

Geometric Registration for Deformable Shapes

4.3 Practical Animation Reconstruction

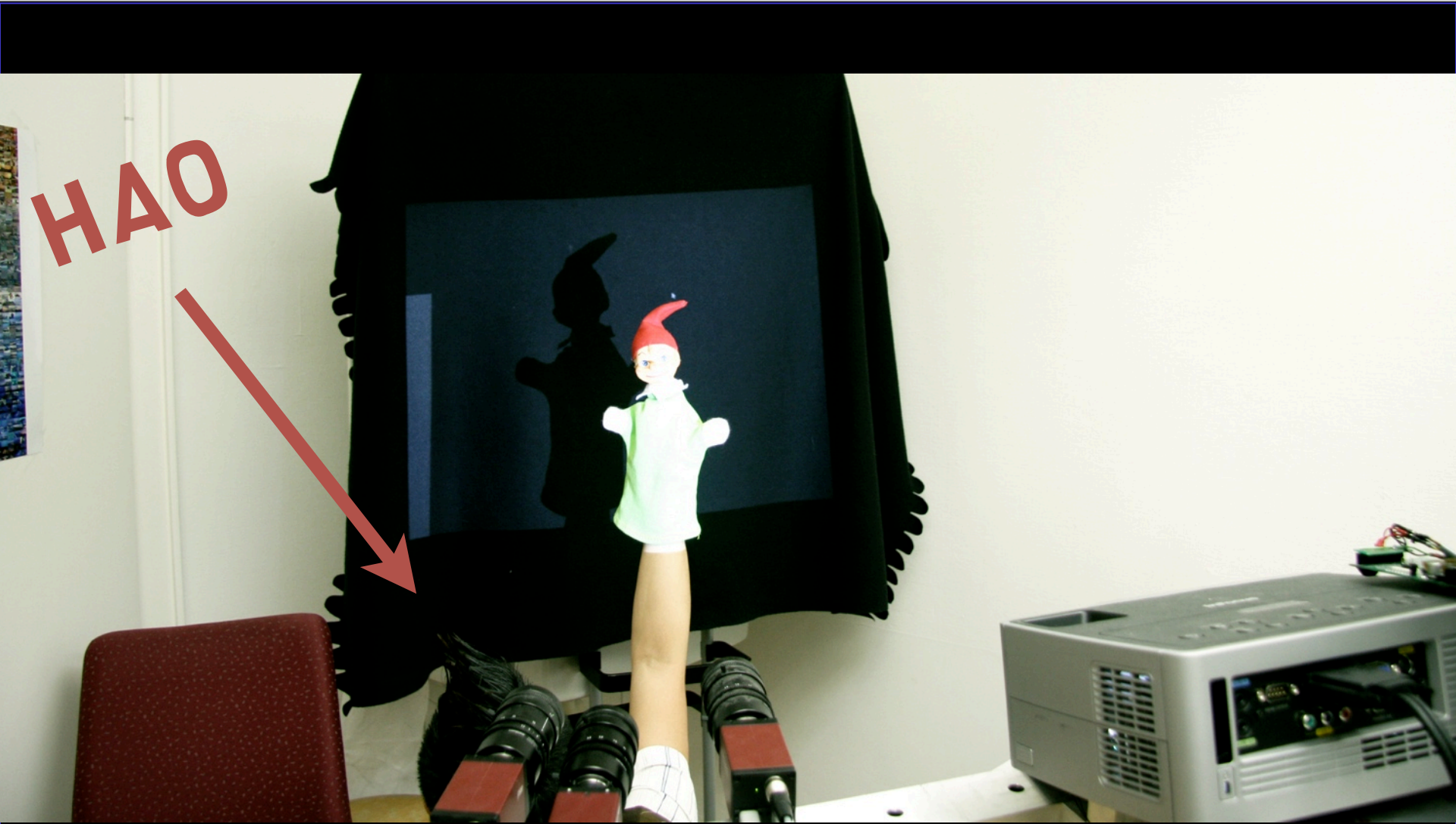
31st Annual Conference of the
European Association for Computer Graphics

