A METHOD OF THE DIAGNOSTICS OF THE DYNAMICS FIELDS OBJECTS

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Abstract – The work states of intelligence diagnostics method of dynamics structures fields is developed. A method allow by a method of processing of the information to make precision measurements and diagnostics for a biotechnical researches.

Keywords: electromagnetic fields, spectrum, diagnostics.

1. INTRODUCTION

A complex diagnostics and irradiation method carry out the information processing for the control of a dynamic fields condition, which the physical characteristics change during the certain interval of the time. The action principle of the sensor modules on interactions of the electromagnetic irradiation with superficial and volumetric acoustic fluctuations of the objects structure is based. Such systems allow to carry out the analysis of changes both form of a surface, and internal pressure, defects of a material. As movement of electric charges in the human body is connected with all metabolic process, than we can concede that disturbances, which appears in this process in consequence of acting hereditary or pathogenic factors, can be reflected in the characteristics of EM-waves, generated by human. That is why measuring with the help of special devices EM radiation of human's body (essentially or stimulated) on the different parts of the body it is possible to diagnose illness in a primitive state of its development.

The researches of the electromagnetic radiation influence on the biological and technical objects (BTO) and the development is the scientific and methodological bases of use of the electromagnetic radiation for the biological and technical researches and medical purposes.

2. THE SIGNAL PROCESSING METHOD IN MEASUREMENTS

The method of information processing on the spectral Fourier-analysis of electromagnetic signals is based [1, 2, 3]. The complex system allows to the accuracy increase of a surface formation of a processable object by the depth definition of the deformed layer of a material.

The management is carried out on parameters of a surface formation (a wave length of the elastic deformations, cutting force), by the spectral density definition of an electromagnetic signal on an output of the complex intelligent system.

The depth of the deformed layer of a processable surface by the distribution laws of pressure in a material of biological and technical object is caused. If the pressure in area near to a point of the appendix of mechanical pressure, the depth of a layer decreases are located.

Let's consider a case if the objects' surface (fig. 1) by normal state is formed. The form and a roughness of such surface can be submitted by periodic function $F_r(\alpha)$ and $F_r(x)$, which have the Fourier series description. In the resulted case it is allowable, which T- time of one revolution of a surface BTO, that is in view of a submicroscopic relief. If the pathologic surface is formed, parameters of periodic function are violated.

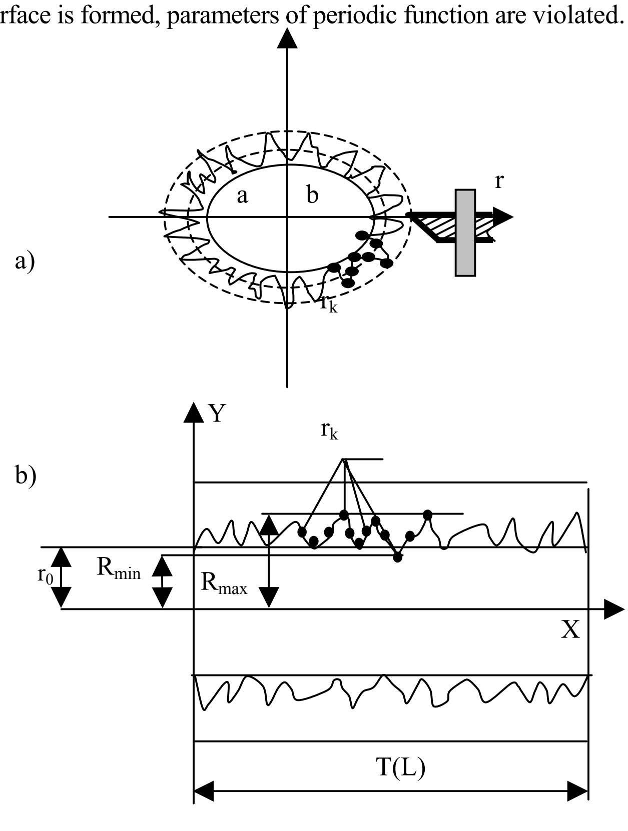

Fig. 1. A surface roughness distribution of the object at the cross-section (a) and longitudinal section (b)

