 Ontologies as a Technique of Knowledge Management in Open E-Learning Systems for Operators of Dynamic Processes

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Summary

In present article the problem of knowledge’s fields design ontology is considered. A decision of this problem is a necessary stage for creation of knowledge base at the Open E-learning systems. The problem is considered with reference to a class of intelligent E-learning systems, which are intended for operators of dynamic processes: pilots, navigators, operators of technological processes etc.

Keywords. Dynamic System, Knowledge, Knowledge Management, Ontology, E-Learning

1. Introduction

Last years are characterized by active development of works on creation of a different sort of simulators on the basis of information technologies and computer-based training systems (CBTS). The theory of intelligent computer systems of training is developing, opportunities and ways of creation of open systems of such assignment are investigating. Standards for systems of training (AICC, SCORM etc.) are developing and improve.

Among wide variety of categories and classes of E-learning systems special place are occupy systems of training of operators for various dynamic systems and processes (planes, ships, automobiles, underwater vehicles, technological processes etc.). Typical feature of such class E-learning systems is presence at a contour of training’s process of computer model of the appropriate dynamic process. Such model should to function in real time, and to display the behavior of real object (with a high degree of accuracy). Besides there is a necessity of representation of the information in the form most precisely describing real conditions (environment) of the operator functioning. For example, at tasks of pilot's training all working devices and controlling means on an instrument desk in the virtual cabin of the plane should be reproduced on the screen of the monitor.

Quality and accuracy of reproduction, i.e. quality of a virtual reality, should be so high, that at trainee there was an illusion of work with real object. Use of inexact computer models of dynamic processes and low quality of computer visualization (display of a reality), and also use of incomplete knowledge in the investigating area, inevitably can result by formation of wrong skills, i.e. to poor-quality preparation of operators of dynamic systems. Role of quality of the mathematical models used in training's systems of such class repeatedly was emphasized and discussed [5, 6, 7].

Hence, there are two major tasks in a problem of development of such class of E-learning systems. First, rather specific and very difficult task is a task of development of the appropriate methods of correction and verification of dynamic processes models and means of their visualization. Approaches to the solution of this task were submitted in [5, 7]. The second task is a
task of the description of ontology in area, for which the E-learning system is intended (for completeness of knowledge in area of control of dynamic processes, and also in area of a technique of realization of training’s process) [2, 3].

This considered class of E-learning systems (we shall name theirs as dynamic E-learning systems) fundamentally differs from the class of usual E-learning systems that can be named as static systems.

2. Structure of training dynamic system.

The structure of the training system may be done on the base of analysis of a usual logic of process of training, which consists in a sequence of the connected steps: "trainee's action => measuring the action => analysis => classification of mistakes => evaluation => advice and recommendations for the trainee => repeating the action => increasing of difficulties of the task => etc.". Such analysis of training's process allows representing it as the structure, which is shown on the fig 1.
Functions of each block are shown at their names in figure. It is impossible to clear up main and minor elements in this process, because the loss of any of them destroys the system.

The basic place in design of such systems take a development of knowledge base that ground on ontology of the appropriate fields of knowledge used at training.

3. Levels of Knowledge Representation

Levels of knowledge representation in the knowledge's base of training dynamic system correspond to hierarchy of ontology’s, which describe the area of training's process, in view of all features of this process - pedagogical and cognitive.

The concept of ontology’s into computer science by Thomas Gruber was entered [4]. Within the framework of categories of computer science ontology is a formal specification of the described area’s concepts, defined by means of knowledge representation language [3]. In other words, ontology determines the concepts used for the description and representation of concrete areas, and communications between them. The ontology is used in the knowledge's management, it allows to simplify process of the analysis of nonstructured and illstructured problems, allows to avoid occurrence of some contradictions and mistakes during design of knowledge’s bases.

