Annotation
Dissertation work of doctoral candidate Ph.D on specialty 6D070200 - "Automation and control"
Theme: «Development of models and algorithms for the construction of robotic systems in the process of robotics of foundries of non-ferrous metals»

Actuality of work. The analysis of the processes of production of commercial lead, zinc and magnesium showed their sufficient complexity of mathematical description, the similarity of processes, but also the presence of significant differences. The complexity of the description of these industries is due to the progress of various processes, beginning with hydrodynamics, the presence of heat transfer processes, the work of the carousel filling machine (CFM) or the casting conveyor (CC) as a complex electromechanical system, the presence of stringent requirements for technological procedures for conducting processes and performing operations.

To describe the whole variety of processes proceeding, a stratified representation of the production data is proposed. The analysis revealed a number of technological operations (TO) performed manually: removal of the oxide film from the surface of a metallic melt of lead and zinc cast in a fixed ingot mold of the casting machine, removing the oxide film from the surface of the magnesium melt cast in moving molds of the oxide film and transferring the metal stream from one molds into another foundry conveyor.

One of the ways to reduce the share of manual labor is to use industrial robots (IR) and build robotic technological complexes (RTC) to perform these maintenance operations.

When constructing the RTC, it is necessary to perform the stages of selecting models of mass-produced IR, construction of layout schemes of the RTC. In this paper, we consider the development of models and algorithms for selecting the type of a mass-produced robot, taking into account the stringent requirements for geometric parameters, such as the working space (WS). On the basis of the chosen model it is possible to build a layout scheme (LS) of the RTC, where also the dimensions of the OL are taken into account and the problem of their adaptation to the geometric dimensions of the process equipment is solved.

These problems can be solved using visual modeling approaches that have an advantage in visualizing the results, but have low accuracy at the boundaries of the IR. Therefore, to solve these problems, analytical approaches are proposed with the use of the capabilities of the mathematical apparatus of R-functions.

Objective. For the construction of the RTC for the production of lead, zinc and magnesium, it is proposed to develop formalized models and algorithms for choosing the type of a mass-produced robot and for constructing a RTC computer using the mathematical apparatus of R-functions.

The main idea of the work. Application of the mathematical apparatus of R-functions for a formalized description of the procedure for selecting the model of the IR. The implementation of the algorithm for selecting the IR model in the form of a two-stage procedure, at the first stage, a choice is made by numerical parameters, at the second stage, a choice is made for the RP of the PR. Development of models and algorithms for a formalized description of CS with approximation of RTC elements by rectangular cylinders and rectangular prisms, using the mathematical apparatus of R-functions.

Objectives of the study. To solve these problems:

- to develop a stratified description of the foundry productions of lead, zinc and magnesium;

- to develop a formalized statement of the problem of selecting the model of the PR, while the RP of the PR are described using the mathematical apparatus of the R functions;

- to develop a formalized description and algorithms for constructing the CS in the approximation of RTC elements by rectangular cylinders, using the mathematical apparatus of R functions;

- to develop a formalized description and algorithms for constructing the CS in the approximation of RTC elements by rectangular prisms, using the mathematical apparatus of R-functions.

Object of study. The object of the study are the technological processes and operations of the production of lead and zinc in the KRM and the production of commodity magnesium in the LC.

Methods of research. When solving the tasks set, the following methods were used: methods of system analysis, the fundamentals of robotics, multilevel hierarchical systems, the mathematical apparatus of R functions, the technology of object-oriented programming, and so on. As a modeling tool, the DELPHI software environment was used.

Scientific novelty of the work:

- levels of description are revealed and a stratified description of the production of lead, zinc and magnesium is developed;

- a description of the working spaces of robots with the application of the mathematical apparatus of R functions and the development of an algorithm for selecting the type of robots over workspaces;

- a formalized description and algorithm for constructing a layout scheme for approximating the elements of a robotic complex by rectangular cylinders with the use of logical expressions for R functions.

- formalized description and algorithm of construction of the layout scheme when the elements of the robotic complex are approximated by rectangular prisms with application of logical expressions of R - functions.

The following scientific provisions are made for defense:

- developed stratified description of the production of lead, zinc and magnesium.

- developed formalized description and algorithm for choosing the type of PR for the RP, described with the use of logical expressions for R functions.

- The developed algorithm of construction of layout schemes at approximation of elements of the robotized complex by rectangular cylinders and the description of working spaces of the robot with application of logical expressions of R - functions.

- The developed algorithm of construction of layout schemes at approximation of elements of the robotic complex by rectangular prisms and the description of working spaces of the robot with application of logical expressions of R - functions.

Practical significance of the results of the research.

Developed stratified description of foundry production of lead. Zinc and magnesium can be used in the automation and robotization of production processes. The developed models and algorithms for selecting the RP model for the RP, the construction of the RTC CS can be used in the construction of the RTC in various industries. The results of the research, including author's developments, are used in laboratory and practical classes in the disciplines of the department: "Automation of standard technological processes and productions", "Automation and control in technical systems". The results of the work are used in educational and methodological complexes of disciplines, syllabuses and work programs on the above disciplines.

Received an act on the implementation of the results obtained in the laboratory "Management of technological processes" in Lublin Technical University, Lublin (Poland).

Specific personal participation of the author in obtaining the results stated in the thesis is as follows:

- developed a stratified representation of foundry, lead, zinc and magnesium foundries;

- developed a formalized description and block diagram of the algorithm for selecting models of industrial robots;

- developed a formalized description and block diagram of the algorithm for constructing layout schemes of the RTK when it is approximated by rectangular cylinders;

- developed a formalized description and block diagram of the algorithm for constructing layout schemes of the RTK when its elements are approximated by rectangular prisms;

Approbation of work.

The obtained results are reported at conferences and discussed at scientific seminars of the Department "Automation and Control", at the Lublin Technical University, Lublin (Poland).

Publications.

On the topic of the thesis published 12 works. Of these, 4 articles are in scientific journals from the list of the Higher Attestation Commission of the

Republic of Kazakhstan, 3 reports are published in the proceedings of international scientific conferences, 5 articles are published in foreign publications included in the international database on quoting "Scopus".

The structure and scope of the dissertation: The thesis consists of an introduction and four sections, contains 211 pages, 116 drawings and 1 table, a list of sources used from 129 names and 3 applications.