As top diagnostic tool during movement has a complex trajectory L_p of movement can have the description through curvilinear integral for cross-section:

$$L_{PK} = \oint_L [R_{min} + F_r(x,y)]dl \; ; \qquad (1)$$

and for longitudinal section: $L_{PL}\int_0^L F_r(x,y)dl.$ (2)

On the other hand there is an opportunity with sufficient reliability to approve, that there are such two cylinders with sizes $R_{min}\times L$, $R_{max}\times L$ with the axes conterminous to BTO. And in addition value of function $F_r(\alpha)$ is will coincide only in one point with a circle in educated radius R_{min}, and the greatest value $F_r(\alpha)$ will coincide only in one point with a circle in educated radius R_{max}. Under such circumstances restriction be relative to radius r_p, that is $R_{min} \le r_p \le R_{max}$ will be carried out. From here follows, that $r_p = R_{min} + F_r(\alpha)$ (fig. 1). Period T of function can be received through modes by

$$L_{ob} = T_c V_p, \quad \text{then, } T_c = 2\pi R_{ob} / V_p, \qquad (3)$$

T_c - time parameter of periodic function for which occurs creation forms and roughness of a object surface.

At such way of definition of period T it is necessary to notice, that its defined on objects' radius R_{ob} that as was it is shown, is in astable size. And in addition it is necessary to notice, that between L_{ob} and L_{PK} there is an essential difference in sizes, that is condition L_{PL}>> L_{ob} always satisfies. Such difference arises for the reason, which in mathematical dependence (3) into account only projections of linear and the sizes of a surface on axis Z is taken. For the beginning we shall consider of a objects' cross-section. Using a principle of superposition, function of a roughness and the surface form $F_r(\alpha)$ by Fourier series:

$$F_r(t) = A_0 + \sum_{k=1}^{\infty} A_k \sin(\omega_k t + \omega_k), \quad k = 0,1,2\ldots\infty \qquad (4)$$

where A_k - amplitude k- points of a surface roughness; $\omega_k = 2k\pi / T$, where T - the period of function.

As normalization of a roughness occurs on base length of a surface to final number n the selected points of a surface, $F_r(\alpha)$ function for considering roughness for number n points of a surface is expedient. Then the surface of a BTO can have the description, using allocations (at $T = 2\pi$) at the period $[-\pi;\pi]$:

$$F_r(\alpha) = \frac{a_0}{2} + \sum_{k=1}^{n}(a_k \cos kt + b_k \sin kt), \qquad (5)$$

where a_0, a_k, b_k are determined by formulas Fourier - Euler (for period $T = 2\pi$).

Function $F_r(\alpha)$ and $F_r(x)$ is odd, that it is necessary the following grade.

The stady of a objects' form, that is its approach the ideal form can be taken into account through approach to final geometry. Thus the following conclusion it is possible.

At first, Fourier-Eulers' formules will receive by:

$$A_k = a_k = \frac{4}{T}\int_0^{T/2} F_r(t)\cos k\omega t n dt, \; (k = 0,1,2,3, \ldots)\ldots \; b_k = 0; \qquad (8)$$

$$F_r(t) = A\cdot\cos(\omega t + \varphi_1) + A_2\cdot\cos(2\omega t + \varphi_2) + \ldots A_k\cdot\cos[k\omega t + \varphi_k]\ldots(9)$$

At second, behind approach the ideal form should satisfy a condition:

$$\lim_{R_{max}\to R_{min}} F_r(t) = 0\,. \quad \lim_{R_{max}\to R_{min}} \sum_{i=0}^{k} A_k \sin(\omega_k t + \varphi_k) = 0 \qquad (10)$$

