Using Intelligent Synthetic Characters for Behavior Training in Primary Schools

[1)] Zhigeng Pan, [2)] Ruth Aylett, [1)] Jiejie Zhu, [1)] Caohui Zhu, [1)] Guilin Xu

[1)] State Key Lab of CAD&CG, Zhejiang University, Hangzhou, P.R.China
[2)] The Centre for Virtual Environments, University of Salford, UK
{zgpan; zhujiejie; zch; xuguilin} @cad.zju.edu.cn

Abstract

This paper introduces our on-going project whose aim is to apply synthetic characters to behavior training in primary schools. Project groups include research centers from UK, Portugal, and China. Research members include artificial intelligent group, graphical group, educational group and psychological group. 24 months co-operation work and 4 meetings exchanging idea proof plentiful and substantial results. A closer link between China and EU countries in the use of 3D interactive graphic environments in e-Learning in primary schools has been established. Investigate results of synthetic characters in Potential Virtual Environments (PSE) in general and educational research results of students' bullying phenomena, empathy change theory in different cultures make a new research spot light. In addition, the open source movement of fast and open source graphic program for design synthetic characters in virtual environments has been launched. Both Asia IT&C committee and project members are looking forward to new results.

Key words: Virtual Environment, Synthetic Characters, Behavior Modeling, Behavior Training, Bullying; Empathy

1 Introduction

Virtual Environment (VE) has been explored new development in recent years. Synthetic characters with its significant feature of interactive and intelligent behavior shows remarkable usage and advantages in VEs[1,2,3]. In virtual learning environment, such characters attract learners' interest in a great sense. However, in spite of all technological and artistic advances, synthetic characters lacking of intelligence and human like behavior are still far from perfect in their realism. Besides, lacking of unified interface, which aims to link between the intelligent control module, blocks the flexible way to apply such synthetic character.

E-Learning with Virtual Interactive Synthetic characters (ELVIS) project aims to explore the potential of synthetic characters' behavior training in primary school. It will do this by creating a liaison between a leading Chinese technical centre in graphics, associated schools in China, and the members and associates (including education authorities and schools) of two e-Learning projects in the EU, who form the direct target groups. Chinese education bodies including schools in Zhejiang province, Macau and the rest of China form later indirect targets. Two years project activities will include visits by project participants to schools in China and the EU, assessment of cultural and social differences, production of open source software, dissemination and adaptation to Chinese conditions of outputs from the VICTEC and ELVES projects.

Along with it, ELVIS will create an animation engine and a mapping mechanism from abstract world to visualization world. It investigates the potential of VEs in general and Synthetic Character in particular to enhance the school curriculum in China and transfers synthetic character technology into open source form so that it can easily be taken up in Chinese school. As a meaningful supplement to agent system, AgentLib should support for the creation of 3D synthetic characters and merge together 3D and agent approaches which providing 3D representation for agent systems and means for building intelligent behavior for animated characters.

A number of worthy systems and architectures for synthetic character behavior control have been proposed. Bruce Blumberg[4] etc. believe the ability to learn is a potentially compelling and important quality for interactive

synthetic characters. And an autonomous animated dog was build that can be trained with a technique used to train real dogs. Mazin Assanie[5] builds synthetic characters that can accept and enact direction in real-time from the narrative manager. These characters must adhere to both the character design as intended by the author, as well as the performance requirements of their autonomous behavior, such as military doctrine or social roles. John E. Laird[6] etc. develop and evaluate synthetic characters with multiple skill levels and with human-like behavior. Through empirical and human judgments they evaluated a bat skill level and humanness of the variations. Their results suggest that both decision time and aiming skill are critical parameters when attempting to create human-like behavior. Song-Yee Yoon[7] believes compelling synthetic characters must behave in ways that reflect their past experience and thus allow for individual personalization. Rui[8],etc., built BeLife a multi-agent system for up-level behavior control for synthetic character. This system is a simulation tool with teaching objectives that include educating core concepts behind the management of greenhouses, fostering the understanding of experimentation in this particular context. Burke[9] focus on a particular cognitive ability, and found it instructive to build complete systems that creatures can interact with each other and with human participants.

This paper constructs in a way that first gives an overview of our project, which aims to apply synthetic characters to behavior training in primary schools. And in the second part, two researches result will be introduced to illustrate a clear idea of using synthetic character software to make psychology investigation results and open source movement for building a mapping interface for high-level AI model and low-level animation engine. A possible architecture of entire synthetic character model is also put forward.

