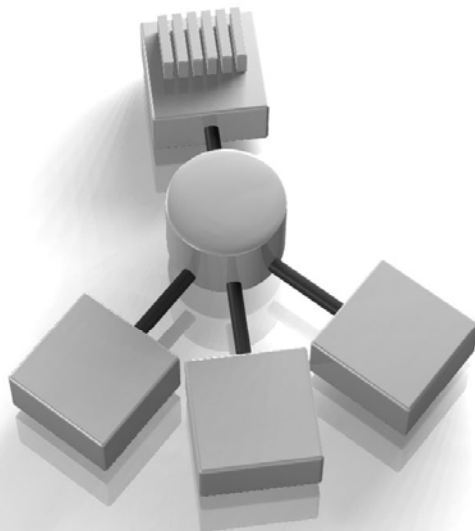


**SIXTH FRAMEWORK PROGRAMME
PRIORITY IST-2002-2.3.1.8
Networked Audiovisual Systems**



**Uni-verse project
Deliverable D 5.5
Radiosity Module
June 1, 2006**



STREP project

Project acronym: Uni-Verse

Project full title: A Distributed Interactive Audio-Visual Virtual Reality System

Proposal/Contract no.: 002228

Distribution: Public

| | |
|---|----------|
| WP 5.5 RADIOSITY MODULE | 3 |
| 1 Introduction | 3 |
| 2 Description | 3 |
| 3 Development | 4 |
| 4 Integration into the High Performance Renderer (HPR) | 5 |
| 5 Conclusions and Results | 5 |
| 6 Availability | 6 |

WP 5.5 Radiosity Module

1 Introduction

In the context of this project the term module denotes an application that will be made available as a library that can be used to integrate it into other Verse applications. This radiosity module contains the functionality to calculate and perform necessary operations for realistic light simulation. The input must be colored polygons and light sources. Then, then radiosity module calculates the light distribution in the given scene and outputs the new colored polygons. This library can be integrated into other rendering systems to enable the computation of global illumination.

The Radiosity Module was defined to be a rendering preprocessor within the High Performance Rendering Client (D4.2), allowing a more physical based lighting then the standard rendering modes.

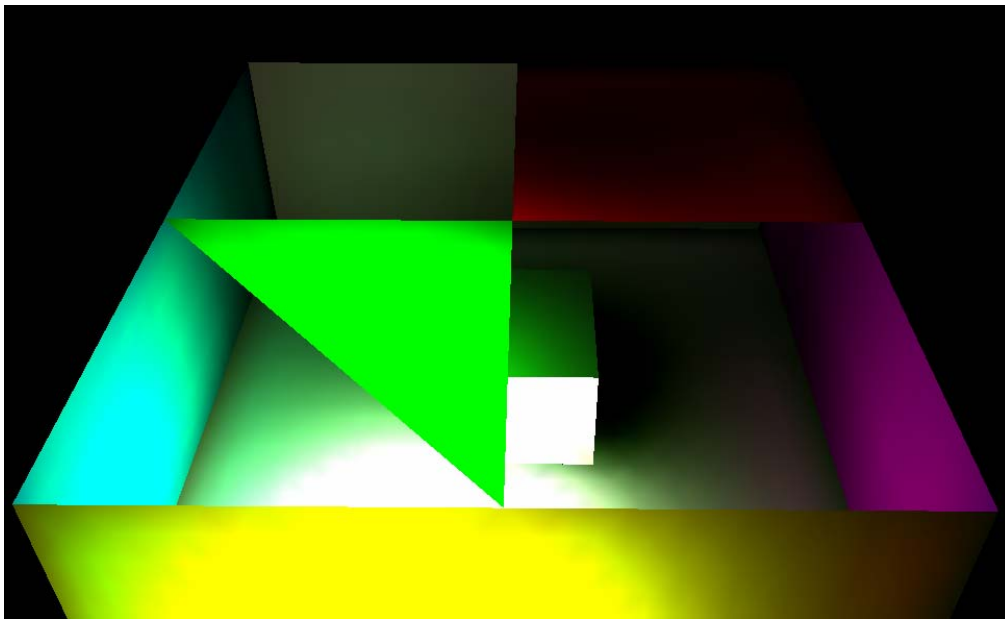


Figure 1: A screenshot from the output of the standalone radiosity system. Several color bleeding effects from secondary light rays are visible.

2 Description

The radiosity module was developed using C++, Visual Studio .NET 2003.

