Methods and means of knowledge elicitation in Chinese Image Medicine for achieving the tasks of its ontological modeling

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***Abstract*— The substantiation of a complex of methods and means of knowledge elicitation in Chinese Image Medicine (CIM) for the tasks of its ontological modeling in addition to the development of intellectualized information systems is the topical issue of the article. The methods of specific knowledge elicitation from the CIM experts has been defined in the research, the templates of questionnaires for a group survey have been developed as well, the axiomatic-deductive strategy of the structural and logical organization of the acquired knowledge has been used, according to this data a fragment of the diagnostic ontology of the CIM has been implemented.**

Keywords*— *knowledge elicitation, ontology, Chinese Image Medicine, Integrative Medicine, onto-based informational systems, e-learning systems, axiomatic-deductive strategy

INTRODUCTION

At present, alternative and complementary methods of human health improvement are being keenly developed around the world. They are important components of the integrative research medicine, which is based on the principles of the evidence-based medicine, uses an individual, holistic patient approach, and is focused on disease prevention and effectively integrates diagnostic and therapeutic technologies of the Western (conventional) medicine and traditional medical practices. Therefore, according to the strategy of the World Health Organization (WHO) in the traditional medicine [1], development of a scientifically based approach to the implementation of traditional medical practices into the conventional medicine is topical. The Chinese Image Medicine (CIM) is an important part of the integrative medicine that is an integral part of traditional Chinese medicine. According to the International Program of the Researches in Chinese Medicine for 2017-2023 [2], it is necessary to develop a variety of measures for research and scientific substantiation of the CIM methods and means. In order to address the challenge adequately it is necessary to be read in the knowledge of national healers (image-therapists) acquired by centuries, to unify and internationalize the terminology of the CIM, to transform this knowledge into metadata for its reuse in the information systems. Since, for the most part, the direct oral conveying of knowledge and skills from the practitioner to the beginner is used in this field, the priority task toward this goal is knowledge elicitation from the CIM experts, its further formalization and development of the CIM ontology as a source for an integrated onto-oriented information and analytical environment of scientific research, professional healing and e-learning of the CIM. The development of such an environment enables the implementation of the International Program at a high scientific level.

LITERATURE REVIEW

The relevance of development of the integrated onto-oriented information and analytical environment of scientific research, professional healing and e-learning of the CIM, generalized architecture of its components is defined and presented in the research [3]. In the study [4] a generalized formal model of the CIM ontology is established, as well as the variety of parts and conceptual projections of the CIM theory that allows ontological modeling of the CIM. The writing [5-7] is aimed at acquiring and saving the cognitive experience as well as the difficulties accompanying these processes. A new approach to solving the problem of semantic heterogeneity of the CIM knowledge and the meaning of ontology, i.e. an axiomatic-deductive strategy for establishing this knowledge, is developed in the paper [8]; its advantages are defined as well. The issue of knowledge elicitation from the CIM experts is practically underreported in the literature [9, 10]; the first researches on it cover the analysis of peculiar features of this process, accurate interpretation of the heuristic experience and the context knowledge of the CIM experts.

THE AIM OF THE RESEARCH

The aim of the research is to substantiate the methods and means of effective knowledge elicitation from the experts in Chinese Image Medicine as well as to formalize the acquired knowledge in order to develop the CIM ontology and knowledge base as a semantic core of the integrated onto-

oriented information and analytical environment of scientific research, professional healing and e-learning of the CIM.

RESULTS

For the qualitative ontological modeling of the knowledge of Chinese Image Medicine, the main components of the CIM ontology are defined (Fig. 1).

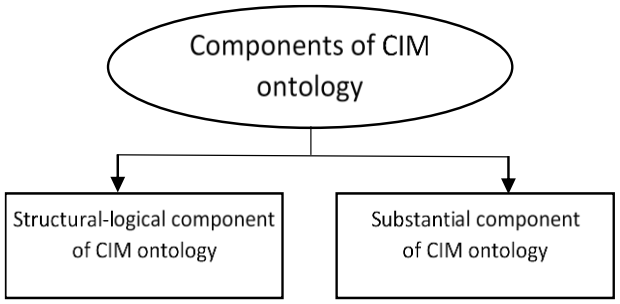

Fig.1. Components of CIM ontology

The structural-logical component of the CIM ontology is formed by an axiomatic-deductive strategy of knowledge development [8]. The strategy of axiomatic-deductive knowledge organization provides a clear, compact, and structured organization of the CIM knowledge that provides significant benefits over the non-axiomatic strategies. According to the axiomatic-deductive strategy the acquired knowledge can be organized into the following structural components of the CIM data base:

