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Intelligent diagnostics of the state of carriage retarders

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ABSTRACT: The article describes a new intelligent system to increase the efficiency of sorting stations through automation. The new system has been studied economically and in accordance with the technical requirements. A step-by-step deceleration system was proposed, and their control and calculation were created. The algorithm of operation of systems and time matrices for technological situations is formed. Through a new intellectual analysis, the prospects for improving the reliability of the railway and solving problems have been demonstrated. A block diagram of a software system that automatically counts axes is provided. Information is provided on the computing points and the sensors located there. Data is transmitted by monitoring the operation of the sensors, logic verification, calculation and diagnostics.

KEYWORDS: carriage, determining, controllers, railway, automation, telemechanics.

I. INTRODUCTION

To date, all the necessary conditions have been formed for creating a new class of intelligent expert systems for diagnosing the state of railway automation and telemechanics (RAT) devices, operating with an adequate mathematical model for analyzing the state of devices and allowing diagnostics to be carried out remotely, without the need to stop the technological process. A typical example of the use of intelligent methods for diagnosing hump devices is the method for determining the state of wagon retarders.

At present, the resources for increasing the efficiency of the sorting stations through the automation of its main processes have been exhausted, and we see the way out in the creation and implementation of new generation systems — systems of intelligent functioning, which corresponds well with the restructuring program announced in the industry [1].

The intelligence of the work of the sorting stations are determined by the general logic of functioning, which includes a person's biological component of the complex [2], a set of intellectually functioning elements and subsystems [3].

In the existing normative literature on the restructuring of the industry (individual enterprises), numerous scientific, research much attention is paid to the organizational problems of transformation. The ideology, structures, mechanisms of restructuring and functioning of the industry (enterprise) in the new economic conditions are investigated in sufficient detail. At the same time, technical and technological problems remained outside the close attention of the industry management. This determined the choice of the research topic.

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II. METHODS

During the operation of retarders, the most difficult task is to predict a failure, characterized by a gradual decrease in the retarder's ability to extinguish the energy of moving cuts in a given corridor of design speeds. There are known methods that make it possible to assess the deviation of the braking power of a car retarder from the declared passport data [4]. The method for estimating the power of the retarder proposed in this work consists in a sequence of measurements of the speed drop when passing through a cut retarder with specified properties, H_d - decelerated at the fourth stage, which assumes the presence of a series of similar events of deceleration and their subsequent analysis [5].

The energy characteristic was estimated according to the following formula:

$$H_d=v^2_{in}/(2g') - v^2_{out}/(2g')+\triangle H_v - \triangle H_0 - \triangle H_c \qquad (1)$$

where: v_{in}, v_{out} are the speed of the wagon entering and exiting the retarder, respectively (m / s);
g = 9,6 m / s^2- free fall acceleration taking into account the inertia of the rotating masses of the carriage;
$\triangle H_v$- correction for the difference in marks of the positions of the center of gravity of the wagon in moments of its entry into and exit from the retarder, m;$\triangle H_0$, $\triangle H_c$- correction for the energy height lost by the wagon, respectively, due to the specific resistance to movement [6].

For the application of this method in modern conditions, a system is being developed that allows analyzing the dissolution process in order to identify the most similar situations when cuts pass through the braking positions and then analyze the data obtained within the framework of the method proposed in the work.

The main parameters characterizing the passage of the cut through the braking position are the mass, the initial and final travel speeds. Finding the cut on the TP at each moment of time is characterized by the current stage of retarder braking and the number of cut axes involved in the braking process. The parameters “number of axles” and “stage of retarder braking” form a specific structural-temporal image that uniquely describes the dynamic characteristics of the braking process of a given cut, which is conventionally called a braking scenario [7]. Thus, we can say that the problem is reduced to identifying the resulting braking scenarios. The system functioning algorithm is as follows:

1) Formation of time matrices for all technological situations in a given analysis interval.
2) Search for the longest chains of similar situations (the spread of the mass and cut speed should not exceed a certain threshold, the main condition should also be met the similarity of braking scenarios).
3) Calculation of the value of the energy characteristic of the moderator according to the data of the obtained chains of events using formula (1).

