MyWorld4D: Introduction to CG with a Modeling and Simulation Twist

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Figure 1: A navigatable model of Downtown Pittsburgh – complete with bridges, waves, animated funiculars, and a "Let's Go Pens" blimp, created by student Nat Wetzel as a final project for the Pitt CS Introduction to Computer Graphics course. The project is based on OpenGL.

Abstract

We describe the design, implementation and results of a senior-level Introduction to Computer Graphics course that successfully blends Modeling and Simulation concepts in the "classical" rendering-pipeline syllabus. Evaluation over two years shows record enrollment-retention and student satisfaction when compared to the simple geometric primitive rendering approach at the same institution. Students demonstrate an increased ability to handle computational challenges and to incorporate concepts from senior-level courses such as Artificial Intelligence, Scientific Computing, or Networking into graphics applications.

Keywords: education, computer graphics, modeling, simulation

1 Introduction

Education in Computer Graphics at our midtier-I university typically starts at the senior level, with a target group of primarily computer science and computer engineering students. However, a recent university-wide initiative in Computational Modeling and Simulation is leading to tighter coupling of the curriculum across Computer Science, Math, Engineering, and Natural Sciences. We see increasing numbers of CG students majoring in Computer Science and either Math, Physics, Chemistry etc., whose primary interest is clearly in physically-based modeling and simulation.

To answer the needs and interest of this target audience, we designed and developed an Introduction to Computer Graphics course that successfully blends modeling and simulation concepts with the basics of rendering.

2 Approach

Our challenge is to engage students into deep understanding of the computer graphics rendering basics, while enabling them to experiment early on in the course with modeling and physically-based simulation. We enable modeling and simulation by giving the students ready, although gradual access to the OpenGL rendering pipeline. For example, support code for the first assignment covers the rather tedious basic OpenGL and callback setup; the students are encouraged to experiment instead with vertex-based geometric shapes and to use timeout events to control the geometric coordinates of the shapes. Later assignments show examples of setting up the camera, lighting, shading or texturing in OpenGL, while asking the students to implement their own parametric shapes, geometric transformations, scenegraphs, and lighting schemes.

To ensure the students stay motivated in understanding the rendering pipeline, particular emphasis is placed on highlighting the math behind each algorithm, the computational cost of each approach, and the toll this computation takes on realistic models and simulations. Furthermore, while students are not asked to implement neither a virtual camera from scratch, nor ray tracing, they use the same principles to pick a 3D object using a mouse, or to compute the post-collision direction of a moving object. The syllabus follows the rendering-pipeline structure of Foley et al. (the graphics framework, geometric transformations, viewing, scan conversion and clipping, color and the visual system, shading, texture mapping, and ray tracing), interspersed with lectures on tessellation, particle systems, collision detection, and video games.

3 Results and Conclusion

The final projects (see http://vis.cs.pitt.edu/teaching/cs1566/) and student feedback show the students are fascinated by physically-based modeling and simulation. Evaluation over two years shows this new approach to be superior in terms of retention and student satisfaction when compared to the rendering-based approach at the same institution.

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