Shape from Sensors

A new approach to 3D reconstruction using inertial sensors

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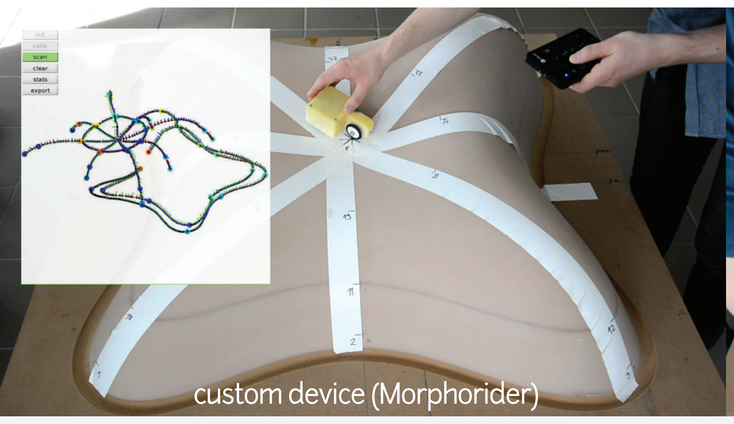
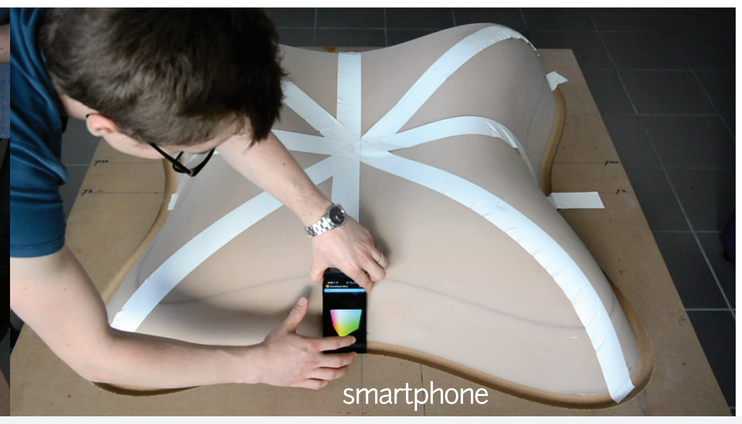
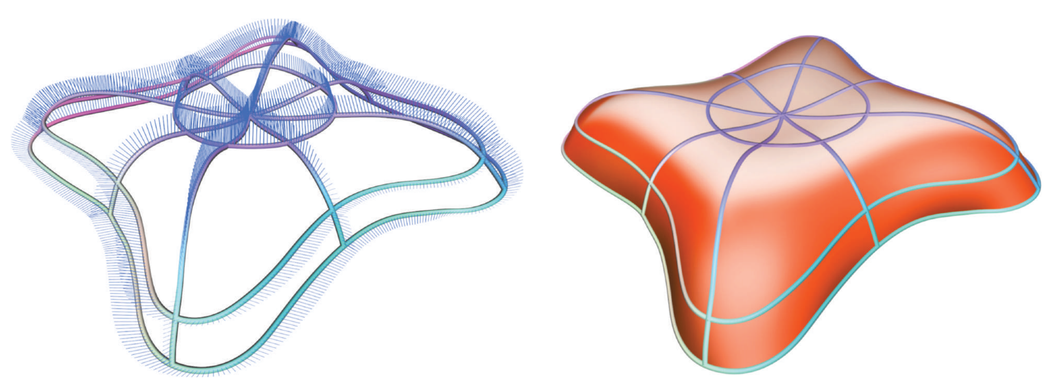
Framework overview

1. Acquisition of orientations
2. Curve network + normals
3. Surfaced network







Main challenges

• no positions, only orientations • inconsistent data at curve intersections • noisy sensor measurements •

Key ingredients

• general, unified formulation • discrete representation (polylines, meshes) • constrained optimization •

a) Orientation filtering via regression on SO(3)

"Riemannian smoothing spline & normal constraints at intersections"

$$\text{minimize } E_{approx} + \lambda E_{stretch} + \mu E_{bend} + \xi E_{normal}$$

b) Poisson reconstruction of curve positions

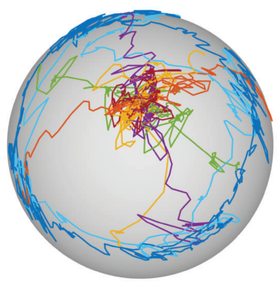
"Laplacian of curve positions is the divergence of the tangent field"

$$\Delta x = \nabla \cdot T \rightarrow \text{solve } Ax = b$$

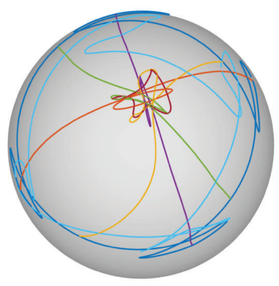
c) Variational surfacing with normal control

"Laplacian of surface positions is the mean curvature normal"

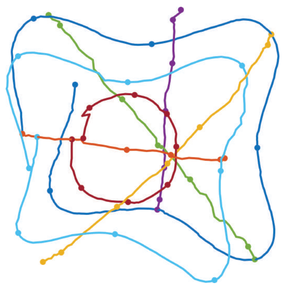
$$\Delta s = -2HN \rightarrow \text{minimize } \iint_M \| \Delta s + 2HN \|^2$$



