Graph model of robotized technological operations of non-ferrous metallurgy

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Abstract

The paper discusses the importance of manual operations in non-ferrous metallurgy. Based on the various signs of manual operations there was highlighted their classification. After analyzing manual operations, it is possible to construct a graph model of the classification characteristics of manual operations.

Keywords: technological process, manual operation, non-ferrous metallurgy, classification of manual operations.

1 Introduction

Technological processes of non-ferrous metallurgy (TPNFM) are characterized by widespread use of service operations performed manually, this circumstance greatly holds back the technological progress of the industry and has profound social consequences.

The survey and analysis of manual operations (MO) revealed a number of characteristic properties:

1. The content, the sequence of actions and the cyclical nature of manual operations are unchanged and are determined by the characteristics, parameters of the technological processes for servicing of which manual operations of technological equipment are used in which they take place;
2. There may be a drift in the technological process parameters, leading to a drift in the MO characteristics. For example, the drift of the spatial position of the positioning points and (or) movement trajectories, positioning time points or speeds and accelerations of movement along the trajectories of the working tool or load, force-moment characteristics necessary to perform the MO;
3. There may be different modes of conducting the technological process, affecting the characteristics of the MO. For example, change of the spatial position of the positioning points and/or trajectories, the moments of positioning or speed and acceleration of the movement of the working tool or load, changes in the force-moment characteristics necessary to perform the MO;
4. There may be adverse conditions (aggressive environment, fire and explosion hazard conditions, the presence of high temperature and other conditions) in the technological space where the MO are performed.

The above-mentioned features of technological processes make it possible to identify the main features, according to which MO requiring robotization are classified.

Classification of manual operations. By the possession of various characters, from the listed series there can be selected many classes of MO. Let consider these classes. As can be seen from the description of the classification features, they can be divided into eight groups.

The first group includes signs 1-3, reflecting the types of action components of the MO. The second group includes signs 4-6, they reflect the spatial characteristics of the MO. The third group includes signs 7-8, reflecting the relationship between the spatial positions of the positioning points and the MO trajectories with the drift of the parameters of the technological equipment (TE). The fourth group includes signs 9-11, they reflect the time characteristics of the MO. The fifth group includes signs 12-13, reflecting the relationship of the time characteristics of the MO with the drift of the TE parameters. Signs 14-15 belong to the sixth group, they display the force-moment characteristics of the MO. Signs 16–17 belong to the seventh group; they reflect the characteristics of the environment in which the MO take place. The eighth group includes signs 18-19, they reflect the existence of any other factors that are not included in the previously listed signs that affect the performance of the MO.

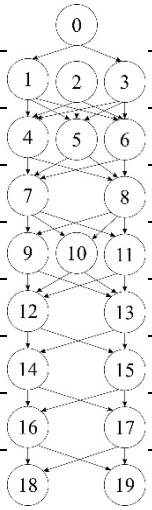
2 Conclusion

Classifying the MO, each class is characterized by eight main features according to one of the selected groups.

Therefore, in total, during the signs possession, from each group there can be distinguished 864 MO classes.

At the same time, the regulation or control of the technological process parameters or technological equipment can be used to control the classification characteristics of the MO and to provide the conditions under which it is possible to solve the problem of their automation or robotization, using standard means of robotics or developing special or specialized industrial robots.

TABLE 1 Graph model of classification signs of manual operations

Classification signs	MO nomination
1st level 	
2nd level	Types of actions required to perform manual operations;
3rd level	Spatial characteristics of manual operations and their relationship with the characteristics and parameters of the technological process
4th level	Spatial characteristics of manual operations and their relationship with the characteristics and parameters of the technological process
5th level	Temporary characteristics of manual operations and their relationship with the characteristics and parameters of the technological process
6th level	Temporary characteristics of manual operations and their relationship with the characteristics and parameters of the technological process
7th level	Force-moment characteristics of manual operations and their relationship with the characteristics and parameters of the technological process
8th level	Characteristics of the production conditions in which manual operation is performed
9th level	The existence or absence of other unrecorded factors affecting the performance of a manual operation

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