- a meta-disciplinary logic-semantic core of the Chinese Image Medicine;
- an own abstract logic-semantic core of the Chinese Image Medicine;
- a set of partial logical-semantic domains of the Chinese Image Medicine;
- a periphery of semantic space of the Chinese Image Medicine.

The substantial component of the CIM ontology is developed by the knowledge acquired from the CIM experts by means of the methods of knowledge elicitation; the analysis and effectiveness of the CIM data is presented in the study.

Knowledge elicitation is an interaction of an expert in a specific subject domain with a cognitologist (knowledge engineer), which results in an obvious structure of the expert's knowledge of the subject domain and the process of their philosophy in decisions making. Concept and relations of mind are the basis of any rational form of semantic representation, therefore the aim of knowledge elicitation is to define the main concepts of the subject domain and establish relations between them. The elicitation and conceptual analysis (structuring) of expert awareness of knowledge engineering are lacking nowadays. Regarding the Chinese Image Medicine, this issue is complicated by a poorly structured and formalized nature of knowledge in CIM. In view of the ancient Chinese origin of the CIM, most of its diagnostic and therapeutic methods are only empirical, and knowledge is poorly structured, vague, and polysemantic that challenges its comprehension. Therefore, a cognitologist must clearly understand the purpose of knowledge elicitation, since the efficient and adequate functioning of information systems developed on the basis of this knowledge depends on the choice of methods for knowledge elicitation. The specific character of this subject domain requires involvement of many experts, since the expert determines the level of competence of the ontology and knowledge base developed on its basis. The full process of development of the CIM onto-oriented knowledge base is presented in Figure 2.

At the stage of knowledge elicitation, a large number of heterogeneous, sometimes contradictory fragments of the CIM knowledge, is obtained. This is due to the fact that image-therapists have mostly intuitive, imaginative, ambiguous knowledge, which often do not conform to the laws of logic, are subconscious and vague. This knowledge can be divided into superficial and profound. The superficial knowledge is awareness of visible interrelations between individual events, phenomena and postulates of the CIM. The profound knowledge is more significant regarding the CIM: abstractions, analogies that reflect the structure and nature of diagnostic and therapeutic processes, explain the nature of phenomena and can be used for prediction. Thus, it is important to develop the most complete domain of the CIM at first. The CIM domain is an informal description of the main concepts of the CIM and interrelations between them that is the concepts distinguished from the knowledge system of an expert in the form they exist in their memory and in that interpreted by a cognitologist. The effectiveness of the CIM ontology barely depends on the formal logic conclusions, but it does depend on the knowledge of the CIM experts that can be obtained and presented in a form suitable for computer processing.

The elicitation and structuring of knowledge is to some extent in parallel, as at the stage of knowledge elicitation their structuring and development of the domain takes place. At the early stages, the combinations of the following methods of knowledge elicitation proved to be effective:

- Lectures;
- Observation;
- Free dialogue;
- Interviews;
- Questionnaire.

The lectures help the cognitologist-engineer quickly and effectively immerse in the Chinese Image Medicine, eliminate the differences between professional terminology of the expert and everyday language of the cognitologist. In this regard, the cognitologist-engineer selects all the terms used by the expert, and specifies their meaning, designing a dictionary of terminology (in fact, these are the first iterations of data structuring through the processes of object decomposition and aggregation).

