

The G3D Engine as Platform for Research and Education

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Figure 1: Screenshots from recent research projects using G3D; the right-most is a photograph of a G3D-powered 4-wall stereo VR display.

Introduction

G3D is a robust 3D engine used in commercial games, research, military simulators, and university courses. Like most professional middleware, it supports several C++ compilers on Win32, Linux, and OS X, ships with sample code and manuals, works with all graphics cards, and has 24/7 technical support. *Unlike* most professional middleware, G3D is Open Source (BSD License). The combination of high quality, liberal licensing, and a layered architecture make G3D a good platform for research and education.

The need for open 3D scene infrastructure has been by open packages like Delta3D [Conkey 2005], OGRE, Irrlicht, Alice [Cooper et al. 2003], and OpenSceneGraph. In contrast to these, G3D is a low-level 3D engine for games and real-time graphics research. It allows direct access to all hardware capabilities like shaders, render buffers, and input devices. G3D eschews high-level mechanisms like scene graphs. This is because we believe that high-level code hard for us to provide because it is application-specific and moreover, it is relatively easy for developers to create because it is platform-independent. Our goal is to instead provide an easy-to-use layer that abstracts low-level routines for OS, hardware, and file format negotiation.

Despite our low-level focus, G3D is easy to use: about 100 lines of C++ can to open a window, render a 3D model, and process user input. The key to combining power with ease-of-use is the open layered architecture in Figure 2. Each layer abstracts the previous one for ease-of-use, but these abstractions are open so that high-level code has the power to manipulate the underlying objects. This avoids the ‘you can’t get there from here’ problem associated with other APIs; e.g., Java3D locks developers out of the latest hardware features because it completely hides the underlying system.

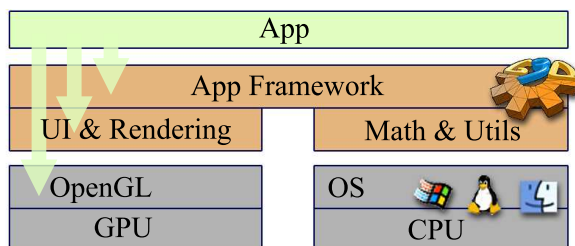


Figure 2: Open Layered Architecture Diagram.

Feature Highlights

- Shaders** GLSL, Cg, and ASM with error checks and extensions
- Performance** State change minimization, vertex buffers, render-to-texture, GPU profiling hooks, MMX and SIMD
- Formats** 3DS, IFS, PLY2, MD2, BSP, JPG, PNG, PPM, GIF, BMP, TGA, AVI
- Algorithms** Compute tangent space, mesh welding, SVD, KD-trees, collisions, tessellations, polyhedron cuts, silhouettes
- Network** TCP/UDP, serializers, compression, messages, discovery
- Multiple Paths** Workarounds for known driver bugs, feature emulation on older cards, vendor-specific optimizations
- Library Bindings** For SDL Mixer and fMod (audio), ODE (physics), wxWidgets, Qt, and GLUT (GUI)
- Documentation** 500 page manual including tutorials and FAQs

Results

We have been very successful at growing and disseminating G3D, and using it to enhance research and education. It is consistently rated in the top 50 most active projects of the 100,000 hosted on SourceForge and has been downloaded 60,000 times in three years.

Our primary academic test site is Brown University, which uses the library in four graphics courses and many research projects. We have observed that the common code base enables students to transfer their knowledge between courses. It also helps them transition from assignments to G3D-powered research; e.g., ten students from the advanced graphics course extended their work to research presented in the SIGGRAPH 2005 posters session.

Students and faculty are currently using the library at other institutions including [G3D 2006] the University of Ulm, the University of Kent, Harvard Extension School, the University of North Carolina, Guang Dong University of China, Georgia State University, and Rensselaer Polytechnic Institute. We actively encourage more widespread adoption and collaboration on the library through our website, <http://g3d-cpp.sf.net>.

References

- CONKEY, C., 2005. Delta3D-an open source project to commoditize 3D game based training for the U.S. Navy. GDC Poster.
- COOPER, S., DANN, W., AND PAUSCH, R. 2003. Teaching objects-first in introductory computer science. In *SIGCSE*.
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