A spectrum definition of a roughness behind (8) arise the following complexity. At first, definition of amplitudes series A_1, A_2, A_3, …, A_{2k+1}, that, at second, unknown values of harmonics phases. We shall consider opportunities of definition of amplitudes series applying the analysis of function $F_r(x)$, which full value as it was already specified, there is the real radius, modulated by additional function, dependent from a corner a (fig. 1), that is $r_p(a) = R_{min} + F_r(a)$ or at parametrical record

$$r_p(t) = R_{min} + F_r(t) \qquad (11)$$

Substituting (11) in (8), the following result:

$$A_k = a_k = \frac{4}{T}\int_0^{T/2} F_r(t)\cdot\cos k\omega t dx \qquad (12)$$

$$\int_0^{T/2} F_r(t)\cdot\cos k\omega t dx = \pi\cdot R_m^2\cdot\frac{T}{2},$$

$$A_k = \frac{4}{T}\cdot\frac{T}{2}\cdot\pi\cdot R_m^2 = 2\pi\cdot R_m^2, \; (k = 0,1,2,3, \ldots)\ldots (13)$$

$$\pi\left(R_{max}^2 - R_{min}^2\right) = 2\pi R_m^2, \qquad R_m = \sqrt{\frac{R_{max}^2 + R_{min}^2}{2}} \qquad (14)$$

at equality of all A_k with (9) the following:

$$F_r(x) = 2\pi R_m^2\{\cos(\omega t + \varphi_1) + \cos(2\omega t + \varphi_2) + \ldots + \cos[k\omega t + \varphi_k] + \ldots\} \; (15)$$

This equality can be executed only under condition which $\varphi_k = 0 = \pi$. Thus last member of lines should be equaled plus of unit, that is $\varphi_k = 0$.

The mathematical analysis in any section of BTO and to receive a corresponding series of values R_{min}, R_m and R_{max} can be carried out. Therefore consideration of $F_r(X)$ function in lengthways section to mark X ϵ is important (fig. 1). Feature of such consideration is that it is necessary for periodic at $0 \le x \le L$, which satisfies to conditions Dirihle function with $T = L$ period, or for less severe constraints with $T = 2L$ period, that is more convenient at automatic transforme of the $F_r(L)$ functions in Fourier series results in the same result, as well as previous as it inherent same properties.

The flexible hybrid multichannel systems allow to execute multiparameter monitoring of performances of the electrical signals in real time, identifying to a time history of operation of control of a biomaterials condition.

By the development of the monitoring modules the problem of security of reliability of these devices activity is actual. Reliability can be determined properly to save in time in the installed limits of value of the parameters describing ability to design required functions in the this conditions and conditions of usage, that is property to save the function ability in the period of time.

2.1. Diagnostic principle of the spectrum analyzers

The essence of work consists in research of the power and resonant processes in the biological object spectrum on cell and fabric levels, development of methods of the control of the interaction of the biological objects with electromagnetic radiation on the basis of mathematical modelling of interaction of objects with electromagnetic radiation.

Thus if imagine it by Fourier spectrum

$$F(f_x, f_y, t) = \int_{-T/2}^{T/2} \int_{-R_0}^{R_0} \int_{-T_o/2}^{T_o/2} \begin{matrix} F_r(x)F_r(y)F_r(t) \cdot \\ \cdot \exp[-j(f_x x + f_y y)] \\ \exp[-j\frac{2k\pi}{T}]dxdydt \end{matrix}, \quad (16)$$

we can determinate the modifications of the BTO conditions in the time period T.

Now we pass on to polar coordinates.

$r^2 = x^2 + y^2$; $\rho^2 = f_x^2 + f_y^2$; $\varphi = tg^{-1}(f_y/f_x)$;

$x = r\cos\theta$; $f_x = \rho\cos\varphi$; $dxdy = rdrd\theta$;

$y = r\sin\theta$; $f_y = \rho\sin\varphi$; $\theta = tg^{-1}(y/x)$.

The $F_r(t)$ function is bordering of the maximal function value of BTO surface.