In the field of creation of dynamic e-learning systems ontology includes:

- the ontology of areas for which the system of training is created,
- the ontology of techniques of training’s process, namely pedagogical and cognitive aspects of training, and also the ontology of the necessary supplements used in system of training of dynamic processes operators (for example, models of dynamic objects and processes).

Let’s consider formal model of ontology on an example of intelligent computer-based training system of civil aircraft’s pilots, which was developed within the International project of 5-th Framework Program of European Union - "ASIMIL" (Aer User-friendly Simulation Based Distance Learning) in which authors took part at 2000-2003 years [1].

The conceptual model of a field of knowledge is specified by a set:

\[ MA = \{TM, IM, LM\}, \]  

where:

- \( MA \) - model of area for which the system of training is created;
- \( TM \) - training model, i.e. model of dynamic system (process);
- \( IM \) - information model
- \( LM \) - model of training’s process.

In turn, ontology of areas „ the training model ” is determined by a set:

\[ TM = \{MFD, MPP, MLG\}, \]  

where:

- \( MFD \) - model of flight dynamics;
- \( MPP \) - model of engines (power-plant);
- \( MLG \) - model of landing gears.

Information model \( IM \) is represented as:

\[ IM = \{FC, ME, NS, VR\}, \]  

where:

- \( FC \) - characteristics of flight,
- \( ME \) - model of an environment,
- \( NS \) - characteristics of non-standard situations
- \( VR \) - visual representations of devices and elements of a cabin in process of virtual flight.

In turn, the model of training’s process \( LM \) is represented in the following kind:

\[ LM = \{FP, TSP, CI, PVI, OII\}, \]
where: \( \text{FP} \) - flight procedures,
\( \text{TSP} \) - a training of standard procedures;
\( \text{CI} \) - coordination of the instrumental and noninstrumental information;
\( \text{PV1} \) - proposals of the virtual instructor,
\( \text{OII} \) - operative intervention of the real instructor.

The similar way represents ontology at the subsequent hierarchical levels of representation of the information. For example, the model of flight dynamics \( \text{MFD} \) is represented as:

\[
\text{MFD} = \{\text{MSM, SD, LFP, PCM}\},
\]

where: \( \text{MSM} \) - models of separate modes of motion;
\( \text{SD} \) – signal’s disturbances;
\( \text{LFP} \) - limitation of flight’s parameters:
\( \text{PCM} \) - parameters of crisis modes.

Not considering further sequences of representation of ontologies within the scope of given article, we shall notice, that the methodological foundation for construction of metaontology and ontologies of training’s intelligent systems (irrespective of concrete area) is the structure submitted on fig. 2.

Fig. 2. The general structure of the automated training’s systems creation problem (on the base of [6])
This block diagram represents the general structure of a task of computer training’s systems creation [6, 7]. The basic complexity at creation of such systems consists in extreme heterogeneity of training’s technologies and used means. For successful use of such systems each component of training’s system should be carried out on identical high level.

Irrespective of area for which intend the computer dynamic training’s systems, they should provide simulation of standard and non-standard situations in a mode of real time. Their interface should be in accord with psychophysiological features of the person concerning perception and processing of the necessary information. And at last, the dynamic computer training's system should provide realization of the control and management functions of training's process. It concerns to tasks of pilot’s training, and to tasks of training of technological processes operators and to other subject domains. And at the same time distinctions in character of activity determine specificity of knowledge’s bases structures and a technique of application in various areas. Taking into account of such specificity of knowledge’s fields plays a paramount role at creation of e-learning systems.

4. Conclusion

In this article some tasks of design of intelligent e-learning systems for training of dynamic system’s operators are considered. Is shown, that the major place takes up problems (tasks) of knowledge engineering and knowledge management. Their decision demands laborious work on description of ontologies in all areas touched by intellectual system of training.

Authors knowingly did not concern some aspects at the ontologies description, namely formulations of definitions for the concepts represented in ontologies, and also representation of communications between these concepts as these tasks at elaboration of intelligent dynamic systems of training have especially subject character.

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