A Team of Pedagogical Agents in Multimedia Environment for Children

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Abstract

This paper presents the multimedia product for teaching Natural Sciences to 10-12 years old children. In this product three pedagogical agents, Teacher and two pupils guide the learner through the virtual environment. The inclusion of a team of pedagogical agents permits us to create a micro-model of lesson activity and gives a reliable support of individual learner differences. The script-based approach is used for creating the rich multimedia content of this product. Scripting object-oriented language NML and authoring environment NATURA is described.

Keywords

Virtual learning environment, Pedagogical agents, Scripting language, Authoring environment

Introduction

The rapidly growing number of instructional multimedia software is accompanied by increasing research in new forms of multimedia presentation and interactivity.

One of the modern and progressive techniques in Human-Computer Interface design is the application of interface agents – on-screen animated characters. Interface agents enable computer interfaces to become more human or more "social" (Hermans, 1997). In educational software the interface agents have become for pupils not only the conductors in the new computer world but they have also started giving educational information fulfilling the functions of teachers (Nijholt, 2001).

This new form of educational programs is especially good for schoolchildren as it provides a high level of motivation and gives the possibility to realize active forms of training (Lester at al., 1997).

In this article we go through the multimedia educational system for the school course in Natural Sciences. The system was developed at Multimedia System Laboratory at Mari State Technical University. Three animated characters – Tatyana Mikhailovna, a teacher, and her two pupils, Masha and Petia, are setting off in a virtual travel to wonderful islands to study some basic physical and chemical concepts and phenomena. For realization of the multimedia educational product on Natural Sciences we worked out a special authority program environment called NATURA and the language NML for script writing. All these are described in Section 3.

Pedagogical agents in the virtual world of natural sciences

Appearance of animated human-like characters as the interface agents is the logical step in evolution of graphic user interfaces. It is caused by the fact that the use of the agent technology transforms human-machine interaction into a "face to face" dialogue, where an interface agent provides the information exchange (Huang, 1999).

Interface agents in educational environments are called the pedagogical agents. These agents usually have enough understanding of the educational context in order to be able to play certain roles in education scenario and interact with learners during the education course (Shaw, 1999).

Pedagogical agents are also used to create effective educational software for children. Besides the afore mentioned advantages of using the agents for providing learning materials to the kids, the application of animated human-like characters allows the creation of an educational environment similar to computer games. It helps to stimulate children's interest in utilizing such a program and therefore it can add motivational value to learning.

All these potential benefits associated with pedagogical agents were the reasons to include the animated characters in the concept of the multimedia software for teaching Natural Sciences to 10-12 years old children. The new form of multimedia presentation allows us to create an effective educational environment for learners to be able to grasp and retain some of the fundamental concepts of Physics and Chemistry.

When choosing the proper character for the role of the pedagogical agent, many factors are to be taken into account, including pedagogical functions of this agent, a target audience and an educational content of courseware (Moreno, 2000).

Presentation and explanations are considered to be the major functions of the pedagogical agent in this project. It is obvious that the agent acting alone as a Teacher would perfectly perform those functions. A traditional monologue lecture format however is not appropriate for pupils of primary school age who are mentally, socially and emotionally ready for much more vivid and lively forms of teaching. The transition to a learning environment with a team of pedagogical agents is more suitable in this instance.

For several centuries the teaching method has been known as the Socratic dialog. It is used for conversations between Teacher and Learners in order to discover the truth. The form of such dialogues has also been applied to explain complex concepts and theories. It was Giordano Bruno, Galileo Galilei and Voltaire who cast their works in the dialogue form. At present, in the modern e-learning systems, the "Socratic" method of teaching is employed to help the students better understand and learn from the course content. It is also important to note that the dialogues and discussions, not only between teacher and learner but also among learners are essential parts of a traditional classroom activity.

