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Creation of third generation e-learning systems using telepresence robot and specialized visual programming language

This paper describes approaches to the creation of third generation electronic learning systems and practical steps for their implementation, taking into account trends in Internet technologies, robotics and mobile computing platforms.

INTRODUCTION

E-learning systems as one of the important elements of the educational process can augment the quality of education. Web technology development products including content management systems, all have characteristic features and require the skills in the creation and maintenance of web-based training material. These electronic teaching systems offer real advantages[1] which has resulted in their widespread use in the educational process at all levels, however new solutions are required to reduce or eliminate some of their shortcomings.

EXAMPLES OF E-LEARNING SYSTEMS

The main limitations of the existing second generation e-learning systems or e-learning 2.0[2], can be reflected upon using the example of the Moodle system,

[1] A. Nagy, *The Impact of E-Learning*, in: P.A. Bruck, A. Buchholz, Z. Karssen, A. Zerfass (Eds), *E-Content: Technologies and Perspectives for the European Market. Berlin*: Springer-Verlag, 2005, pp. 79–96.

[2] B.E. Crane, *Using Web 2.0 Tools in the k-12 Classroom*, Neal-Shuman Publishers Inc., 2009, p. 3.

which is, de facto, the standard in this field. The majority of similar systems have the following typical features:

1. an interface structure that is focused on "classic" Web browsers for desktop computers,
2. an educational process that requires particular teacher's skills such as, a basic knowledge of web-design, HTML etc,
3. limited contact with the audience or time delay.

There are a number of ways now available to solve the first task i.e. the support for a wide range of mobile and tablet platforms. It is possible to use individual web interfaces or templates depending on the client's platform, especially with the Moodle system and a gradual transition from Flash and SCORM to HTML5 and Tin Can API is probable[3].

The main problem with the second task is the need to train the instructor – an expert in his own field – to acquire basic knowledge about web development and design for e-learning management systems (LMS) which have resulted through the evolution of systems supporting websites (CMS) with modular organization patterns and plug-ins like Adobe Flash.

To expand the functionality and improve both the web interface and the server side of e-learning systems, we propose using specialized interpreted visual programming language[4], which is executed inside the web browser and which is integrated directly into both the teacher's and administrator's web interface.

The third task i.e. limited contact with the audience through the web interface, can also be described as the distance between the audience and the teacher. The very possibility of remotely conducting educational activities is one of the key advantages of electronic education, but the web interface facilities are limited. One of the solutions is to use video conference e.g. Skype or Open Meeting, during a remote session, but the question of feedback still remains. In order to ensure the effect of maximum presence we suggest using a robotic system of remote presence, or as it is called – the robot telepresence[5].

The uniqueness of the proposed telepresence system, unlike the existing analogues are:

1. Integration with an e-learning system, with the ability to control the robot via Internet by teacher or administrator using web interface with audio and video streaming.

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[3] *SCORM – Project Tin Can: Phase 3 – Capabilities*, SCORM – Project Tin Can: Phase 3 – Capabilities. Rustici Sofftware. Retrieved 27, August 2012, http://scorm.com/tincancapabilities.

[4] M. Matviychuk, R. Hasko, Ya. Hasko, *Intertpreted algorithmic language as the tool for extention of web-oriented e-learning and informations systems* // Bulletin of Lviv Polytechnic National University "Computer Sciences and Information Technology" 694, 2011.

[5] Markoff J., *The Boss Is Robotic, and Rolling Up Behind You*, The New York Times September 4, 2010.

2. Elements of autonomous behaviour, control of the robot environment to prevent emergencies. For example, the robot independently controls barriers, looks for the free paths, builds a map of the room with possible gradual refinement
3. The use of visual programming language which allows the teacher to set the robot's route through the web interface at a certain time period and not be distracted from the actual learning process.

THE STRUCTURE OF E-LEARNING 3.0 SYSTEM

The set of proposed solutions allows for the building of a third generation e-learning system (e-learning 3.0) (Fig. 1). To create a prototype of the remote presence (Telepresence) robot, a robotic complex MINDSTORM 2.0[6] was used as the mobile platform and a tablet computer running Android OS was employed to provide bilateral video communication, to control commands transfer from teacher's web interface via the e-learning system.

