

Java Applets as an Efficient Tool for Computer Graphics Education

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Abstract

On this paper we present an ongoing project titled Computer Graphics Virtual Textbook. The objective of this project is twofold. First, it will enhance the undergraduate research activity at the University of Warwick by involving several undergraduate students in developing the Computer Graphics Virtual Textbook. Second objective of the project is to create an interactive series of WEB pages called Computer Graphics Virtual Textbook with Computer Graphics (CG) content. It will be used as a supplementary material for CG courses but it will also be an independent source of information for all people interested in Computer Graphics. It will contain description of the very basic CG methods such as the plot of a point, a line and a circle and also the advanced methods such as the modeling, rendering and visualization techniques, fractals etc. To support the interactions the small interactive programs (java applets) will be used. Java applets allow users to try and see how the described algorithm/method is working in real time.

1. Introduction

This project is involving undergraduate students in developing a Computer Graphics Virtual Textbook. Computer Graphics is one of the very attractive and fast developing parts of computer techniques. The popularity of CG has rapidly increased with the fast development of the computer systems and with the growing number of users. The basic aim of today's communication between a user and a computer is an interaction based on following idea: "What you see is what you get". This communication improves the software-user relationship.

2. Teaching and Learning Aspects

All We consider teaching as an integral part of learning and We have always given as much effort to teaching as to our own research Our vision is to use this interactive WEB page as a main or as a supplementary material for the undergraduate Computer Graphics course. This WEB page is going to be a part of e-learning system in which student are going to have an opportunity to test themselves by using didactic tests. They will be also able

to find more theory about CG and Java applets. This WEB page will also be used as a source of the important information for scientific community.

Most of the CG WEB posted algorithms will be programmed as java applets and offered in an interactive form to users. Whole WEB page will be published as an open source in a way that the user can add to the existing material his/her own applications. Mathematics in CG algorithms/methods will be described using MathML code, which is a standard for visualization of a mathematical text on the WEB.

Several undergraduate students will participate in creating the Virtual Computer Graphics Textbook. This will promote their learning of CG in several ways

- It will help them better understand the new learned ideas in the Computer Graphics course, to apply them and to bring their new ideas.
- This project will give students opportunity to further discuss the applications of CG with experts.
- It will give the undergraduate students opportunity to learn about and to participate in a project that is more extensive than the projects done as homework.
- It will show them how to do their own research of the newest trends in Computer Graphics.

Students and scientific community will be the final users of the proposed Virtual Computer Graphics Textbook. We believe that it is very important to know how the algorithms are used in real life. Here the Virtual Computer Graphics Textbook holds great potential as it will help undergraduate students and the scientific community

- to understand mathematics (geometry, linear algebra) employed in CG algorithms and methods
- to understand techniques of the mage generation, image processing, modeling and visualization
- to understand and to be able to implement basic CG algorithms using graphical programming standards (e.g. OpenGL, Java applets)

3. Research Question/Methods

The main part of the research is presented in the development and the implementation of the CG algorithms in the form of java applets. Java applets are small interactive mini-applications (executable programs), that allow users to see how the described algorithm/theory is working in real time. We decided to use Java programming language for several reasons. First, it is quite complex and general programming language, which allows creating of interactive applications for WEB pages. Java was derived from C language with special focus on the platform and hardware independence and also with the focus on security. The source code is compiled into native format for Java Virtual Machine (JVM).

JVM is an environment which allows running Java applications. JVM is a part of main WEB browsers (Netscape, Mozilla, Firefox, Explorer, etc.). For the security reasons, an applet can not be accessed from the hard drive. One minor disadvantage of the JVM implementations in the browsers is that it has rather large hardware requirements. In real live it means, that the Java programs are somewhat slower than the similar applications written and compiled in C/C++ language. However, with the present computational power the differences are becoming very small. With the interactive Java applets one can make static WEB pages “live” and create the educational applications. Java applets are of a very small size, which is a major advantage concerning the downloading time for the slower networks.

