

Web Based Multi-User Interactive Graphics Worlds for Education

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Abstract

Several technologies are currently being developed that will have a huge impact on the future of education. Advances in computational power and graphics capability will give the future home PC the capabilities of very high-end workstations of the present. Advances in connectivity will allow everybody to be connected at all times with a very high bandwidth. Advances in computer graphics software technology, combined with advances in other fields, such as simulation and artificial life, will allow us to create realistic worlds for students to investigate. These worlds will be Multi-User Shared Environments (MUSE), i.e., students will be able to interact with instructors, other students, and intelligent agents in these worlds.

In this paper, I will briefly discuss the background issues, vision for the future with some specific examples, and our current efforts in this area.

1. Background Issues

1.1. Technology

Current home computers in the \$2,000 price range have a substantial amount of graphics and processing power, e.g., a 400 Mhz P II, 128 Mbytes Ram, Open GL accelerated graphics card with 8Mbytes of RAM, a 12 Gbyte disk, and a 17-inch monitor. This is rapidly increasing and within a year this class of machine will have a 700Mhz processor with enhanced instructions for 3D Graphics and MPEG-2 decoding, e.g., the Intel Katmai cpu, 256 Mbytes RAM, a 20 Gbyte hard disk drive, and a faster graphics card.

If we assume that Moore's law (computers double in power approximately every eighteen months) will continue to hold, then a conservative prediction for the home PC (with a cost of under \$2,000 U.S.) of the year 2009 will be as follows:

- Processing power about one hundred times that of a Pentium 400 mhz cpu

- Main memory of about one to two gigabytes
- Disk space of about one terabyte

People will be able to carry these computers around and use portable displays such as eyeglasses, i.e., the computing will be ubiquitous. Another technology advance is in improved Internet bandwidth into the home. Currently most people connect via 56 K modems, but more other technologies are rapidly becoming available. For example, in many cities either Cable Modems or telephone based DSL lines are becoming available for about \$50/month. These allow for speeds up to 1.5 mbits/sec or about as fast as a T-1 line.

By 2007 this will be of the order of fast ethernet (100 mbytes/sec) and will be wireless. The introduction of VRML 97 and Java 3D, combined with the rapid advances being made in the simulation of animals (artificial life) and of humans are allowing us to approach the ideal of the Star Trek Holodeck. We will be able to create worlds for students to inhabit such that they can change the parameters or else just live with other creatures.

1.2. Trends in Education

Three major trends in education are:

1. The increasing emphasis on Distance Learning, especially Web based learning
2. Life-long education
3. The increased use of technology in education

This means that web based learning technologies and interactions are becoming increasingly important. Students, especially older students, are less and less interested in coming to a central campus to listen to traditional lectures. They want to be able to learn on their own time and at home. However, there is still a role for the professor-student interaction, either one on one or with one professor and a few students, although this may become a virtual interaction.

2. Vision for the Future

Imagine an Art History class where the instructor is holding office hours in the class world, which is structured as a virtual Art museum. A student approaches the instructor avatar and states that she has a question on a particular painting. The instructor and student walk to the painting and the instructor answers the student's questions. The instructor goes into another room and finds three students discussing a particular sculpture. The instructor joins in the discussion and walks the students around the sculpture, pointing out different aspects of the work. Note that the participants are at their homes and are interacting via computer and conversing using microphones.

If a student logs into the art world and the instructor is not there, then the student can ask questions of her virtual companion. The companion, one for each student, is an intelligent agent that knows some information about the art works in the museum. But, perhaps more importantly, each companion is privy to the sessions between the instructor and the other students, and so can report about new interesting insights that the instructor has given to other students.

Imagine a biology class where the instructor leads a group of students on a tour of a cell. One of the students asks about the DNA replication process and the instructor leads the group into another world where this is occurring. The instructor discusses what is happening with the students while they observe the process. The instructor and/or students are able to modify the process by changing certain kinetic parameters and observe the changes.

Imagine a zoology class where the students can enter a virtual ocean and observe the interaction of different species. The students might themselves be different types of aquatic creatures, one might be a shark and others might be a dolphin, swordfish, whale, etc. They can design a new species of predator, set up its parameters and observe how it changes the inherent ecology.

All of these scenarios involve the use of a 3D Graphical MUSE. In some of the environments, e.g., the Art museum, the primary interaction would be between students and their virtual companion and the professor or other students. In other environments, e.g., the virtual ocean, there are other entities that interact with the students,

i.e., the students might not know which of the other creatures were other students and which were virtual creatures that were programmed to behave in a realistic fashion.

3. Current Work

While the above scenarios are futuristic, we have begun to work to develop aspects of them. We are currently working with Art History faculty from the School of Art and Design at Georgia State University to design and implement a prototype of a MUSE Virtual Art Museum. Our goal is to create a generic museum that can be populated with different sets of art works depending upon the particular course. For example, a course covering Renaissance Art would require one set of works while a course focusing on the Twentieth Century would require a different set.

We are using the Sony Community Place server for this project and currently have a demo version that allows three simultaneous users (we are negotiating for a system that will allow up to fifty simultaneous users). With this system, each student can be given a CD-ROM with that contains the Virtual Art Museum and a set of avatars. Each student will be assigned to be a particular avatar. The student can log into the server, and interact with the other students who are logged in. Currently this interaction can either be via typed text or microphone. An advantage to this system is that the bandwidth requirements are kept low. Each user has the basic world plus avatars on their own machine so all the system needs to transmit is the updated viewpoint of their own avatar, the updated positions of the other avatars, and any communication (via text or audio). Therefore, students at home with only modem connections to the Internet can use it.

This project has just begun and we will report on our progress at the GVE 99 workshop. Our initial plans are to implement the Virtual Art Museum, test it out with GSU students, and then to begin implementing some aspects of the intelligent agents.

Conclusion

The convergence of rapidly improving technology, especially the improving graphics capabilities of inexpensive computers, plus the increased need for non-traditional distance learning has given rise to the possibility of using web based interactive 3D graphics worlds to radically improve education.

These worlds will be multi-user so they will be able to facilitate student-student and student-instructor interaction at a distance. We have begun work on the design and implementation of one such world, to teach Art History courses.