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MODULAR STRUCTURE OF INTELLIGENT CONTROL SYSTEM IN CONSTRUCTION AND ROAD MACHINES

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The task of improving the efficiency of control system of construction and road machines (CRM) has been considered. The structure of intelligent system of CRM has been offered as well as the modern means of engineering communications that allow realization of modular principle of control system.

Розглянуто задачу підвищення ефективності системи управління будівельно-дорожніх машин (БДМ). Запропоновано структуру інтелектуальної системи БДМ, а також сучасні засоби технічних комунікацій, що дозволяють реалізувати модульний принцип системи управління.

Рассмотрена задача повышения эффективности системы управления строительно-дорожных машин (СДМ). Предложена структура интеллектуальной системы СДМ, а также современные средства технических коммуникаций, которые позволяют реализовать модульный принцип системы управления.

***Keywords**: efficiency, intelligent system, diagnostic parameters, element base, mathematical models, optimization, structural model, modular principle, operation, mode*

Introduction. Today a more complicated structure of the system of intellectualization of construction and road machines (CRM) is being developed. The main subsystems of this structure are: the subsystem of high-speed computer devices; the subsystem of information high-precision sensors; the subsystem of mathematical models of optimizing the parameters and working modes of machines. Each of these subsystems is characterized by a set of hardware and software with its requirements for operation and maintenance.

The current tasks of managing complex objects are accompanied by analysis of many factors, processing large arrays of information obtained from diverse, distributed in space, information sources. The decisions on the workflow are taken in terms of the dynamic changes in the external environment. Managing such objects requires adequate and relevant responses to conflict situations arising during the operation. The control systems of construction and road machines can be the examples of such information and control structures.

Topicality. The concentration of road construction work requires the use of high technology. Given the size requirements of these machines, extensive ways of their perfection only by increasing the drive power and design strength cay not provide a significant increase in performance. One of the effective ways to improve road-construction machines is implementing mechatronic design principles, which requires solution of an actual scientific task of creating the theory of road-construction machines workflows as intelligent mechatronic systems. An effective approach to solving such problems of control can be the use of distributed information and control response systems. The variety and priori uncertainty by the type of conflict requires the use of situational principle of control in the systems of response. In such case, depending on the content and nature of the situation controlled, it is necessary to create structural-parametric configuration of control system adaptively (ad hoc).

Papers review. The development of CRM control systems is stipulated by the increasing number of sensors, modernization and complication of standard algorithms for managing complex work operations of construction and road machines [1]. There is an integration of algorithmic methods for managing complex objects and artificial intelligence methods for tasks with the uncertainty of the output information [2]. These tasks include: assessment of the situation; forecast of the object behavior in normal mode and in emergency situations; synthesis and evaluation of the possible actions of the operator and their best choice. [3] A distinctive feature of intelligent systems is the ability for planning, adapting and training [4]. The network-centric technologies are developed and implemented effectively accompanied by road-building equipment [5].

Purpose and problem description. The purpose of the work is to improve efficiency of road construction machinery control due to design and development of an intelligent response system in changing operation conditions.

To achieve this goal it is necessary to analyze the typical structure of construction and road machines intelligent control system, define the basic modules, analyze the existing tools of implementation and put forward the requirements of their functioning.

Analysis of the intelligent control system of construction and road machines. In the most classic form the structure of CRM intelligent system consists of three levels. The lower level of input/output includes sensors, actuators. The intermediate level consists of controllers. Their task is to process the obtained data, to give the control action, to transfer data to the upper level. At the top level there are the database servers and operator stations, whose task is to give the operator a man-machine interface and to carry out the exchange with the server and programmable logic controllers (PLC). The structure of a CRM intelligent system is presented in Fig. 1.

The mechatronic approach involves a high degree of integration of mechanical, electrical, hydraulic, electronic and information subsystems in CRM design. Thus, the machine should be presented as a set of interconnected actuators and basic housing design elements that change their position in space under the action of their power system drives as a result of computer control. The principles of control should be incorporated in CRM intelligent system – an onboard computer software for solution of multi-objective optimization of the working cycle according to the criteria of performance, power consumption and reliability considering limiting factors and failures prediction based on current data about the parameters that characterize the state of machine elements and the properties of the environment, problems obtained from the operator and an external control system.

CRM intelligence system performs the following tasks: adaptive optimization of workflows of CRM subsystems; estimation of actuators efficiency – the analysis of compliance of the indicators of performed operations and technical conditions of the machine design elements to

specifications; predicting the residual life of CRM structural elements on the base of loading analysis during the time of its operation and history of respective units substitution; collection of data on the workflow parameters and failures of CRM structural elements; coordination of machines workflow with the functioning of other equipment of the machines system; ensuring the safety of machines operation.