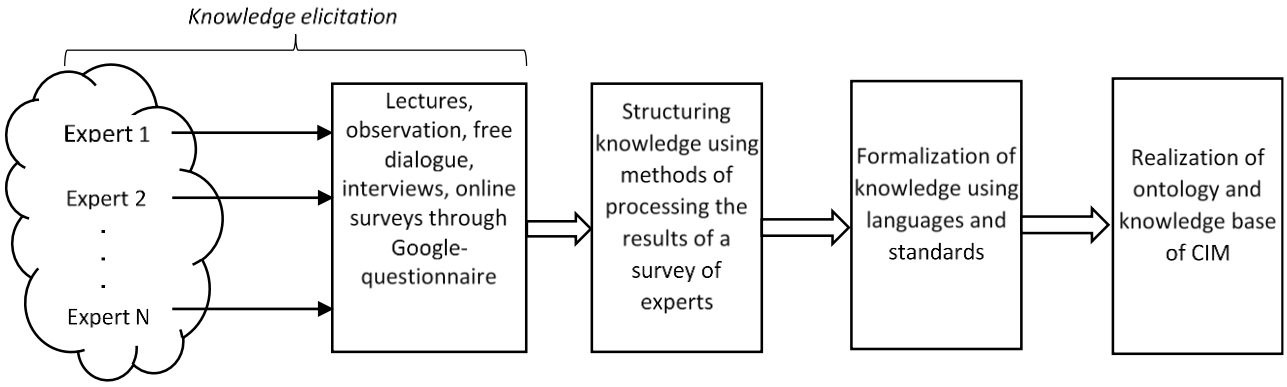

Fig.2. Sequence of development of onto-oriented knowledge base CIM.

Since the complex stages of experience are a lion's share of the CIM knowledge, it is worth investigating them by the methods of observation and recording the 'thoughts aloud' in parallel. The simultaneity is reasonable due to the fact that commencing with the Speculation 1 the expert develops Speculation 2, sometimes not realizing that the chain of considerations led to Speculation 2, for example, Speculation1 → SpeculationN → Speculation2. The thoughts aloud, by which the expert explains diagnostic or therapeutic decisions, make the observations more comprehensible for the knowledge-engineer. It is also worth noting that thinking is dialogic. Consequently, using a dialogue or polylogue (in case of a group session), the cognitologist-engineer helps the expert to acquire non-verbal knowledge, which is stored in their memory in the form of images or feelings that is especially relevant in the CIM. To involve a large number of the Chinese Image Medicine experts and form a single opinion simultaneously, a questionnaire is organized using Google-forms (it is a convenient cloud service that allows using various types of questions, images and videos) that is an important part of collective expert evaluation procedure with the possibility of automated search for an optimal alternative among the possible expert assessments.

The questions in the Google-forms are worked out using a down-stream methodology: from general to specific concepts. Such combinations of certain methods of elicitation promote increasing the cognitive adequacy; the knowledge engineer can make sure that the field of knowledge developed by them corresponds to the CIM model used by the expert.

The preliminary analysis has proved that at the stages of knowledge elicitation presented above, a dual subjectivity of the semantic model of the CIM is established that is the subjectivity of the reflection procedure in the interpreting of expert's knowledge by the cognitologist, which is also not subjective. To eliminate it, a joint effort together with the expert is necessary by working out and structuring the knowledge, defining the chains of reasoning, developing the strategies of decision-making. Such cooperation of the cognitologist and the expert for formation of the CIM domain is iterative and uses taxonomic and meronomic description of the information. A characteristic feature of the conceptual model of the CIM is its orientation, on the one hand, to the information needs of the user, and on the other hand – to the information needs of the domain. Therefore, for formalization of the domain, the chosen method of its description replaces the presentation of knowledge with a machine-implemented language; in this case, the language of ontology description OWL is chosen. As the result of formalization of the domain, the first prototype of the CIM data base has been developed.

The editor Protégé was used for the program implementation, which is adapted for development of specialized subject-oriented ontologies. It contains the mechanism of reasoning (Reasoner), which allows checking whether statements and definitions in the ontology are mutually consistent as well as recognizing the conformity of definitions with certain concepts that is very important for further research.

