

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      ] AABB.AxisAligned_EnterExit_PositiveAndNegativeDirs
[ OK       ] AABB.AxisAligned_EnterExit_PositiveAndNegativeDirs (0 ms)
===== 1 test from AABB (2 ms total)

===== 6 tests from TriangleIntersect
[ RUN      ] TriangleIntersect.Basic
[ OK       ] TriangleIntersect.Basic (0 ms)
[ RUN      ] TriangleIntersect.MissCases
[ OK       ] TriangleIntersect.MissCases (0 ms)
[ RUN      ] TriangleIntersect.TimeWindow_RejectionAndClamping
[ OK       ] TriangleIntersect.TimeWindow_RejectionAndClamping (0 ms)
[ RUN      ] TriangleIntersect.TriangleInXZPlane_Hit
[ OK       ] TriangleIntersect.TriangleInXZPlane_Hit (0 ms)
[ RUN      ] TriangleIntersect.DegenerateTriangle_ReturnsFalse
[ OK       ] TriangleIntersect.DegenerateTriangle_ReturnsFalse (0 ms)
[ RUN      ] TriangleIntersect.MultiTriangleMesh_HitCorrectTriangle
[ 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      ] BVH.BasicConstruction
[ OK       ] BVH.BasicConstruction (0 ms)
[ RUN      ] BVH.SingleObject
[ OK       ] BVH.SingleObject (0 ms)
[ RUN      ] BVH.EmptyTree
[ 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.

