Principles and possible ways of building an intelligent system of integral medicine

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***Abstract*—The conceptual framework of an intelligent system of integral medicine in the medical-technological basis of functional spectral-dynamic diagnostics is considered and the ways of its building are determined.**

***Keywords*—intelligent system, diagnostics, integral medicine**

I. Introduction

Under the concept of integral medicine, let us understand the model of iatric thinking based on the integration of knowledge from the main methodic approaches of world medical science and practice.

This is, firstly, the convergence of various fields: oriental (traditional Chinese, Indian and Tibetan medicine), allopathic, homeopathic, naturopathic (the usage of natural pharmaceuticals, including bioactive accessory food substances), physiopathic (isopathic, frequency-resonance and spectral-dynamic methods) ones.

In addition, integral iatric thinking necessarily includes two more dimensions. The second dimension is the integration of knowledge of the health-improving (health-protective), preventive and curative branches of medicine. And the third dimension is the integration of knowledge about the main etiological levels of pathology, including genetic, morphological, biochemical, functional and mental ones.

II. Medical-technological basis

For the next generation of physicians to be able to successfully complete their tasks in the paradigm of integral medicine, a single medical-technological basis is required. Today, spectral-dynamic technology claims to be the single medical-technological basis of integral medicine [1]. This is determined not only by the technological advantages (simplicity, rapidity and passivity of the diagnostic procedure) but also by the possibilities of practically unlimited spreading of the spectrum of diagnostic markers and the creation of problem-oriented marker bases that facilitate the work of a physician and are a necessary condition for the building of automated systems for completing various tasks based on new algorithms developed by physicians.

The development of the theory, methods and technological means of integral medicine is a new large-scale field in the theory and practice of medicine. It is important to clarify that this process preserves the existing structure of medical activities. In other words, the question is not about all physicians becoming specialists in integral medicine, but about the fact that physicians of various specialties will gain access to its methods that can radically improve the quality of health-improving, preventive and curative care.

In practice, the methods of integral medicine can become available to physicians only if there is an intelligent system that provides full-scale usage of the capabilities of integral medicine.

Currently, the main obstacle in the way of building an intelligent system of integral medicine is the differentiation of conceptual constructs of different fields of medicine. The overcoming of this is possible only on the way of ensuring semantic compatibility and semantic convergence of subsystems in the process of designing intelligent systems [2]– [4].

III. Key terms

Before identifying a means of overcoming these obstacles, let us consider the correlation of the concepts "intelligence", "task" and "diagnostics".

The tools of thinking are systems of concepts and systems of images. The imaginative and conceptual constructs contained in the memory of the subject of thinking are the corresponding systems of their knowledge. The world cognition by a child begins through images, which are then joined by concepts.

Images and understanding of problems can be intuitive, that is, the understanding of problems is not carried out at the level of argumentation, and the resulting formulations may be unprecise. In this case, the communicative moment necessary for the transfer of knowledge obtained at an intuitive level, using associative relations, may be difficult. Thus, it is possible to talk about two ways or two levels of thinking – intuitive and analytical ones, the last of which includes the structuring of concepts and the nature of their connections.

In the humanities and natural sciences, which belong to poorly structured areas of knowledge, decision-making at the initial stage is often not only, and sometimes not so much, argumentative as intuitive. Intuition and argumentation as a type of reasoning are two sides of the same phenomenon. Since the knowledge accumulated in the form of experience is often intuitive and cannot be described [5]. According to A. Bergson [6], "intelligence is carved in intuition", and intuition, according to K. G. Jung [7], is a psychological function that provides the transfer of perception to the subject in an unconscious way. At the same time, intuitive thinking is "fueled" by imaginative representations. The so-called "internal images" of objects, phenomena, situations, that exist as a stimulus, in the absence of a directly affecting prototype, can act as generalizing ones for imaginative phenomena that correspond to a certain situation [8], [9]. In medicine, intuition helps to search for diagnostically significant traits or their combinations (syndromes) and can contribute to the choice of a rational way of the patient examination, which optimizes the diagnostic process that includes mental intuitive-imaginative hypotheses [5].

