GENERIC ATTRIBUTE DEVIATION METRIC FOR ASSESSING MESH SIMPLIFICATION ALGORITHM QUALITY

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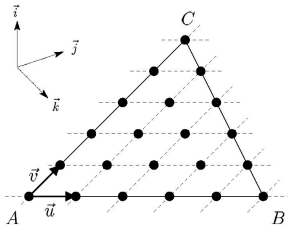
Abstract

We propose a **mesh comparison** method using a new **Attribute Deviation Metric** (ADM). Considered meshes contain geometric and appearance attributes (material colors, textures, normals,...). The proposed deviation metric computes **local differences between attributes** of two meshes. Mesh comparison assessment can be done easily and quickly using this metric. We present an application to mesh simplification algorithm quality assessment and mesh smoothing evaluation.

Introduction

Attribute deviation metric is used to **compare two meshes**. Main advantages are:

- **Generality**:
  - ADM is suitable for real scene numerical models and synthetic models.
  - ADM manages geometric features as well as other surface attributes.
  - Comparison method is independent of the viewpoint and the attribute type.
- **Locality**:
  - Assessments are done for given points on the mesh surface.
  - Assessment resolution can be increased by a surface sampling method.



Surface sampling method

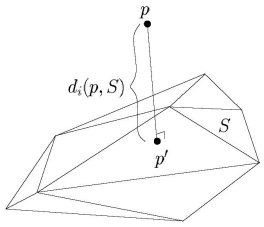
- **Applications**:
  - Mesh processing algorithm characterization and comparison (simplification, segmentation…).
  - Reverse engineering (comparison between a CAD model and a numerical model of the real object).

Attribute Deviation Metric

Given a surface S and a point $p \in \mathbb{R}^3$, the deviation $d_i(p,S)$ between the attribute i of the point p and the surface S is defined as:

$$d_i(p,S) = \left\| f_i(p) - f_i(N_s(p)) \right\|$$

with $N_s(p)$ the nearest point to p on the surface S, *and* $f_i(p)$ the attribute i of the point p.



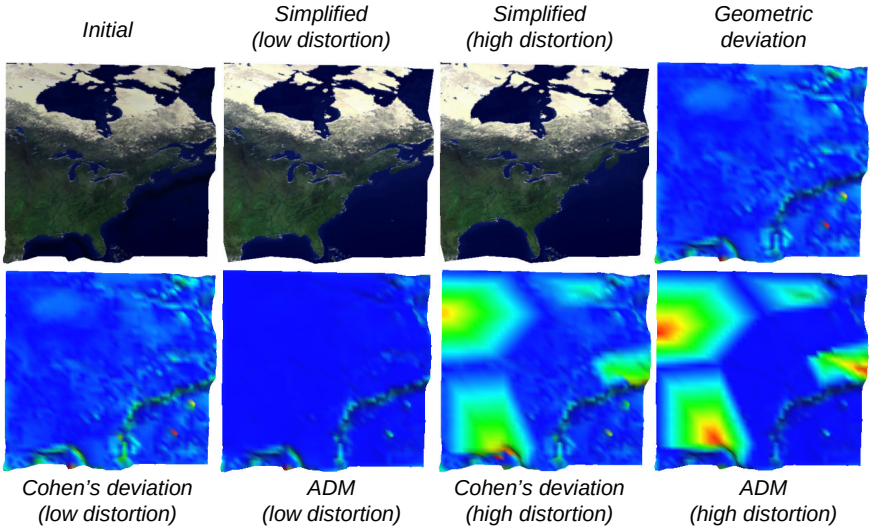
Deviation Assessment

Given two meshes M_a and M_b, their respective surface S_a and S_b, and a set P of points $\{p_j \mid p_j \in S_a \text{ and } j=1,\ldots,m\}$, the deviation $D_i(M_a|_P, M_b)$ of the attribute i between $M_a|_P$ and M_b is defined as:

$$D_i(M_a|_P, M_b) = \left\{ d_i(p_j, S_b) \mid j = 1,\ldots,m \right\}$$

- Attribute deviation assessments allow to **highlight local differences between two meshes**.
- Mesh M_a is called **reference mesh** and is **restricted to a point set** taken on its surface (constituting the measurement points for the attribute deviation metric).
- ADM is guided by the geometrical correspondence between meshes, and is **not symmetric** (if meshes M_a and M_b are inverted, results may be different).

