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ANALYSIS OF PROMISING SYSTEMS FOR MONITORING THE STATE OF RAIL LINES FOR THE RAILWAYS OF THE REPUBLIC OF UZBEKISTAN

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Abstract:

The article discusses the issues of determining the parameters of control signals transmitted along the line, their change not only under the influence of rolling stock or as a result of violation of the integrity of the rail lines, but also under the influence of a number of destabilizing factors. Improvement of systems for monitoring the states of rail lines by transferring technical means to modern microelectronic equipment using new signal processing algorithms.

Keywords: : System for monitoring the state of rail lines, rail circuits, control signals, monitoring of rail lines, microelectronic element base.

INTRODUCTION

Rail circuits are the most important element of practically all devices of railway automation and telemechanics of the railways of Uzbekistan. The system for monitoring the state of rail lines performs the following functions: control the freeness and integrity of the rail lines of track sections on the tracks and stations; with their help, signals are transmitted from one signal point to another, as well as from the path to the locomotive.

The problem of determining the freedom and integrity of rail lines is solved based on the results of evaluating the information parameters of the rail line monitoring (RLM) signals.[1] When the rolling stock occupies a rail line, the parameters of the control signals transmitted along this line change. If one or both of the rail lines are broken, the signal level decreases. However, the parameters of the RLM signals can change not only under the influence of the rolling stock or as a result of violation of the integrity of the rail lines, but also under the influence of a number of destabilizing factors.[2] The main ones include the following: changes in the parameters of hardware, railway automation devices, instability of the resistance of the train shunt of the rolling stock, changes in the primary parameters of rail lines and, above all, insulation resistance, and others.[3]

METHODS

Further improvement of systems for monitoring the state of rail lines is associated with the transfer of technical means to a modern, more reliable microelectronic element base, the use of new algorithms for processing a useful signal.

Ways to increase the stability of the operation of rail circuits under the influence of destabilizing factors are aimed at improving the characteristics of technical means, searching for the most rational forms of useful signals, creating modern algorithms for deciding on the state of the rail line. One of the promising directions for increasing the stability of the functioning of RLM systems under the influence of destabilizing factors is the improvement of methods for processing control signals.[4]

Algorithms for detecting useful signals in microelectronic receivers, as a rule, are designed to work in real time. Precision signal processing using special methods of statistical analysis makes it possible to automatically detect changes in the state of a rail line at low signal/noise ratios, which saves significant energy resources.[5]

When constructing receivers of signals for monitoring the states of rail lines, designed to operate under conditions of unstable resistance of a train shunt, reduced resistance of ballast, as well as under conditions of exposure to a complex of electromagnetic interference, the use of a mathematical apparatus for detecting the disorder of a random process gives good results.[6]

The efficiency of detecting useful signals in track circuits is determined by many factors: processing methods, the signal/noise ratio at the input of the receiver's solver, the capacity of the analog/digital converter, the stability of the parameters of the communication channel, etc. However, the most important role is played by the quality of algorithmic support used to solve problems of monitoring the states of rail lines. A large number of pilot signal detection algorithms are currently known. Their variety is due to the optimality criteria adopted in the synthesis, methods of technical implementation of hardware, element base and a number of other factors.

Let us estimate the efficiency of using various algorithms in the receivers of RLM systems. The quality of functioning of detectors will be determined by the probabilities of errors of the first and second kind.

As applied to RLM systems, the first kind of error will mean the probability of false detection P_{lo} of a useful signal in the shunt or control modes. Errors of the second kind will be characterized by the probability of making a decision about the absence of a signal in the event of its actual presence P_{pr}.[7]

RESULTS

From the analysis of the detection algorithms [1], it follows that the receiver operating according to the cumulative sum algorithm has the best performance.

The advantages of the Cumulative Sum Algorithm (CSA) detection method are:

- taking into account the statistical structure of interference in the form of the distribution laws in shunt and in normal operating modes;
- the presence of the fundamental possibility of distinguishing close hypotheses, which is especially important at low values of the signal-to-noise ratio (with a higher resistance of the train shunt);
- automatic restoration of the working state after long power interruptions.

The development of systems for monitoring the states of rail lines with high operational and technical characteristics, the need to reduce energy and material consumption while increasing the reliability of hardware and increasing the reliability of processing procedures for useful signals under the influence of various kinds of destabilizing factors is an urgent task.

DISCUSSION

In recent years, in connection with the progress in the field of electronics and, in particular, with the advent of microprocessors, there has been a tendency for their widespread use in railway automation systems. The introduction of microprocessor and microelectronic technology makes it possible to eliminate the main disadvantages of relay systems for monitoring the state of a rail line, such as the instability of operation under the influence of destabilizing factors, low reliability and high cost, low speed and significant energy and material consumption.[8]

Distinctive features of receiving devices of rail line condition monitoring systems, built on the basis of microprocessor elements, are:

- the possibility of implementing adaptive or adaptive-robust algorithms for detecting a useful signal, which can significantly increase the stability of the functioning of systems for monitoring the state of a rail line in conditions of a priori uncertainty regarding the parameters of destabilizing factors;
- the possibility of hardware and software integration in order to increase the indicators of stability and operational safety;
- the possibility of reprogramming, aimed at the implementation of certain functions, without changing the composition of the hardware;
- a high level of unification of elements;
- reduction of operating costs for maintenance;
- reduction of development time and cost reduction of equipment production;
- automation of hardware diagnostics processes.

CONCLUSIONS

A new generation of systems for monitoring the state of a rail line, built on the basis of microprocessors, has the properties of adaptation (adaptation) and robustness (insensitivity, stability) to changing external influences. These properties are the most valuable qualities of receivers of signals for monitoring the state of a rail line, since they allow significantly expanding the functionality of the systems for interval control of train traffic, making them universal in the field of application without a proportional increase in hardware or expanding the range of devices. All this makes it possible to outline the prospects for the development of the signaling technology of the railways of Uzbekistan from an extensive to an intensive way of development.

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