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Generation and Rendering of Fractal Terrain

Paper Reference: <https://worldcomp-proceedings.com/proc/p2013/CGV4061.pdf>

From a height map, the algorithm will read the elevation data at each pixels and generate a vertex at the height data. However, how can we generate a terrain without a heightmap that look realistic.

Landscapes are self-similar in that looking at the landscape at different scales exhibit same basic characteristics. For example, a big mountain contains several peaks and each peak when zoomed out contains smaller peaks. Fractals are similar in this nature. Therefore, this characteristic allows us to represent terrain as fractals

Fractals are often used in landscapes to make it realistic. In terrain generation, close-by points are close to each other so in generating vertex, we will take into account the proximity of their neighboring vertex.

Diamond-Square algorithm to have each point’s height depending in four directions of the grid. The algorithm is iterative process including:

1. Assign random altitudes to the four corners of a grid.
2. Diamond step: Average the four corners and add a random perturbation evenly distributed between –ri and ri. Assign this to the midpoint of the four corners.
3. Square step: For each diamond produced, average the four corners and add a random perturbation with the same distribution.
4. A screenshot of a diagram

   AI-generated content may be incorrect.Repeat this step

A computer screen shot of a program code

AI-generated content may be incorrect. Code:

**Result: A black and white background

AI-generated content may be incorrect.**

Rendering Fractal Terrains on Approximated Spherical Surfaces:

A triangle with text on it with Great Pyramid of Giza in the background

AI-generated content may be incorrect.The algorithm combines spherical approximation by tetrahedron subdivision and midpoint displacement.

1. Tetrahedron subdivision: The more we subdivide the tetrahedron, the better approximated the sphere is
2. As we subdivide the tetrahedron, we assign the check if the edge already exists. If it doesn’t, we assign random displacement offset to the midpoint. to generate another face of the triangle
3. Checking if the edge already exists:

**Implementation:**

Vertex structure contains position x, y, z

Node structure: reference each triangle face. Each node will store reference to its left, top, center and right child node, its parent node, and the three vertices defining the triangle, the three midpoint vertices the define the subdivision process, its node type

QuadTree structure: defines the whole QuadTree structure with a root node.

**Step:**

1. Initialize a new tetrahedron with two parameters: height variance and roughness constant. The height variance of a child node is equal with its parent multiplying by the roughness constant:

A computer screen shot of a program code

AI-generated content may be incorrect.

1. Subdivide the tree: initialize a queue with the list of nodes in order to perform bread first traversal. Once we reach the leaf node, we will subdivide the node (triangle)

A screen shot of a computer program

AI-generated content may be incorrect.

1. Subdivide the node: This function check to see its neighbor triangles have already been assigned a midpoint displacement. If not, it will assign a midpoint with displacement variance. Then the function will create four new children nodes left, right, top, center.

A black and white image of a triangle

AI-generated content may be incorrect.**Result:** The current code doesn’t work well to generate the terrain on the sphere. Its current result just generated a regular tetrahedron

Debugging: I am printing out the list of node vertice and realize that the vertice getting smaller and smaller. I think it is related to normalization issue. But I ran out of time to be able to fix it.

How to distribute the elevation”

1. Biome types: high elevations get snow, rock, tundra; medium elevations get shrubs, deserts, forests, and grassland; low elevations get rain forests, grassland, and beaches.
2. Rivers from high elevations down to the coast

High elevation: snow, rock, tundra

Whittaker categozorixed two abiotic factor: temperature and precipitation