Contribution ID: **12** Type: **Academic talk (15min)**

Reducing the dynamics of deformable complex surfaces.

Saturday, 2 July 2022 14:00 (20 minutes)

Simulating dynamics of deforming surfaces is very expensive, particularly when internal forces, acting on vertices and/or their connecting faces, require real-time update, and especially because the 2-dimensional objects embedded in 3D spaces are meshes with hundreds of thousands of vertices. The dynamical behavior of such structure is governed by Newton's law of motion for mechanical systems under internal and external forces, $\mathbf{M}\ddot{q}(t) = f_{int}(q(t)) + f_{ext}$.

Utilizing the variational formulation of the system, we can write positions $q(t) \in \mathbb{R}^{N\times 3}$ of vertices at different time steps, as a minimizer that compromises between both momentum and potential energies accompanying the mechanical structure. The computations then can be divided into many parallel local nonlinear solves and one linear global solve; this is well known as the projective dynamics scheme.

The nonlinear internal forces, such as bending and strain, express and control the material behavior of the surface as a geometrical object and they require re-computation at every time step. External forces typically remain constant during computations.

We explore tackling the computational complexity of the problem by projecting to a low dimensional reduced subspace, we consider different candidate methods, namely proper orthogonal decomposition, localized sparse-PCA and localized quaternion-PCA. We compare to skinning subspaces which have been introduced earlier in literature.

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Session Classification: Scientific program Saturday