

Homeostatics and acupuncture

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The development of ideas about the mechanisms of self-regulation of complex systems showed the insufficiency of our knowledge about the laws of control in both living and inanimate nature.

The paradigm of scientists involved in modeling control laws in natural and complex technical complexes is that the model should not contain contradictions within itself. Real systems are still being built on this principle. Any models containing an internal contradiction are considered not to reflect reality and are not viable. Nevertheless, a thorough study of natural objects (primarily living organisms) shows that internal contradiction plays a constructive role in these systems [3, 9]. This phenomenon was noticed in time immemorial and was one of the most important philosophical generalizations of human thought in the form of the law of struggle and the unity of opposites.

In the Western scientific tradition, the idea of the constructive value of the adaptive mechanism of living organisms to changes in the external environment was expressed by the outstanding French scientist Claude Bernard [2, 17]. At the same time, he pointed out that certain relationships between the organism and the environment can, under certain conditions, be fixed and transmitted to subsequent generations, creating various types of organisms and various forms of life.

The significance of the constancy of the internal environment of the body and its role in maintaining health was studied by W. Cannon [18, 19]. He gave a definition of this concept - "homeostasis" (homeostasis). In interpreting this term, Cannon emphasizes that the word "Stasis" means not only something stable, immobile, or stagnant, but also a condition apparently leading to these phenomena. Word "homeo" does not point to identity (same), i.e. not for some permanently fixed or rigid state, but on the similarity and similarity of phenomena (like or similar). Cannon stresses that the term "statics" accepted in mechanics does not apply to living things, since in the phenomena of homeostasis the physiological mechanisms are so specific and so diverse that they are not at all identical with the term "statics" used in technology. Thus, homeostasis is not characterized by the stability of the processes, but their dynamics is limited by certain boundaries of physiological parameters (the norm of reactions). Developing this concept, we can already talk about homeostasis in relation to static and cyclic processes [4].

Currently, a new scientific discipline called homeostatics is being formed in the field of cybernetics [3]. She studies the issues of maintaining the dynamic constancy of vital parameters, functions, rhythms, cycles and development trends in wholes of various natures. It examines the issues of harmony and disharmony in living, natural, social and artificial systems.

The homeostat is an elementary structural unit of a homeostatic system [4]. Just as an organism consists of a kind of building blocks of cells, so the control system of an organism consists of elementary functional units that add highly specialized control structures that ensure a given level of constancy of optimal conditions for the functioning of a living system. Morphologically and energetically

homeostats of various systems can be built from any tissues and biochemical components, however, their functional features in terms of information processing remain fundamentally the same type.

From the name of the functional unit of the control element received the name and branch of science that studies this class of management systems - homeostatics.

Homeostatics - Homeostatics (from Latin homeostatics) is a new branch of cybernetics in the field of management of complex systems, which studies the properties and phenomena of multi-connected hierarchical management, including the relationship between parts of the homeostat and the external environment, ensuring the maintenance of dynamic constancy of vital parameters and functions, including rhythms and development trends [5]. An important place in homeostatics is occupied by studies of the mechanisms of occurrence of various pathologies and catastrophes.

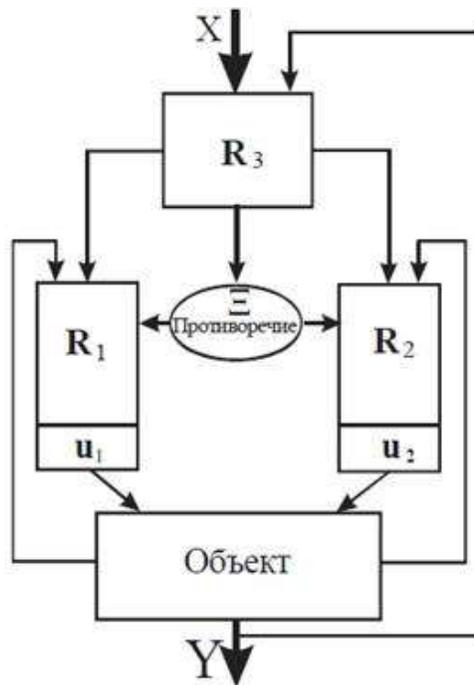
The essence of homeostatic control is controlled contradiction. In this case, the contradiction management system itself forms a homeostat. The totality of statements, procedures, models, their transformations, as well as solving problems of managing contradictions and, in particular, pathological contradictions, form a scientific discipline - homeostatics.