4. Nature of Collaboration

Part of the collaboration in this project will be based on the interaction with undergraduate students. More than half of the Java applets will be developed as small student projects under my supervision during the course. Each student or group of students will develop a single java applet and its description for end user. Students will be involved in the whole developing process starting with the study of the method, structure planning and design, project management, programming and final release. There will be consultations, discussions and partial evaluations of the work progress on regular basis (one time in two weeks). Each applet will be accompanied with copyright due to students who developed it. Student's names with their affiliation at University of Warwick will be written on the WEB page under the appropriate java applet.

Other important source of collaboration will be based on a communication with other CG experts and colleagues from the University of Warwick and other European Universities. A CG expert from Komensky University,

Bratislava, Slovakia will be invited to give an invited lecture about selected CG topic to the audience collected mostly from undergraduate students and also from other researchers and professors interested in CG.

We have a very successful and positive collaborating experience with people (Dr. Andrej Ferko, Dr. Valent Zlatko, Professor Jan Cizmar) from the Department of Geometry at Komensky University, Bratislava, Slovakia. We cooperated on their various activities such as their yearly conference (Spring Computer Graphics Conference) or student seminar (Central European Seminar on Computer Graphics). We will base on this experience and we will setup the possible collaboration with the experts from their department since we believe that it is very useful to start the discussion and exchange opinions with these very experienced people from the CG area.

4.1. Related Work

Work on similar projects started at Komensky University in 1999. One of the very earliest projects is “Animation of Computer Graphics Algorithms” done by Z. Cernakova, V. Dudikova and M. Prochaczka. The aim of this project was to create a video and shipping documets. Material on the videotape illustrated some graphics algorithms “in action”. The tape with animated algorithms has been used very succesfully in education process.

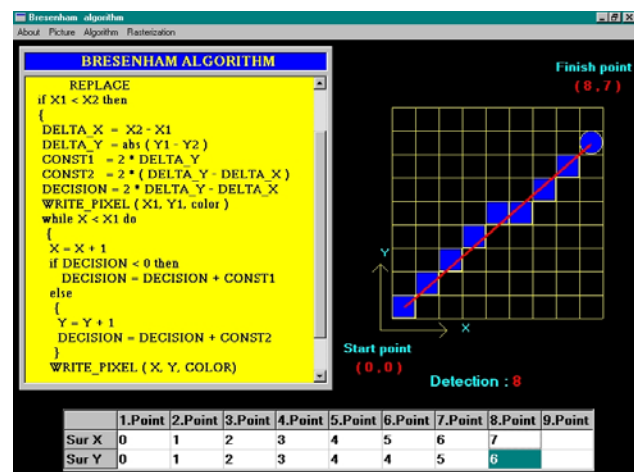


Figure 1. A TV screenshot from education video titled Animation of the Bresenham Algorithm developed by Vladimira Dudikova.

The goal of another very succesfull project named Interactive Simulations of Elementary Physical Experiments developed by Alena Kovarova was created an interactive CD ROM, which will provide simulations of several elementary experiments in physics. The CD ROM has been used as a learning tool in the educational

process. Before entering this virtual laboratory, students are offered a brief introduction to the simulated problems. The software has been developed using Macromedia Flash MX, which offers the opportunity to control the running application by changing several parameters. After setting the parameters a physical experiment is simulated and shown to the student via animation. This work was motivated by the book “Physics as an Adventure of Cognition” (Einstein & Infeld, 1971).