2 Project Overview

2.1 Constraints

China has the largest education system in the world and educates 25 percent of the world's students. Technology is seen there as a key to development and to moving the country into a leading international position, and applying Information Communication Technology (ICT) in the classroom is being actively pursued in many regions under a central government national ITC education policy. Thus there are schools in some eastern provinces where ICT presentation resources are available in every classroom and a Visualiser display is for interactive teaching & learning. An ‘e-learning for life’ initiative funded by Coca-Cola is leading to the setting up of e-learning centers. However there is a danger that this activity will concentrate on lower-level ICT to the exclusion of new approaches developed in EU programmers such as the i3 network (‘Classrooms of the Future’), IST programmers in e-learning, and MINERVA-funded classroom activity. Many of these new approaches are based on 3D interactive graphics (virtual reality - VR) and the use of synthetic characters (sometimes known as Intelligent Virtual Agents, Virtual Humans, or, incorrectly, Avatars). For example, the Minerva project ELVES is investigating the use of VR in general in the classroom setting, while the Framework V IST project VICTEC is looking at how synthetic characters can be used to create empathy with child users in personal and social education where attitudes rather than knowledge are important. Through analysis of educational policy materials from China Education Department, 6 main constraints are drawn as reasons and blocks to carry out this project.

- Synthetic characters application situation is little known in elementary schools in China.
- Speed is slow of large scale adoption of 3D interactive graphics in general.
- Open source support provides no support for the development of synthetic characters.
- Application of synthetic character-based ICT in China concerns different social and cultureal milieu.
- The ability to build empathy between a child user and synthetic characters involved in virtual dramas is of key importance.
- Synthetic characters can be used to create empathy with child users in personal and social education where attitudes rather than knowledge are important.

2.2 Tasks

The aim of the project is to produce liaison between organizations in China and Europe to facilitate and improve contacts with and the participation of Chinese partners in existing European IT&C initiatives. The project will focus particularly on the European Commission’s Research and Technological Development Program, Framework V

Information Society Technologies projects in e-Learning with synthetic characters, in particular the i3 project, NIMIS, VICTEC (Virtual ICT with Empathic Characters) and with the European Commission's Education and Training Socrates Minerva projects in ICT in education, especially ELVES (Empathic Learning with Virtual Environments). The specific objectives to be addressed in order to achieve the liaison and contacts will be:

1. To investigate the potential of Virtual Environments (VEs) in general, and Synthetic Characters in VEs in particular, to enhance the school curriculum in China
2. To transfer synthetic character technology into Open Source form so that it can easily be taken up in Chinese schools.
3. To identify the strengths and weaknesses of using VR and synthetic character solutions for personal and social education program in Chinese schools with particular reference to social, organizational and cultural differences.
4. To integrate and transfer Chinese graphics programming skills into e-Learning with synthetic characters in Europe.
5. To strengthen the world Open Source movement in the 3D graphics area by providing library support for synthetic characters.
6. To disseminate project outcomes through the Open Source movement, through the web, and through educational channels in China and Europe.

3 Research Results

3.1 Chinese version of E-Teatrix(E-Teatrix)

E-Teatrix[10] is a tool for designing virtual interactive characters with emotions to help them study in traditional classroom. It can not only enrich the free time of children, but also improve the creative ability and design ability of children. In E-Teatrix, every child controls a character, and each character supports five emotional states. The emotion of character is automatically controlled by system, but the emotion controller can also help child change the character's emotion which will be detailed introduced in this paper, emotion controller can also check other children's emotion state. Figure 1 shows the Teatrix architecture.

The character that every user controls are an agent, each agent has some sensors. When these sensors get information, they turn this information into perception. Having filtered useless information, these perceptions are sent to the mind. The mind accepts those perceptions and analyzes the whole scene. Figure 2 shows some of implemented character in E-Teatrix.