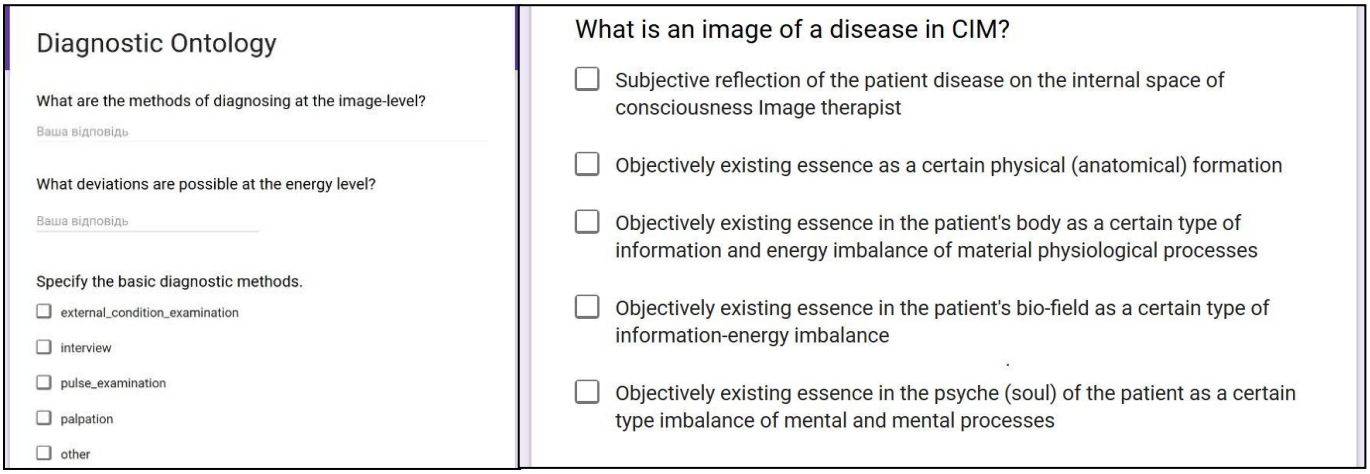

Fig.3. A fragment of Google Form.

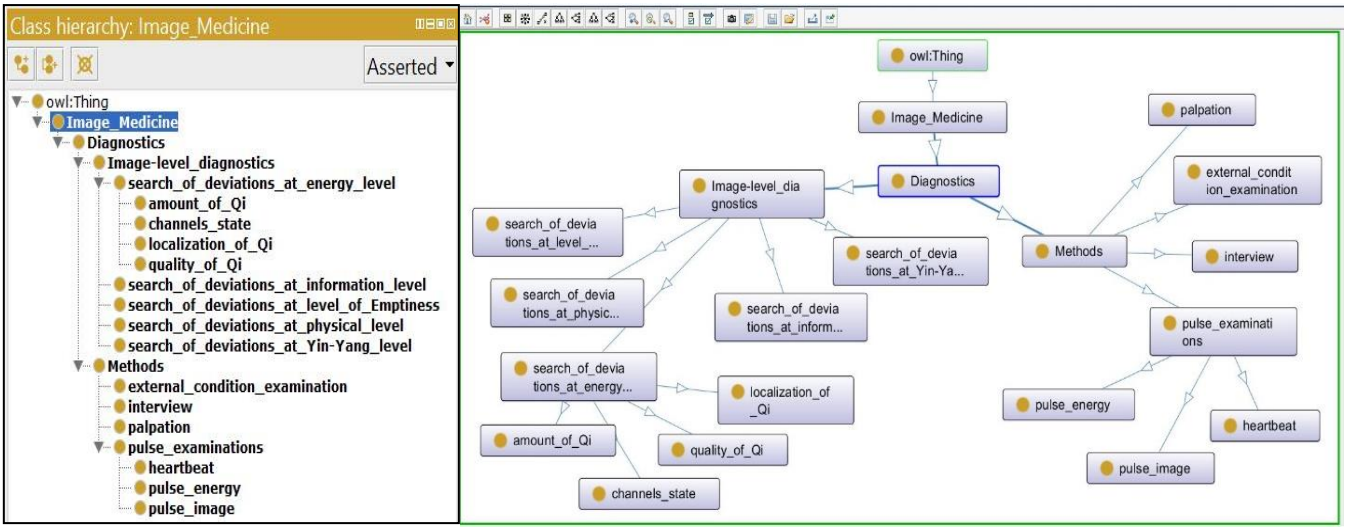

Fig.4. A fragment of diagnostic ontology CIM.

A part of a Google application form is presented in Figure 3. A fragment of the CIM diagnostic ontology developed on the basis of the acquired knowledge and proceeded results of the online survey of the practicing Chinese Image Medicine image-therapists is presented on Figure 4.

