapping of the first type leads to mathematical problems of integer programming, and of the second type - to mixed (linear and integer) programming. The problem of synthesis of the mechatronic module structure in this case can be formulated in terms of optimised quality indicators, with a constraint on the cost of functioning:

$$F_0(x_{ik}, x_{imn}, x_{imj}, x_{jp}) \rightarrow \text{opt.}$$

In this case the required mapping θ - a multitude of interrelated tasks and their phases G_i on the set of interconnected nodes of the system G_j is defined by a corresponding set of variables. Two types of mappings are possible when distributing tasks between the nodes of the mechatronic module θ : 1) each task (stage) is performed in only one of several possible nodes of the system; 2) tasks (stages) are performed in several nodes of the system.

Fig.1. Alternative-graph formalisation of the structure

Conclusions. The presented formalisation of synthesis of the control system structure allows to solve the problem of task distribution between elements (nodes) of the technological machine built on the basis of mechatronic modules, and the corresponding methodology of optimisation of the packaging equipment structure.

References. Kryvoplias-Volodina L., Gavva O., Blazhenko S., Marunin A., Volodin, O. (2023) Architecture of hybrid mechatronic dosing and packing module of packaging machine based on qualitative analysis. Eastern-European Journal of Enterprise Technologies, 4(2-124), pp. 70-79. doi: <https://doi.org/10.15587/1729-4061.2023.286615>