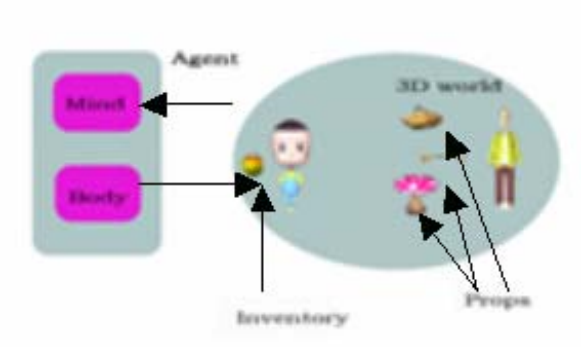


Fig. 1 E-Teatrix architecture

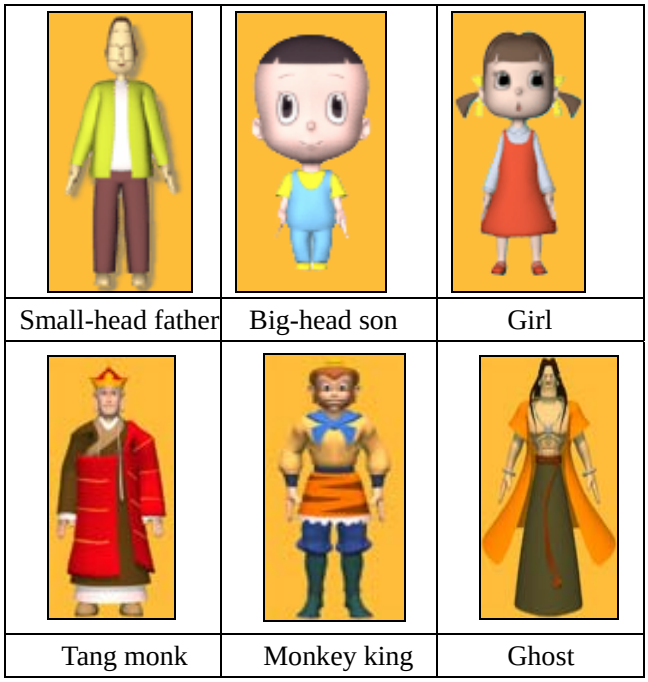


Fig. 2 Cartoon-like Character implemented in E-Teatrix

Character emotion design can be divided into two parts. One is done by system automatically. If children follow the system prompt and achieve the destination, then the system will change the character's emotion state to happiness. Otherwise if children don't follow the system's prompt, and the character's emotion state will be to disgust. Another control way is to define the emotion and its changes by user. E-Teatrix helps educational researchers to explore following investigation in China(see Figure 3):

- Review of Potential Virtual Environments' application in General
- Analysis of bullying research and results in

elementary schools in China

- Analysis of empathy research and results in elementary schools in China
- Analysis story creating skills of elementary students in China
- Evaluation and testing this software in a different culture country

(a) Select Characters in scene

(b) Exchanging ideas controlling characters

Fig. 3 Example of using E-Teatrix

3.2 Open Source Movement

Standards like VRML, OpenSG contains no support for the development of synthetic characters, leading EU projects such as VICTEC (and others) to interface to proprietary systems such as games engines which do offer such support. Thus to make ICT using synthetic characters widely accessible in countries like China, some technical work is required to develop Open Source support for synthetic characters. The sub-project name titled AgentLib which means linking agent mind to bottom 3D engine. The graphics expertise in Chinese Universities is such that this work could be carried out there if a strong graphics group such as that at Zhejiang University was able to work alongside EU program in the area. This work would then feed back into the Open Source movement in Europe and internationally.

AgentLib Ontology

The mind includes basic rules for the world. Mind is not the scope for AgentLib. It is just a commander to call functions in bottom level. Agent based structure and layers are defined in abstract world model as the second layer. Agent structure is grouped into 4 different levels:

- Entity: basic components in world (bottom level, first level).
- Object: components with attribute provided (second level).
- Agent: goals driven object that finish some specific tasks (third level).
- Autonomous Agent: agent with mind analysis to make out its plan (top level, forth level).

The mapping interface is the mechanism that links the world model to visualization world. It also provides a clearly defined edge between the abstract world and the engine. Observer design pattern[2] is used to implement this interface to improve the flexibility of adding new required functions. Abstract world doesn't necessary know how to call the basic rendering functions to execute a specific character action. And the engine doesn't know which goal is the next target, either. The visualization world includes basic graphic component for rendering, such as geometry, body, animation. Sensor and effector are designed to handle input/output events. Sound functions are also supported for multimedia functions.

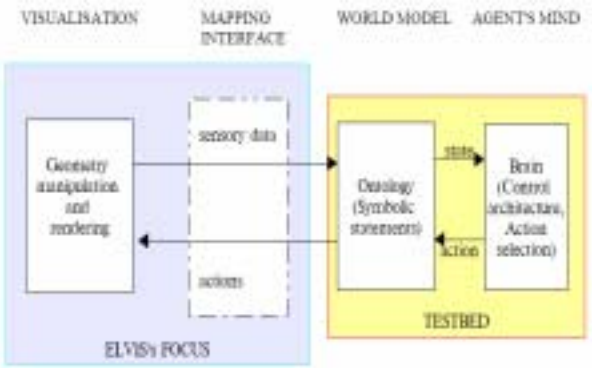
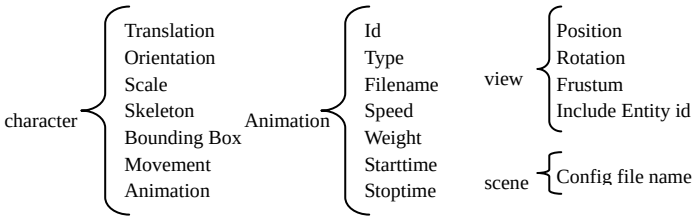


Fig. 4 3-Layer Design for AgentLib

Visualization World components

The visualization world is not equal the real rendering world. It concerns only the components that the abstract world is interested. Figure 5 shows a detailed components of visualization world.