Comparison Between Attribute Deviation Metric and Cohen's Texture Deviation Metric

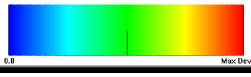


Cohen's texture deviation

(SIGGRAPH'98)

$$T_i(p_a, S_b) = d(p_a, F_b^{-1}(F_a(p_a)))$$

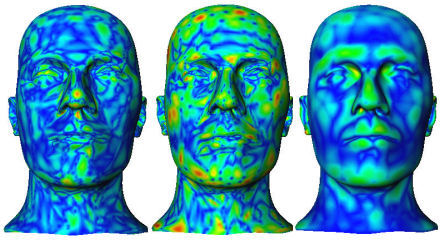
Color scale



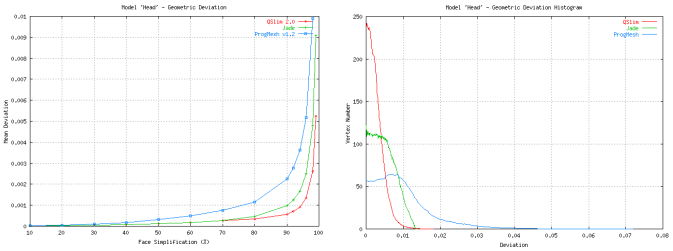
Conclusion

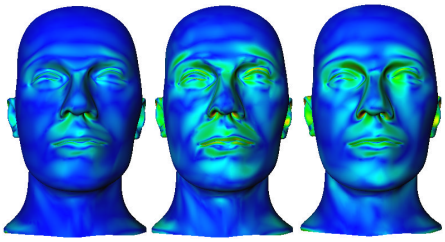
- ADM gives more precise results.
- If there is no texture distortion, Cohen's measurement indicates a deviation coming from strictly geometric distortion.

Mesh Simplification Algorithm Quality

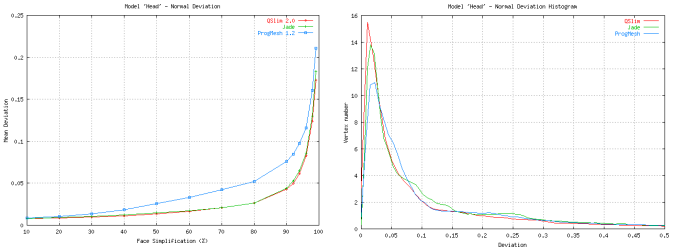


Geometric Deviation

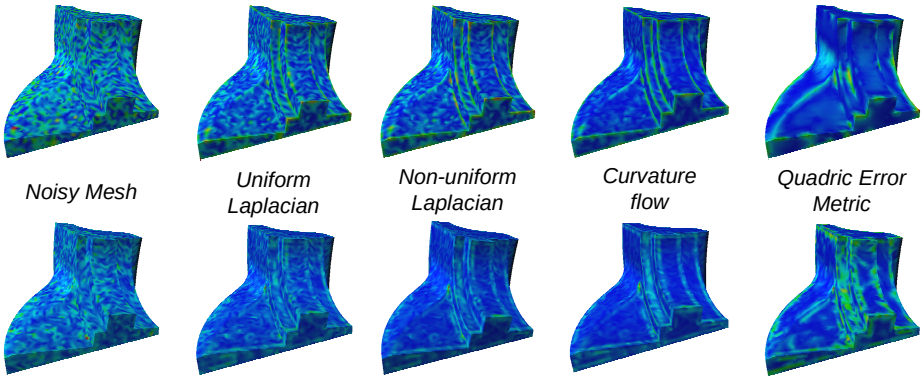




Normal Deviation



Mesh Smoothing Evaluation



Geometric Deviation

Normal Deviation