IT works as a plug-in library for the High Performance Rendering system, allowing a more physically lighting model. Every time the scene is modified, the radiosity module processes the complete scenes, subdividing patches and distributing energies. The result of the processing is an illuminated subdivided view of the scene-patches which are e.g. passed to OpenGL for rendering into the High Performance Client.

The module does not rely on coherences. It processes each scene change as if it is a complete new scene, so big changes in the scenes are allowed without time penalties. This allows the processing of fully dynamic scenes, like they are described by verse.

The actual system processes the incoming data in 3 Steps:

- In the first step a preprocessing is done which subdivides the single patches of the scene and calculates areas for the patches in a hierarchical way.
- The second step does the energy distribution. This step uses the hierarchy to speed up the distribution process by merging far patches to illuminate them together.
- The third step uses the information from the energy distribution stage to illuminate the patches and returns the illuminated polygon list.

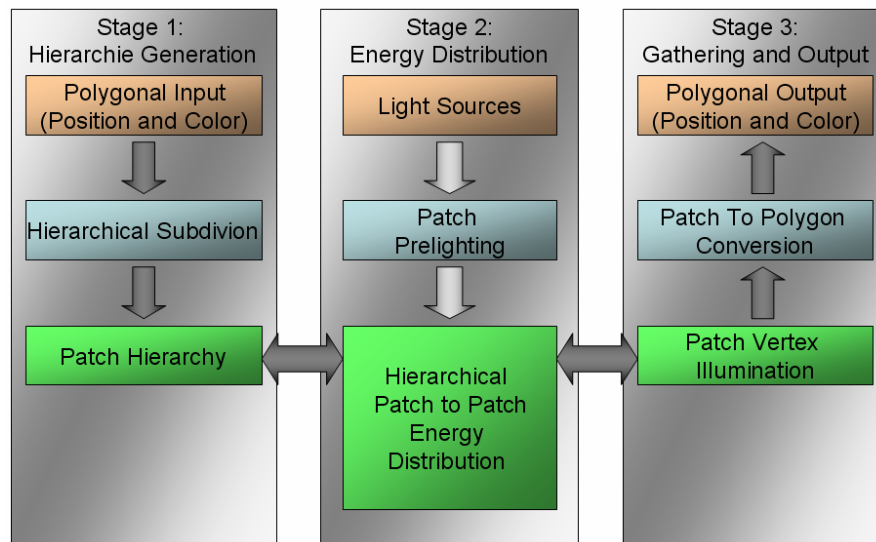


Figure 2: System overview of the Radiosity Module.

Because Verse scenes are heavily dynamic the calculation time should be at least approximately to real-time. Using the combination of these three steps enables the library to achieve this goal.

3 Development

The initial development started as an extension of the Fraunhofer NLight Radiosity System (EU project ARCADE). The NLight system calculates the light distribution for non real-time applications. This stand alone radiosity system was adapted to the necessary functionalities required to create the radiosity module. As a standalone system the radiosity system required a special data format and several resources, Verse does not provide. Additionally manual inputs were necessary, which had to be taken out to allow batch processing of data.

Since Verse demands a short refresh time of the scene (many continuous changes in a short time and no signal when these changes are finished) several changes to the radiosity core had to be made. Especially the form factor calculation and the initial subdivision of the patches had to be changed completely to simplify the energy distribution process for speedup. This was done by integrating shadow calculations inside the lighting process of a progressive radiosity theme. Additionally the energy distribution and the lighting process that were done in one step in NLight had to be separated into discrete operations to speed up the calculation process again. Therefore a lot of calculations could be avoided.

Two approaches for the module were researched. The first GPU based version was developed to allow calculations of hard shadows and fast energy distribution

computation. The second approach uses the CPU only and computes the light distribution with soft shadows.

Tests of both researched approaches resulted in the decision that the GPU based implementation lacks of the benefit of a hierarchical patch organization and is therefore only suitable for fairly small scenes but with high quality. The CPU version enables a faster light computation for larger scenes and soft shadows and hardware independency. In the delivered version of the module the CPU based radiosity solution is integrated.

4 Integration into the High Performance Renderer (HPR)

The radiosity module is integrated as a preprocessor for the geometrical data into the High Performance Rendering client. The module is available as an additional rendering option within the clients user interface.