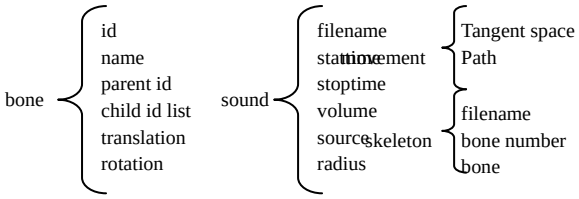


Fig. 5 visualization world components

Mapping Interface

The mapping interface should keep data consistent between abstract world and visualization world. We use observer design pattern[11] to implement it. The Observer pattern assumes that the object containing the data is separate from the objects that display the data, and that these display objects observe changes in that data. In order to keep users be ignorant of the observer concepts, we have to encapsulate each observer. We provide observer box as a black box to be used to encapsulate all concrete observers and a subject box is used to encapsulate all concrete subjects. Each concrete subject is independent to other ones, and they are linked with each concrete observer. For example, skeleton subject is linked with skeleton observer. If abstract world needs access skeleton subject, it set up the skeleton observer and the observer will update all changed data. Figure 6 shows the process of subject and observer working process.

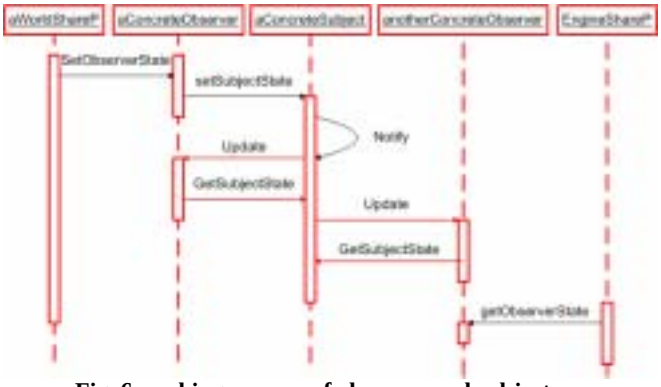


Fig. 6 working process of observer and subject

On-going Testbed Example

A testbed example called "*YY*" goes mushroom picking is designing to explore the whole ideas. It is a story about a Chinese little girl called *YY* picks mushrooms for her parents to cook her favorite meal (mushroom soup). The *YY* model is composed of body, basket and two pigtails. The model supports a set of animation concerning picking mushrooms. Different sizes of mushrooms are designed to be one factor to change *YY* picking path. Besides, *YY* sings specially when finds good mushrooms and she find mushrooms by "*smell*".

Figure 7 shows the imaginary scene and implemented scene. Mushrooms are randomly generated according to *YY*'s location. Which mushroom should be picked first was the goal generated by the mind. In order to simplify the example, we just take 3 rules to decide the goal.

- Nearest mushroom location
- Biggest mushroom group
- Biggest mushroom size

Expand considerations including adding a small dog character which represents the animal character and its behavior. This little dog will change the example a little bit, since two characters have to communicate with each other, which will cause a series of complex state change.

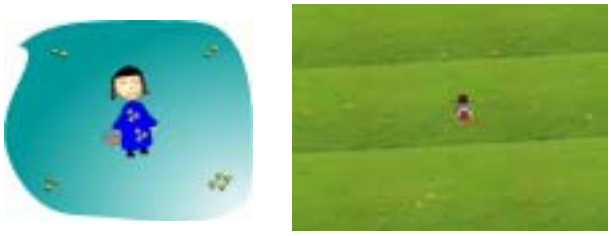


Fig. 7 "YY" imaginary and implementation

4 Conclusion

Computer graphics and virtual reality are widely used in Chinese education field. More and more people, especially students, need virtual interactive characters with emotions to help them study in traditional classroom today. This paper investigates the potential of VEs in general and Synthetic Character in particular to enhance the school curriculum in China and transfers synthetic character technology into open source form so that it can easily be taken up in Chinese school.

E-Teatrix is a tool for solving this problem. It can not only enrich the free time of children, but also improve the creative ability and design ability of children. In E-Teatrix, every child controls a character, and each character supports five emotional states. The emotion of character is automatically controlled by system, but the emotion controller can also help child change the character's emotion which will be detailed introduced in this paper, emotion controller can also check other children's emotion state. As a meaningful supplement to agent system, AgentLib should support for the creation of 3D synthetic characters and merge together 3D and agent approaches which providing 3D

representation for agent systems and means for building intelligent behavior for animated characters.

Expected future results include analysis of impact of social and cultural factors on architecture, release of final version of Open Source library, and a final workshop will be held to exchange ideas of the related results. Besides, investigate impact on target groups is also an important sum up for further research.

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