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# INTELLIGENT CONTROL TECHNOLOGY, THE RELIABILITY OF THE MEASURING INFORMATION

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***Abstract:*** *The use of excessive measuring information and the organization on this basis of metrological self-verification, self-control and self-certification, giving the measuring tools the property of intelligence, provide a significant reduction in the risk of using in monitoring and control systems of inaccurate measurement information and reduce operating costs.*

***Keywords:*** *intelligent sensors, metrological self-control, measuring systems, measuring range, intellectualization of measuring systems.*

Research in the intellectualization of control systems and process control direction are conducted in the UK, Germany, China, Russia (St. Petersburg, Moscow, Ufa, Chelyabinsk, Omsk, Tomsk, etc.).

In Russia, there is a set of national standards "intelligent Sensors and measuring intelligent systems", which includes "Basic terms and definitions", "methods of metrological self-control" and "methods of accelerated testing", establishing that the sensors and measuring instruments belong to the class of intelligent only if they have the ability to perform the functions of metrological self-control. In this regard, it is useful to refer to the results of a survey of experts in the field of measurement technology, conducted in 2009 by the international journal "Sensors and Tranducers" and recorded the important fact that the vast majority of the surveyed experts, connect the artificial intelligence systems of measurement attributed to the presence of their functions, self-control, self-certification and samohvalisanje. Intelligent measuring instruments are performed in the form of sensors, primary measuring transducers or separate control and measuring devices of the widest functional purpose [1, 2].

In GOST R. 8.734-2011. «GSE. Intelligent sensors and intelligent measuring systems. Methods of metrological self-control " contains illustrative examples of methods of metrological self-control (MS), formulated the basic requirements for intelligent measurement systems, the recommended maximum calibration and calibration interval, justified at the development stage. The latter depends on the probable time of error components over the permissible limits and limits that are not detected by the adopted method of metrological self-control. The duration of the maximum calibration interval with possible self-correction can be up to ten years or more [3, 4].

Finally, the GOST R. 8.825-2013 "GSI. Intelligent sensors and intelligent measuring systems. Methods of accelerated testing " regulates the evaluation of the recommended maximum calibration interval in the conditions of ensuring the lowest risk of consumers and the cost of testing.

In the process of organization of metrological self-control, the value of mismatch of the current value of the diagnostic parameter of the intelligent measuring instrument from the corresponding reference value is estimated, and in some cases, due to the operation of self-correction of the critical component of the error, the minimization of this deviation is achieved [5].

Usually, the calibration interval of the intelligent measuring device under study is fixed in such a way that all the components of the error of the latter do not exceed the reference tolerance, which does not exceed only the insignificant components of the error selected during the pre-selection [6]. The level of critical components is automatically controlled and can be adjusted to an acceptable level, because for intelligent measuring instruments it is quite possible to increase the calibration (or calibration) interval, which leads to an increase in the reliability of the measurement results. For these purposes, during the verification tests of the measuring device, in addition to the operation of monitoring the compliance of the diagnostic variable with its reference value, perform an additional operation to control the stability of the ratio of the calibration and diagnostic dependence parameters both at the stage of verification (calibration) and at the stage of operation. The increase of non-critical components of error is a consequence of the fact that the oscillations of this ratio relative to the reference parameter provided that the diagnostic parameter in the measuring range does not exceed the permissible error value.

One of the effective ways to improve the efficiency of automated control and management systems is the development of conceptual foundations and their practical implementation in the construction of flexible adaptive systems capable of learning and self-learning, self-tuning and operational restructuring, decision-making and evaluating their reliability, i.e. systems with elements of artificial intelligence.

Recently appeared concept of intelligent sensor (Smart Sensor) defines measuring systems with a complex five-level hierarchical structure. At the first level, there is a transformation of a physical phenomenon into an electrical signal, at the second – the compensation of the external environment (for example, temperature correction, elimination of electromagnetic effects, etc.). Digital communication of the sensor with the data collection system or automatic control is carried out at the third stage of the hierarchy; the communication can be two-way. At the fourth stage, issues related to the automatic diagnosis of the sensor are solved. Finally, the fifth level relates to the control: the sensor is equipped with switching devices and produces control actions.

Using the capabilities of artificial intelligence, a network is created that combines several sensors that allow measuring individual physical parameters, as well as an expert system that stores information that corresponds to the subjective feelings of a person. The first stage in the creation of such networks – data collection – is the most time – consuming process; the second-is to train the processor network with artificial intelligence methods of processing the accumulated information at the first stage. As a result of the training, the processor should be able to determine the relationship of the measured parameters and quality indicators of the final product. Finally, the third stage is the testing and evaluation of the network.

Figure 1. the block diagram of use of elements and algorithms of intellectual support at automation of technologies of control and management of quality of industrial production is resulted.

Quality assessment and reliability forecasting involves the following sequence of actions: measurement of the characteristics of industrial products (identification of the initial situation), analysis of the data obtained in order to make a decision on the quality of the object of control and the formation of the conclusion (prediction of the outcome). In the process of product quality management, the sequence of actions is similar: analysis of the current situation, assessment of possible events and outcomes. In General, there is a chain of mappings of the form: situation □ event □ outcome.

