

# Assignment 3: Basic Ray Tracing

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## 1 Introduction

In this assignment, I modified interaction.cpp, bvh\_tree.h, integrator.cpp and bsdf.cpp to realize basic ray tracing.

## 2 Implementation Details

For compilation, I downloaded clangd and upgraded cmake. I used "cmake -B build -G Ninja -DCMAKE\_POLICY\_VERSION\_MINIMUM="3.5" -DCMAKE\_EXPORT\_COMPILE\_COMMANDS=ON" at the root directory and successfully compiled it. The result is as follows.



According to the formula  $p_0 + u \cdot (p_1 - p_0) + v \cdot (p_2 - p_0) = o + t \cdot d$ ,  $u = \frac{[d \times (p_2 - p_0)] \cdot [u \cdot (p_1 - p_0) + v \cdot (p_2 - p_0) - t \cdot d]}{(p_1 - p_0) \cdot [d \times (p_2 - p_0)]}$ ,  $v = \frac{d \cdot (p_1 - p_0) \times [u \cdot (p_1 - p_0) + v \cdot (p_2 - p_0) - t \cdot d]}{(p_1 - p_0) \cdot [d \times (p_2 - p_0)]}$ ,  $t = \frac{(p_2 - p_0) \cdot (p_1 - p_0) \times [u \cdot (p_1 - p_0) + v \cdot (p_2 - p_0) - t \cdot d]}{(p_1 - p_0) \cdot [d \times (p_2 - p_0)]}$ , I calculated u, v and t through these formulas and added checks on these parameters.

Then I realized the AABB intersection, I confirmed the entering and exiting time of the ray and judged whether the intersection was valid.

After completing triangle and AABB intersection, the result of intersection test is as follows.

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```
===== Running 7 tests from 2 test suites.
[Global test environment set-up.
1 test from AABB
RUN   OK   AABB.AxisAligned_Exit_PositiveAndNegativeDirs (0 ms)
1 test from AABB (2 ms total)

6 tests from TriangleIntersect
RUN   OK   TriangleIntersect.Basic (0 ms)
RUN   OK   TriangleIntersect.MissCases (0 ms)
RUN   OK   TriangleIntersect.TimeWindow_RejectionAndClamping (0 ms)
RUN   OK   TriangleIntersect.TriangleInXZPlane_Hit (0 ms)
RUN   OK   TriangleIntersect.TriangleInXZPlane_Miss (0 ms)
RUN   OK   TriangleIntersect.DegenerateTriangle_ReturnsFalse (0 ms)
RUN   OK   TriangleIntersect.MultiTriangleMesh_HitCorrectTriangle (0 ms)
6 tests from TriangleIntersect (12 ms total)

Global test environment tear-down
7 tests from 2 test suites ran. (21 ms total)
PASSED 7 tests.
```

In bvh\_tree.h, I set up a stop criteria based on parameters CUT-OFF\_DEPTH, span\_left and span\_right and sorted the nodes in [span\_left, span\_right) according to their centroid's 'dim'-th dimension with function 'std::nth\_element'. The result of bvh test is as follows.

```
===== Running 3 tests from 1 test suite.
[Global test environment set-up.
3 tests from BVH
RUN   OK   BVH.BasicConstruction (0 ms)
RUN   OK   BVH.SingleObject (0 ms)
RUN   OK   BVH.EmptyTree (0 ms)
3 tests from BVH (5 ms total)

Global test environment tear-down
3 tests from 1 test suite ran. (10 ms total)
PASSED 3 tests.
```

In integrator.cpp, I completed the IntersectionTestIntegrator class, realizing functions like adding offsets for anti\_aliasing, updating ray direction, occlude detection and assigning color.

In BSDF.cpp, I modified PerfectRefraction::sample and set the 'interaction.wi' to the direction of the "in-coming light" after refraction or reflection.

## 3 Results

The result is a program for basic ray tracing, the results are as follows.