Thus for the periodical function ($T = 2\pi$) received

$$F(\rho) = F(f_x, f_y, f_t) = \int_0^{R_{max}} rdr \int_0^{2\pi} \exp[-jr\rho\cos(\theta-\varphi)]d\theta \times \int_0^T \exp\left[-j\frac{2\pi}{t}\right]dt \quad (17)$$

Used the known Bessel function zeroth order first type:

$$I_0(z) = \frac{1}{2\pi}\int_0^{2\pi} \exp[-jz\cos(\theta-\varphi)]d\theta. \quad (18)$$

Thus we can received (17) as:

$$F(\rho) = 2\pi \int_{R_0}^{R_{max}} I_0(r\rho)rdr. \quad (19)$$

Used the Bessel function first order first type, we can received (19) as:

$$F(\rho) = \frac{2\pi}{\rho}\left[I_1(\rho R_{max}) - I_1(\rho R_0)\right] \quad (20)$$

(with $zI_1(z) = \int_0^z \alpha I_0(\alpha)d\alpha$).

Thus the spectral parameters of BTO electromagnetic fields function can be dependent on surface roughness functions' parameters. It is necessary to diagnostic of the BTO dynamic conditions and its characteristics are determinate. We can determinate study of BTO surface is normal or is given by some new growths.

If the BTO surface is given by some new growths, on this surface the pathological state is arise and its texture is change. This surface can be determinate as an aperiodic function ($T \neq 2\pi$) into finite horizon, for example, at the length of the BTO texture analysed.

At the same time coefficient b_k of the Fourier series (5) is estimate as

$$b_k = \frac{1}{T/2}\int_{-\frac{T}{2}}^{\frac{T}{2}} F_r(r,t)\sin k\frac{2\pi}{T}tdt,$$

where T – the function, which not multiple 2π,

and as

$$b_k = \frac{1}{T/2}\frac{R_{max}+R_0}{2}\sum_{n=1}^{\infty}\frac{1}{\sin\theta_n}\int_{-\frac{T}{2}}^{\frac{T}{2}}\sin k\frac{2\pi}{T}tdt = \frac{1}{T/2}\times$$

$$\times\frac{R_{max}+R_0}{2}2\sum_{n=1}^{\infty}\frac{1}{\sin\theta_n}\int_0^{\frac{T}{2}}\sin k\frac{2\pi}{T}tdt = 2(R_{max}+R_o)\times$$

$$\times\sum_{n=1}^{\infty}\frac{1}{\pi\sin\theta_n}\sin^2 k\frac{\pi}{2},$$

where the amplitude value R_n into $[R_0, R_{max}]$ finite horizon is change,

where R_0 –radius of the normal surface without some pathology, i.e. with practically ideal texture of the BTO,

R_{max} – radius of the elementary surface of the BTO at maximal height is given by some new growths,

θ_n – angle of the hot fix by dynamic acoustic waves and the multifocal uptakes are reflected the electromagnetic irradiation.

Thus the surface indications and effects from this BTO we can receive as:

$$F_r(r,t) = 2(R_{max}+R_o)\sum_{k=1}^{\infty}\sum_{n=1}^{\infty}\frac{1}{\pi\sin\theta_n}\sin^2 k\frac{\pi}{2}\sin k\frac{2\pi}{T}. \quad (22)$$

This function is determined the basic characteristics of the BTO dynamic condition.

The information need about this characteristics is conditioned by creation of the database for the intelligent sensors system, which intend for detection of BTO electromagnetic fields,

The algorithms of the complex device work of an irradiation with different parameters of the target signals are offered (fig.2). For direct measurement of parameters of a superficial wave cover by the extended beam of radiation, for example, a dynamic cutting zone or dynamic biological crate, the skin deformation.

Calculating size of depth of the deformed layer of a surface it is possible to determine deviations from nominal size for the given regimes of processing.

Formation of managing teams on change of the operations regimes of dynamic system carries out the computing block of a signal processing of the system analyzer. At excess of an allowable level the managing block forms on the regimes change.

The rigging by such techniques of the automated medical instrumentation enables to fix the image on a videoroller, to save in archive and to estimate a condition ill in dynamical changes in time of the enough long-lived span for improvement of the diagnostic and the treatment, for the analysis of change of the parameters of the shape of a object surface.

Thus, usage of a tendered method in the automated recording system and processing of the optical maps micro both macrostructures of a technical and biological parentage enables to increase efficiency of the diagnostic of the critical situations, emergences of a condition of the frame of an biological and technical object.

