CRYPTO-COMPRESSION OF 3D OBJETS

CONCEPT

3D Crypto-Compression relies on an efficient data representation coupled to an encryption algorithm.

By implementing the Edgebreaker algorithm, which efficiently traverses the mesh to describe its connecivity, we can store the triangle/vertex incidence graph on 2 to 3 bits per vertex.

Positions are quantized and stored as coordinates on a regular grid. This step reduces the representation of a vertex to 30 bits with minimal loss.
Compressing normals can be achieved by representing them as a 17 bits index to a dictionary. By pre-computing 2^{17} normals, we can achieve perceptually lossless compressions of the data.

Encryption is done with a Geometry Preserving Algorithm capable of preserving the 3D nature of our data and its bounding box, while occluding any pertinent information.

KEY PAPERS

Michael Deering, “Geometry Compression”, sun Microsystems, 1995

Jarek Rossignac, “Edgebreaker: Connectivity compression for triangle meshes”, Georgia Institute of Technology, 1999

Jarek Rossignac, “3D mesh compression”, College of Computing and GVU Center Georgia institute of Technology, January 2003

Marc Éluard, Yves Maetz, and Gwenaël Doërr, "Geometry-preserving Encryption for 3D Meshes", Technicolor R&D France, November 2013

First we load a 3D model.

Its vertices, positions and normals are represented by 3D points/vectors (3 floats, 96 bits).

Each triangle is represented by 3 ints, 96 bits

3D MODEL

We quantize vertices positions on a discrete grid, and normals on a precalculated dictionary.

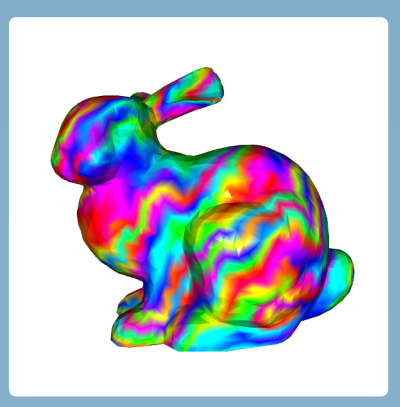
This step compresses data as positions are now represented on 30 bits and normals on 17 bits.

QUANTIZATION

Edgebreaker compresses the mesh by representing triangle strips on a low entropy format.

This step can squish a triangle in 1.5 bits, but 3 bits is a more realistic representation for worst case scenarios.

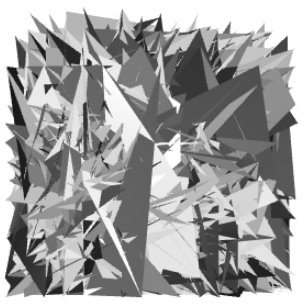
EDGEBREAKER



Then, we use a Geometry Preserving Encryption.

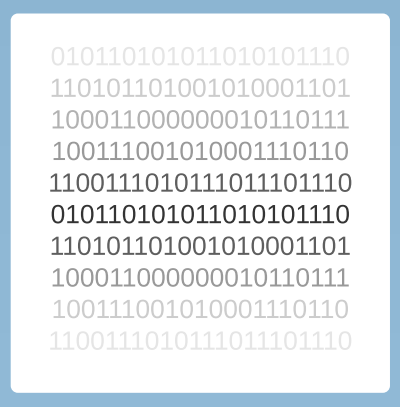
This is an encryption algorithm capable of preserving the 3D nature of our data while concealing its shape.

ENCRYPTION



Finally, an entropic compression can be done to further increase the compression ratio.

ENTROPIC COMPRESSION



Finally, a 3D model is returned.

That 3D model could either be "scrambled" if we used the wrong key during decryption, or a quantized mesh if we used the right key

3D MODEL

We use the Edgebreaker decompression to reconstruct our mesh.

EDGEBREAKER

Then we decrypt our data using a key. As the algorithm is geometry preserving, it will give us inteligible data even without the right key.

DECRYPTION

First, we decompress our file.

ENTROPIC DECOMPRESSION