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Geometry compression based on normal uncertainty

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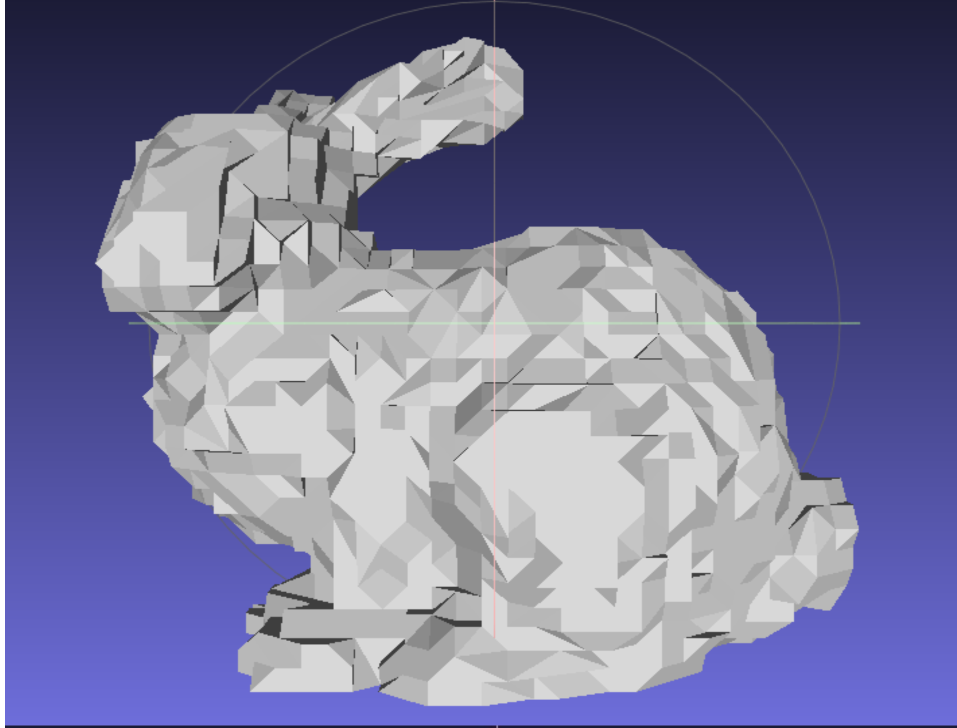
Supported by:
SGS-2022-015 Nové metody pro medicínská, prostorová a komunikační data
GAČR 22-04622L Data compression paradigm based on omitting self-evident information - COMPROMISE

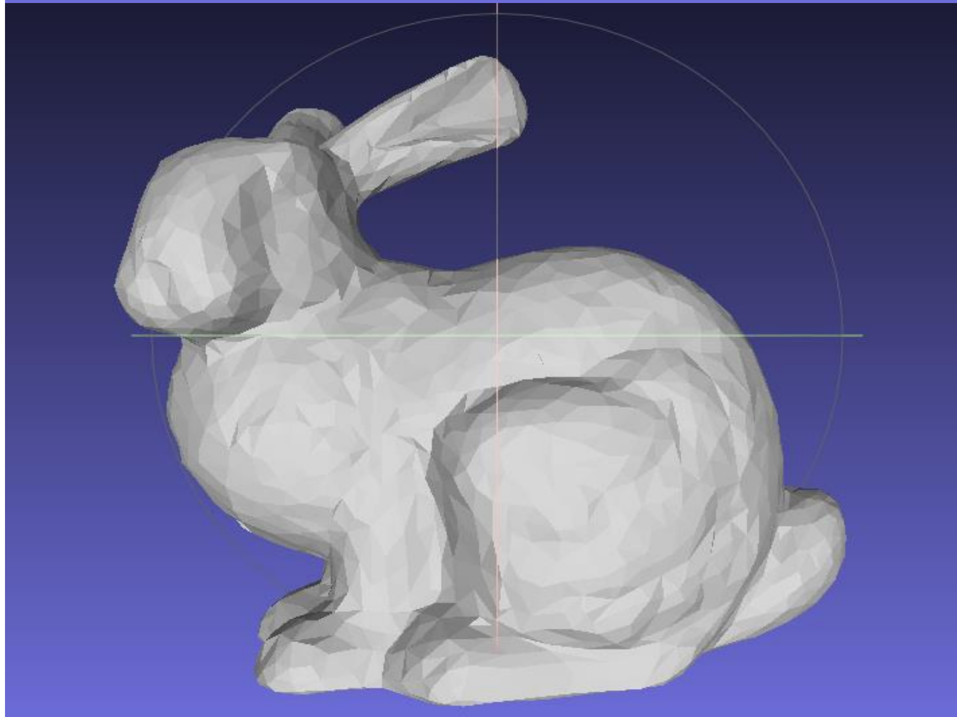
Mesh compression:

- geometry compression – about 10 bpv
- connectivity encoding – 1-2.5 bpv

Our method:

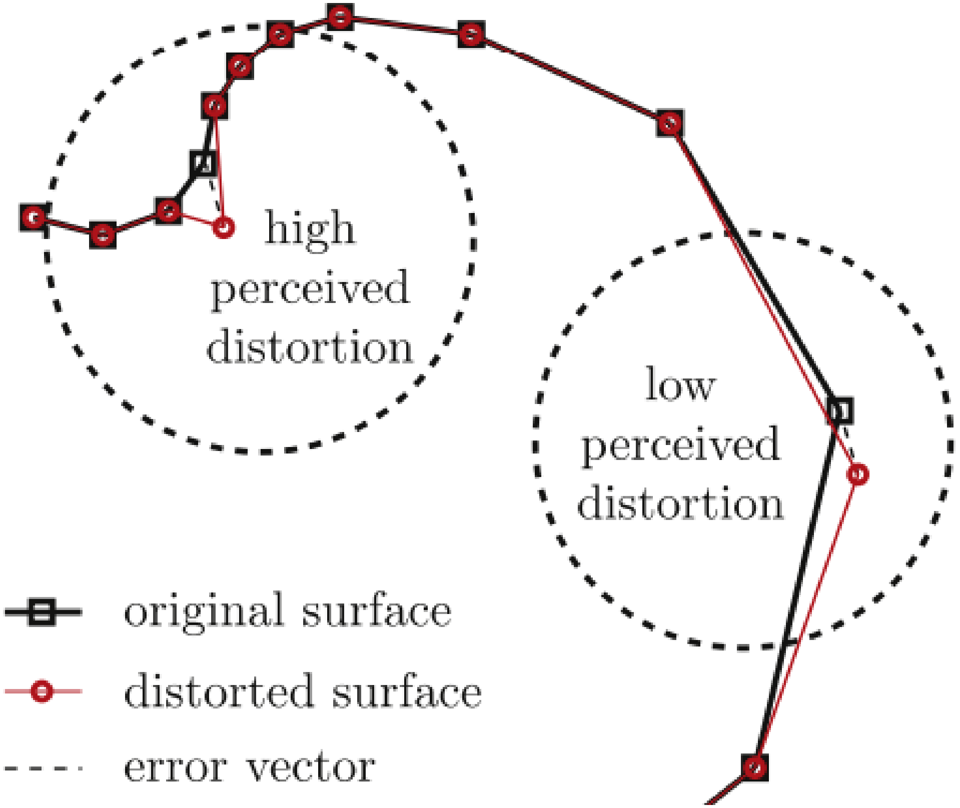
- progressive geometry compression
- connectivity is known





Not all vertices are required at the same precision.

