Conclusions

As a result of laboratory tests and production surveys, method to increase boiler department efficiency, based on the principle of optimal load distribution among parallel boiler units was proposed. For boiler units operating on a common steam collector, and having close passport and different energy efficiency characteristics, analytical formulas were obtained to determine optimal loads values for each boiler included in operation. Algorithm and calculation program have been developed, as well as main screen form for CHP plant head automated workplace. The optimum load values of each boiler unit are used as tasks in boiler load stabilization circuit in period among calculations. The efficiency of control subsystem and advantages of proposed control method is confirmed by simulation modeling methods in comparison with traditional one. Research results will be used to modernize the existing control system at the sugar plant and in the educational process.

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UDC 681.51

FEATURES OF THE MOBILE ROBOTS CONTROL SYSTEMS

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DOI: 10.15673/atbp.v9i3.718

Abstract: The article is devoted to mobile robots. Mobile robots are devices that can move autonomously to accomplish their goals. As the title implies the article describes traffic guidance systems for the mobile robots. A generalized scheme of the mobile robots control systems is shown. It compiles on the basis of the hierarchical principle. Attention is paid to each level of

scheme. In addition, the classification of traffic guidance systems for the mobile robots is being compiled. It gives a detailed analysis of each block of the scheme. The traffic guidance systems are considered in accordance to the degree of human participation. Much attention is given to the automatic system. The necessity of involvement artificial intelligence in further development has been pointed out.

Keywords: mobile robots, control systems, traffic guidance

1. Introduction

Nowadays, humans guide almost all vehicles. This creates a number of problems. It can briefly be described as the human factor. It urges to create an AGV (Automated Guide Vehicle) in general and especially mobile robots for industry challenges.

A mobile robot is able to move in accordance with the control program in the working environment. Also it can be equipped with a manipulator. Mobile robots are programmed in advance. It must be able to navigate and perform tasks independently, relying only on their own intelligence. Such robots are called mobile, because they are not linked to the operator directly.

The traffic guidance system should provide traffic planning in nondeterministic conditions on the cartographic base, taking into account continuously incoming information to the control system from the sensors and the navigation system.

There is a need to develop a method of guide a mobile robot through a passage without collision in an environment of obstacles.

Planning of mobile robot movements is very important problem for their functioning.

2. Main part

There are two great classes of robots varied by their function. The first class is manipulation robots. They have dimensional mechanisms as kinematic chains that are ending with working body. The second class is mobile robots that differ by locomotion ability.

Task of movement control is to plan the movement in determined or non-determined conditions based on mapping database with data from navigation and sensors systems.

The complexity of the control task, which depends on the degree of stochastic environment, the availability of a priori information about the route of movement of the robot, the necessary autonomy of the control system of work, the composition of sensor systems, determines the complexity of the control system.

