EasyChair Preprint

№ 4853

The Use of Hybrid Knowledge Bases in Designing Engineering Systems

Valery Khranilov, Pavel Misevich and Elena Pankratova

January 3, 2021

The Use of Hybrid Knowledge Bases in Designing Engineering Systems

Khranilov V.P.
Nizhny Novgorod State Technical University
Nizhny Novgorod,
Russian Federation
hranilov@nntu.ru

Misevich P.V.
Nizhny Novgorod State Technical University
Nizhny Novgorod,
Russian Federation
p_misevich@mail.ru

Pankratova E.N.
Nizhny Novgorod State Technical University
Nizhny Novgorod,
Russian Federation
pen_nntu@mail.ru

Abstract — Frame networks (as tools of the situational approach) are used to draw up technical specifications, the conceptual design of systems and to describe the subject area. In the paper the authors describe modifications of frame models for solving applied tasks. New classes of software system generate new requirements, and researchers must develop and modify conceptual models and instrumental systems for building software. The authors focus on frame models and describe new classes of frames. They are the multimedia frame and the frames with procedures of fuzzy logic. The authors describe instrumental systems and stages of designing software using frame models.

Key words - frame networks, conceptual models, multimedia frame, frame models, fuzzy logic, develop, software.

I. INTRODUCTION

The Artificial Intelligence models are used in designing technical systems to improve their consumer properties during the life cycle. The system inherits the properties of the base knowledge model which is used for developing the information support of artificial intellect system.. This is the reason for using knowledge base models to design and support various projects.

For example, semantic networks are actively used for designing open information systems [1-2]. Semantic networks are used for distributed automated systems and semantic modeling and structural synthesis of onboard electronics protection. The success of using semantic networks in these projects is based on the static property of this knowledge representation model.

Production systems are a classic tool for developing expert systems. The success of the production rule systems is based on the properties of additivity and locality of changes in the type of the knowledge base[3] .

Frame networks are used to descried the hierarchy of situations in the subject area [4]. The situational approach is being actively developed now. The fact determines the use of frame networks for monitoring systems, decision support systems and management support systems - situation centers and so on.

The use of different forms of knowledge representation has shown that each form has advantages and disadvantages. For example, if a designer uses a system of product rules for building information system he transfers the weakness of this mathematical apparatus to the project. They are the following:

- a logical rule system may contain conflicting elements;
- a production system may contain rules which are not used during the lifecycle;
- there are problems in describing the hierarchy of situations using logical rules.

The authors in the paper use the frame model to develop tools for projection software. The choice is based on the properties of frames. They are the following:

- the naturalness of situational descriptions for a human;
- the applicability of frames in building conceptual models of subject fields;
- the possibility to describe frame networks using specialized languages;
- the possibility of a graphic representation of frame networks ;
- the ability to build tools for automating the development of information and software systems using frame conceptual models. This opportunity was realized by Soviet scientists in the subject area of CAD [6];
- the possibility to realize all stages of system development using a single conceptual approach. This is quite a rare and useful property. As a rule, different approaches are used to implement different stages of information system development.

For example, in the database theory the methods of modeling entities, hierarchy of abstractions etc. are used for the concept design stage. The method of normal forms is used for the logical design of DB. The applications of the situational approach allow us to implement all stages of designing an information system using a single theoretical basis. The possibility to realize all the stages of system development using a single conceptual approach is the biggest advantage of the situational approach and frames.

The frame approach is machine-oriented. It has been used in designing software systems for a long time. The reason for that is the active development of the situational approach in management theory. The approach is used for developing of technical systems and in management. The technical systems are the following:

- situation management centers;
- systems for situation monitoring;
- decision support systems.

New classes of automated systems require the creation of tools that facilitate their design. These facts cause using the classical apparatus of describing the situations (frames). These tools also include mathematical models

for describing the implementation of operation scenarios and the interaction of subsystems in the automatic systems [6]. In the paper [6]. It is shown, that the process of the system operation is represented in the form of a dynamic system.

II. MULTIMEDIA FRAMES AND FRAMES WITH THE FUZZY LOGIC PROCEDURES

The development of graphic and multimedia systems required the modification of the classical representation of the frames [4]. Therefore, the authors in paper [7] suggested a new separate class of frames – multimedia frames. These are frames with multimedia objects: maps, charts, photos, presentations and videos.

The development of the frame approach using the new class of multimedia frames has opened up new opportunities in the conceptual model development in various subject areas. The tools transform the multimedia frame into a subsystem of a hardware and software complex. This subsystem corresponds to the situation in the subject area. The elements of this subsystem support the situation analysis and the procedures of solving tasks in our subject area.