Gorsky Yu.M. et al. [1, 4, 6, 7, 8, 10, 16] noted that homeostatics can reveal the information mechanisms of the development of many catastrophic phenomena. This unity is manifested, first of all, in the generality of the principles of organization and methods of management of systems of different nature, in which the issues of managing the contradiction occupy an important place.

Homeostatics is actively developing as a scientific direction. Since 1991, a permanent international seminar "Homeostatics of living, natural, technical and social systems" has been working, which is an associate member of the World Organization of Systems and Cybernetics (WOSC). A course of lectures "Homeostatics of Complex Systems" has been created, which has been delivered for 5 years at the Irkutsk State Economic Academy. Similar work in the field of medical homeostatics is carried out by Dr. med. Stepanov A.M. [12, 13]. Conceptual questions of homeostatics are developed in his works by Doctor of Technical Sciences. Teslinov A.G. [15].

The ancient Chinese healing method of acupuncture is based on correcting the flow of vital energy Qi, which has two qualitatively polar main varieties - Yin and Yang. The Chinese dialectic, used in all spheres of life, is generally built on the interaction of opposites and their harmonization by the third element. Thus, a person is considered as the middle link of the "Heaven-Man-Earth" triad, and it is in him, in a man, that the action of the laws of Heaven and Earth should be balanced. In the ancient Chinese treatise I Ching, where opposites are symbolically indicated by solid and broken lines, all the laws of the universe are considered as a change in the Yin and Yang balances in trigrams and hexagrams. A large section of acupuncture is based on the application of the laws of change (I-Ching) for the diagnosis and treatment of patients. In this case, the acupuncture system,

Let us consider the simplest homeostat scheme as a functional building block of control systems in living systems (Fig. 1).



Rice. 1. Schematic block diagram of an elementary homeostat
 X - input signal; Y - output signal; R₃ - regulator-distributor of tasks on the chain
 information processing; R₁ - regulator-executor of the first circuit; R₂ - regulator-
 executor of the second circuit; u₁ and u₂ - sources of information transfer
 information; Object - executive mechanism (control object)

The homeostat circuit is at least a two-level hierarchical control. The upper level is the regulator R₃, the function of which is the distribution of information flows to the two chains of processing this information at the lower level and setting the magnitude of the contradiction between them. The underlying level of information processing is represented by the regulators R₁ and R₂ with its own mechanisms for maintaining energy resources u₁ and u₂...