The most important means of intelligence - the ability to conduct a targeted selection of information to ensure its accuracy for an adequate assessment of the situation and make the best decision. The main reasons for the existence of unreliability of information in the control and management of the quality of industrial products are: the lack of the possibility of ensuring the objectivity of estimates; noise data; errors due to the wrong choice of methods or means of obtaining them; random noise distortion, etc.

The range of intelligent measurement tools is expanding much more slowly than the growth of industrial automation requests, due to the increase in the level of industrial safety and the need to reduce the cost of operation of control and management systems [7]. This trend increases interest in intelligent systems that can be implemented using traditional automation tools [8].

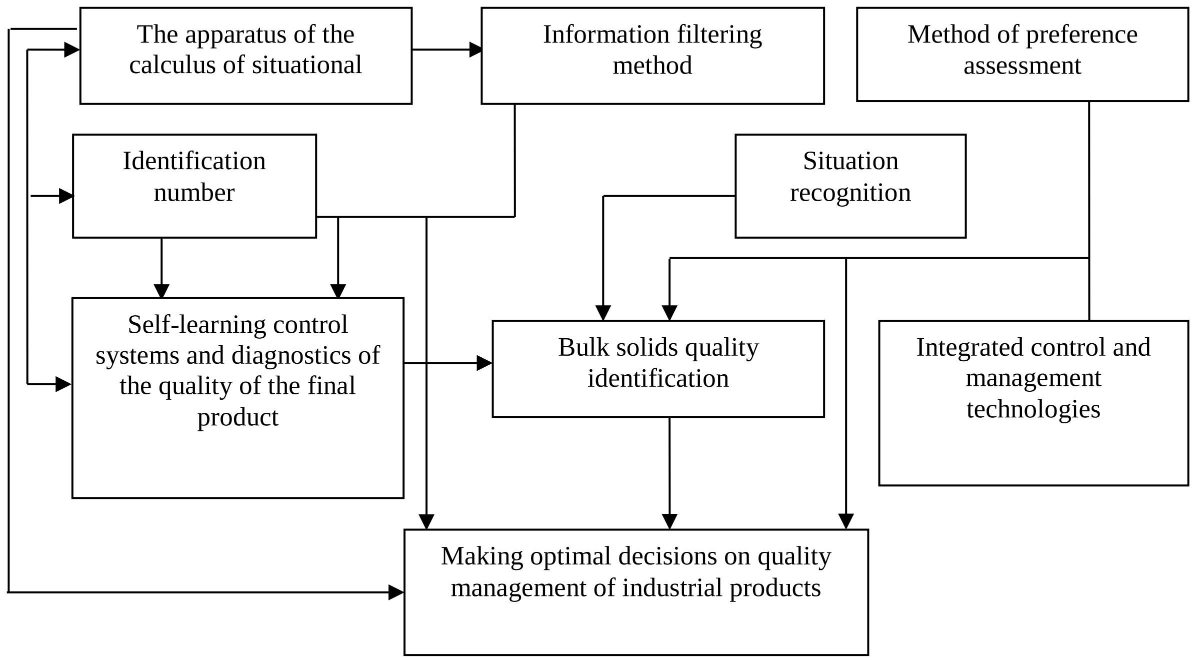


*Figure 1.* ***The block diagram of use of elements and algorithms of intellectual support at automation of technologies of control and management of quality of industrial production is resulted.***

With this approach, the diagnostic parameter is determined for a set of measuring channels of the system under consideration, which is supplied with an Autonomous programmable controller with its special software filling. Metrological self-control can be carried out by changing the structure of the measuring channel (for example, providing multiple redundancy and feedback through the implementation of digital-analog Converter), which makes it possible to use statistical methods for evaluating the results of single measurements.

Metrological verification and self-control involves periodic correlation analysis of measuring signals and evaluation of metrological reliability of measuring signals. If necessary, the correction of the characteristics of the measuring channel and assessment of its serviceability. If there is a malfunction of the measurement channel, then appropriate changes are made to the algorithm for processing the primary measurement information and issuing the appropriate signal to the operator panels and dispatchers. Certification verification and self-control can also be accompanied by an additional analysis of the metrological serviceability of primary measuring transducers using reference measures.

Implementation of metrological self-control is complicated by the presence of the methodological component of measurement error, which is determined by the accuracy of the relations connecting the relations between the values of the measured parameters. To achieve the reduction of the mentioned methodological error can be achieved by aligning the profiles of the measured and influencing parameters.

Accelerated calibration tests include cyclic tests of one type in the normal mode and another type at a forced rate, when the sequence of the acting parameters and their combination with the measured variables should ensure the implementation of the most significant processes of radiation, which cause deterioration of the metrological characteristics of the system under study and a decrease in the level of reliability of primary and secondary measurement information.

In conclusion, it should be emphasized that the intellectualization of control technologies and management of complex technical objects and systems in terms of ensuring the required reliability of measurement information significantly increases and tightens the requirements for the level of training of metrologists, instrument-makers, operators and dispatchers of industrial enterprises that participate in their development and subsequent production operation. Intellectualization of measuring systems significantly reduces the amount of work and industry costs for their production operation.

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