TetGAN: A Convolutional Neural Network for Tetrahedral Mesh Generation.

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Method

Convolution & Down/Up-sampling

TetGAN uses operators defined using key properties of tetrahedra:

- **Convolution**: To define a convolution, we simply operate over the fixed-sized immediate neighborhood of each tetrahedron.
- **Down/up-sampling**: To define down/upsampling, we observe that any tetrahedron may be divided into 8 sub-tetrahedra. By iterative subdivision starting from a low-resolution grid with large tetrahedra, we may construct higher-resolution grids such that groups of 8 tetrahedra may be aggregated into one super-tetrahedron.

Pipeline

The input shape is represented as a feature field over the tetrahedral grid. The shape is encoded into a latent vector $Z$, which is decoded back into a feature field from which an output shape may be extracted. Two discriminators operating at the global and per-tetrahedron level learn to classify a sampled feature field as real or fake.

Deformation-based Laplacian Smoothing

In order to achieve smoother results, we apply Laplacian smoothing weighted by cosines between network-predicted deformations. We observe this weighting achieves sharper fine features than standard Laplacian smoothing with cotangent weights.

Experiments

Ablations

- Full TetGAN
- No Patch Discriminator
- No Global Discriminator
- TetGAN (VAE)

Novel Synthesis

- Hold-out Reconstruction
- Novel Sampling
- Shape Interpolation

TetGAN demonstrates mesh editing capabilities through latent arithmetic. The boxed feature in the background indicates the desired insertion feature. We subtract the mesh in the background to isolate the selected feature. Then, we add this encoding to the red base mesh, which gives the result.