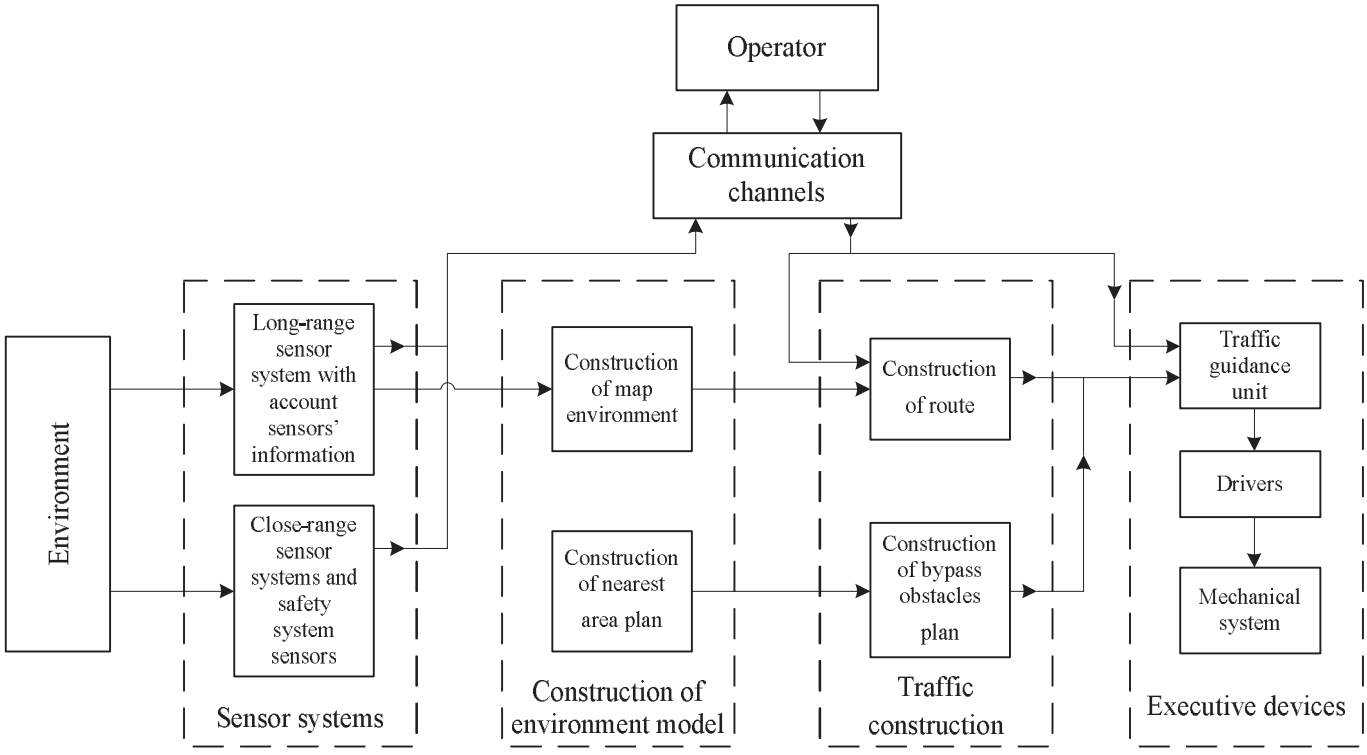

Fig 1. – The typical scheme of the mobile robot traffic guidance system

Literature review has shown that one of the main principles of movement organization is the hierarchical principle. It describes that traffic guidance must be multilevel. Fig. 1 shows a scheme of such mobile robot traffic guidance system. This scheme has 3 levels and 4 main blocks:

1. Strategic level includes sensor system block;

2. Tactical level includes construction of environment model and traffic construction blocks;
3. Executive level includes executive devices.

The traffic guidance unit controls the traction drives and chassis turning actuators. The route construction block synthesizes and optimizes the traffic trajectory. It minimizes the energy consumption, which is especially important for robots with autonomous power supply. It also minimizes the task execution time, when the task of ensuring the maximum speed is needed.

The block for constructing the environmental map presents it in a convenient form for solving the problem of route selection, in particular, with the identification of insurmountable obstacles and dangerous or unclear areas. If the task execution requires knowledge of a larger environmental area than the sensor systems define in the initial position of the robot (i.e. before the start), the terrain map is formed and transmitted to the route construction block by fragments as the robot moves. The synthesis of the motion trajectory is successively carried out by the same sections. In this case, the first approximation for the whole trajectory is made according to the available a priori information about the terrain. And the general direction of motion is determined.

At the lower system-wide level of the control system is a traffic control channel in the near zone, which includes the most detailed model of this zone and implements traffic safety algorithms.

The required level of the system adaptation and artificial intelligence is determined by the degree of uncertainty and complexity of the terrain and the nature of the performed tasks. That is the purpose of the robot. In the latter respect, the minimum necessary degree of the robot autonomous control, determined by the list of its actions, which must be fulfilled without the participation of the human operator. This also takes into account the possibility of a temporary loss of communication with the operator, limited bandwidth of communication channels, incompleteness and limited reliability of the information received by the operator from the robot and its delay in time.