In fig. 1 shows an example of the result of the system's operation, characterizing the unsatisfactory operation of the first retarder in the first braking road BR (negative values of the energy height parameter) and the subsequent improvement of its performance (growth of values in the positive part of the scale) associated with maintenance [8].

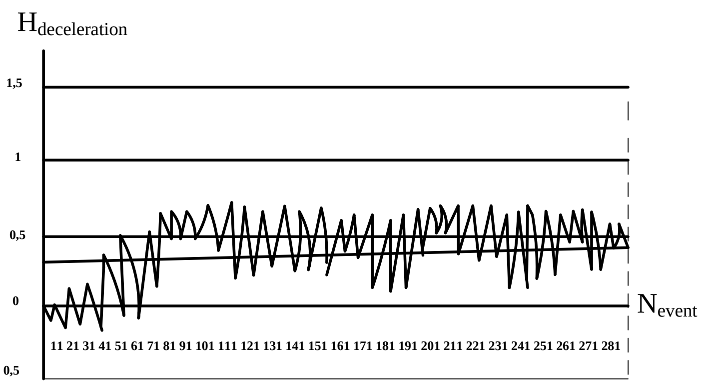

Fig. 1. The results of the system of intelligent analysis of the functioning of wagon retarder.

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A significant effect is predicted from the introduction of intelligent diagnostic systems. Research shows that traditional maintenance methods preventive and corrective - are very costly and time-consuming. At the same time, the “on condition” service method is the most cost effective in view of carrying out works as needed, based on the predicted values. At the same time, the intervals for the maintenance and repair of devices are determined dynamically by a system built using intelligent technologies.
The main goal of the transition to the “on state” service method is to eliminate emergencies and long downtime required for routine maintenance from the process. The main task of the intelligent system for diagnosing the state of devices is to get answers to the following questions:
-assessment of the functional state of the device;
-if the parameters corresponding to the normal state of the device go beyond their limits, then for what reason;
-how long will it take before the critical failure.

III. RESULTS

Knowing the answers to these questions can help you plan more efficiently your maintenance and repair work. Where in the cost of work, according to preliminary estimates, will decrease by at least 20% [9]. Thus, the introduction of control and diagnostic complexes of station devices and the creation of decision support systems on their basis opens up broad prospects for the creation of intelligent expert systems of a new generation to solve the problems of increasing the reliability of the functioning of railway equipment and increasing the efficiency of the industry as a whole [10].

The main system is a complex of logical protection of arrow (LPA), which is designed to exclude the transfer of switches under the rolling stock, as well as to transmit information to the control computer systems of hump automation systems about the fact that the axes of the moving units have passed through the axle count sensors [11].
The complex of logical protection of the arrow consists of floor and guard equipment.
The block diagram of the L PA complex is shown in Fig. 2.

The floor equipment includes three counting points based on reversible rail sensors for fixing the axle passage, installed on the protective section of the hill switches: the first counting point is installed in front of the switch points at a distance of not more than 500 mm from the points, the second counting point is at a distance of 3500 mm from the first, the third counting point is at a distance that ensures the length of the arrow protection section - 6500 mm from the arrowheads).

Counting points can consist of one or two rail sensors. If two sensors are used at the counting point, they are installed in the alignment on adjacent rail lines. The number of installed sensors is determined by the requirement that the probability of missing an axis by one counting point is not more than 10^{-6} in real operating conditions. If the rail sensor provides the probability of missing an axis not more than 10^{-6}, then the counting point must consist of one sensor, otherwise the counting point must be of two sensors.

The station equipment includes a unit for processing signals from axle counting sensors and logical determination of the presence of moving units in the controlled area, made in the form of a safe controller capable of generating a signal that the switch section is busy or free and transmitting this signal to the control circuit of the hump switches.