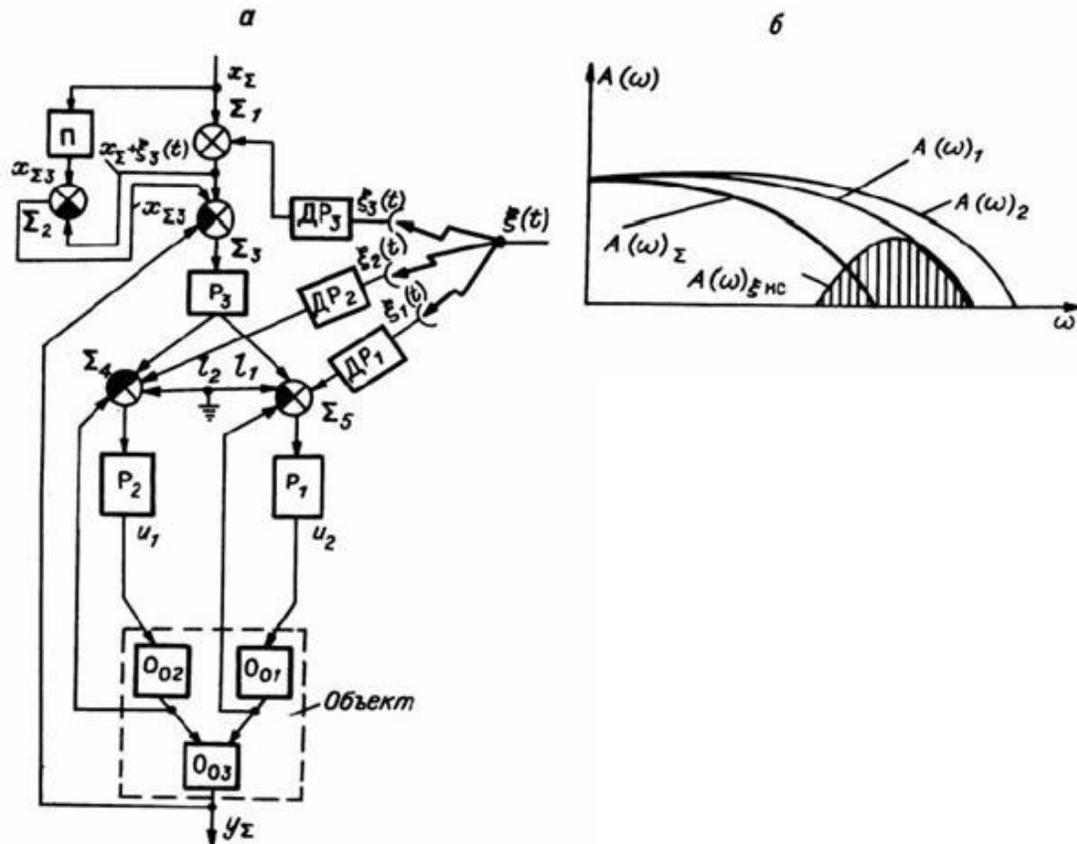
Signals from the R regulators₁ and R₂ are fed to the input of the control object, where they are summed up, with different signs. If the values of the input signal are the same, then they are reset to zero and the object remains in the mode of the current state; if there is a difference, then the signal -u is the control action of the homeostatic control system. The diagram also shows local and general feedbacks. All this makes the model built according to such a scheme resistant to interference (the penetrating interference becomes in-phase and is subtracted at the output), sensitive to small signals, and ultra-stable.

Let us recall, for example, that in humans, the magnitude of the signals transmitted through the nerve fiber is in tenths and hundredths of a volt, and the induction on the skin surface can reach significant values (hundreds of volts) due to static electricity when wearing clothes made of synthetic materials, and, however, the control of the internal organs is not impaired.

Hypothetically, the acupuncture system, as one of the systems for correcting the state of internal organs and systems, has homeostatic characteristics. This makes it possible to analyze its computer model and identify the most significant electrodynamic properties of signals that control the state of associated systems and organs with acupuncture points. In the model under study, it was assumed [14] that each

the homeostat has at least three acupuncture points or biologically active points (BAPs) advanced towards the corresponding type of interference (it can be assumed that for each type of interference that has a significant effect on the homeostat, there should be its own triad of BAPs).

In this model (Fig. 2), BAPs are sensors-receptors (DR1 and etc2), advanced towards the interference and having controlled conductivities.



Rice. 2. Block diagram of a homeostat of one parameter with a system of active points (a) and amplitude-frequency characteristic of the homeostat and its individual parts (b)

Obviously, if the penetrating noise $\xi(t)$, reduced to the inputs of the regulators performers R_1 and P_2 , is in phase and has the same value, i.e. $\xi_1(t) = \xi_2(t)$, and the transfer functions of these regulators together with the split part of the object are the same $W_{p1}(p) W_1(p) = W_{p2}(p) W_2(p)$, then due to the difference of signs in the executive bodies P_1 and P_2 additive interference is completely self-compensating in the controlled object.

