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The Role of Virtual Educational Spaces in Higher Education

Yusuf Shodievich Avazov
Doctor of Technical Sciences, Professor of the Department of Automation of Production Processes, Tashkent State Technical University, Tashkent, Uzbekistan

Kamola Rustamovna Abdullaeva
Senior Lecturer, Department of Automation of Production Processes, Tashkent State Technical University, Tashkent, Uzbekistan

Abstract:

Today, the virtual educational space is becoming a means of ensuring the operation of the electronic education system with the Internet. The virtual educational form of teaching organization in higher education institutions is stimulating the development of an intellectual educational environment. Together, the Internet of Things (IoT) and Semantic Web technologies enable virtual learning to integrate with real-world processes. The article analyzes the role and tasks of the virtual educational space in the higher education system, the advantages and disadvantages of its organizers. Levels of virtual learning space explained. Information on standard technologies for building a virtual learning space is provided. Also, the importance of the level of intellectualization in the organization of the virtual educational space is highlighted. The role of agents and their influence in the intellectualization of the virtual educational space is described.

Keywords: virtual education, educational environment, internet of things (IoT), intelligent agent.

Introduction

The Virtual Educational Space (VES) is usually built as a successor to the DeLC (Distributed eLearning Center) e-learning environment, providing e-learning content and e-learning services for planning, organizing and conducting the educational process at the university. Some features of the environment are as follows:

- internationally recognized standards are supported for the two most important for activities in the educational process - SCORM 2004 for self-study and QTI 2.1 - for electronic testing of students;
- a specialized educational portal provides access to information about environmental resources;
- a specialized educational portal provides access to information about environmental resources;
- offers affordable infrastructure and supporting middleware for mobile applications.

DeLC being a successful project on the use of information and communication technologies in education, DeLC has significant drawbacks, one of which is the lack of close and natural integration of the virtual environment by systems with the physical world in which the real learning process takes place. The Internet of Things (IoT) and the Semantic Web, two new technologies in the Internet space, can help address this critical DeLC shortcoming. In addition, these technologies can contribute to an increase in the degree of intelligence of the environment. Thus was born the idea of transforming the DeLC environment into a new infrastructure called Virtual Educational Space (VES).

Based on the development of initial ideas, over time, a general concept has been formed that provides, on the one hand, to continue to develop and improve the virtual educational space as an intelligent e-learning environment, and on the other hand, to be built as an experimental environment for solutions and implementation of prototypes related to control - in the form of developing complex intelligent systems, primarily in the field of IoT and robotics. To support learning, two forms of e-learning will primarily be developed – blended learning and lifelong learning.

[1-4] articles examine the issues of training specialists in higher education through virtual education and the use of virtual educational space in it.

Let us turn to the current state of the virtual educational space and summarize the main problems and challenges associated with the future of the virtual space.

The current state of the problem of virtual educational space.

In accordance with the basic principles of the organization of the Internet of things (IoT) [5], the virtual educational space is built as an ecosystem built on the following three logical (conditional) levels:

- Level of access to space resources;
- Operational and analytical level;
- Touch level.

Level of access. Access to information resources and services of the educational space is mainly carried out through assistants (personal assistants - PA). An additional opportunity is provided by the specialized educational portal DeLC 2.0.

Personal assistants. The main goal of the PA is to support students and teachers in their work. They work as a kind of personalized entry point to the VES. When registering, users are provided with their own PA. To do this, a genetic PA is supported, which, interacting with the educational portal and the registration module, forms a PA specific to this particular user. Personal assistants are designed as rational agents. In the current version of the VES, a prototype of the PA for students was created, called LISSA, in which a simplified interface is integrated with the ability to understand and generate phrases in natural language [6].

Educational portal DeLC 2.0. The current version of the educational portal supports two forms of e-learning - blended learning and lifelong learning. More than 20 electronic lecture courses, curriculum for two academic disciplines – “Internet of Things” and “Cognitive Robotics” are intended for the mixed form of education. Testing of students is carried out through an electronic testing system.

Information resources for lifelong learning in four areas:

- Cognitive Robotics - a resource developed on the basis of a university course in accordance with the characteristics of lifelong learning;
- rules of the road - the choice of this topic is motivated by the fact that not enough hours are allocated to this problem in the curricula. The goal is to learn the rules of the road in a creative way in a realistic environment. From a research point of view, it is of interest to create intelligent agent-based environments for game learning.
- cultural and historical heritage - development of electronic content and means of presenting the country's cultural and historical heritage.

Study of the possibilities of semantic modeling (ontologies) for intelligent search and delivery of educational content in the virtual space. Two forms of providing electronic content are provided - in the form of dynamically generated context-dependent and personalized cultural and historical guides:

- language training - a project that provides interesting opportunities. Two forms of support are being considered. The first one combines language with game learning. The second is language training, specializing in the terminology of such areas as, for example, software technologies, artificial intelligence, robotics, the Internet of things, mechatronics

Operational and analytical level. This level is extremely important for the "degree of intelligence" of the virtual space, since it contains full sensory information that allows you to implement decision-making models related to working in a virtual educational space [7]. There are two models involved in the current version:

- student book - solutions to improve student achievement;
- magazine teachers - solutions to support the student book textbook (assessment papers) and improve the efficiency of teaching activities.