The multimedia frame supports photos, presentations, videos, maps and diagrams for conceptual modeling. Developers use maps and diagrams to design the remote control and monitoring applications. The visualization of these images does not require sending the whole image via the network. The image is built with the use of a set of parameters. The set does not take up much memory. Thus, the software sends small data through the network. This fact allows us to develop the projects of remote control and monitoring using the cellular network 2-2,5 G.

The use of the multimedia frames has expanded the scope of the software building technology.

The developers of software and hardware systems are able to use the frame conceptual models for conceptual description of the subject areas with multimedia images.

It should be noted, that the stages of building software and hardware systems, which are described above, have not changed.

Thus, the technology of building hardware and software systems has developed. It allows us to develop the tools for automating the transition from the conceptual design stage to the programming stage of the subsystems.

Another branch of the frame approach development is based on the creation of hybrid knowledge bases. The frames contain the procedure (demons) which are supplemented by the procedures of fuzzy logic.

It makes possible to use the situational approach and frame network to build new classes of systems.

The systems for the situational monitoring [7-9] belong to this class. The monitoring tasks are solved under the conditions of changes in the external and internal environment. Thus, the classic types of frames must be supplemented with the frames of the fuzzy logic procedures.

We define a set of situations and their frame descriptions for the subject area of the remote control and monitoring systems. The results of the analysis are shown in table 1.

TABLE I. THE LIST OF TYPICAL TASKS

Table Column Head		
The typical tasks describing frame network elements	***The frame network class***	***The Design pattern of the frame.***
Selecting an element from the set of alternatives	The class is the interactive branching	The drop-down list, switch systems and similar systems are used for designing the program templates
The system displays messages for users	The class is the directive message	The forms and message boxes are used for designing the program templates
The implementation of computational procedures	The frame for displaying the numerical procedure progress	The computer libraries of subprograms and indicators are used for designing the program templates
Generation of the report in an EXCEL - file.	The class consists of multimedia frames	A specialized program code template is used for designing the program
Generation of the report in a Word - file.	The class consists of multimedia frames	The specialized program code template is used for designing the program
Sending the user a situational description using a cartographic multimedia image	The class consists of multimedia frames	The MapInfo system is used for designing the program
Sending the user a situational description using a photo	The class consists of multimedia frames	The photo library and web-technologies are used for designing the program
Sending the user a situational description using a video	The class consists of multimedia frames	The video library and web-technologies are used for designing the program
Sending the user a situational description using a presentation	The class consists of multimedia frames	The presentation library and web-technologies are used for designing the program

Sending the user a situational description using a hypertext with photos, videos and presentations	The class consists of multimedia frames	The web-technologies are used for designing the program

The frame programming tools are partially included in the instrumentation building programs VS.Net. If the tools are not included in Vs.Net, then programmers generate the tools.

III. Example

In the paper [8-9] are described examples of using fames with fuzzy logic procedures.

Let us consider the following the example of using the frame with fuzzy logic (Figure 4).

Using the fuzzy production rules, the Mamdani algorithm calculates the alarm level value for subframes in the frame model tree, which determines the order in which information is output from these subframes, as well as the choice of executing scenarios associated with these subframes by condition (for example, sending alerts).

The apparatus of fuzzy logic allows you to generate an alarm level (as the final value of calculations for the frame), depending on several factors (a set of monitoring parameters). At the same time, a human-oriented interface is used - verbal utterance rules for the formation of conditions for the presentation of information about the monitoring object.

This example ("CPU" subframe) describes the dependence of the processor alarm level indicator for a computer server on temperature, in combination with the server load and the cooling fan speed. The rule base may contain the following statements:

1) If the processor temperature is "medium" and the server load is "small" and the fan speed is "high", then the alarm level indicator is "high";

2) If the processor temperature is "high", then the alarm level indicator is "high";

3) If the processor temperature is "low", then the alarm level indicator is "low";

4) If the processor temperature is "medium" and the server load is "small" and the fan speed is "low", then the alarm level indicator is "low".

The situations hierarchy is described by a network of frames (Figure). The frames are programmed using the tools which are described in table 1. This approach reduces the developing software cost.

I. Conclusion

The frame approach is machine-oriented. The experience of its application allowed engineers to formulate a sequence of stages of developing software and hardware systems. They are the following:

Stage 1. The study of the subject area in order to determine the requirements for the designed system. At this stage, the situational approach is used to create a hierarchical description of the interrelated typical tasks in the subject area. The system is an important part of the technical specifications.

