METROLOGICAL SUPPORT FOR MEASUREMENT INFORMATION SYSTEMS AND PROCESS CONTROL

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We present the results of comprehensive research in the field of metrological support for modern measurement information systems and process control. Directions for future work are proposed.

It has been characteristic of technological development for a long time to make broad use of measurement information systems for solution of both global problems (space, ecology, energy conservation) and special problems in specific disciplines (machine design, transportation, medicine, process control, etc.). The need to obtain a guaranteed level of quality in measurement, control, and identification has led to the creation and development of a new scientific discipline — metrological support.

At the end of the seventies, the statement and solution of this problem was assigned to the All-Union Scientific Research Institute for Metrology for Measurement and Control Systems (which is now the State Scientific Research Institute for Systems of Ukraine). Together with the specialists at this institute, leading scientists from other organizations — G. I. Kavalerov, V. P. Kuznetsov, G. N. Solopchenko, É. I. Tsvetkov, et al. — have conducted research in this area.

The result of this work has been creation of scientific, engineering, and management bases for metrological support for the systems developed in the seventies and eighties (the systems of the first three generations [1]). Practical introduction of these results was accomplished by implementation of a group of programs for metrological support of systems in the periods from 1981-1985 and 1986-1990. The programs were implemented at tens of organizations, ministries, and departments under the scientific direction of the State Scientific Research Institute for Metrology for Measurement and Control Systems.

The breakdown in economic relations and the unified information field at the beginning of the nineties ended the cooperation of scientists, industrialists, and metrologists in the independent states of the former union in the area of metrological support for systems, a most important activity for the national economy.

With the goal of mobilization, the State Scientific Research Institute for Systems was directed by the Ukrainian government to analyze the state of metrological support for measurement information systems and process control at state metrological centers and departments in Ukraine. The analysis made it possible to establish not only the extent of metrological support for existing designs and systems, but also contemporary approaches to developing them and directions for further research on advancement of metrological support for modern measurement information systems.

Because the processes of measurement, classification, decision making, and control are practically integrated in measurement information systems and process control systems, it is difficult to draw a boundary between measurement and control functions implemented in a system, since this boundary is usually drawn within software [2]. Usually, when we are dealing with metrological support for systems, we can distinguish three groups of problems: theoretical (scientific) problems, problems of standardization and law, and problems on metrological assurance for systems. We will consider the most significant results of work in each of these areas, and paths for further development that allow for the features of modern measurement information and process control systems.

Work in the area of theory and methodology has been concerned with both solution of metrologically classical problems (which have their own features) and unconventional problems resulting from systems implementing unmeasurable functions, the use of measurement results for control, identification, obtaining complex quality indicators for objects, etc. [3].
Study of the features of measurement information and process control systems and their interaction with objects of measurements and the metrological properties of individual system components has been used to develop metrological models for measurement channels and systems distinguished by allowance for discrete and nonlinear properties of components and dynamic operating modes. These models have been used as a basis for constructing a collection of metrological characteristics of measurement information systems that adequately describe their metrological properties.

The dynamic nature of most objects of measurements has two aspects: allowance for dynamic transformation of signals in channels as the result of inertial properties of their components, and estimation of the error in sensors that appears in subsystems for synchronization of channels. In connection with this, the collection of standard dynamic characteristics includes the set of features of conventional linear measurement systems (pulse transfer characteristics, transfer function, etc.) with error in report updating [4].

No less important is the development of methods for estimating the error in dynamic measurements made with multichannel systems, and estimation of the error in determination of the dynamic characteristics of measurement systems used as samples for investigation of the dynamic properties of systems and determination of their dynamic characteristics.

The State Scientific Research Institute for Systems has developed a methodology for estimating the error in time and frequency characteristics that is applicable to linear analog devices. Future research will be directed toward development and field implementation of these methods in measurement systems using analog-to-digital conversions.

A methodology has been developed for metrological assurance of systems [5]. The need for assurance, generally conducted under operational conditions with physically dispersed systems has made it necessary to investigate the influence of variable factors on the results of determining metrological characteristics.

The result of this work has been creation of a protocol that regulates determination of metrological characteristics of measurement channels in measurement information systems from the characteristics of their components with allowance for the interaction of components, operating conditions, and methods for determining the characteristics of errors in measurement channels with allowance for software processing of data (the protocol is currently confirmed by the Government of Ukraine). The disadvantages of these and other available methods for determining metrological characteristics is that they use linear analog channels, which greatly limits their application.