Sensory level. The main function of the sensory level is the collection, registration, transformation and transmission of data necessary for the operation and management of virtual space. In general, VES supports three types of sensors - virtual, physical and logical. Physical sensory information is received and pre-processed by space means. The physical world is a set of physical sensors.

Unlike physical sensors, virtual transducers are abstractions. Typical data sources for virtual sensors in space are:

- SCORM 2004 Engine - sensory information for self-learning;
- QTI 2.1. Engine - sensory information for testing students;
- Event Engine - sensory information about events occurring in the system.

Logical sensors are a combination of the two data source types represented.

The role of the so-called logical protection (LP) is extremely important, the task of which is to collect raw (primary) data from individual or groups of physical sensors. This data can be initially processed, transformed and transported to other components of the educational space.

Modeling the virtual space

The IoT is evolving as a complex ecosystem of different types of intelligent components that are complexly interconnected and difficult to manage and synchronize. Using models to analyze the architecture and behavior of prototypes is essential to the success of a project. Virtual space modeling experiments are carried out using Calculus of Context-aware Ambients (CCA), a context-aware environment, which is a formal system that provides appropriate mathematical notation and tools for modeling mobile and context-aware systems [8]. Separate elements, CCA – environments are presented as an environment (from ambient - surrounding).

VES technologies. What is the unified technological development environment for the software and hardware implementation of the project? The hardware and software system is a very complex system that uses various types of software and hardware components. Supporting efficient development requires a single, integrated technology that provides:

- homogeneity - if possible, a single software base and execution environment;

- connectivity - the ability to use appropriate interfaces, protocols and standards to ensure the interaction of various types of software and hardware components.

Table 1 summarizes the technologies used for the current prototype implementation of the individual layers and their components. Grails (Groovy) interfaces - JADE and HTML5/JavaScript-JADE are proprietary.

Table 1. Standard technologies for building a virtual educational space

Level	***Component***	***Technology***
Access		
	Educational portal	Grails, Groovy, Grails (Groovy)-JADE
	Personal assistant	Jadex, JADE, LADE-LEAP, Android Studio, WS-*, RESTful-services
Analytical Level		
	Student ID	Jadex, JADE, WS-*, RESTful-services
	Teacher's Journal	Jadex, JADE, WS-*, RESTful-services
	Ontology	Protege VES 2
	Educational games	HTML5, JavaScript, HTML5/JavaScript-JADE
Sensory level		
	Protections	OSGi, JADE-OSGi
Modeling		EC (event calculus), ITL (interval timing logic), CCA (context-sensitive calculus)

The problems accompanying the construction of a virtual educational space are primarily related to ensuring the required degree of its intellectuality.

Building a single integrated technology. The integrated technology provides opportunities and means for syntactic and communicative interaction between different types of components used in the virtual space and located at different architectural levels. The basis of the integrated technology is the standard Java technologies presented in the table in Table 1. The main components of the space are agents implemented as intelligent agents - autonomous programs with a relatively complex internal architecture [9]. The agent itself is a software component that works with regard to the dynamics of the environment. Services are a good solution for implementing functionality, but they are static, not active, and cannot be standalone components in a virtual space. For this reason, agents include appropriate interfaces with respect to their internal architecture. Thus, the virtual space is an e-learning ecosystem open to expansion through new educational services. In addition, agents must be able to communicate with the physical world. For this purpose, the corresponding interfaces in the form of an agent-sensor are used.

Ensuring full interoperability in VES. The integrated technology provides the core interoperability of the VES, but it is not sufficient to provide the conditions for intelligent interoperability. It is necessary to supplement it with approaches, methods and means that support the semantic aspects of interaction. Such approaches are:

- agent-oriented approach – a powerful approach to the development of autonomous intelligent software components with a mentality, including the ACL interaction language;

- use of e-learning standards SCORM 2004 and QTI 2.1. to specify a structure (for example, LOM) with unambiguous syntax and semantics, which allows unifying the interpretation by different types of space components;
- semantic modeling is an essential aspect of intelligence, referring to the degree of formalization and automated interpretation of the data used. The agent – based approach and the use of standards solve this problem partially and to a limited extent. Additionally, semantic information modeling is used (in the form of ontologies);
- a single unified event model.

Proactive and self-learning agents. Mandatory requirement to ensure satisfactory intelligence of the VES. In this case, "intelligence" refers to agents that display context-informed reactive, proactive and social behavior, depending on the state of the virtual educational space. In this sense, it is extremely important to implement different approaches and theoretical models. The problem is to conduct research and experiments on the creation of specific, suitable for the purposes of this VES models, for example, a genetic model is possible that is common to all or groups of agents or for each individual intelligent agent.

Conclusion

Summarizing, we can conclude that in the future it is possible to use space in the following directions:

- e-learning – strengthening and expanding support for blended learning and lifelong learning. The introduction of two new themes in both forms is essential – "Internet of Things" and "Robotics";
- scientific experiments - an environment for finding intelligent solutions, developing and experimenting with prototypes of complex IoT and robotic applications;
- virtual teamwork – the space should provide an opportunity for collaborative research work for physically separated teams.

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