

The Monte Carlo Tracer

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Abstract

In γ ray and cosmic ray astronomy it needs dedicated simulations of detectors to develop and run the instruments which observe particle interactions far beyond any energy accessible in the lab. The Monte Carlo Tracer exists since we do what we must, because we can.

Keywords: ray tracing, photon propagation

1. The scenery tree

1.1. The root of the scenery tree

The frame at the root of the tree structure represents the whole scenery. Before ray tracing is performed on the scenery tree, all frames in the tree estimate their position and orientation w.r.t. the root frame. This way rays can easily and fast be transformed back and forth from the root tree to an individual object frame.

2. How to set up a scenery in source code

We will build a little scenery of a house with a roof and chimney as well as a simple tree. Further we add a small telescope with a reflective imaging mirror. First we will define the geometry and their surfaces, second we will declare the relations between them. Third and finally we will update all frames relation w.r.t. the root frame to enable fast tracing (post initializing). First we define the main frame of our scenery. The main frame, often called world, will be the root of the scenery tree 1.1.

```
28 |   Frame world;  
29 |   world.set_name_pos_rot("World", Vector3D::null, Rotation3D::null);
```

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examples/set_up_scenery.cpp

Second we define frames that hold individual structures like a tree which will be composed from several objects. The tree will be placed in $x = 5$ m w.r.t. its later mother frame, i.e. the world.

```
31   Vector3D tree_pos(5.0, 0.0, 0.0);
32   Frame tree;
33   tree.set_name_pos_rot("My_Tree", tree_pos, Rotation3D::null);
34
35   Color leaf_green(0, 128, 0);
36   Sphere leaf_ball;
37   leaf_ball.set_name_pos_rot("leaf_ball", Vector3D(0.0, 0.0, 2.0), Rotation3D::null);
38   leaf_ball.set_outer_color(&leaf_green);
39   leaf_ball.set_sphere_radius(0.5);
40
41   Color wood_brown(64, 64, 0);
42   Cylinder tree_pole;
43   tree_pole.set_name_pos_rot("tree_pole", Vector3D(0.0, 0.0, 0.5), Rotation3D::null);
44   tree_pole.set_outer_color(&wood_brown);
45   tree_pole.set_radius_and_length(0.1, 1.0);
46
47   tree.set_mother_and_child(&leaf_ball);
48   tree.set_mother_and_child(&tree_pole);
```

examples/set_up_scenery.cpp

Also part of the tree is the wooden pole.

examples/set_up_scenery.cpp

and the rest of the source...

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