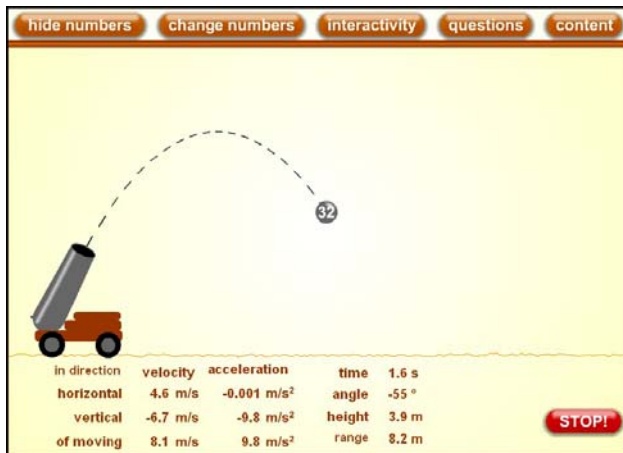


Figure 2. A screenshot from interactive program called Shooting Cannon developed by Alena Kovarova

They are also other very similar projects already exists, but most of them are not available for the public use or they are written in other language than English. For example here are 4 projects developed at Komensky University in Bratislava, Slovakia, written in Slovak language:

<http://www.cagd.sk>

authors: Michal Polan, Dr. Valent Zatzko

<http://dip.sccg.sk>

authors: Gabo Blazovics, Dr. Michal Fano

<http://www.sccg.sk/~valentova>

authors: Zuzana Valentova, Dr. Andrej Ferko

<http://www.netgraphics.sk>

authots: Juraj Stugel, Dr. Andrej Ferko (see Figure 1.)

5. Intended Outcomes of the Project

The first intended outcome of the described project will be to enhance the undergraduate student research-based activity by involving several of them in creating the WEB page for Computer Graphics. It will help them better understand the new learned ideas in the Computer Graphics course. It will show them how to do their own research of the newest trends in computer graphics. Further, it will give students opportunity to further discuss the applications of computer graphics with experts.

Finally, students will get opportunity to participate in a project that is more extensive than the projects done as homework as they will be involved in all aspects: project management, development and programming techniques and releasing of an open source WEB material for public.

The second outcome of this described project will be an interactive WEB page, which will contain description of CG algorithms and methods. The mathematical/CG text will be illustrated with interactive java applets, which will allow the user to observe the algorithms/methods in progress.

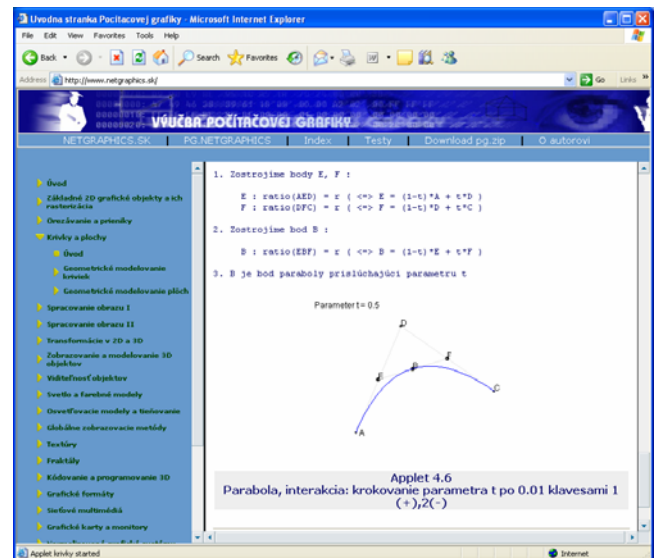


Figure 3. A screenshot from interactive WEB page titled: “Výučba Počítačovej Grafiky” (Computer Graphics Training) in Slovak language developed by Dr. Juraj Stugel.

7. Conclusion

Evaluation of the project will be based on the evaluation of the progress of the project of each involved undergraduate student (i.e. on evaluation of the development of the individual interactive java applets). Each project will be done in several stages and each stage will be evaluated separately. The stages are

Each student will have to become familiar with the chosen CG topic

The students will need to write codes to implement the chosen CG topic and it will be tested

Next the students will create interface and design suitable for the internet.

Finally the student's interactive java applets will be implemented for final release and tested.

8. Acknowledgement

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