The approach to automation of designing knowledge base in the device-making industry

O.V. Bisikalo

Ph. D. in Technical Sciences, Associate Professor, Vinnytsia State Agricultural University
inter@vsau.org

Abstract

The development of the expert system knowledge base in the device-making industry by means of using the hierarchic linear structures is highlighted in the article. A formal model of the interaction of prolonged and associative memory within the figurative thinking is suggested as architectural solution through the introduction of the tribasic algebraic system.

Introduction

Efficient management of the modern device-making production requires both the adoption of advanced technological methods and up-date information support of the whole production cycle [0]. The development and application of expert systems (ES) are considered to be long-term means of decision-making support in the management practice. However, the level of the ES adoption in the device-making industry is evidently lower than in other branches of industry. Firstly, it is connected with dynamic structure of the production and quick replacement in produce variety. As a result it is also interrelated with high labour intensity and cost price of producing appropriate ES [0]. Possible way for solving the above-mentioned issue could be found in the development of such architecture of the ES knowledge base that provides an opportunity for the system to improve itself through specialized materials of free dissemination including those available in the Internet.

Research on the improvement of educational space structure by means of identification of concepts or knowledge atoms is aimed at the development of context-orientated hyper-space and context-orientated navigation [0]. For instance, a statistic approach is used in outlining automatically some basic notions out of educational material and estimating the value of each of them according to the criteria of their utilization amount. One is able to evaluate the level of knowledge obtained through the determination of a rang of basic notions adopted [0]. Nevertheless, the statistic approach has got some linguistic difficulties in the Slavonic languages but on the other hand, the amount of utilization does not always correspond to the expert evaluation of importance of this or that notion in the context of the whole subject-matter. Nowadays a concept "common sense" has not been widely presented in the ES knowledge base yet. It evidently reduces the efficacy of natural linguistic dialogue between a user and expert system.

The application of knowledge base as a semantic frame network modelling the mechanism of the interaction of neuron ensembles and human pyramid neurons are considered the most universal method of developing architecture of context-orientated hyper-space [0]. Since associative-projective structures are similar to the human knowledge base it will be logically grounded to develop a general architecture of the ES in the above-mentioned way. It has been proved experimentally that the understanding of a phrase is provided by direct event communication. One may consider the theme and new idea of a text as a semantic core [0]. In addition, one must bear in mind the appearance of the human conditioned reflex on important words (terms of subject-matter) in the ES knowledge base. Ii is shown in [0] that a set of tasks formally outlined can be presented as succession of known models and algorithms of processing hierarchic structures within functional programming. Hence, it appears necessary to consider the task of formal designing of the ES knowledge base and ensuring its automated up-grading through text material, which highlight modern ideas of experts of the subject-matter area.

Formalization

In order to solve the objective one may use the following algebraic system:

$$Algebra = \langle B; \Omega \rangle, \qquad (1)$$

including the following

$$\text{bases } B = \{Image, Role, Long\_mem\} \qquad (2)$$

and operators $\qquad \Omega = \{IF, OP\}$. $\qquad (3)$

Bases B are defined by expert-developers at the initial stage of designing of the ES knowledge base. The bases consist of the glossary (list of terms) Image and specialized material Long_mem demonstrated in the form of a framed list. Major terms of the subject-matter are included to Image glossary in the first place. Long_mem frames being models of the long-term human memory are formal reflections of syntagmas (sentences) which constitute a text. Transformation of a linguistic sentence in the hierarchic list is provided with the help of concepts word-term that is can be seen in the following formula:

$$Image = \{OQ, O, N, M, MQ\}, \qquad (4)$$

where OQ – object quality; O – object; N – notion; M – method; MQ – method quality. Having the following

$$O = \{Ob, Su\}, \qquad (5)$$

$$OQ = \{ObQ, SuQ\}, \qquad (6)$$

$$M = \{Wh, T, H\}, \qquad (7)$$

where Ob – action object; Su – action subject; ObQ – object quality; SuQ – subject quality; Wh – adverbial modifier of place; T – adverbial modifier of time; H – adverbial modifier of manner, one can present a syntagma as list element Long_mem in the form of the following tree (Figure1):
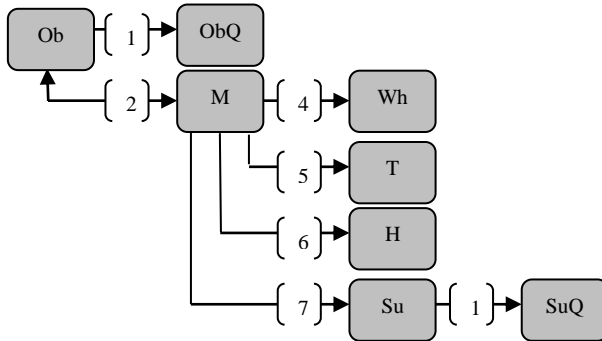

Figure 1. Tree graph of word-term interchange within syntagma.

