Modification of the harmony search algorithm using the system management model.

This research proposes an innovative way to modify the harmony search algorithm (HSA). It is proposed to apply a specific methodology at the initialization stage of the algorithm to form the initial harmony memory using the model of system control and systemology.

The essence of this methodology is to represent the initial harmony memory of the algorithm in the form of a functional system of external and internal construction factors. The authors propose to use a special model of systematic management, which is based on the general principles of systemology. This methodology of the systematic approach allows achieving the ultimate functional goal as soon as possible - the creation of an interdependent purposeful set of elements of the memory system that mutually contribute to the achievement of a given useful result (harmonization of the production system), which is accepted by the main system-forming factor at the stage of initialization of the harmony search algorithm.

In this scientific study, the harmony memory is a complex system consisting of interconnected elements and interrelationships between them. In the context of harmonization of system management and the use of promising strategies, the methodology of technological reliability of the production system is also used.

The reliability of a production system is a complex property of the production system to function at a satisfactory level within a given time period, with the acquisition of quantitative time characteristics, such as reliability, functionality, reliability, durability, stability, survivability, safety, etc.

Determination of technological reliability in the assessment of the result implies, if necessary, structural reorganization of the system and functional replacement of some elements (unreliable, failed) with other elements that previously performed other functions to ensure a given result.

This approach obliges the developer (decision maker) to adhere to a clear structural scheme of harmony memory with all the attributes of system engineering with a certain composition of elements, connections and empirical data. The realization of the research innovation is reflected through the list of complete control functions, system behavior of elements and transformations between information modules of the system in the process of optimization.

The aim is to determine the reliability of the initial harmony memory (HM) at the initialization stage of the algorithm (HSA) using the principles of system control. The indicator of the technological reliability of the system of elements of the initial harmony memory (HM) at the initialization stage will reduce the number of algorithmic iterations and speed up the optimal decision-making in construction.

The authors of the study propose that the reliability of the algorithm initialization stage is based on the system-forming factors of the construction environment (atmospheric phenomena, working conditions, biological factors, functional barriers) and the professional responsibility of the developer (professional knowledge, specialized standards, professional skills, professional experience, professional competencies, innovation, self-control, endurance).

The system-forming factors are united by certain functions into three main groups: information modules of management, actions of the management subject, and management tasks.

The group of factors of the information module of management contains indicators of the information state of a separate variable of the decision vector $\mathbf{x^i_j}$. The information state changes the measure (PAR) of a separate variable of the decision vector (a separate element of the harmony memory system), which leads to a new material content of this element.

To introduce seven information modules into the model of systematic control of algorithm initialization (HSA):

1) the first information module ($\psi 1$) - assessment of the state of management of the object;

2) the second information module ($\psi 2$) - determination of the subject's own state of management;

3) the third information module ($\psi 3$) - determination of the state of neighboring objects with which interaction is performed;

4) the fourth information module ($\psi 4$) is the state of the environment in which the system elements interact;

5) the fifth information module ($\psi 5$) - the state of the structure that carries out management (management entity);

6) the sixth information module ($\psi 6$) - instructions and restrictions from higher management structures;

7) the seventh information module ($\psi 7$) - distinction-methodology (awareness of the system management process through the combination of all seven information modules).

Management functions ensure the circulation of information and information transformation in the management process and also reflect the sequence of actions of the management entity:

1) action one (X1) - recognition of the environment factor, i.e. the factor that affects the system with which the intelligence is faced;

2) action two (X2) - formation of a recognition stereotype, i.e. recognition of the environment factor for the future;

3) action three (X3) - forming a vector of goals for each environmental factor and adding the time vector to the overall vector;

4) action four (X4) - formation of the target function (concept), management based on the solution of the problem of sustainability by foresight;

5) the fifth action (X5) is the organization of a management structure that manages and carries the target management function;

6) the sixth action (X6) - control, monitoring of the system structure in the process of management;

7) the seventh action (X7) - maintaining performance or liquidation - maintaining the performance of the structure in the management process or its liquidation (if necessary).