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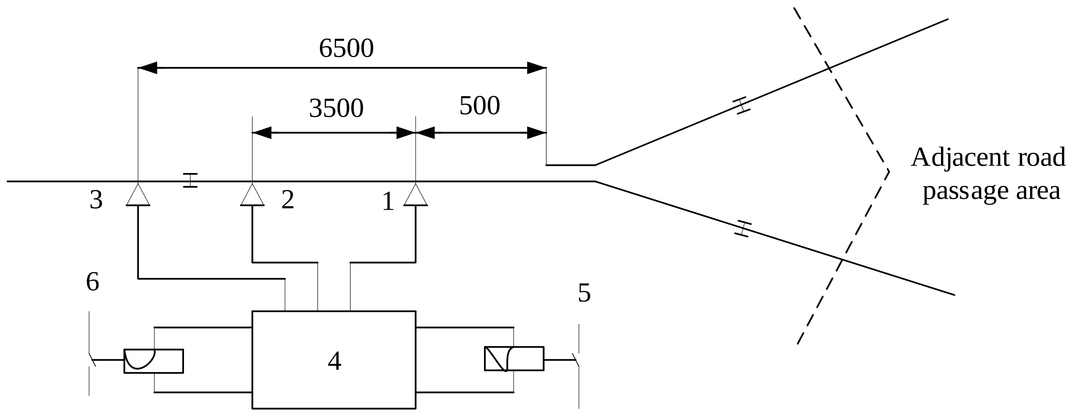

Fig. 2. The structure of the logical protection of the axle.

The technical result of the work of the complex is the protection against the switch under the rolling stock.

IV. DISCUSSION

Description of the complex operation.
The L PA complex works as follows:
When the wheels of the rolling stock move over the axes' counting sensors of the counting points 1, 2, 3, signals are generated from their outputs to the corresponding inputs of the logic controller 4, where the direction and speed of the axes movement is determined based on the sequence of signals received, and the sensors are also diagnosed [12]. When the car is moving along the control section, the sequence of the axes passage is determined, and according to this sequence, the identification of the car that is currently on the section is made [15]. This makes it possible to determine the location of the axles and bogies of the car on the switch section at any time and to exclude the possibility of moving the switch until the car completely leaves the section [13]. When the free arrow is determined by the controller 4, a signal is generated by which the relay for monitoring the state of the arrow 5 is put under current, the contact of which is included in the control circuit of the arrow and, when closed, provides the possibility of its transfer. When the contact of the state control relay of arrow 5 is open, the arrow cannot be moved [14].

In addition, the complex generates a signal that the switch section is occupied, coming from the LPA controller to the control relay of sensors 6 for 2 seconds from the moment of fixing the axis passage over one of the sensor heads of counting points 1, 2, 3 (by analogy with the operation mode of magnetic pedals) [16]. In this case, the rear contact of the relay for monitoring the operation of sensors 6 is connected in series to the power circuit of the switch unit, and within 2 seconds from the moment the axle passage over the sensor is fixed, the possibility of moving the arrow is blocked [17].

The logic controller also transmits information about the fact of the passage of the axes of moving units by axle counting sensors and diagnostic information about the status of sensors through the interface bus to the RS-232 serial channel [18]. This information can be used by the control computer complexes of hump automation systems when solving problems of controlling the routes of movement and the speeds of rolling cuts on the humps [19].

The logic controller is designed as a secure redundant system with strong connections - type 5 in accordance with the recommendations of RTM 32 TSH 1115842.01-94. The block diagram of the controller is shown in Fig. 3.
The LPA controller consists of the following main parts:
-a circuit for interfacing signals from axle counting sensors;
-two micro controllers, in which the programs for determining the passage of the wheel by axle counting sensors and determining the logical occupancy or vacancy of the controlled zone of the switch section are executed;
-schemes for fixing the failure of micro controllers;
-programmable logic matrix (PLM) for input-output of discrete signals;
-circuits for amplification and galvanic isolation of discrete input-output signals.
Composition and operation of the LPA controller.

