vec, inversevec, diag, svd from linearalgebra

ElementSets from MeshConnectivity

NeighborVerticesInFace, Faces, VertexOneRing, OrientedVertices from Neighborhoods(M)

$$
\begin{aligned}
& M: \text{ TriangleMesh} \\
& \bar{x}_i \in \mathbb{R}^3 \text{ rest pos in 3D} \\
& x_i \in \mathbb{R}^2 \text{ current pos in 2D} \\
& \varepsilon \in \mathbb{R} \text{ eps}
\end{aligned}
$$

$$
\begin{aligned}
V, E, F &= \mathit{ElementSets}(M) \\
S(f, x) &= \begin{cases} 0 & \text{if } |m| <= 0 \\ A \ \left(\|\mathfrak{J}\|^2 + \|\mathfrak{J}^{-1}\|^2\right) & \text{otherwise} \end{cases} \\
& \text{where} \\
& \quad f \in F \\
& \quad x_i \in \mathbb{R}^2 \\
& \quad a, b, c = \mathit{OrientedVertices}(f) \\
& \quad n = (\bar{x}_b - \bar{x}_a) \times (\bar{x}_c - \bar{x}_a) \\
& \quad b1 = \frac{\bar{x}_b - \bar{x}_a}{\|\bar{x}_b - \bar{x}_a\|} \\
& \quad b2 = \frac{n \times b1}{\|n \times b1\|} \\
& \quad ar = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \\
& \quad br = \begin{pmatrix} (\bar{x}_b - \bar{x}_a) \cdot b1 \\ 0 \end{pmatrix} \\
& \quad cr = \begin{pmatrix} (\bar{x}_c - \bar{x}_a) \cdot b1 \\ (\bar{x}_c - \bar{x}_a) \cdot b2 \end{pmatrix} \\
& \quad m = \begin{bmatrix} x_b - x_a & x_c - x_a \end{bmatrix} \\
& \quad mr = \begin{bmatrix} br - ar & cr - ar \end{bmatrix} \\
& \quad A = \tfrac{1}{2} \ |mr| \\
& \quad \mathfrak{J} = m \ mr^{-1} \\
psd(x) &= u \ \ \mathrm{diag}(ps) \ \ v^T \\
& \text{where} \\
& \quad x \in \mathbb{R}^{p \times p} \\
& \quad u, sigma, v = \mathrm{svd}(x) \\
& \quad ps_i = \begin{cases} sigma_i & \text{if } sigma_i > 0 \\ 0 & \text{otherwise} \end{cases} \\
\mathit{Energy}(x) &= \sum_{i \in F} S(i, x) \text{ where } x_i \in \mathbb{R}^2 \\
e &= \mathit{Energy}(x) \\
H &= \sum_{i \in F} psd\left(\frac{\partial^2 S(i, x)}{\partial x^2}\right) \\
G &= \frac{\partial e}{\partial x} \\
d &= H^{-1}(-G) \\
y &= \begin{cases} \mathrm{vec}^{-1}{}_x(\mathrm{vec}(x) + 0.1 \ \ d) & \text{if } \sqrt{-d \cdot G} > \varepsilon \\ x & \text{otherwise} \end{cases}
\end{aligned}
$$