Full management functions can be realized only in an intelligent management scheme, which implies the creativity of the management system, the presence of the manager's intelligence, who is obliged to solve the following tasks:

1) task one ($\chi 1$) - identification of environmental factors that affect the production system (this cannot be done without a creative approach);

2) task two ($\chi 2$) - formation of goal vectors (this is also a creative process);

3) task three ($\chi 3$) - formation of new management concepts (how to do all this, what new tools to use, what promising forces?)

4) task four ($\chi 4$) - improvement of the methodology of forecasting and correction in solving sustainability problems by predictability according to the “predictor-corrector” scheme;

5) task five ($\chi 5$) - the ability of the control system to independently produce a new information module based on the control systemology.

To increase the reliability of initialization of the HSA algorithm using a system-forming model that reflects the structure and logic of complex interaction between the elements of the HM harmony memory.

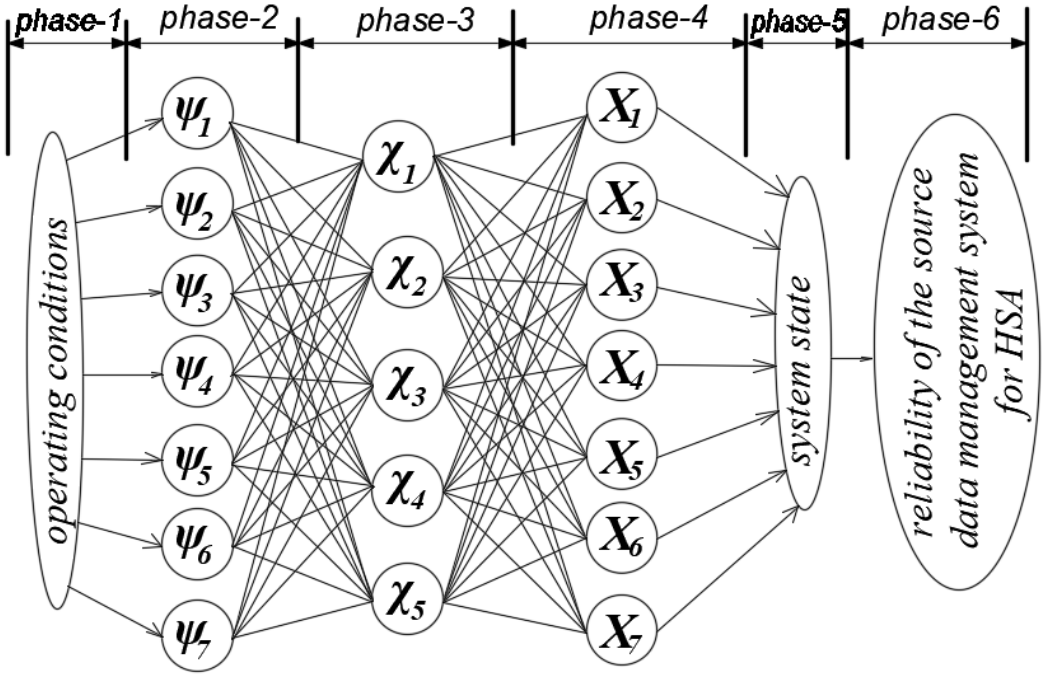

Figure 1 - A system-forming model to ensure the reliability of HSA initialization

The model in Figure 1 reflects the interconnection of information modules, complete functions of production system management and combines the states of the system's perspective development through the following transformation phases: the first phase is the phase of system environmental conditions (initial data); the second phase is the phase of information capabilities of functional flows; the third phase is the phase of an intelligent control scheme; the fourth phase is the phase of implementation of functional processes of system management; the fifth phase is the phase of system state formation; the sixth phase is the phase of targeted possibilities.