Following an analysis of different sources classification of traffic guidance systems had been constructed. There are such indicators as “degree of autonomy”, “ways of generating control signals”, “type of move”.

By the degrees of human participate, traffic guidance systems are divided into

-manual
-automated
-automatic

In manual control systems operator participates actively in the mobile robots control at the executive level. The main disadvantages of this type consist in aspects of radio signal and influence of the human factor.

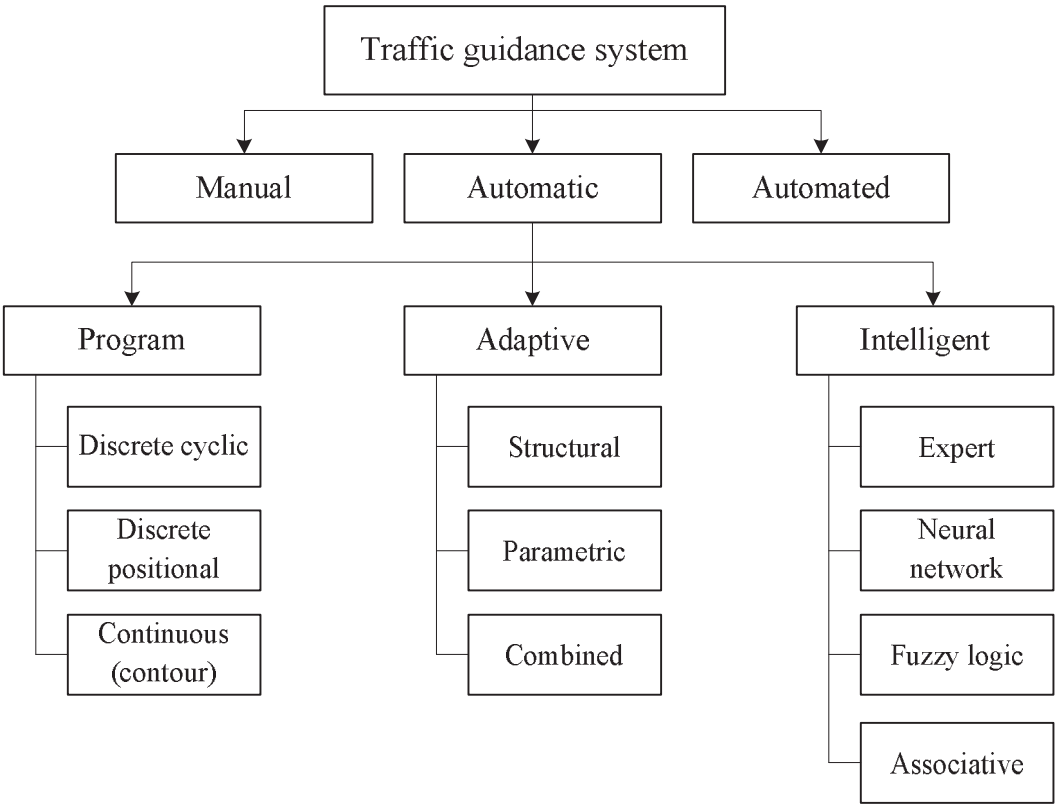

Fig 2. – Classification of traffic guidance systems of the mobile robots

Systems of automated control provide for the implementation of a certain set of operations that do not require decision-making (intelligence), in automatic mode, and others - with the participation of the operator. The use of automated migration management systems is appropriate in the case of low changing environment.

Automatic control systems completely exclude operator participation. The algorithms have realized in the traffic guidance systems of the mobile robots, include the decision of tasks by the way of movement trajectory planning. The traffic guidance systems, in turn, are divided by the ways of forming a control signal into:

-program
-adaptive
-intelligent

Program control systems implement an easy way to control. In this case the movement trajectory of the mobile robots planning and programming in advance. Such a control involves fully deterministic external and internal conditions.

By type of movement divide such systems as discrete cyclic, discrete positional and continuous (contour).