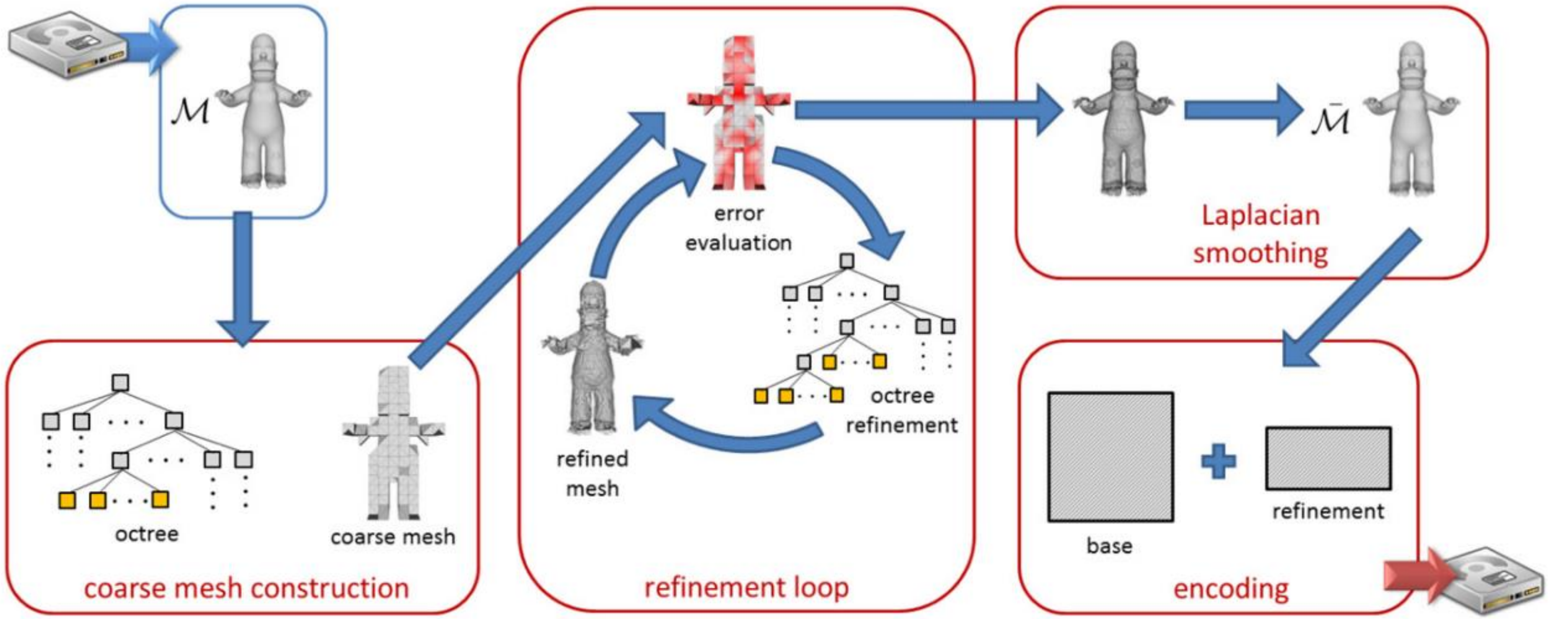
Classical metrics will evaluate this error differently than perception metrics.



