3. ПРОЦЕСИ АВТОМАТИЗАЦІЇ ТА РОБОТИЗАЦІЇ

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KNOWLEDGE-ORIENTED APPROACH TO THE AUTOMATION OF THE MAIN PIPELINE COMPLEX

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Nowadays the automation of complex technological process control takes place in different industries. One of such industries is the gas transportation branch of Ukraine. That is also caused by the tendencies of Ukraine integration into the common European gas transportation system. The multilevel control systems are created on the basis of advanced hardware and software automation tools. Automated workstations built on the basis of Supervisory Control and Data Acquisition (SCADA) technologies provide collection, storing, displaying and primary processing of data and also make it possible to control the complex technological objects on dispatching level of main pipeline complex (MPC) control.

One of the primary goals of MPC control is to provide the exploitation reliability and service durability of the main pipelines, that’s why it is vitally important to pay attention to the process control of pipelines electrochemical protection (ECP) from corrosion [1]. However, in order to make the high-quality and well-grounded decisions on the MPC dispatching control level it is necessary to consider a lot of both external and internal factors that have explicit or implicit impact on the control object. In order to make a decision in conditions of various dynamically changing factors it is necessary to involve highly qualified specialists with great experience (domain experts). The involvement of experts is a toilful, expensive, and continuous process. Along with this, efficiency of control decisions making is one of the main requirements put upon the technological processes in gas transportation branch. In order to overcome such a problem, it is expedient to apply the approach based on the expert system technology that is able to give the information and intelligent decision support.

In connection with stated above the actual problem is the development of knowledge-oriented models [2], that can be used as a basis for expert system creation and may increase the effectiveness and quality of MPC control.

Well-known up-do-date methodologies of expert knowledge acquisition and structuring such as Task Structures, Role-Limiting Methods, Method-to-Task, KADS that are based on the use of the so-called «paradigms» of problem solutions (such as Heuristic Classification and Propose-and-Revise) and oriented on the reuse of existing task solution methods make it possible to pass from the specific knowledge engineering branch to the classic engineer problems. But the problems connected with difficulty of formal problem description, checkout of conformity between the selected problem and the method of its solution and some other problems complicate the solution of a specific problem.

On the basis of the situation stated above the functional knowledge-oriented model that is based on a set of typical intelligent elements is proposed. Typical intelligent elements are based on “knowledge source” concept of KADS-methodology [3-4] and make it possible to solve the analytical and logical tasks, as well as the tasks connected with classification, abstraction, specification, finding of regularities and others that often arise in decision making process of MPC control.

The main advantages of the developed functional knowledge-oriented model are: modularity (representation of monitoring, diagnostics and control processes of complex technological objects in a form of separate knowledge-oriented components interaction); universality of the typical functional blocks library (solution of typical tasks, arising in the process of technological object control); adaptability (easy adaptation to a specific domain); openness (gives the user a possibility to set the desired behavior); activity (interaction of typical functional blocks with each other that makes it possible to automate the process of knowledge acquisition and processing and also interaction of functional blocks with a hybrid production-frame model using the service block inputs (frames) and mechanism of pointers (production systems) that allow to increase the effectiveness of knowledge procession during the control decision making process).

Every typical intelligent element is a functional block with a set of inputs and outputs. The behavior of such block is defined by its purpose.

The whole set of typical intelligent blocks that is used in construction of functional knowledge-oriented model according to the block purpose can be divided into five classes: blocks that return value (of attribute or variable) (they are intended to find values of object attributes on the basis of logical or analytical task solution, and also to search values of object attributes in database); blocks that return an analytical expression (they are intended to find analytical regularities between the different attributes); blocks that return generalized domain concepts (classes) (they are intended to make dynamic transformation of object structure in the process of specific problem solution); blocks that return operation results (they perform the auxiliary functions in comparison of the same-type object attributes with each other); blocks that control the model branching (they are intended to make branching in the model on the basis of domain object classification). The behavior of typical intelligent elements can be set by three different ways: static (is set in behavior editor), for example, production systems that describe the behavior of such blocks as «calculate logically» or «classify by rules»; dynamic (obtained from the output of previous block), for example, at the input of «calculate analytically» block the analytical expression found by "find regression" block can be entered; static hidden (user compiled modules), for example, user can set the desired block behavior in cases when the use of typical block is not rational or is impossible (complex search algorithms, non-linear or multiple regression etc.). In such cases the element behavior will be hidden and the element will be seen as a «black box».

Two different relations are used to connect function blocks with each other: "output-input" and "precedence". "Output-input" relation means that the result obtained by the previous block is directly used by the next. In contrast to the "output-input" relation, the "precedence" relation shows only a logical sequence of functional block activation. In that case the connection between the functional blocks is performed by means of common database.

Thus, the functional blocks have the configurable behavior and may interact with each other during the process of finding a solution by the pre-defined set of relations. There were also developed the mechanisms of interaction between the typical functional blocks with the well-known knowledge representation formalisms such as production systems and frames. Interaction with a frame model is performed by means of service inputs of functional blocks that make possible to define the value of frame slot, reconfigure the frame structure and even the whole frame hierarchy i.e., making it "live".

On the basis of the developed model for the functional knowledge acquiring, representing and processing the expert system for the dispatching level automated workstation of the ECP process control has been developed. Nowadays this expert system is integrated and maintained in "Ukrtransgas" that is an affiliated Company of "Ukraine Naftogaz" National Joint-stock Company as a part of automated system of electrochemical protection of main pipelines from corrosion.

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