europa
graphics 2010

Digitizing Dynamic Objects



Real-Time 3D Scanner



Geometry and Motion Reconstruction



Input 3D Scan Sequence



Space-time Reconstruction

State of the Art

Industry Standard

3D Scanning



XYZRGB

Motion Capture

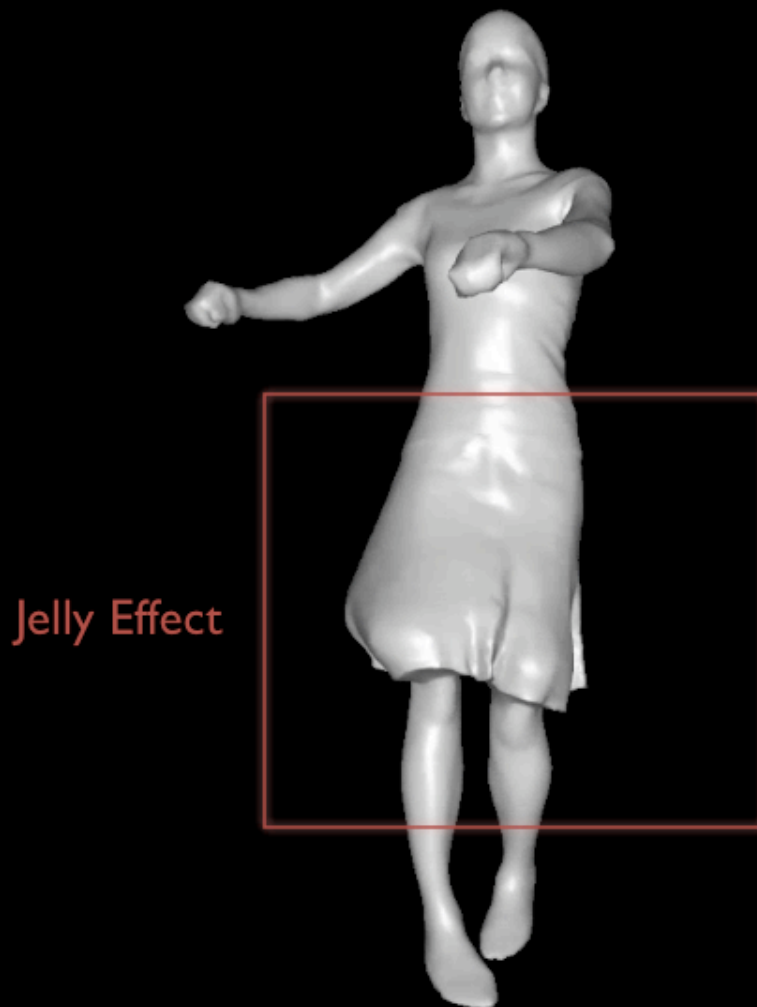


[Park & Hodgins '06]

Markerless Performance Capture



Limitations



[Masic, et al. '08]

Real-Time 3D Scanner



[Weise et al. '07]

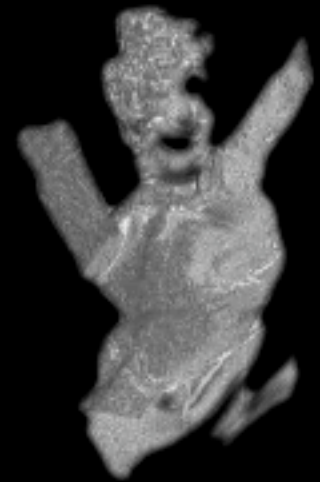
Dense Space-Time Reconstruction



[Wand et al. '09]



[Süssmuth et al. '08]



[Scharf et al. '08]

Early Test – 34 Frames



Correspondence Issues

[Süssmuth et al. '08]