In difference to a stand alone version this option allows a high amount of code reuse, since the module is placed near the OpenSG part of the renderer where all geometry from verse has already been parsed. As input, lists of triangles are passed into the radiosity module. After processing it outputs a list of triangles with color information, which describe the lighting. The input and the output data structures are equal. This allows a simple pass through operation if the module is not needed or switched on. Additionally the scene data is processed each time the scene graph is modified. This plug-in style architecture allows an extension of the functionality of the High Performance Renderer without losing the advantages of the OpenSG Scene Graph like driving rendering clusters, caves and HEyewalls.

5 Conclusions and Results

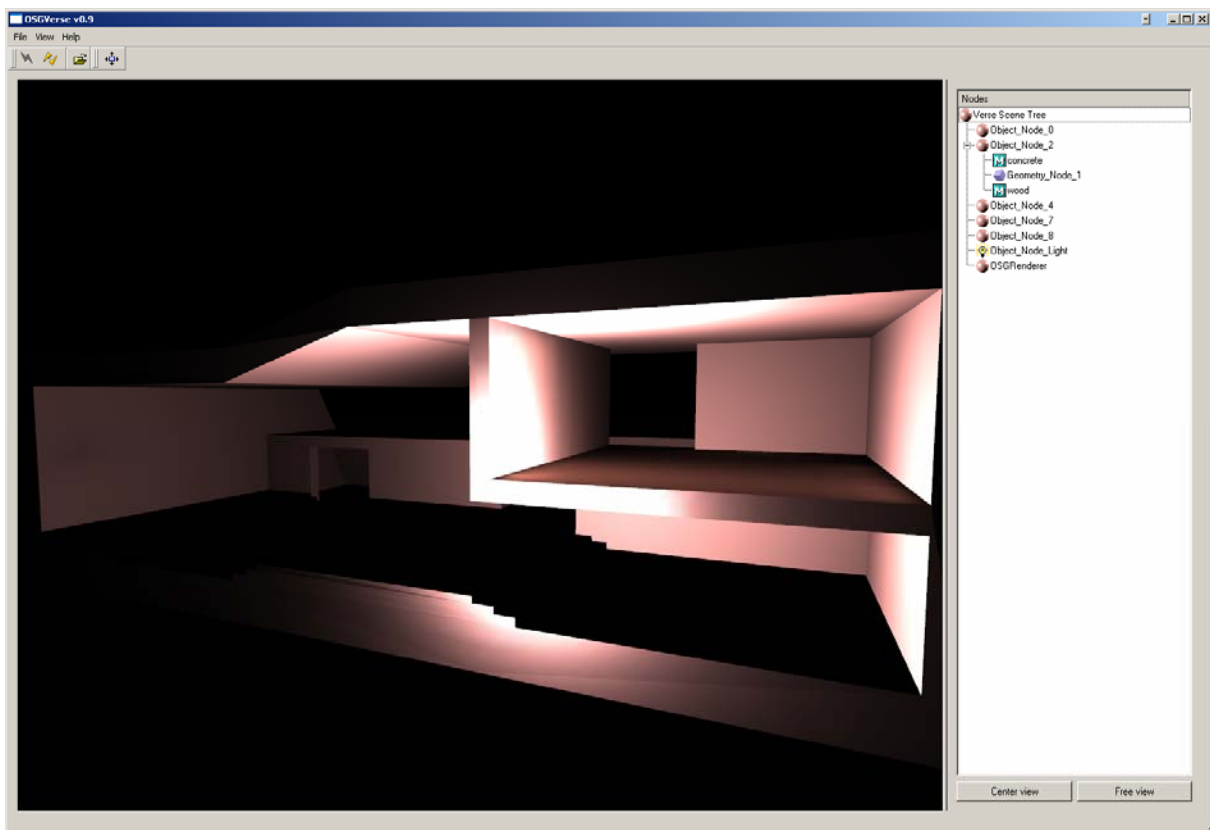


Figure 3: Radiosity module illuminating a scene integrated into the high performance renderer.

In work package 5.5 a radiosity module was developed that allows processing of small to medium scenes with near real-time interactivity. The necessity of optimizing the existing radiosity system leads to a unification of processing shadow and energy transport. This unification leads to a range of possibilities which now can be researched further. Especially its ability to be evaluated on the GPU gives an interesting set of options which could not be handled further during the research and can be addressed in later research.

Together with the rendering system developed within work package 4.2 a High performance system was developed with the possibility to use radiosity on immersive devices like the HEyeWall as presentation area for the rendered interactive 3D scenes.

6 *Availability*

The library is available as standalone library and integrated into the High Performance Renderer at the Uni-Verse website.