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THE MULTI-LAYER HYPERMEDIA MODEL FOR INVENTIVE PROBLEM SOLVING AND ITS APPLICATION

Ph.D. thesis

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Inventive engineering problem solving

The tools of inventive engineering problem solving help creating new engineering systems and further developing existing realizations. The uniform and algorithmic handling of these tools is very important in the fields of electrical engineering where research and development requires multidisciplinary knowledge. Inventive development supporting computer systems help engineers to solve technical problems.

This research field is rather new in Hungary and has fragmented literature in the world so first I had to arrange the literature in detail. My purpose was to determine the requirements that are necessary for an engineering problem solving support knowledge-handling system.

After that, I concluded that a composition system of hypertext and semantic network is suitable for achieving these requirements. Hypertext is a new way for text and content representation and displays knowledge elements uniformly. In a semantic network the connections between knowledge elements are represented. Hypertext structure is a suitable tool for receiving existing knowledge and also for constructing new knowledge so it can be applied in every steps of the problem solving process to represent problem solving knowledge. Existing hipertext systems do not fulfil all the requirements so a new hypertext model is required for problem solving support systems.

THESIS 1

I determined the requirements that are necessary for an inventive engineering problem solving support knowledge-handling system. I concluded that a composition system of hypertext and semantic network is suitable for achieving these requirements. Existing hypertext systems do not fulfill all the requirements so a new hypertext model is required.

The multi-layer hypertext model

I created the new multi-layer hypertext model. This model fulfils all the requirements that I determined. The basis of the model is that every kind of knowledge handled and created by the user is included in the hypertext system and all knowledge elements are handled uniformly with so-called layers. With using layers, knowledge represented in the hypertext system become more well-arranged, more flexible and can be used easier. Knowledge types allow us to use typed links and nodes and to implement different hypertext views. Hypertext materials from diverse sources can be built into the knowledge handling system easily with new hypertext layers. The model does not give any restriction to store hypertext elements so its implementation can be made with any kind of system-oriented hypertext basis.

The multi-layer hypertext model gives the possibility to process the stored knowledge by computers. Processes are based on the types of the connections and the attributes of the hypertext objects. With these processes, we can implement and support a set of problem solving techniques.

THESIS 2

I created a new multi-layer hypertext model with the following features:

1. every kind of knowledge (information, structure and modification) handled and created by the user is included in the hypertext.
2. hypertext becomes more perspicuous, flexible and treatable by using layers.
3. hypertext structures, levels and views are based on knowledge types.

Application of the model

I realized the multi-layer hypertext model to create and use electronic textbooks. I created a frame system to handle the textbooks and produced several special didactic hypertext layers. These layers integrate the activities of the bookmaker and the reader. Every layer consists of a set of hypertext nodes and links and produces new functionality in the system. Separated layers contain the hypertext pages, the navigational tools created by the bookmaker, the tools of the reader and the personal knowledge of the reader. I widened the model with didactic layers that ensure that the reader perceives the interconnections in the topic and organize it actively.

I implemented the model under the name of MINERVA. Minerva can be a part of a software system that supports the whole problem solving process. This part supports receiving external knowledge and integrating it into personal knowledge of the engineer. Minerva system based on the multi-layer model was used at several distance-learning institutions successfully.

THESIS 3

I implemented the multi-layer hypertext model to create and use electronic textbooks. During implementation I produced several special didactic layers.

List of publications

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[2] L. Farkas, "Multimédia oktatási keretrendszer" in Végzős konferencia '97, ed. T. Tron, Technical University of Budapest, 1997, pp. 125-130. (in Hungarian)

[3] I. Vajda, L. Farkas and Z. Vig, "The Multimedia Challenge in Engineering Education" in Proc. of Humanities and Arts in a Balanced Engineering Education, ed. J. Szpytko, Oficyna Cracovia, 1997, pp. 231-243.

[4] L. Farkas, "Visualization of Heat Distribution in Superconductors" in Proc. of 5th Japan-Hungary Joint Seminar on Applied Electromagnetics in Materials and Computational Technology, ed. H. Tsuboi and I. Vajda, Technical University of Budapest, 1998, pp. 125-128.

[5] L. Farkas, "A hipermédia jelene és jövője az oktatásban, I. rész" in Elektrotechnika, vol. 10, 1998, pp. 376-378. (in Hungarian)

[6] L. Farkas, " A hipermédia jelene és jövője az oktatásban, II. rész" in Elektrotechnika, vol. 11, 1998, pp. 419-421. (in Hungarian)

[7] L. Farkas, "Hypermedia Tools for Investigating Superconductivity" in Proc. of 3rd Japan-Central Europe Joint Workshop on Modelling and Simulation of Non-linear Engineering Systems and Related Phenomena, ed. M. Mahel, M. Uesaka and E. Usak, Comenius University, 1998, pp. 165-168.

[8] L. Farkas and I. Vajda, "Scientific Problems and Scientific Solutions to Hypermedia Engineering", Czasopiosmo Techniczne ser. Elektrotechnika, vol. 4-E/1998, 1998, pp. 46-52.

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[10] L. Farkas, "Hipermédia az oktatásban: egy lehetséges megoldás" in Elektrotechnika, vol. 6, 2000, pp. 265-267. (in Hungarian)

[11] L. Farkas and I. Vajda, "Problem Solving Support by the Multi-Layer Hypermedia Model" in Periodica Politechnica (accepted)

[12] L. Farkas, "Approaching the HTS Power Applications by Advanced Engineering Problem Solving Methods" in Energy and Information in Non-linear Systems, Proceedings of the 4th Japan-Central Europe Joint Workshop on Energy and Information in Non-linear Systems, ed. A. Gottwald, CSAEM, 2001, pp. 222-225.

[13] I. Vajda and L. Farkas, "Computer Aided Problem Solving in Power Engineering Education" in Proceedings of Tomorrow's Education in Electrical Technologies: Revisited Methods and Tools for Renewed Motivation, EPE Association, 2001, pp. II-61-69.