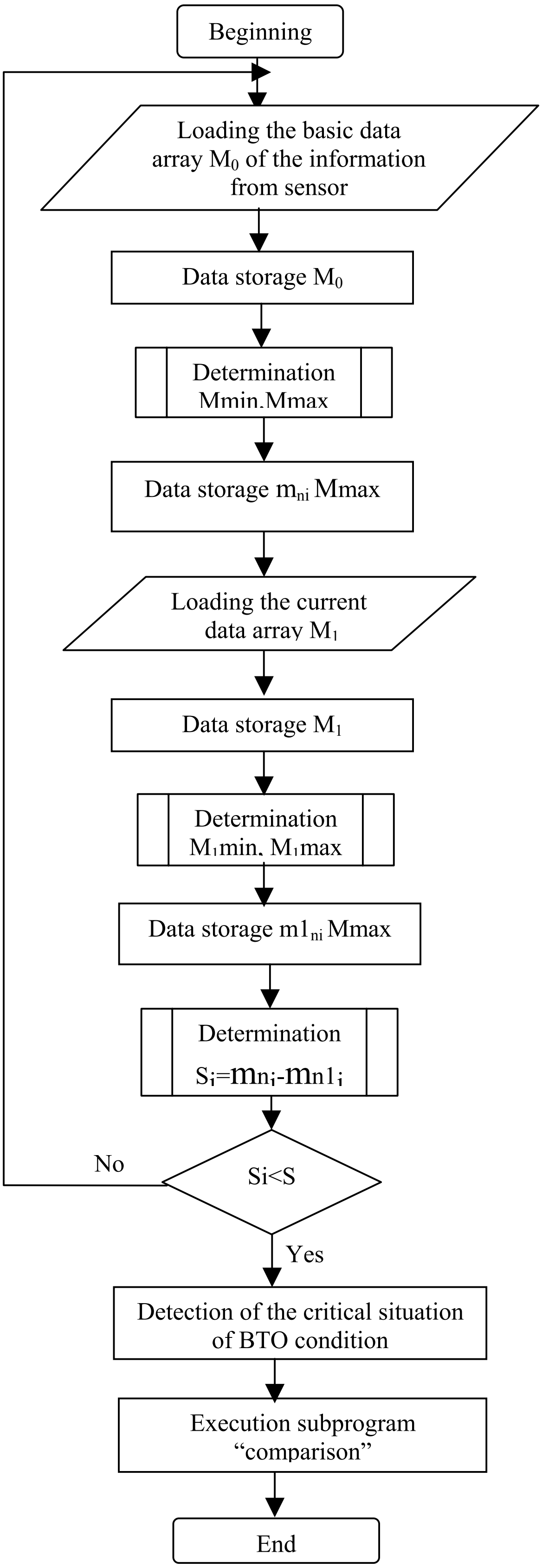

Fig.2. The functional algorithms of the complex instrument for diagnostic critical situation of BTO condition

3. CONCLUSION

Existing procedures of definition of the treated signals parameters of the dynamic fields of the object ground a statistical analysis are investigated.

1. The carried out assaying of classified tests of improvement the quality of control condition of the biological or technical object to justify requirements for developing the reference equipment of quality of a control processes has allowed.
2. On the basis of the assaying of interrelation of parameters of dynamic phenomena in a interaction zone with quality of a surface principles for the control BTO condition of a control and measurement process for dynamic changes of the parameters of acoustic emission signals, and signals of electromagnetic force are stipulated.
3. The schemes of diagnostic intelligent system of a normal condition and the critical conditions monitoring of the biological or technical object is adduced.
4. The carried out review and the comparative assaying of the schemes devices of quality surveillance, founded on different physical and engineering principles, has allowed to determine function operational feasibilities of intelligent monitoring systems of evaluators of the object condition for a computer-assisted management quality of a machining.
5. The feasibility of the intelligent hybrid monitoring systems with high efficiency and reliability for the formation of control commands of the flexible computerized intelligent-systems is analysed.

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