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The LPA controller operates as follows:
In two microcontrollers, the same programs for receiving signals from the axle counting sensors are executed, and the fact of the wheel passage is determined with the fixation of logical employment or the freeness of the controlled area of the switch section. During normal operation, microcontrollers form health signals from their outputs, which are checked by the microcontroller failure fixing circuit. In addition, the program for determining the logical occupancy or vacancy of the controlled area of the switch section generates a signal of the state of the switch section, which is fed to the PLM circuit [20].

If the health signals from both microcontrollers, the circuit for fixing the failure issues an enabling signal to the PLM circuit for input-output of discrete signals, which transmits control signals to the control relay of the freedom of the turnout section. In the absence of service signals from one or both microcontrollers, the failure latching circuit issues a prohibiting signal to the PLM circuit for the input-output of discrete signals, blocking the possibility of installing the freedom control relay under current, thereby setting the logical state of the arrow [21, 22].

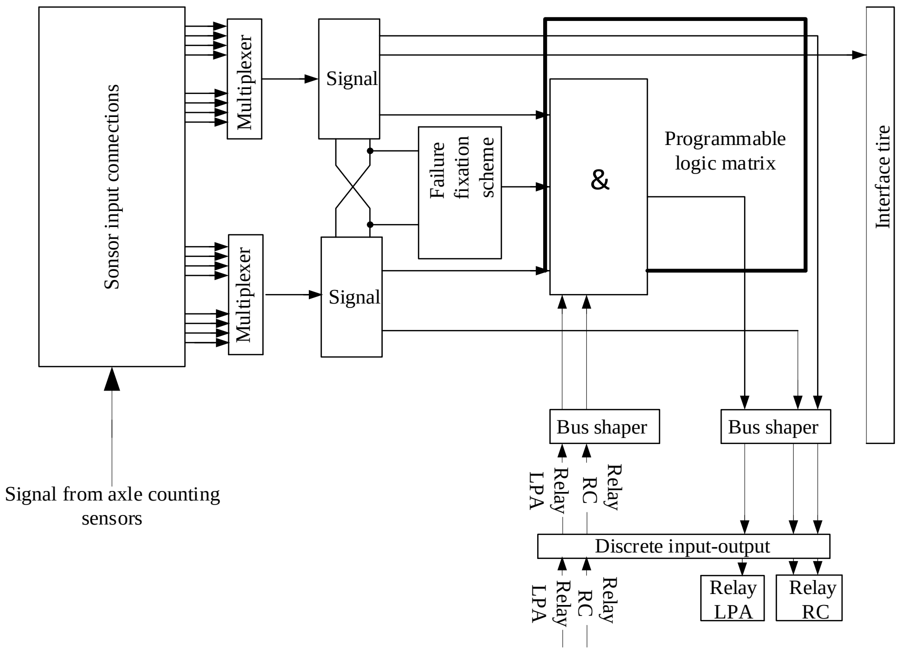

Fig. 3. Structural diagram of the LPA controller.

Thus, the arrow free signal on the relay control will be generated when the following conditions are met:
1. Both micro controllers independently of each other have determined the logical freedom of the control area by the set of input signals from the axle counting sensors.
2. The circuit for fixing the failure of micro controllers determined their normal functioning and formed an enabling signal into the PLM circuit for input-output of discrete signals.

V. CONCLUSIONS

For the purposes of diagnostics, signals for monitoring the state of the switch section and the position of the arrow coming from the standard means of protection of the switch are entered into the L PA controller.

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The L PA controller also provides a function for determining the occupation of the switch section when a signal is received from any of the axle counting sensor heads (by analogy with the operating mode of magnetic pedals).

Through the new intelligent system created to solve the problems at the sorting station, the time savings and economic efficiency in sorting wagons will be significantly increased. As a result of studying the existing problems, the process of sorting wagons in the new system is considered safe for system devices. The system of automatic data retrieval through sensors and serial deceleration improves performance. Application of this system in modern conditions allows to determine the danger of the processes that go through the state of the drills. The analysis process given by the system's performance algorithm allows the construction of time matrices. Intellectual analysis is much more cost-effective than traditional analysis and takes less time. One of the greatest conveniences in this system is the assessment of the functional status of the device, which helps to plan maintenance and repair work more efficiently.

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