The process of discrete program control consists of 3 steps – acceleration, steady cruise and deceleration. The duration of the 2nd step is determined by the distance of required displacement and might not be necessary altogether. However, the method of positioning cyclic control systems provides much more precision and performance, compared with positional systems. Because discrete positional systems have a closed feedback in the control system and the cyclic systems have a one-step relay control without feedbacks. Moreover, in positional systems there is a high role of the mutual influence of drivers. Positional systems are more sensitive to non-stationary parameters and the influence of external factors compared with the cyclic systems.

The main difference between robots with continuous control from robots with discrete position control is the continuous motion along the trajectory. And the fundamental differences are in the requirements for the accuracy, stability and quality control. When planning the movement of the mobile robots in non-deterministic conditions, with the bypass of random obstacles, the implementation of program control is impossible.

Adaptive control of the mobile robots is a control based on current information about the external environment and the state of the robot. The necessary condition for its realization is the availability of sensory systems and sensors of the internal state. This allows obtaining operative information about the conditions of the robot.

There are such variants of adaptation:

Structural adaptation is the choice of the control program from the finished set or its synthesis from a set of typical routines.

Parametric adaptation is determination of the values of previously unknown parameters for their introduction into the control program.

Structural-parametric (or combined) adaptation consists both in the choice of the management program, and in changing its parameters.

Systems of intelligent control are based on the methods of artificial intelligence. They allow organizing the control of robots in an automatic mode in a rapidly changing environment.

There are the methods of artificial intelligence (AI) that allow the implementation control of the mobile robots: expert systems, neural network, fuzzy logic and associative memory. For intelligent control as for adaptive control, the presence of sensory systems is a prerequisite.

In robotics, AI is needed to solve problems of sensory data processing, formation of environment models, decision making, and motion control. The use of AI in control systems of the mobile robots leads to the expansion of their functionality due to the autonomous solution of complex non-algorithmic tasks.

Therefore, control systems must be built on the principle of maximum autonomy and using AI methods to increase the reliability and functionality of the mobile robots.

4. Conclusions

The traffic guidance system of the mobile robots is based on a hierarchical principle and consists of three levels. The complexity of the control system is determined by the multiplicity of the tasks solved by the mobile robot, the degree of participation of the operator in the control process, the determinism of the operating conditions. To increase the reliability and functionality of mobile robots, their control systems need to be built on the principle of maximum autonomy using artificial intelligence methods.

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УДК 681.5.015.23:658.264

АВТОМАТИЗАЦИЯ РАСПРЕДЕЛЕНИЯ НАГРУЗКИ МЕЖДУ ПАРАЛЛЕЛЬНО РАБОТАЮЩИМИ КОТЛАМИ

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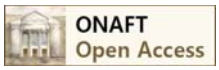

DOI: 10.15673/atbp.v9i3.719

Анотация: Рассмотрен синтез поисковой процедуры для оптимизации распределения нагрузки между параллельно работающими котлами в режиме реального времени. Предложен критерий оптимальности работы котла, учитывающий не только коэффициент полезного действия, но и величину износа оборудования. Решения основаны на использовании поискового алгоритма деформируемого симплекса.

Abstract: The synthesis of the search procedure for optimizing load distribution between parallel running boilers in real time mode is considered. A criterion for the optimality of the boiler operation is proposed, taking into account not only the efficiency, but also the wear and tear of the equipment. The solutions are based on the search algorithm of the deformed simplex.

Ключевые слова: автоматическая система управления, котел, нагрузка, оптимизация, оперативное управление.
Keywords: automatic control system, boiler, load, optimization, operational control.

1. Введение

Классическим методом распределения нагрузки между котлами, работающими на общего потребителя, является распределение по наименьшему относительному приросту расхода топлива. [1]. В виду своей классичности, данный метод применяют на многих энергогенерирующих предприятиях (котельных, ТЭЦ, ТЭС) модифицированный для реализации в современных АСУ ТП.

Однако при оперативном управлении котельным оборудованием, например при возмущениях, связанных с изменением состава топлива, оптимизация его работы не производится. Одной из причин этого является тот факт, что