Relations between terms in the syntagma shown in Figure 1 represent a possible role of a word in a sentence which is as follows:

$$Role = \{1,2,3,4,5,6,7\}, \qquad (8)$$

where 1 – attribute; 2 – predicate; 3 – subject; 4 – adverbial modifier of place; 5 – adverbial modifier of time; 6 – adverbial modifier of manner; 7 – object. Predicates IF and operations OP are included to operators Ω. They permit developing a semantic network Associative_mem out of known components of three bases aimed at accumulating information concerning associative relations between terms of the glossary. Formalization of a model of the human associative memory Associative_mem is provided through a listed presentation of complicated incidence matrix. Every image out of Image has got correspondent sorting on the decreased list of associated images in the form of sub lists of syntagmas from Long_mem, having the given interrelation among images. Operations which ensure the upgrading of the Es knowledge base due to the external frames are as follows:

$$OP = \left\{ \begin{array}{l} Convolution, Add\_event, Deconvolution, \\ Add\_image, Add\_association, \\ Force\_association, Union\_images \end{array} \right\}, \quad (9)$$

where Convolution – recording of specialized text of the subject-matter in the form of non-linear list Long_mem; Add_event – addition of information from syntagma to semantic network Associative_mem; Deconvolution – extension of formalized syntagma through verbal concepts Image; Add_image – addition of new image to list Image; Add_association – addition of new association to semantic network Associative_mem; Force_association – enhancement of existing association within semantic network Associative_mem; Union_images – synonym unity of two images.

Conclusion

Algebra (1÷9) provides an opportunity to build architecture of the ES knowledge base modeling the interaction of the long-term and associative human memory. If expert-developers of the ES knowledge base preliminary define the structure of the glossary in the device-making industry for instance, then the use of algebra (1÷9) ensures accumulation of associative relations both in semantic network of the glossary and within some frames of specialized direction. Unlike the practice of glossary development in the form of static hyper-space, the approach suggested allows automated upgrading of the ES by means of specialized text materials of free dissemination. Polymorphism of operating part concerning elements of list Image irrespective to the source of their origin is considered to be a peculiarity of the approach proposed. All these provide the grounds for incorporating to semantic network Associative_mem not only specialized terminology but notions expressing "common sense" concept.

References

[1] O.V. Bisikalo. *The Development of Analytic-Initiative Model and Method of Evaluating the Efficacy of Managing the Device-Making Production. Author's Abstract to obtain the Scientific Degree of the Candidate of Technical Sciences (Ph. D. in Technical Sciences).* Vinnytsia, 1995. – 23 p.

[2] V.V. Iliyn, O.V. Bisikalo, V.M. Tepliuk. *Didactic and Technological Requirements to Program-Casing for the Development and Use of Electronic Textbooks.* Kyiv, "Agrarna osvita" 2004, 20 p.

[3] F. T. Tschang and T. Della Senta (eds.): *Access to Knowledge: New Information Technologies and the Emergence of the Virtual University.* Amsterdam: Elsevier Science and International Association of Universities, 2001, 167-206.

[4] B.M. Arsentyev, A.K. Duka, O. E. Kovalenko, V.M. Chernyshov. *Training in Computer Technologies.* // Patent of Ukraine, № 71707, G09B5/04, 15.12.2004, Bulletin №12, 2004.

[5] N.M. Amosov, E.M. Kussul, A.M. Kasatkin, L.M. Kasatkina. *Stochastic Neuron-Like Networks with Ensemble Organization.* Kyiv, 1989. – 30 p. – (Preprint/Academy of Sciences of Ukraine. Institute of Cybernetics named after V.M. Glushkov; 89 – 25)

[6] A.R. Luriya. *Language and Consciousness.* Under the redaction of E.D. Khomskaya. Moscow. Moscow University Publishing House, 1979. – 320 p.

[7] O.V. Bisikalo. Designing of Processes of Distance Education on the Basis of Formalization of the Human Cognitive Activities. // *Information Technologies and Computer Engineering*. - 2005. № 3 – 274-280 pp.