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BeSS: Storage Support for Interactive Visualization Systems

A. Biliris
AT&T Research
biliris@research.att.com

T.A. Funkhouser
Lucent Bell Labs
funk@allegra.att.com

W. O'Connell
Lucent Bell Labs
wto@allegra.att.com

E. Panagos
AT&T Research
thimios@research.att.com

1 Interactive Visualization Systems

Interactive computer graphics systems for visualization of realistic-looking, three-dimensional models are useful for evaluation, design and training in virtual environments, such as those found in architectural and mechanical CAD, flight simulation, and virtual reality. Interactive visualization systems display images of a three-dimensional model on the screen of a computer workstation as seen from a simulated observer's viewpoint under control by a user. If images are rendered smoothly and quickly enough, an illusion of real-time exploration of a virtual environment can be achieved as the simulated observer moves through the model.

Unfortunately, models of interesting virtual environments (e.g., buildings with furniture) comprise millions of polygons and contain more data (gigabytes) than can fit into memory on most graphics workstations. In order to support real-time walkthroughs of such virtual environments, a visualization system must store only a subset of the model in memory at once (i.e., the working set) and swap different parts in and out of memory in real-time as the observer navigates through the environment interactively. In order to avoid delays to the perceptible frame rate due to page faults, an interactive walkthrough system must prefetch data asynchronously so that the data is resident in memory before it is displayed.

2 BeSS Storage System

BeSS is a memory-mapped database storage manager based on a multi-client multi-server distributed architecture [1]. BeSS provides unique facilities that can meet the high performance demands of the interactive visualization system being demonstrated. First, trusted application programs can access directly all control structures and data managed by the BeSS server. As a result, these programs extend the BeSS server with the functionality encapsulated in them. Second, BeSS provides extensive support for very large objects including fast random access to an arbitrary byte within a large object, memory-type operations similar to UNIX `memcmp, memcpy, memchr`, non blocking (asynchronous) operations, stripping over several disks, and prefetching.

3 The Demo

This demonstration shows execution of the UC Berkeley Building Walkthrough System, a computer graphics program for interactive visualization of large, furnished architectural models [2]. The system executes with models far larger than main memory by using real-time prefetch algorithms that compute 3D geometric constraints on observer movement and visibility to conservatively predict the set of polygons that can potentially be rendered during upcoming frames. These polygons are loaded asynchronously from disk into a memory resident cache several frames in advance of when they can possibly be rendered. Using these algorithms on a SGI workstation with 128MB of memory, the system is able to maintain seamless frame rates (20 frames/second) during interactive visualization of a furnished model of a seven floor academic building requiring 365MB of data.

References

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[2] T. A. Funkhouser, H. Carlo, T. J. Seth. Management of Large Amounts of Data in Interactive Building Walkthroughs. In *Computer Graphics, ACM SIGGRAPH Special Issue on 1992 Symposium on Interactive 3D Graphics,* Cambridge, MA, pages 11 – 20, March 1992.