ЎЗБЕКИСТОН РЕСПУБЛИКАСИ ОЛИЙ ВА ЎРТА МАХСУС ТАЪЛИМ ВАЗИРЛИГИ
ИСЛОМ КАРИМОВ НОМИДАГИ ТОШКЕНТ ДАВЛАТ ТЕХНИКА УНИВЕРСИТЕТИ

МИНИСТЕРСТВО ВЫСШЕГО И СРЕДНЕГО СПЕЦИАЛЬНОГО ОБРАЗОВАНИЯ РЕСПУБЛИКИ УЗБЕКИСТАН
ТАШКЕНТСКИЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ ИМЕНИ ИСЛАМА КАРИМОВА

ХАЛҚАРО АНЖУМАН
«Жаҳонда стандартлаштириш ва техник жиҳатдан тартибга солиш ҳолати ва ривожланиш истиқболлари»

МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ
«Состояние и тенденции развития стандартизации и технического регулирования в мире»

СБОРНИК НАУЧНЫХ ТРУДОВ

13-14 Октябрь, 2022
Ташкент, Узбекистан

CORRECTION OF DYNAMIC ERRORS OF MEASURING TRANSDUCERS USING DIGITAL FILTERS

Karimova Dilbar Karimovna,
associate professor of the department of Information Technologies,
Sagatov Mirkhusan Mirazizovich,
student, Tashkent State Technical University named after Islam Karimov

Annotation: *Structural and algorithmic bases of construction of computing adjusting devices for indemnification in real time a dynamic error of primary measuring converters of monitoring systems, supervision and management are stated.*

Keywords: *digital filters, measuring transducers, regularization, dynamic errors, corrective devices.*

Аннотация: *Изложены структурные и алгоритмические основы построения вычислительных корректирующих устройств для компенсации в реальном масштабе времени динамической погрешности первичных измерительных преобразователей систем контроля, наблюдения и управления.*

Ключевые слова: *цифровые фильтры, измерительные преобразователи, регуляризация, динамические погрешности, корректирующие устройства.*

Measurement of physical – chemical parameters is the basis for solving complex problems of science and technology, a source of knowledge and a guarantee of scientific and technological progress in all spheres of human activity without exception. Measurements play a special role in scientific experiments and technology, construction, communications, transport, defense, in the creation, testing and operation of technical means of production, in the development of standards, their implementation and ensuring the high quality of industrial and agricultural products. Without measuring instruments, it is impossible to create and introduce new means of automating production processes, including computer control systems [1]. The widespread introduction of methods for mathematical processing of measurement information, the use of computer technology has a serious impact on the development of new measurement methods and makes it possible to count on an increase in the accuracy of measurement results even in cases where existing, insufficiently perfect technical measuring instruments are used as sources of primary measurement information.

The use of computer technologies is relevant for improving the quality indicators of various technical systems. An important direction is the introduction of specialized computing devices into some elements of the system. In this case, the effect of computer enhancement of the physical properties of the system element is achieved. So, for example, it is possible to reduce the cost of a technical system by using cheaper elements with "bad" physical characteristics, or to overcome the fundamental limits of improving the physical design of a system element.

A typical element of a monitoring or control system is a measuring transducer (MT), which is designed to convert a non-electric signal into an electrical continuous or discrete signal. Real MTs do not perform such a conversion accurately. The problem arises of interpreting the registered output signal of the MT, which contains true and false information about the process under study.

If additional a priori information is known (in particular, the mathematical model of the MT), then the ratio between true and false information can be improved by computational processing of the registered signal. The MT input signal, which is not available for direct measurement, can be restored by means of a computational corrective device (CCD) with a very high accuracy. MT and

CCD can be functionally combined into one unit, which has higher physical and technical characteristics compared to the original MT.

Currently, corrective devices (CD) are used to solve a wide range of technical problems in communication channels, sound recording devices, and automatic control systems. It suffices to note only some of the problems solved with the help of CD. For example, when recording information, it is impossible to infinitely reduce the width of the slot of the magnetic recording head, the mechanical inertia of the recorder, the heat capacity of the thermoplastic recorder.

In corrective devices the computational process of restoring the original signal from a distorted registered signal is implemented, taking into account the distorting hardware function. The signal recovery problem is a typical ill-posed problem. Therefore, it is expedient to use the achievements of the theory of ill-posed inverse problems [2] for the CD synthesis.