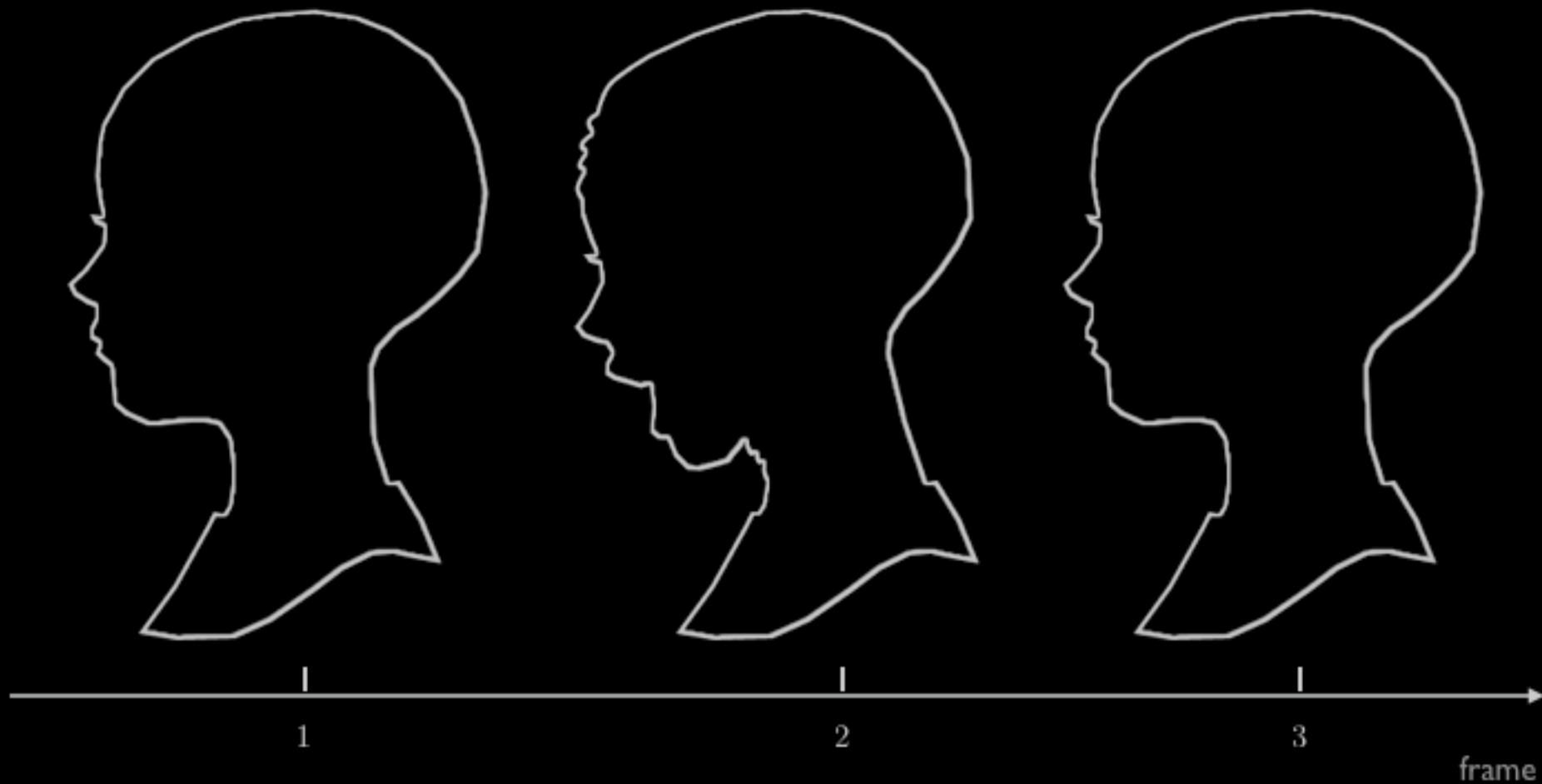
Topology Issues

[Wand et al. '09]

