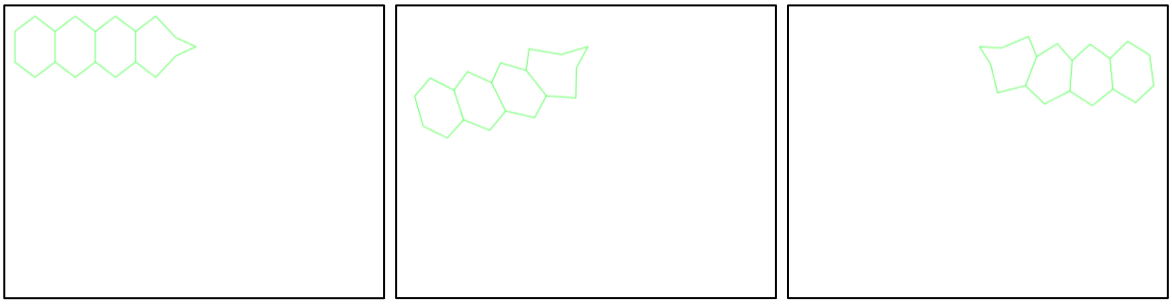
Fast polyhedral dynamics

In recent years, fast simulation methods for the dynamics of elastic object have seen impressive improvements (see for example Macklin et al., Unified particle physics for real-time applications, doi/10.1145/2601097.2601152, or Chen at al., Vertex Block Descent, doi/10.1145/3658179).

Most common discretization approaches are either particles, or finite elements (tetrahedra or hexahedra), however, there are also ways to use general polyhedral elements (see for example Liu et al., Polyhedral Discretizations for Elliptic PDEs, arxiv/2412.06164, or Xu et al., Stabilization-free virtual element method for 3D hyperelastic problems, doi/10.1007/s00466-024-02501-4).

The goal of this project is to combine a (relatively simple) polyhedral element formulation with a VBD-style solver and implement a fast GPU-based (CUDA or similar) simulation for elastic deformation (potentially with extension towards fracture, where the additional freedom provided by polyhedral elements would be especially convenient). Ideally, the result would be competitive with recent PBD/VBD-based methods and eventually enable detailed fracture simulation by supporting general polyhedral elements.

As a starting point, a basic Matlab implementation (example images below) of the core idea exists, which should be translated to an efficient, parallel GPU (CUDA) implementation.



Eventually we'd like to achieve results similar to these examples:

https://graphics.cs.utah.edu/research/projects/avbd/

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