

vec, inversevec, diag, svd from linearalgebra

ElementSets from MeshConnectivity

NeighborVerticesInFace, Faces, Vertices, VertexOneRing, OrientedVertices from TetrahedronNeighborhoods(M)

M : TetrahedralMesh

$\bar{x}_i \in \mathbb{R}^3$ rest pos

$x_i \in \mathbb{R}^3$ current pos

$bx_j \in \mathbb{Z}$, index boundary indices

$bp_j \in \mathbb{R}^3$ boundary positions

$w \in \mathbb{R}$ penalty

$\varepsilon \in \mathbb{R}$ eps

$psd : \mathbb{R}^{p \times p} \rightarrow \mathbb{R}^{p \times p}$, sparse

$infinity : \mathbb{R}$

$V, E, F, C = ElementSets(M)$

$vol_{i,j,k,l} = \frac{1}{6} \cdot |[\bar{x}_j - \bar{x}_i \quad \bar{x}_k - \bar{x}_i \quad \bar{x}_l - \bar{x}_i]|$ where $i, j, k, l \in V$

$mr(s) = [\bar{x}_b - \bar{x}_a \quad \bar{x}_c - \bar{x}_a \quad \bar{x}_d - \bar{x}_a]$

where

$s \in C$

$a, b, c, d = OrientedVertices(s)$

$S(s, x) = \begin{cases} infinity & \text{if } |m| \leq 0 \\ vol_{a,b,c,d} \left(\|J\|^2 + \|J^{-1}\|^2 \right) & \text{otherwise} \end{cases}$

where

$s \in C$

$x_i \in \mathbb{R}^3$

$a, b, c, d = OrientedVertices(s)$

$m = [x_b - x_a \quad x_c - x_a \quad x_d - x_a]$

$J = m \cdot mr(s)^{-1}$

$EXPS(s, x) = \begin{cases} infinity & \text{if } |m| \leq 0 \\ vol_{a,b,c,d} \cdot e^{\|J\|^2 + \|J^{-1}\|^2} & \text{otherwise} \end{cases}$

where

$s \in C$

$x_i \in \mathbb{R}^3$

$a, b, c, d = OrientedVertices(s)$

$m = [x_b - x_a \quad x_c - x_a \quad x_d - x_a]$

$J = m \cdot mr(s)^{-1}$

$AMIPS(s, x) = \begin{cases} infinity & \text{if } |m| \leq 0 \\ vol_{a,b,c,d} \cdot e^{\frac{1}{2} \left(\frac{\|J\|^2}{3} + \frac{1}{2} (\|J\| + \|J^{-1}\|) \right)} & \text{otherwise} \end{cases}$

where

$s \in C$

$x_i \in \mathbb{R}^3$

$a, b, c, d = OrientedVertices(s)$

$m = [x_b - x_a \quad x_c - x_a \quad x_d - x_a]$

$J = m \cdot mr(s)^{-1}$

$CAMIPS(s, x) = \begin{cases} infinity & \text{if } |m| \leq 0 \\ vol_{a,b,c,d} \left(\frac{\|J\|^2}{2} \right) & \text{otherwise} \end{cases}$

where

$s \in C$

$x_i \in \mathbb{R}^3$

$a, b, c, d = OrientedVertices(s)$

$m = [x_b - x_a \quad x_c - x_a \quad x_d - x_a]$

$J = m \cdot mr(s)^{-1}$

$E2 = w \sum_j \|bp_j - x_{bx_j}\|^2$

$e = \sum_{i \in C} S(i, x) + E2$

$G = \frac{\partial e}{\partial x}$

$H = \sum_{i \in C} psd \left(\frac{\partial^2 S(i, x)}{\partial x^2} \right) + psd \left(\frac{\partial^2 E2}{\partial x^2} \right)$