Perception-driven adaptive compression of static triangle meshes

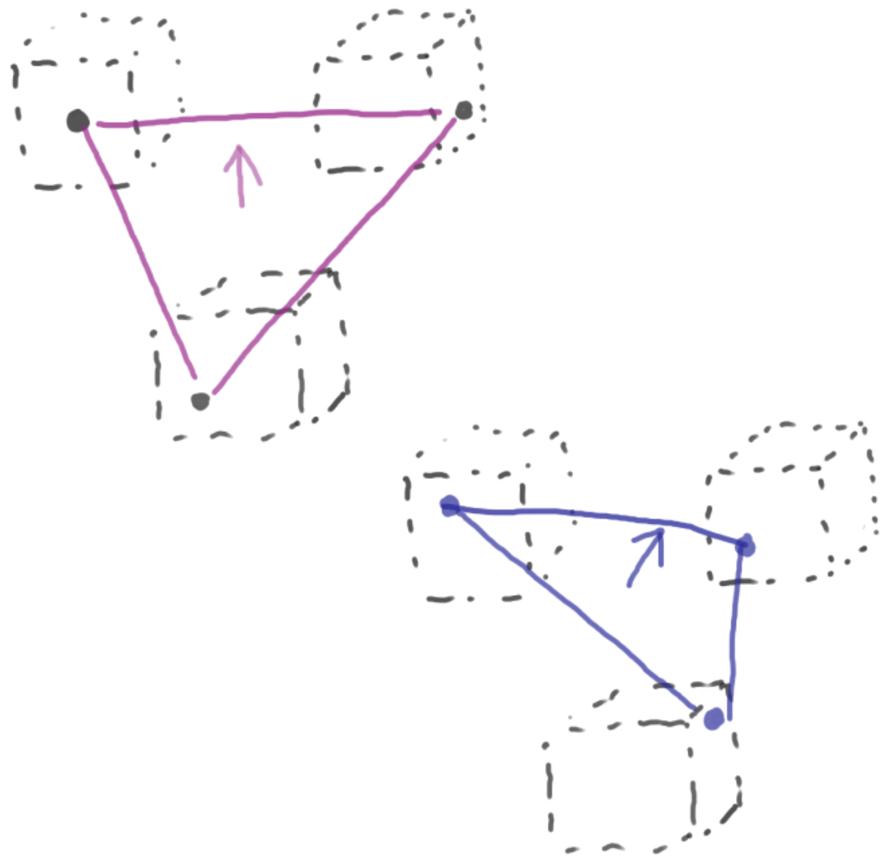
Stefano Marras, Libor Váša, Guido Brunnett, Kai Hormann

- progressive refinement
- refinement in areas contributing to bad metric score
- position of areas to be refined must be a part of the encoded data



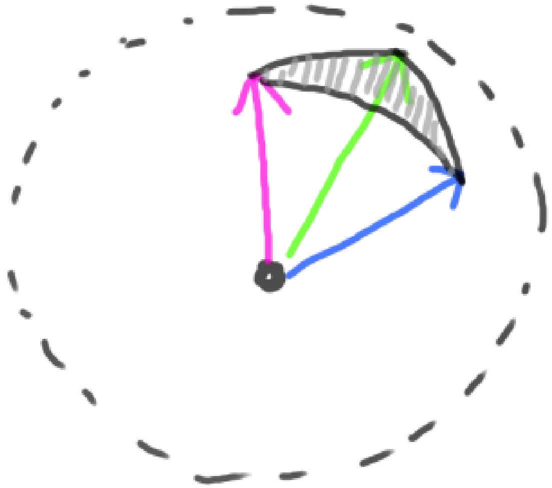
Our method:

- encoder and decoder both know, which area needs refinement next
- avoids using refinement position data
- first encodes a low precision base mesh
- uncertainty in vertex position contributes to the uncertainty of triangle normal direction
- high uncertainty of triangle normal = need for further refinement
- position and size of cells where vertices can exist both affect the uncertainty



Every edge configuration of vertex positions specifies a triangle normal, that can be drawn from the center of a unit sphere.

- likely specifies a “polygon” on the sphere
- all normals with end points within this polygon are possible
  - but not equally likely
  - some configurations result in the same normal
  - points are likely to be near the current estimated surface
- the polygon is connected to the amount of normal uncertainty



Encoder and decoder can both calculate the normal uncertainty for the current version of the mesh.

- the placement of additional precision bits is known without transferring additional data

Precision is added by:

- splitting an octree cell
- adding a bit to quantized coordinates
- splitting a cell by a plane that will add the most information
- …

In every step of the refinement, one vertex is improved.

- improvement can be streamed bit-by-bit
- has to be very fast to be useful
- depends on very efficient uncertainty estimation

Question 1

- Is there a way to calculate the normal uncertainty in a closed form?
  - from polygon surface area?
- What about when we consider that not all possible normals are equally likely?
- How to do it fast?

- Could use a Monte Carlo sampling method, if not many samples are needed to be accurate, and samples are fast to evaluate.

Question 2

- Is there a good way to determine the starting precision for the base mesh?
- Maybe when no normal is entirely uncertain? Is there such a point that we could easily detect? Some condition the base mesh can fulfill, e.g., all vertices are alone in an octree leaf?
- Cells may not be aligned due to prediction schema, perhaps subdivide until cells are not covering each other?

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Thank you for your attention.

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