For various functional and organic reasons, the homeostat channels can be asymmetrical, therefore, even if $\xi_1(t) = \xi_2(t)$, then this does not allow completely self-compensate for interference. For complete self-compensation in static conditions, it is necessary to constantly correct the values of the active conductivity, k_{dr1} and k_{dr2} so that ensure equality $k_{dr1} k_{p1} k_{o1} = k_{dr2} k_{p2} k_{o2}$, where k_{p1} , k_{p2} - coefficients of proportional components of regulation P_1 and P_2 , a k_{o1} and k_{o2} - active conductivity differential part of the controlled object, respectively O_{o1} and O_{o2} ... In this case, the penetrating common-mode interference, which for both channels has P_1 and P_2 additive character, the output will be zero. The specified condition for compensation of interference is necessary, but insufficient, when a dynamic process is considered, since in

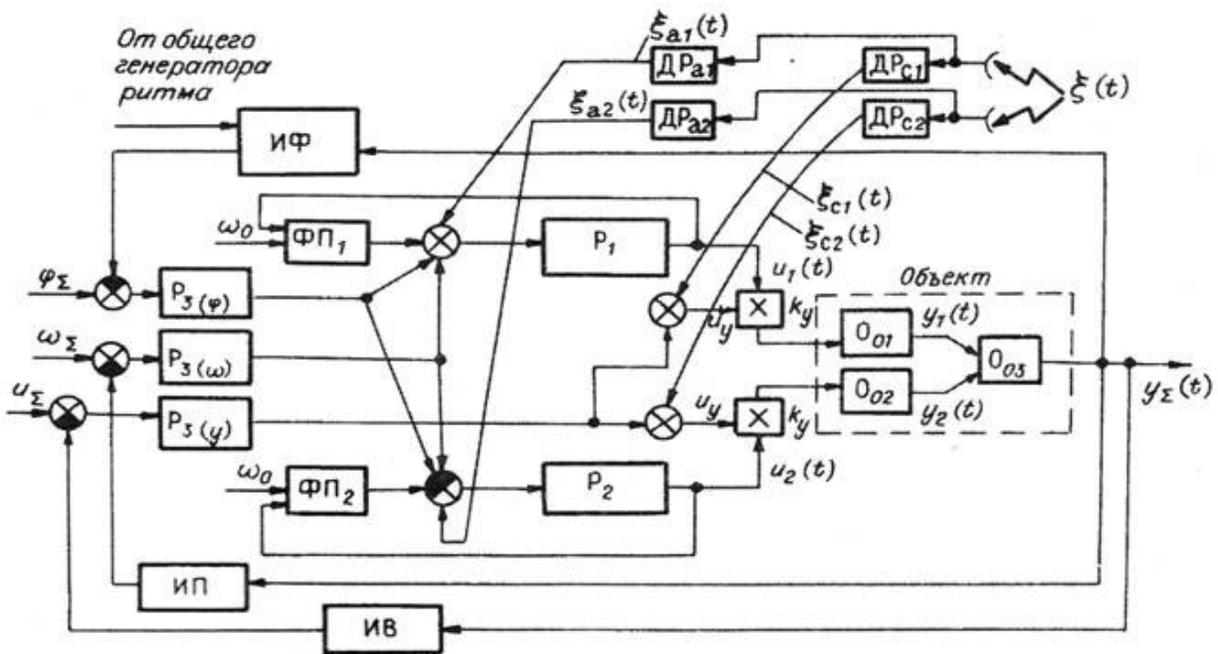
the latter case is already required $W_{dp1}(p) W_{p1}(p) W_{o1}(p) = W_{dp2}(p) W_{p2}(p) W_{o2}(p)$, where $W_{dp1}(p)$ and $W_{dp2}(p)$ - transfer functions of receptor sensors.