The basis of this theory is the idea of regularization, which uses additional a priori information about the desired solution and sources of errors in monitoring, monitoring and control systems to ensure the necessary stability. This made it possible to overcome the limit prescribed by the Kotelnikov theorem, despite the fact that in this case the initial mathematical model undergoes slight changes, the accuracy of the solution often decreases. This theory provided the possibility of practical solution of the problems of interpreting the results of observations through mathematical processing of experimental data.

The formulation of the computational problem of increasing the resolution of observation systems has already become a classic. However, there are still significant problems associated with the choice of the method for introducing regularizing parameters. In this regard, it is almost rarely possible to reach the theoretical limits of solving ill-posed problems, which requires a certain skill and ingenuity from researchers.

Let's turn to the method of structural correction of dynamic systems using the example of an inertial measuring transducer. The essence of this technique is to introduce an additional block into the structure of the measuring transducer - a corrective device with specially selected dynamic characteristics - so that the transfer function of the MT is as close to unity as possible. Signals through such an MT will pass with minimal distortion.

The hardware function depends on the type of MT. Let's pay attention to the differences in the definition of the instrumental function for different types of distortions: defocusing and inertial ones.

Defocus type distortion.

Defocus-type distortions are characterized by a hardware function in the form of a symmetrical bell, for example:

$$A(r)=(1/b)\exp(-(r/b)^2), \quad (1)$$

or:

$$A(r)=(1/b)/(1+(r/b)^2). \quad (2)$$

The b parameter specifies the width of the bell. The symmetric bell of the instrumental function quickly decays with the growth of the argument, which allows us to practically limit ourselves to the finite limits of integration. The convolution of two functions (hardware function A and input signal x) is performed completely: both forward and backward.

Physical dimension of the hardware function is equal to the reciprocal of the argument, which is the spatial coordinate. When taking the integral, this dimension is reduced with the dimension of the increment ds of the integration argument. The amplitude of the bell of the hardware function is inversely proportional to its width. This ensures that the energy of the signal is conserved as it passes through the MT. The bell-shaped pulse, when passing through the MT, expands in width and attenuates in amplitude, but its area is preserved.

In practical applications, the most common is the Gaussian kernel (1). It is typical for the case of Doppler broadening of the spectral emission bands of a heated substance. An additional broadening of the spectral bands is associated with the imperfection of the molecules of the substance, the presence of isotopes, isomers, the vibrational frequencies of which differ slightly. The superposition of many such frequencies results in spectrometer input signals in the form of Gaussian peaks. The distribution of energy within each spectral band in the form of non-monochromatic radiation is also possible due to radiative damping or shock expansion and leads to spectral peaks of type (2).

Thus, a real physical device such as an optical spectrometer performs the convolution of two close bell-shaped functions, one of which is the input signal of the spectrometer, and the other is the hardware function of the spectrometer.

There are three possible approaches to the synthesis of CD. The first approach consists in determining by methods of identification the parameters of the transfer function of the CD for a given input and output signals. The second approach consists in inverting a given transducer operator, taking into account additional a priori information contained in a given MT operator. The third approach is focused on the general case of an MT with a non-linear and (or) non-stationary measuring transducer, the model of which is given by an integral operator with an arbitrary kernel. It consists in restoring the input signal of the MT from the registered output signal of the transducer by solving the corresponding integral equation.

The second approach, focused on the use of the method of inverse operators, generally leads to a convergent iterative process, or balancing process (in terms of the theory of quasi-analogue balancing). It is known that such an iterative process can be most effectively implemented on structures with feedback, both on analog and digital element base. In the linear case, the control of the number of iterations is clearly imperceptible even with a digital implementation. In this case, concepts such as the balancing iteration step, the integration step of the modeling digital filter, and the sampling step of the original signal actually coincide in terms of implementation time.

The application of the decomposition method of regularization [3] to the development of the method of inverse operators naturally logically led to the principle of multi-cascade structural organization of corrective devices. In this case, two alternative ways of introducing regularizing parameters are naturally combined. Multiplicative regularization takes place when decomposing the CG structure into cascades, and adaptive regularization takes place in each cascade (for the purpose of feedback).

