Procedural generation of dense canopy forest for virtual worlds

The internship will take place in the Maverick team at Inria Grenoble and be supervised by Thibault Tricard

Context

Landscape and forest are essential aspects of building a virtual world for a video game or for creating VFX. However, designing each tree and placing them by hand is too time-consuming. In this project, we want to find an efficient algorithm to generate dense canopy forests.

The canopy is the top portion of forests. In real life, the shape of a canopy is determined by the competition for the light plants need to grow. In dense forests, trees expand as much as they can until the top surface of the forest is fully occupied. This competition for resources creates a distinct aspect where each tree occupies a small portion of the top surface and does not intersect with each other.

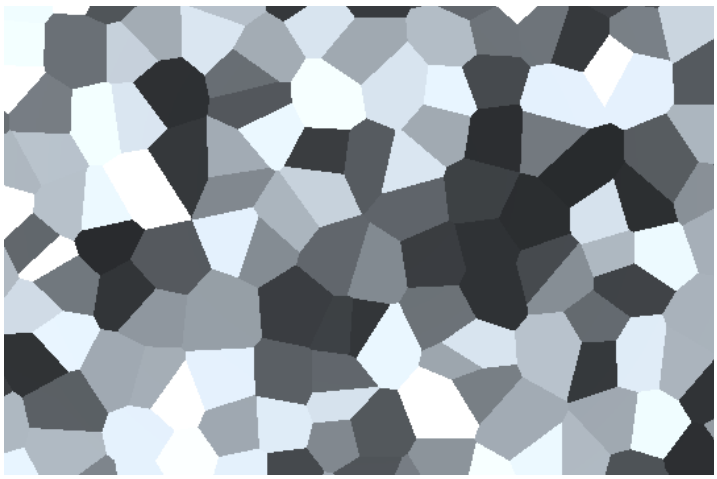
Tree growth can be simulated to create small sets of non-intersecting trees, but for large and dense forests a simulation would take too much time and use too much memory to be used in the industry (i.e. video game /VFX). To alleviate this effect we want to be able to generate a large set of non-intersecting trees without requiring simulations.

In this project, our goal is to design an algorithm to generate the geometry of a large set of non-intersecting 3D trees. This algorithm should have low complexity and be simple enough so

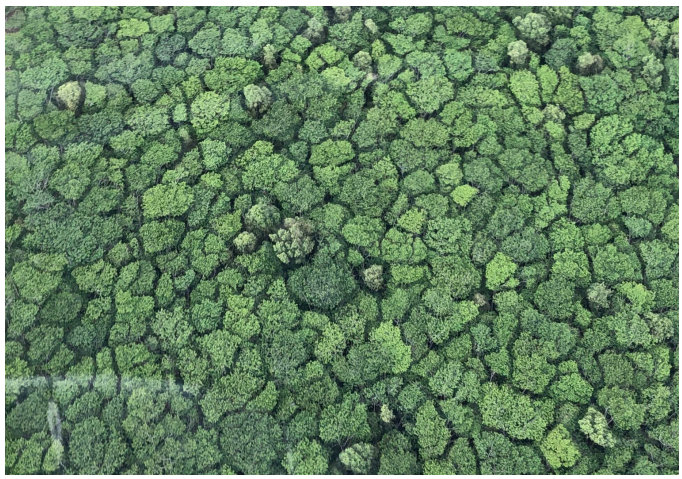
it can be used in the generation of large-scale forests for open-world video games and video special effects.

Internship project: Generating dense forest canopy from voronoï noise functions

The goal of this project is to explore the generation of dense forests using 2D Vornoï noise as a basis to generate coherent non-intersecting sets of trees. This function creates sets of convex non-intersecting cells that resemble the way trees organize in dense forest canopy.



2D Voronoï noise



Dense canopy seen from above

In this project, we will exploit the similarity between the two patterns to create realistic trees. To this end, we need to generate tree graphs that fill the noise cells while following the branching rules of the typical trees found in dense forests. These tree graphs will be used by a renderer to create impressive virtual scenes.
The student will be able to use pre-existing libraries and pieces of code for the rendering and the computation of voronoï noise, and will mainly focus on the extraction of the tree graphs.

Skills

- C++
- A good knowledge of graph manipulation would be a plus.
- An experience with OpenGL or Vulkan would be a plus.
- An experience with GLSL shading language would be a plus.

Contact:

For more informations send a mail to Thibault Tricard: thibault.tricard@inria.fr

Bibliography

Tree growth simulation:

- Interactive Modeling of Virtual Ecosystems, Eurographics Workshop on Natural Phenomena (2009)
- Modeling Trees with a Space Colonization Algorithm, Eurographics Workshop on Natural Phenomena (2007)
- Light-Guided Tree Modeling, Pacific Graphics (2015)

Voronoï noise:

- Wikipedia: https://en.wikipedia.org/wiki/Worley_noise
- Implementation: https://www.shadertoy.com/view/fljGRh