If we accept, as in [4], a proportionally-integrative regulation law in each of the channels, then the conditions for noise leakage to the homeostat output will be determined by the mismatch between the amplitude-frequency characteristics of the first and second channels, i.e. between $A(\omega)_1$ and $A(\omega)_2$ (rice. 2b).

Let us investigate the case when the noise is applied to only one channel, for example, $\xi(t)$ connected to input P1... Then the interference will be largely compensated for by the action of the head regulator (R3), and its seepage will be determined by the difference between the amplitude-frequency characteristic of the entire homeostat $A(\omega)_s$ and frequency response of the first channel $A(\omega)_1$... We can conventionally assume that the curve $A(\omega)_s \xi(t)$ (rice. 2b) will determine in the frequency domain the zone of seepage of out-of-phase interference $\xi(t)$ to the homeostat output.

The most dangerous place for interference is the homeostat entrance. If this interference is not compensated for, then in our model (Fig. 2a) it will pass unhindered to the output of the homeostat. To solve this problem, a sensor-receptor DR is used and is entered by means of the memory element P operational time (for the time t) memorization of the task (x-3). As a result of a series of transformations at the input of the adder -3 we will have $x-3$ since $x- + \xi_3(t) + x-3-\xi_3(t) = x-3$...

Thus, memorizing the task x- to a certain extent allows you to implement an algorithm for compensation of interference at the input of the homeostat. The manifestation of the action of biologically active points can also be considered from the standpoint of a pulsating homeostat. In a pulsating homeostat (Fig. 3) P3 (-), R3 (ω), R3 (y) ensure the maintenance of specified values. In this case, control is carried out at the level of constant signals, and at the output by adding $k_{y1} u_1(t) + k_{y2} u_2(t)$ a periodic signal y is generated $y(t) = y_1(t) + y_2(t)$.



Rice. 3. Block diagram of a pulsating homeostat with a system of active points

Sensors-receptors in pulsating homeostats should be of two types:

active DR_{a1}, DR_{a2} and capacitive DR_{c1}, DR_{c2} conductivities. Under the action of $\xi_{a1}(t)$, $\xi_{a2}(t)$ there is a simultaneous shift $U_1(t)$ and $U_2(t)$ in frequency at $-\omega\xi$, and in such a way as to ensure the maintenance of constancy - - = const. The available experimental material indicates that for the coordinated operation of various mechanisms of homeostatic control in a hierarchical structure, the most important thing is to maintain phase shifts.

By means of sensors-receptors with capacitive conductivity, the interference $\xi(t)$ arrives for multipliers k_y and is subtracted in the controlled object at $\xi_{c1}(t) = \xi_{c2}(t)$, insofar as $y(t) = k_y[U_1(t) (U_y(t) + \xi_{c2}(t))]$. Analysis of the model's behavior allowed formulate the following management characteristics inherent in the acupuncture system:

- 1) BAP are the most important elements in the mechanisms of interference protection of homeostats;
- 2) the discrepancy between the measured conductivities at the points corresponding to the left and to the right sensor-receptors, indicates the asymmetry of the channels of the homeostat itself (however, it does not speak of the pathology of the homeostat);
- 3) imbalance between measurements made with alternating feed to the sensor - the receptor of the regulator-leader of signals of both polarities, will mean a deterioration in the properties of the homeostat in relation to its noise immunity to the action of interference;
- 4) simultaneously acting with small constant potentials on symmetric BAP of a pulsating homeostat, we will change its frequency without changing the phase and magnitude of the output pulsating signal;
- 5) by acting on one of the symmetrical BAP pulsating homeostat, we will cause a change in frequency and phase, and when exposed to an alternating current, also the value of the output pulsating signal;
- 6) maintaining homeostasis in phase is probably more important for the body task than frequency.

Considered patterns parameter electric conductivity acupuncture system from homeostatic positions were carried out according to the methods described in [3, 16]. This is one of the first attempts to analyze analytically the dynamics of the contradictions of the acupuncture system; it is useful for researchers, as well as developers of technical means and methods for providing diagnostic studies and therapeutic effects on the body using an electric current.

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