The possibility of applying the principle of cascading arises if the MT consists of several (not necessarily linear) blocks connected in series (multiplicative decomposition of measuring transducers). However, this possibility always exists. A corrective device with obviously coarse regularization is connected to the output of the MT, and then such a subchannel, consisting of an MT and a CD and considered as a new measuring transducer, in relation to which a new corrective device can be built. With this approach, it is possible to achieve a significantly higher quality of signal recovery than with single-stage recovery. The novelty here lies in the application of this principle to the synthesis of corrective devices and the solution of integral equations.

Thus, the use of CD makes it possible to significantly reduce either the time constant or the nature of the inertia, but not both parameters at the same time. Moreover, a decrease in the nature of inertia (in the limit, an inertialess object) corresponds to a decrease in the time constant of the traditional one-parameter model. In practice, it is important to minimize the time constant of the measuring transducer, and bring the nature of the MT inertia to the level of a single inertial link, which is essential for the secondary processing of the recovered signal.

References

1. A.F. Verlan', A.A. Sytnik, M.V. Sagatov. Metody matematicheskogo i komp'yuternogo modelirovaniya izmeritel'nykh preobrazovateley i sistem na osnove integral'nykh uravneniy. «Fan», Tashkent, 2011, 344 pages.

2. Greshilov A.A. Nekorrektnyye zadachi tsifrovoy obrabotki informatsii i signalov // Izd. 2-ye dop.,M:Universitetskaya kniga; Logos, 2009. – 360 pages.: il.

3.Verlan' A.F., Maksimovich N.A., Gulyamov SH.M., Sagatov M.V. Metod dekompozitsionnoy regulyarizatsii dlya vosstanovleniya signalov. «Promyshlennyye ASU i kontrollery»,№3, 2002. – 19-23 pages.

ISSIQLIK DATCHIKLARINI ISHLAB CHIQARISHDA QO'LLANILADIGAN ISHLOV BERISH TEXNOLOGIYASINI ISHLAB CHIQISH.

Isroilov Faxriddin Murodqosimovich.

Qosimov Orif Faxriddinovich

Jizzax Politexnika Instituti

Annotatsiya: *Monokristalli kremniy ingotlarini gofretlarga kesish quyidagi usullardan biri bilan amalga oshiriladi: olmosli tashqi yoki ichki chetiga ega disklar bilan kesish; po'lat pichoqlar yoki abraziv osma sim bilan kesish; abraziv ultratovushli ishlov berish orqali kesish; elektroeroziv kesish; elektron yoki lazer bilan kesish. Bu usullarning har biri bir-biridan unumdorligi, mexanik shikastlangan qatlamning chuqurligi, foydali materialning chiqishi, yarim o'tkazgich materialini yig'ish va tiklash imkoniyati va turli shakldagi kristallarni olish imkoniyati bilan farqlanadi.*

Kalit so'zlar: *kristalli, kremniy, gofretlar, datchik, Silikon, abraziv, suspenziya, po'lat pichoqlar.*

Annotation: *Cutting monocrystalline silicon ingots into wafers is done by one of the following methods: cutting with discs with an outer or inner edge containing diamonds; cutting with steel blades or abrasive suspension wire; cutting by abrasive ¬ultrasonic processing; electroerosive cutting; electron or laser cutting. Each of these methods differs from each other in terms of productivity, depth of the mechanically damaged layer, the output of useful material, the possibility of collecting and restoring the semiconductor material, and the possibility of obtaining crystals of different shapes.*

Keywords: *crystal, silicon, wafers, sensor, Silicon, abrasive, suspension, steel blades.*

Аннотация: *Резка слитков монокристаллического кремния на пластины осуществляется одним из следующих способов: резка дисками с внешней или внутренней кромкой, содержащей алмазы; резка стальными лезвиями или абразивной подвесной проволокой; резка абразивно-ультразвуковой обработкой; электроэрозионная резка; электронная или лазерная резка. Каждый из этих методов отличается друг от друга производительностью, глубиной механически поврежденного слоя, выходом полезного материала, возможностью сбора и восстановления полупроводникового материала, возможностью получения кристаллов различной формы.*

Ключевые слова: *кристалл, кремний, пластины, датчик, кремний, абразив, подвес, стальные лезвия.*

ТЕНДЕНЦИИ РАЗВИТИЯ ТЕХНИЧЕСКОГО РЕГУЛИРОВАНИЯ В АВИАЦИОННОЙ ПРОМЫШЛЕННОСТИ