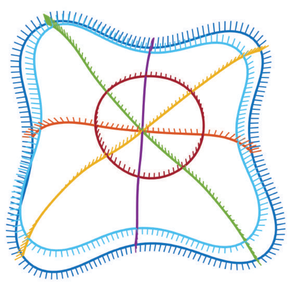
raw orientations
(normal component)



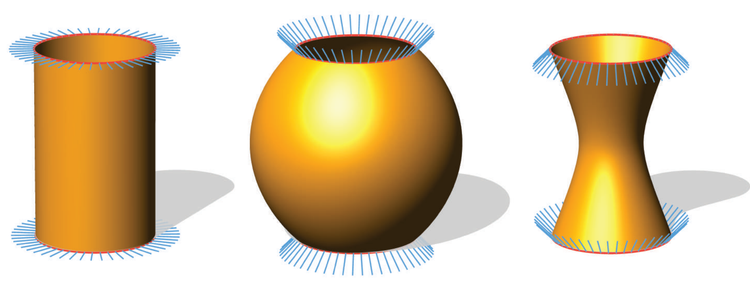
filtered orientations
(normal component)



direct integration
using forward Euler

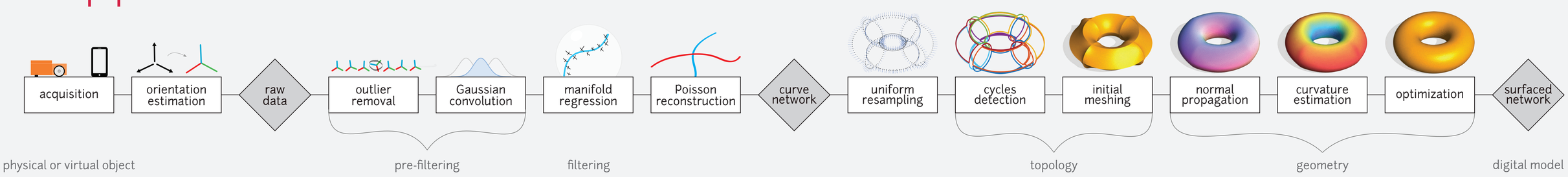


Poisson integration
of orientations



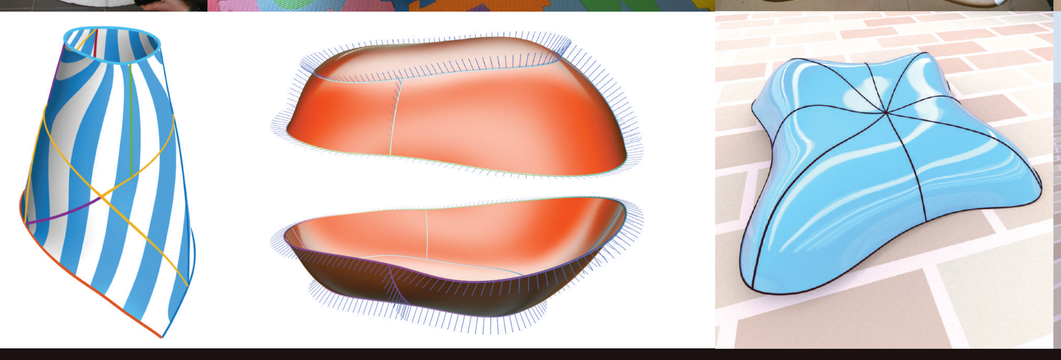
final shape is guided by the normal field along constrained curves

Full pipeline

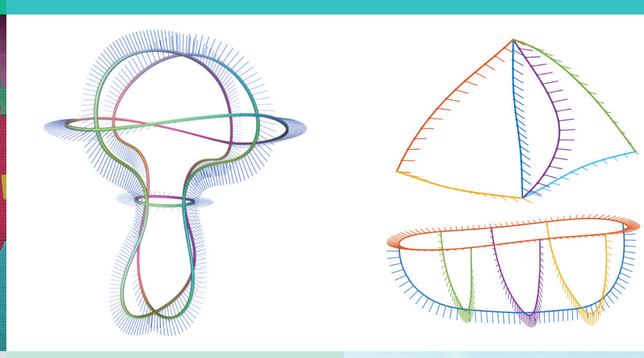


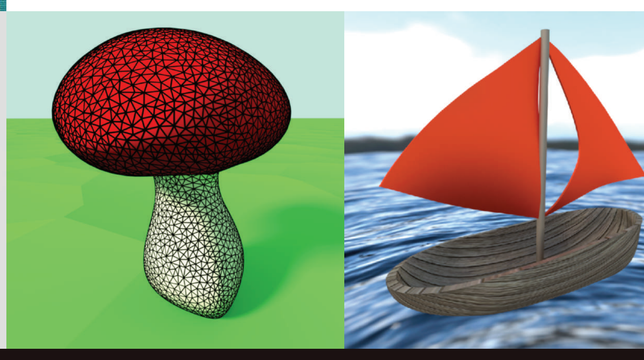
Applications

reconstruction (physical objects)



sketching (virtual objects)





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[2] Stanko T. "Shape reconstruction of meshed smooth surfaces equipped with inertial sensors". PhD thesis, Université Grenoble Alpes, December 2017.
[3] Stanko T., S. Hahmann, G.–P. Bonneau, and N. Saguin-Sprynski. "Shape from sensors: Curve networks on surfaces from 3D orientations". In: Computers & Graphics 66 (Proc. SMI), August 2017. (Best Paper Award)
[4] Stanko T., S. Hahmann, G.–P. Bonneau, and N. Saguin-Sprynski. "Surfacing curve networks with normal control". In: Computers & Graphics 60, November 2016.
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