2011 Kuehler Summer Project

1. Title

Project Astra: 3-D Visualization of a Virtual Universe

2. Student Working on the Project (RA)

John Judnich, Sophomore Student, Computer Engineering.

3. Faculty PI

Nam Ling, Sanfilippo Family Professor and Chair, Dept of Computer Engineering

4. Project Description

The project aims at research, development, and demo of an open-source 3-D simulation engine for visualization of virtual universe. The description is given below:

Existing research has shown that numerous high-performance techniques exist for displaying vast, detailed 3-D terrains. Techniques also exist to render photorealistic forests of thousands of trees very efficiently. With some additional work, adaption enables such technologies to be applied spherically (as 3-D planets). Unfortunately, most of these techniques exist only on paper or as limited tech-demos. As of today, no readily available libraries exist that are powerful enough to render a vast yet detailed universe in real-time.

For this project, we propose to research and develop a simple open-source 3-D simulation engine. Unique in contrast to existing real-time engines, this engine’s key feature is the visualization of a virtual universe of vast proportion: up to roughly one billion planets and stars. Each planet contains millions of square miles of fully detailed terrain, each potentially populated with trees, plants, rocks, and other objects; or planets with just rocky surfaces without life forms.

We plan to include the following features:

- A robust and cleanly designed architecture designed for concurrency.
- Built-in threaded loading and unloading of data from storage media.
- Synchronization system managing a dynamically hot-loaded virtual universe across multiple subsystems: graphics, physics, audio.
- Full implementation of star rendering.
- Basic integration of virtual planetary terrain, planetary vegetation, and other objects.

Later work can add and improve features and as desired (such as visualization of gaseous planets).

C++ will be used to implement this engine, in combination with the OpenGL API for 3-D graphics. Direct calls to OpenGL, however, will be hidden within an abstraction layer to enable easy portability for platforms requiring different APIs (RSX/DirectX/etc.).

5. Deliverables
The deliverables would include the followings:
  - A fully operational open-source simulation engine as described above.
  - A demo simulation built with the engine, allowing the user to fly around the virtual universe and explore various planets, all the way down to ground level.

6. **Summer Availability of Faculty and Benefit to Student**

Faculty will be available during summer. Student Judnich will benefit from the project in the following manner:
  - John Judnich has developed and sold more than 3,000 games [1, 2]. The project will give him a challenging environment to bring his research project to the next level to include concurrent programming technology targeting 3-D visualization in graphics. His last year’s project (while he was a freshman) on efficient real-time planet rendering was very successful and is currently submitted to a research conference.
  - The financial support would help John in his study at SCU.

**References**