Intuitive thinking, which is present in humans, has not yet been implemented in technical systems. Although sometimes image recognition using neural network technologies is called intuitive recognition, it is actually the result of computational procedures on numerous neurons of multilayer perceptrons (Deep Learning). However, fuzzy logical-linguistic (linguological) models [10], which should include intuitive-imaginative-logical systems [5], can be implemented using fuzzy inference algorithms. As a basis for this, imageries can serve, accompanied by factors of confidence of experts, which, in turn, can include intuitive representations of experts. This allows transforming a fuzzy imagery into a relatively ordered one – from a typical or classical image (archetype) to the least similar ones, which are especially difficult to identify [11].

Analytical thinking is present in biological systems and is implemented (modeled) in intelligent technical systems. The communicative aspects of "thinking" can be traced in multi-agent systems and systems that use ant colony optimization [12]– [15]. To formalize mental concepts, it was proposed to use extensions of modal logics [16], [17]. This approach is based on the syntax of the variant of the multi-modal logic of multiplicative time proposed by the authors and on semantics in the form of a set of possible worlds. The result is the formalization of the dynamics of the environment and the behavior of an intelligent agent.

The intuitive and analytical levels of thinking are a means of intellectual support for the operation of a biological or technical system in a specific environment and in the context of a certain value system, explicit or not explicit one. The operational environment of the system can have several levels, which is especially noticeable when referring to manipulators and robots. There are two main levels in the biological system. The first level is the sensory environment, the second level is the thinking environment, which is divided into visual active thinking (innate one, that refers to the subject area), concrete-objective thinking (completion of tasks concerning a real object), abstract-logical thinking, which allows completing creative tasks.

In biological systems, communications are mediated by sensory systems, including, mainly, the visual, auditory and tactile systems of a human, and in cyber physical systems, it is electricity-measuring, low-frequency electromagnetic, infrared, optical, X-ray, biochemical and other sensors.

Intelligent software is, in fact, an analytical tool for a biological or technical system. From this, the following definition can be formulated:

INTELLIGENCE is a tool for cognition, understanding, solving problems and completing tasks.

It should be noted that the fundamentally important characteristics of intelligence are the ability to recognize the essential in the data, the generation of a sequence (purpose – plan – action), the ability to select assumptions relevant to the purpose, reasoning (obtaining consequences from assumptions), decision-making through argumentation [18].

The completion of the task is always preceded by its understanding, which can be implicit (intuitive) or explicit (analytical and communicative), including fixed in the architecture or in the algorithms of the technical system. Explicit understanding can and should be based on both declarative and procedural knowledge. At the same time, finally, a human, including the creator of a technical system, has an understanding formed on the basis of a conceptual construct. The consequence of this fact is the high value of a tight definition of concepts. For example, for the understanding of tasks, the tight definition of the concept of the task itself, given by Yu. L. Yershov and K. F. Samokhvalov, effectively helps [19].

A TASK is something, for which a criterion for distinguishing a completion from a non-completion is defined. Note that, in contrast to the definition of the concept of a task, a PROBLEM is something, for which a criterion for distinguishing a solution from a non–solution is not defined. The definition of such a criterion translates the problem into the rank of a task. The quality (accuracy) of the found criterion for distinguishing a solution/completion from a non-solution/non-completion depends on the level of understanding of the problem.

The understanding of the concept, idea, problem, task, message, event, phenomenon, system, etc. (conditionally generalized, object) is carried out in the actual discourse as a set of relevant, that is, having a sufficiently high rank in the value system, semantic fields of object classes. That is, the actual discourse (late Lat. discursus – reasoning, argument) forms a system of understanding of the object.

There are three levels of understanding of the object.

The first level of understanding can be considered as the identification of the belonging of an object to the semantic fields of a set of object classes that are suitable by association.

The second level of understanding is the integration (consolidation) of the obtained as a result of identification of belonging, that is, semantic identifications, into an integral whole in the current discourse. However, it should be noted that the subjective irrelevance of some objectively significant semantic field of the general discourse leads to an incomplete or incorrect and even false understanding of the object.

The third level of understanding is the identification (including the formulation) of the meaning of the essence of an object as an invariant of its integral understanding in a certain set of contexts. The limiting case of the third level of understanding is a tight definition of the meaning or essence of an object. Thus, the definition of the concept of a task according to [19] led to the need to revise some of the foundations of mathematics. This suggests that the natural language conceptual base is always primary, and the subsequent levels of formalization using artificial languages, including the language of mathematics, are secondary.