CONCLUSIONS AND FURTHER RESEARCH PROSPECTS

The necessity for a careful knowledge elicitation from the experts in Chinese Image Medicine is defined in the research; in this regard the best methods of knowledge elicitation are distinguished. The OWL language is used for formalization of the acquired knowledge; the prototype of the CIM diagnostic ontology in the Protégé environment is implemented. The CIM ontology, firstly, establishes a formal semantics of data that enables creation of a computerized data base for the integrated information and analytical environment; secondly, determines a real semantics of the CIM that allows presenting of the computerized data in a form convenient for perception by interested persons; thirdly, it allows achieving the tasks of further researches. The acquired knowledge as well as the methods of their further processing allows:

- unifying and standardizing the technology of presentation of the Chinese Image Medicine text and knowledge;
- creating a verified terminology device in the Chinese Image Medicine;
- developing a detailed conceptual and mathematical model of ontology using the tools of descriptive logic;
- designing a historical ontology, ontology of general theory of the Chinese Image Medicine, diagnostic and therapeutic ontology, ontology of health and diseases standards that enables development of a comprehensive integrated onto-oriented information and analytical environment of scientific research, professional healing and e-learning.

Successful achieving of these tasks ensures a high quality of the integrated environment according to international standards, as well as using the CIM data base in the intellectualized software applications, above all in development of the computer e-learning system of the Chinese Image Medicine.

References

[1] WHO strategy for traditional medicine for 2014-2023 (2013) http://www.who.int/medicines/publications/traditional/trm_strategy14_23/ru/. Accessed 20 Nov 2018

[2] International program of scientific research in Chinese image medicine and Zhong Yuan Qigong for 2017-2023 [Electronic source]. On-line mode: https://kundawell.com/ru/mezhdunarodnaya-programma-nauchnykh -issledovanij-kitajskoj-imidzh-meditsiny-i-chzhun-yuan-tsigun-na-2017-2023-god, free access (date of access: 15.11.2018)

[3] Lupenko S, Orobchuk O, Vakulenko D, Sverstyuk A, Horkunenko A (2017) Integrated Onto-based Information Analytical Environment of Scientific Research, Professional Healing and E-learning of Chinese Image Medicine. Inf Sys Net J, Lviv, p 10-19

[4] Lupenko S, Pavlyshyn A, Orobchuk O (2017) Conceptual Fundamentals for Ontological Simulation of Chinese Image Medicine as a Promising Component of Integrative Medcine. Sci Edu New Dim J, vol 15, p 28-32

[5] Jens Rasmussen, Annelise Mark Pejtersen, L. P. Goodstein (1994) Cognitive Systems Engineering. ISBN: 978-0-471-01198-9. 396 p.

[6] Vicente, K. J. (1999). Cognitive work analysis: Toward safe, productive, and healthy computer-based work. Mahwah, NJ: Lawrence Erbaum Associates.

[7] Технологии сохранения и воспроизведения когнитивного опыта / Отв. ред. В. Н. Носуленко. – М.: Изд-во «Институт психологии РАН», 2016. – 457 с. ISBN 978-5-9270-0340-2

[8] S.Lupenko, V.Pasichnyk, N.Kunanets, O.Orobchuk, Mingtang Xu. The Axiomatic-Deductive Strategy of Knowledge Organization in Onto-based e-learning Systems for Chinese Image Medicine // Informatics & Data-Driven Medicine. Proceedings of the 1st International Workshop on Informatics & Data-Driven Medicine - November 2018. – Vol. 2255. – P.126-134.

[9] Lupenko S. A., Orobchuk O. R., Zahorodna N.V. (2017, December 26). Formation of the onto-oriented electronic educational environment as a direction the formation of integrated medicine using the example of CIM. Actual scientific research in the modern world: Collection of scientific papers of the XXIII International scientific conference, 12(32), 56-61.

[10] Lupenko S, Orobchuk O, Pomazkina T, Mingtang X (2017) Conceptual, formal and software-information fundamentals of ontological modeling of Chinese Image Medicine as an element of integrative medicine. Wor Sci, vol 1. doi: https://doi.org/10.31435/rsglobal_ws.