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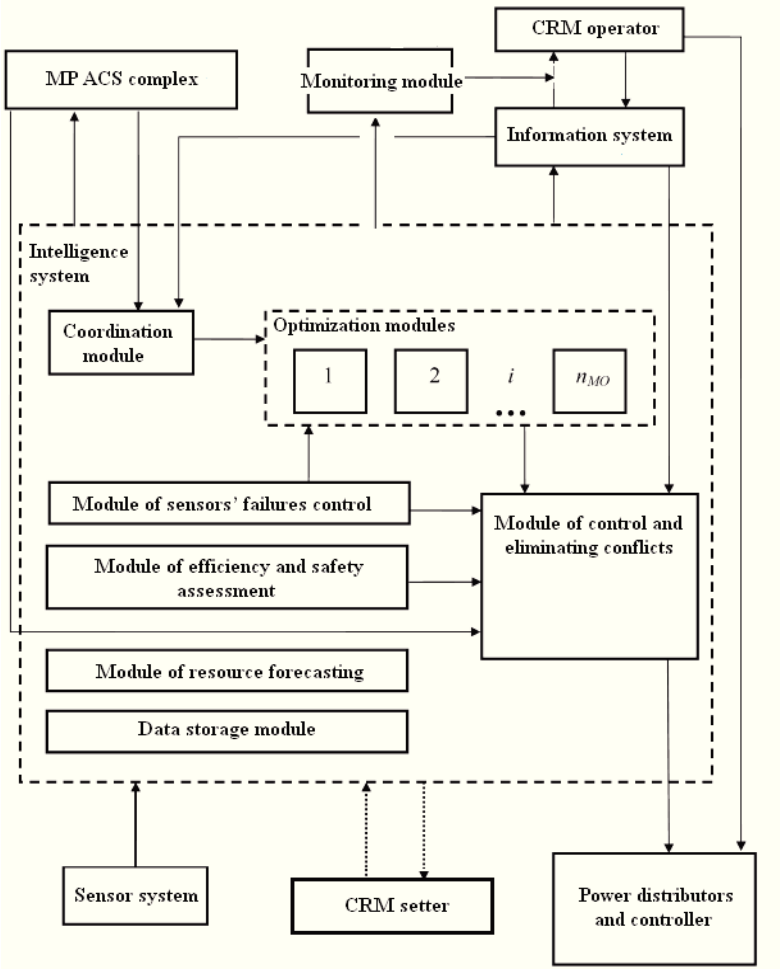

Fig.1. The structure of CRM Intelligence System

Work results. Fig. 1 shows a block diagram of intelligent system of construction and road-machines. The system includes the following modules: the coordination module – it generates the vector of weightage of the criteria of business processes optimization; optimization modules, which are for self-study and assessement of effectiveness of workflow control; the module of sensors failures control – for direct and indirect assessment of working condition of sensors integrated into the machine design elements; the module of efficiency and safety assessment – for fixing the failures of construction machines elements and turning off the machine in hazardous and emergency modes; the module of resource forecasting – to assess the residual life of structural elements of the machine to anticipate their scheduled replacement.

Modern means of technical communication allow realizing the modular approach to management in full, but the challenge of choosing the optimal quantity and range of diagnostic parameters necessary for processing and analysis of remote maintenance center arises.

The following factors can be the criteria that determine the need and possibility to use one of the structural, regulatory or diagnostic parameters in continuous monitoring of the technical state of the remote object:

- integrity of parameters (performance of the machine, engine power, fuel consumption) requires the following advanced troubleshooting, but can quickly respond to a possible change in performance efficiency of machines and reduce the amount of information transmitted;
- availability of the system of self-diagnosis of construction and road machines;
- the impact of controlled parameters on the intense wear of elements;
- the possibility to forecast on the base on the information obtained;
- the necessity to install additional sensors not native to a complete set;
- the cost of technical control of the selected parameters.

To determine the optimal composition of diagnostic information based on the certain priorities (technical and economic indicators, resource indicators, safety indicators, the possibilities of communication systems, etc.) a matrix of diagnostic parameters is created. The physical nature of solution of this problem is the exclusion of faults that are incompatible with the existence of a certain combination of diagnostic parameters being measured. The process of discovering any malfunctions can be considered as reducing the degree of uncertainty of technical condition of the object being diagnosed.

Conclusions. The experience in development of theoretical foundations and practical implementation of CRM intelligent systems indicates their great promise for the use in roadwork.

Designing intelligent systems for CRM operator support is iterative in nature and is based on the design of individual modules, subsystems and their integration into a single unit based on artificial intelligence and the use of modern tools of creation of intelligent applications.

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ПЕРСПЕКТИВНЫЕ МЕТОДЫ ПЛАНИРОВАНИЯ КОНТРОЛЯ ВЫБРОСОВ ПРИ ПРОИЗВОДСТВЕ ДОРОЖНЫХ ПОКРЫТИЙ

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Рассмотрены возможности использования вейвлет-преобразований при создании математических моделей контроля выбросов асфальтобетонных предприятий. Показана возможность обнаружения нестационарности процессов.

Розглянуто можливості використання вейвлет-перетворень при створенні математичних моделей контролю викидів асфальтобетонних підприємств. Показана можливість виявлення нестаціонарності процесів.

The possibilities of using wavelet transforms in developing mathematical models for plan control of emissions from asphalt concrete plants. The possibility of detection of time-dependent processes of air pollution for the adoption of adequate management decisions.

Ключевые слова: *выбросы, контроль, план, экологический мониторинг, математическая модель, вейвлет-преобразования*

Актуальность работы. Технологический процесс производства дорожных покрытий, обеспечивает целенаправленное и последовательное изменение свойств сырья, полупродуктов, вспомогательных материалов для получения нового продукта с заранее заданными свойствами.

К числу отходов, образующихся в ходе технологического процесса, относятся продукты побочных химических реакций, неполные или, наоборот, чрезмерные превращения сырья, вещества полимеризации или конденсации сырья и промежуточных продуктов, фильтраты, промывные воды,