In general, the understanding of "what it really is" is possible only in the discourse of the laws of human nature, including the laws and determinants of health. This statement is correct in relation to almost all objects, with a few exceptions of purely technical, restricted professional issues. It is obvious that a sufficiently complete and noncontradictory understanding of tasks and problems by natural or artificial intelligence is a necessary condition for their correct solution and completion.

The tasks of recognition and classification in poorly structured areas of knowledge in artificial intelligence systems are completed using heuristic and logical algorithms. Next, let us focus on the class of diagnostic tasks.

DIAGNOSTICS is the identification of the belonging of an object or process to a certain semantic category. It is based on sensory, imaginative, computational and verbal data (exclusively verbal data can be found in the diagnostics of mental diseases in medicine, the comparison of images and their coordinates in astronomy).

As a semantic category, in medicine, the positions of nosological classification (classification of diseases) or disease exposure (prenosological diagnostics) are most often used. In technical diagnostics, this can be, for example, a classification of failure risk levels.

As sources of sensory data for medical diagnostics, equipment based on the fixation of electrical measurements, low-frequency electromagnetic waves, infrared or X-ray radiation and data from other sensors can serve.

Regardless of the source of the sensor signals, the input data for diagnostic systems is usually a parametric vector or matrix, in particular, an image. In both cases, neural network, logical and logical-statistical recognition algorithms, as well as their combinations, are applicable.

IV. Prospects of intelligent diagnostic systems

Medicine is in urgent need of the development of intelligent diagnostic systems (IDS). The history of existing IDS has convincingly demonstrated their high efficiency and low potency of widespread usage. A similar situation occurs with new IDS developments. This contradiction is caused not only by organizational and financial issues but also by the complexity of integrating intelligent decision support systems into medical information systems due to technological incompatibility, the main component of which is the problem of semantic convergence.

The real possibility of overcoming this contradiction is provided by the principles of the organization of the Open Semantic Technology for Intelligent Systems (OSTIS) [20]. On this basis, the prospects of ontological design, production and operation of semantically compatible hybrid intelligent computer systems are being opened.

The prospect of using the OSTIS Technology to create medical IDS can be seen in the following example.

Over the past two decades, the technology of functional spectral-dynamic diagnostics (FSD-diagnostics) has been developed using a medical spectral-dynamic complex [1]. This technology is based on recording a low-frequency electromagnetic signal from the patient's skin surface using a passive electrode (FSD-sensor) and allows simultaneously obtaining diagnostic information on all body systems in the amount of tens of thousands of diagnostic characteristics. The most valuable quality of FSD-diagnostics is the possibility of early detection of infectious and common noncontagious diseases [21].

The mass character of early detection of diseases will be provided by the technology of automatic FSD-smart-diagnostics [22]. This technology will make it possible to use a personal smartphone (or other means of Internet communication) for automatic FSD-diagnostics of infectious and chronic noncontagious diseases at the early stages of their development for individual prevention and early treatment. The set of essential interacting automatic diagnostic systems requires their semantic compatibility, and therefore the OSTIS Technology best corresponds to the tasks of implementing smart diagnostics [23]. And most importantly, that FSD-diagnostics uses markers that take into account the features of the diagnostics of the main fields of medicine, including allopathic, naturopathic, isopathic and homeopathic ones.

V. Conclusion

The above considerations allow assuming that the combination of FSD-diagnostics technology (in combination with other sources of diagnostic data) and the OSTIS Technology can serve as an effective basis not only for creating IDS for a wide range of common infectious and noncontagious diseases but also for building an intelligent system of integral medicine.

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Принципы и возможные пути построения интеллектуальной системы интегральной медицины

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В работе рассмотрены концептуальные основы и определены пути построения интеллектуальной системы интегральной медицины в медико-технологическом базисе функциональной спектрально-динамической диагностики.

Изложенные в работе соображения позволяют считать, что сочетание технологии ФСД-диагностики (в сочетании с иными источниками диагностических данных) и технологии OSTIS может служить эффективной основой не только для создания ИСД для широкого спектра распространенных инфекционных и неинфекционных заболеваний, но и для построения интеллектуальной системы интегральной медицины.

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