Research and Development about
Voxels
Octrees
Level Of Details
Definitions

- **Model**
  - 3D mesh made of **points** and **triangles**

- **Voxel**
  - Volume element
  - Unit cell of 3D grid
  - A **box**
Definitions

• Octree
  • **Recursive** tree data structure
  • Store **positions, dimensions** and **data**
  • Each node can have **8 children nodes**

• Level Of Details
  • Amount of informations

• Bounding Box
  • Minimum and maximum points
Project Description

- Objectives
  - Create a **voxel world**
  - **Voxelize** a mesh
  - **Recursive** level of details
  - [Cellular automata]
  - [Game]
References

- Voxlap
- Minecraft
- Cell Emergence
Libraries

- WebGL ThreeJS
  - Universal Internet browser
  - Modern javascript framework
  - Easy to use examples
Routine Procedure

- **Setup**
  - Voxel **Engine**
  - Mesh **Voxelization**
  - Octree **Insertion**

- **Update**
  - Voxel **Raycasting**
  - Octree **Visualization**
  - Level Of Details **Localised**
Voxel Engine

- A grid represented by a **list** (size*size*size)
- **Unique** index from space position
- 3D position from voxel index
- 8 grids for each **octant**

// Get index from position
round ( x + y * (sizeX * sizeZ) + z * sizeX )

// Get position from index
x = index % sizeX
y = floor ( index / ( sizeX * sizeZ ) ) % sizeY
z = floor ( index / sizeX ) % sizeZ
Voxel Display Optimisation

• Do not
  • Create numerous object to render

• Do
  • **Merge** geometries into one mesh

• Only one draw call to GPU
Voxel Raycasting

- **Picking** voxel
  - Test **raycast** on the **voxel mesh**
  - **Offset** with **face normal**
  - **Round** hit position

- **Manipulate** voxel
  - Create
  - Clear
Mesh Voxelization

- Iterate **mesh triangles**
  - Iterate voxels in **triangle bounding box**
    - Test overlapping voxel / triangle

- Fill volume
  - Iterate voxels **slice of bounding box**
    - Iterate **voxels columns**
      - Test triangle normals
      - Fill column between two voxels
Octree Insertion

- **Insert** point in **root node**
  - Node **have children** nodes
    - **Insert** point in **child node**
  - Already **have a point**
    - **Split** node (create children)
    - **Reinsert** previous point in **child node**
    - **Insert** new point in **child node**
  - Have **no point** stored
    - **Store** point in **current node**
Octree Visualization

- Iterate with **fixed scope**
  - Recurrence test
  - Split leaf nodes

- Explore from a point
  - Distance Test
  - Show voxels in a range
  - **Local level of details**
Local Level Of Details

- Radius range with logarithmic falloff
  - Camera position
  - Mouse raycast hit position
Generate Depth

• Split octree node
• Rules
  • Random
  • [Shrink]
  • [Cellular automata]
Interface

• Made with Dat GUI
• Prototype friendly

Controls

• Orbit camera
• First person camera
Debriefing

- Futur engine
- Cellular automata
- Game