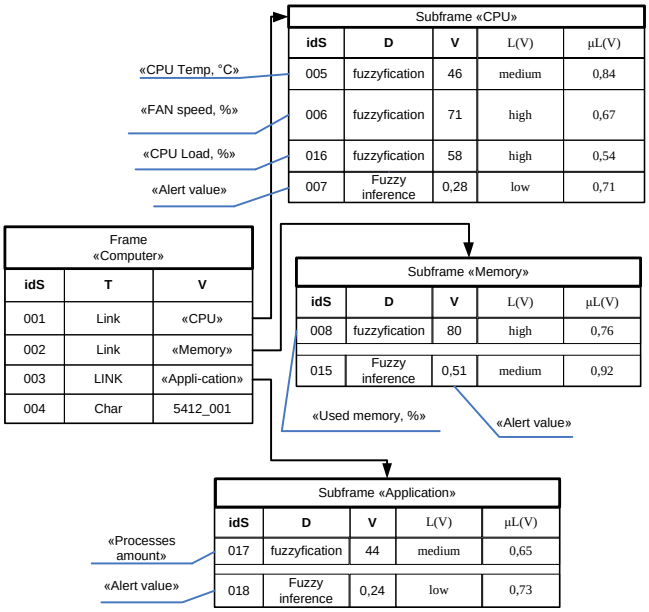

Figure 1

Stage 2. Conceptual design of the system. This step provides a detailed description of the system operation scenarios, the description of the situation in the external and internal environment of the automated system. The situations are described for a typical task, a typical scenario, and for each event. The network of the frames represents the system description.

Stage 3. Logical system design. At this stage, the elements of the frame network are displayed in the information and software of the system. Program designers separate the subsystems and carry out their testing.

Stage 4. Assembling and testing of the system. At this stage, developers integrate subsystems into a single hardware and software complex. The complex is tested.

The formulation of these four stages assists the design of situational systems. These stages are interrelated. The result of each design stage is the source data for the next one. This is a consequence of applying the unified situational approach for designing this type system.

II. Acknowledgment

The authors are grateful to our colleagues for their continued support and encouragement. They thank V.V. Kondratiev, V.G. Baranov, A.V. Miakinkov and D. V. D.V. Zhevnerchuk.

REFERENCES

[1] Zhevnerchuk, D.V. Semantic modeling of the program code generators for distributed automated systems / D.V.Zhevnerchuk, A.S.Zakharov, L.S.Lomakina, A.S.Surkova // IV International Research Conference Information Technologies in Science, Management, Social Sphere and Medicine. Advances in Computer Science Research (ACSR). –2017. – vol. 72. – P. 266-270.

[2] Zhevnerchuk, D.V. Semantic modeling and structural synthesis of onboard electronics protection means as open information system / D.V.Zhevnerchuk, A.S.Surkova, L.S.Lomakina, A.V.Golubev // Journal of Physics: Conference Series. – Volume 1015. – Issue 3. – article id. 032157 (2018). doi :10.1088/1742-6596/1015/3/032157

[3] Bessmertnyi, I. Nevidimov, A., Eliseev, S. About creating intelligence systems in ternary logic // Proc. of 4th Int'l Conf. on knowledge engineering and ontology development. – Barcelona: SciTePress. –2012. – P. 161-165]

[4] M. Minsky . A framework for representing knowledge . MIT AI Laboratory Memo 306, June, 1974.

[5] V. V. Semenov" Principles of formation and fragments of knowledge base for control automatic theory", General mathematical support of computer-aided design systems , Moscow, MAI, 1981.

[6] Khranilov, V. Identification operators of dynamic control models in the state space for engineering applications / V.Khranilov, V. Andreev, P.Misevich, E. Pankratova. //Samara, Russia, IEEE Xplore Digital Library,2019 XXI International Conference Complex Systems: Control and Modeling Problems (CSCMP), 3-6 Sept. 2019. https://ieeexplore.ieee.org/document/8976864 DOI: 10.1109/CSCMP45713.2019.8976864

[7] D. A.Belov, P. V. Misevich, V. P. Khranilov,"Using the mobile Internet in the problem-oriented monitoring system for the train movement", Automation in the industry, Moscow, 2009, pp. 49-51

[8] A.E Ermilov, P.V. Misevich "The development tools for monitoring systems using frame model and fuzzy logic",Control systems and information technologies, Voronezh, 2014, vol. 3, no. 57, pp..62-65.

[9] A.E. Ermilov. Monitoring systems development using situational approach and fuzzy logic. 2019 IOP Conf. Ser.: Mater. Sci. Eng. 695 012016