For these reasons an agent 'learner' makes an appearance alongside the agent 'teacher' in virtual world of educational software. The agent 'learner' can put questions to the teacher, listen to his answers and then answer questions from the agent 'teacher'. However the communications between a teacher and only one pupil cannot reproduce the whole social-psychological context of a real educational environment. For this purpose the communication formula "a teacher and two pupils (a boy and a girl)" is more appropriate.

Therefore, three autonomous pedagogical agents named Tatyana Mikhailovna (a teacher), Masha (a girl, a brilliant pupil) and Petya (a boy, an inquisitive and creative child) (Figure 1) act in this virtual educational environment.

The inclusion of such a team of pedagogical agents permits us to resolve the following problems:

- Create a micro-model of lesson activity - child's customary environment.
- Improve the opportunities for dramatizing agent dialogues.
- Give a reliable support of individual learner differences.

Besides, the functions of interaction with the virtual world objects are assigned on the pedagogical agents for the purposes of the investigation and demonstration of physical processes.

Software implementation of the multimedia course

Powerful software tools are required for the development of the learning environment with numerous different media objects and life-like characters. Modern computer game engines possess such capabilities for presentation. However there are financial restrictions on employment of those engines for development educational software. It should be noted that VRML often used for educational purposes does not have enough expressive power for multimedia learning environments with pedagogical agents. Therefore a new, technology–effective and

functionally rich authoring environment, has been designed to create the multimedia software for Natural Sciences teaching.

Figure 1. Pedagogical agents in multimedia Natural Sciences

Using scripts to create complex multimedia system

Using internal scripting language is the best way to create computer games and educational multimedia software, which combines 2D-graphics and real-time 3D animation. Main advantage of scripts is to define accurately all multimedia presentation details (visual appearance and spatial location of the graphical elements, temporal synchronization of media-components, interactivity). In addition to this, the preparation of interactive presentation is separated from development of the visualization software. It can simplify the process of creating rich multimedia content presented via a wide range of media components and their integrated forms.

Taking into account, an authoring environment NATURA has been designed to create the multimedia product for Natural Sciences teaching. The NATURA comprises a rendering engine and tools for preparing multimedia data and script of their presentation.

In the authoring environment the script is written in a specially developed NML language (NATURA Multimedia Language) and translated into binary code by a translator for more effective use. The presentation model is a hierarchical structure consisting of scenes, multimedia objects and their compositions. (Figure 2)

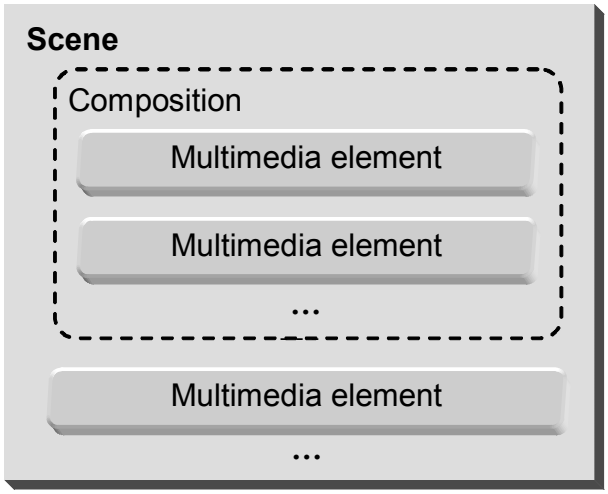

Figure 2. The multimedia objects hierarchy in NML

The description of multimedia presentation in NML language is performed in the following order. The constants are defined in the beginning of the script then follow the templates of multimedia objects, compositions and scenes. Next, the scenes themselves are described. Each scene gets its name and the description of the multimedia objects, compositions and events. The list of basic multimedia objects used in NML is given in Table 1.

Table 1. Multimedia objects in NML

Image	Static graphics
Anim	Animation
Audio	Sound
Video	Video clip
Html	HTML-document
Object3d	Mesh based 3D object
Motion	3D object motion
Speech	Speech of 3D character
Camera	Camera in 3D-world
Light	Lighting

NATURA Engine

NATURA engine renders multimedia objects. The engine includes several modules (managers): Application Manager, Scene Manager, Render Manager, Sound Manager and Resource Manager. The structural diagram of the NATURA engine is given in Figure 3.

