

# Computational Geometry Project

## Represent Polyhedra and Shadow Generation using BSP Tree

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### 1. Introduction

In Computer Graphics study, BSP tree has been used in many aspects, e.g. hidden surface removal, ray tracing. In this project, I focus on the method described by Thibault[1] to define a polyhedra by a BSP tree. Furthermore, I implemented part of the BSP shadow generation method proposed by Chin and Feiner[2]. In this shadow generation method, SVBSP (Shadow Volume BSP) is calculated.

### 2. Details

The project is based on C++ and OpenGL.

For BSP implementation, data structures `BSP_tree`, `Polygon` and `Utility` is defined. In `BSP_tree` structure, function `void DrawShadow()` and function `void Add_Polygon()` are used to construct the SVBSP.

For model loading, a file parse function is defined to load `.obj` file, such that the plane normal is outside the given plane regarding the vertex order in the file.

In the original paper[2], the shadow generation method supports multiple light sources, however here I only complete a method for moderate size scene and single light source. These parts may be implemented in the future.

### 3. Result

Figure 1 and Figure 2 are the traversing result of the BSP tree of each model, no depth information is used, and since BSP traversing is highly efficient, result of different eye position can be shown in real time. Figure 3 and Figure 4 are the shadow of single light source, in Figure 3, shadow is represented in gray color, while in Figure 4, shadow is in red color. These two pictures give right outcome for the shadow, but in the pipeline for the shadow construction, shadow polygons are stored into a new BSP tree, which might have a large size, the right way to do this is to decide for each fragment in the original BSP tree.

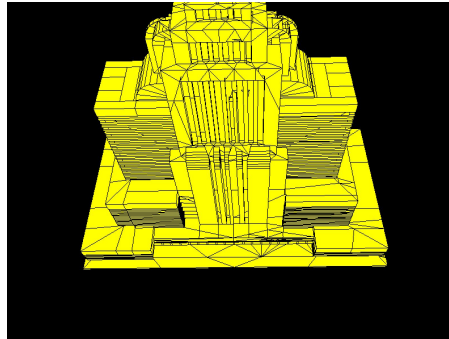


Figure 1: Skycraper BSP model

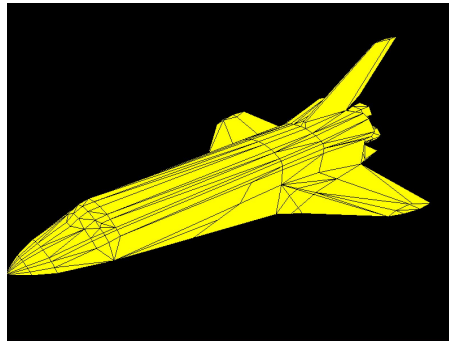


Figure 2: Shuttle BSP model

### Reference

- [1] W. C. Thibault and B. F. Naylor. Set operations on polyhedra using binary space partitioning trees. *Comput. Graph.*, 21:153-162, 1987. Proc. SIGGRAPH '87
- [2] N. Chin and S. Feiner. Near real time shadow generation using bsp trees. In *Proc. SIGGRAPH '89*, pages 99-106, 1989

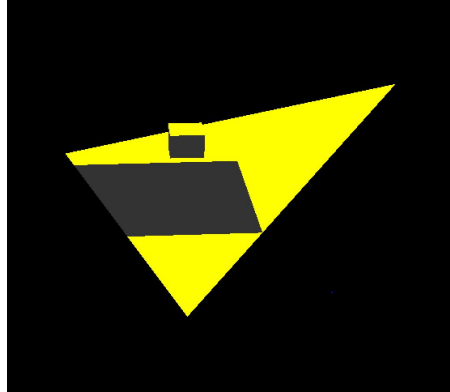


Figure 3: Shadow demo 1

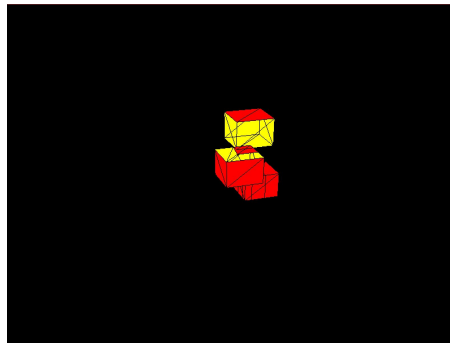


Figure 4: Shadow demo 2