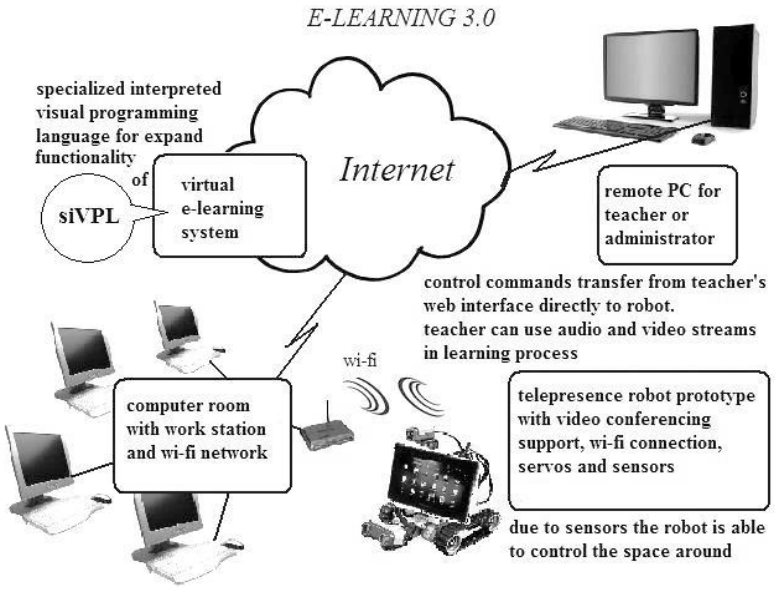

Fig. 1. Structure of the third generation e-learning system

Source: authors' conception and drawing.

[6] Gindling J., Ioannidou A., Loh J., Lokkebo O., Repenning A., *LEGOsheets: A Rule-Based Programming, Simulation and Manipulation Environment for the LEGO Programmable Brick*, Proceeding of Visual Languages, Darmstadt, Germany, IEEE Computer Society Press, 1995, pp. 172–179.

Thanks to ultrasound and light sensors, directed forward at an angle, the robot is able to monitor the space in front of itself. In case of interference, such as the end of the horizontal surface or a vertical wall, the robot stops and turns while trying to find – through the aid of sensors – a reliable path. Corresponding current information and each new "step" by the robot is displayed on the teacher's web browser for possible intervention and correction, if necessary. The telepresence robot prototype is shown in Fig. 2.

Two servomotors are employed to ensure horizontal movements and rotations. The third servomotor is used for vertical tilting of the webcam with a tablet computer. Two rear touch sensors with extended ends are used for additional control. Servomotors, sensors, surface control etc. are controlled by a separate mini-computer NXT, which is a part of the MINDSTORMS 2.0 system.

POSSIBLE APPLICATION OF E-LEARNING SYSTEMS

It should be noted that the possibility of using of this project as a comprehensive theoretical and practical training for IT specialists combines the study of web technologies, programming for mobile OS[7] and robotics with practical experience.

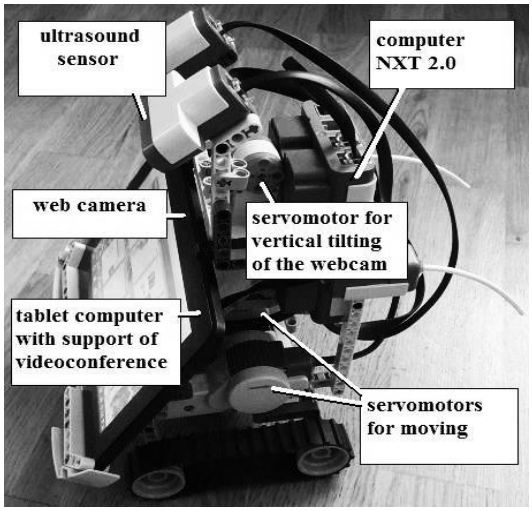

Fig. 2. Telepresence robot prototype

Source: photo made by the authors from the prototype created.

[7] McClure W.B., *Nathan Blevins. Professional Android Programming with Mono for Android and .NET/C#*, Wrox, 2012, pp. 552.

This project is a part of a special course taught in the students' scientific and academic laboratories. The main server platform is an open source e-learning system, i.e. Moodle 2.0.

The objectives of this project is to formulate the concept of a new generation of e-learning systems, first-rate means of improve learning, prototyping telepresence robots for virtual teacher's control of the educational process. The proposed approach is not limited to e-learning systems, it can be successfully applied in the systems support of a new generation of videoconferences and other web-based e-business systems due to the capabilities of telepresence robot and visual programming language.

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Summary

The article describes the typical drawbacks of existing e-learning systems based on Web 2.0 and proposes the basic structure for a new solution. The key feature is a telepresence robot with elements of autonomous behaviour controlled via a web-interface. The second feature is the use of built-in visual programming language to empower both the learning process and the autonomy of the telepresence robot. A working prototype of the proposed e-learning system with telepresence robot based on MINDSTORMS, Android powered tablet PC for video and MOODLE-based server side was developed.

Tworzenie systemów e-learningowych trzeciej generacji przy użyciu robota telepresence i specjalistycznego języka programowania wizualnego

Streszczenie

W artykule przedstawiono typowe wady istniejących systemów e-learningowych opartych na Web 2.0 oraz zaproponowano podstawową strukturę ich nowej generacji. Kluczowym elementem tego rozwiązania jest robot telepresence sterowany za pomocą interfejsu WWW z elementami autonomicznego zachowania. Drugą ważną cechą jest wbudowany wizualny język programowania (VPL) pozwalający na wzmocnienie zarówno procesu uczenia się, jak i autonomii robota telepresence. Wykorzystano system oparty na MINDSTORMS, tablet PC działający pod systemem Android do wideokonferencji i serwer MOODLE do konstrukcji działającego prototypu zaproponowanego systemu e-learningowego z robotem telepresence.