The NATURA engine works as follows. The Application Manager initializes graphical libraries, creates the main window, initialises another managers and passes the control to the Scene Manager. The Scene Manager loads the script of a starting scene, runs threads for loading multimedia objects and initializes them. Next, the control is transferred to the Render Manager that requests the list of visible elements from the Scene Manager, combines them and displays the result on the screen. While a presentation is played, graphical dynamic multimedia elements can send the messages about the necessity of updating its image to the Render Manager. Render Manager, in turn, requests from the Scene Manager the list of all graphical elements intersected with this element and displays their union on the screen.

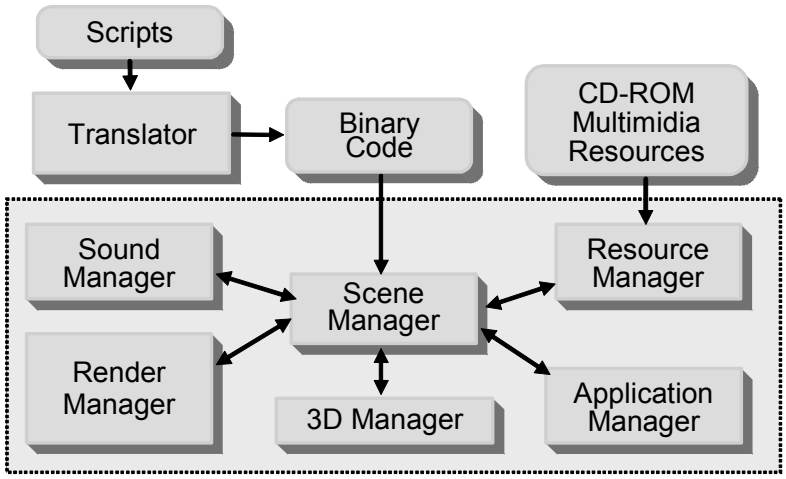

Figure 3. The structure diagram of the NATURA engine

When the “go” command is executed the Scene Manager pauses the Render Manager and Sound Manager, and then removes from memory an old scene and all its multimedia objects. Next, a new scene and all its multimedia objects are loaded and initialized. The Render Manager and Scene Manager then resume their execution.

Interactive multimedia natural sciences software for children

The rich possibility of the developed authoring environment allowed us to create intriguing learning software. Pedagogical agents, a teacher Tatyana Mikhailovna and her pupils Masha and Petya, are taking a walk through the virtual islands "Matter", "Forces" and "Physical phenomena". They can go to the forest, to the park, to the stadium, to the beach and to many other places where they can learn many new and interesting things about basic physical and chemical concepts and phenomena.

Various forms are used for the presentation of learning materials in this multimedia software. The agents-pupils do not just listen to the teacher and ask her questions, they also interact with the objects in a scene for the demonstration of physical science phenomena. For example, in the lesson on the concepts of friction, Petya goes down from the children’s slide, roller-skates in the park and attempts to shift a car manually. When Newton’s laws are studied, Petya and Masha ride bumper cars. Furthermore, a set of learning exercises with game-like interactivity is also incorporated into this learning environment. So children are performing interactive exercises and the pedagogical agents are assisting them during this process.

Figure 4. Petya and Masha are studying Newton’s laws

Conclusion

For years advanced forms of multimedia (real-time 3D characters, virtual reality) have been used in the computer game industry with excellent results. Now they are starting to be adopted in the Computer Based Learning industry. However many efforts will be needed to realize new potentialities and possibilities for creating educational multimedia software which is not only engaging, but also effective. The interactive multimedia Natural Sciences software for children and authoring engine NATURA presented in this paper are one of the steps on the way to new generation of multimedia learning system.

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