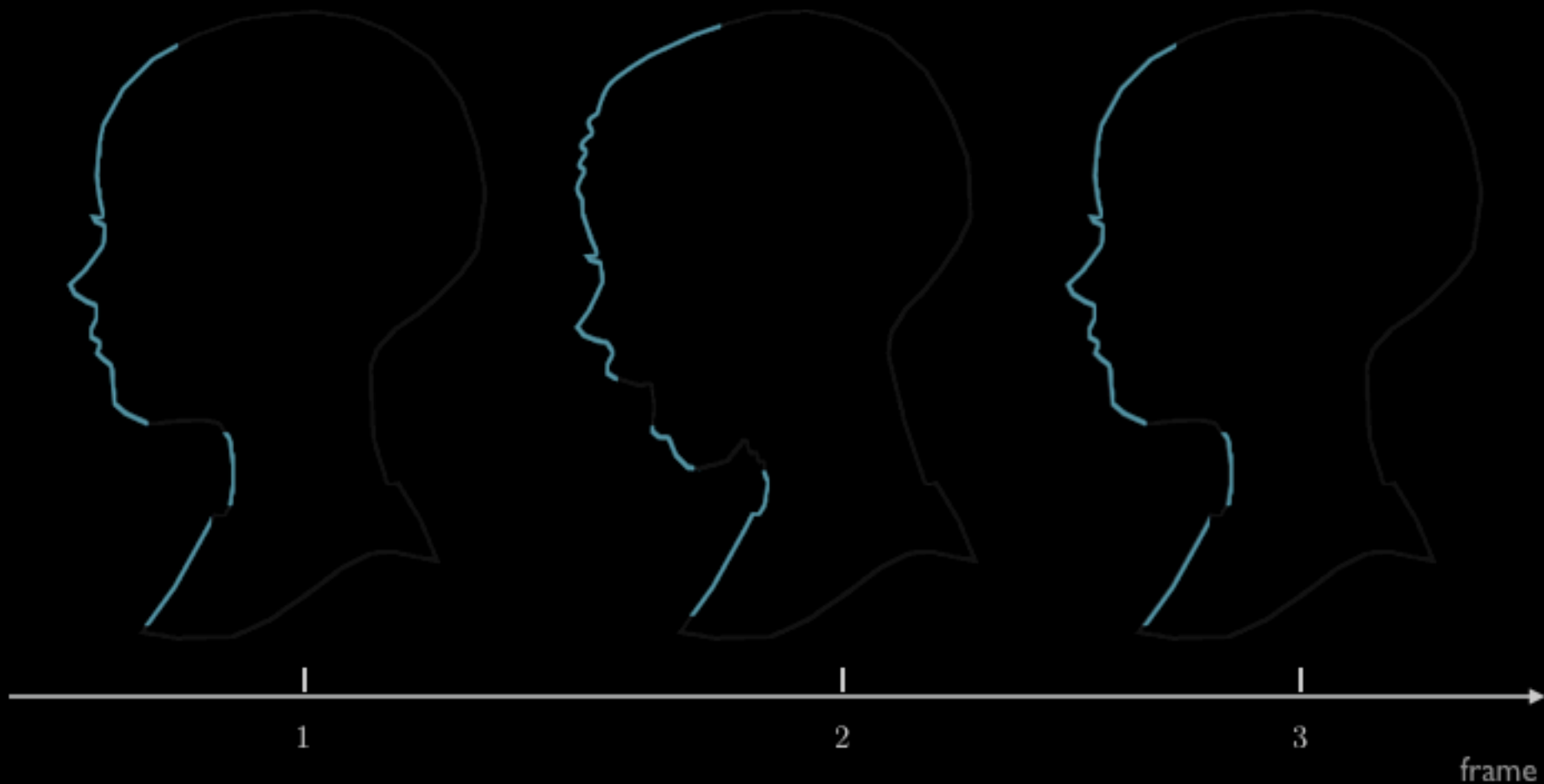


Bi-Resolution Approach

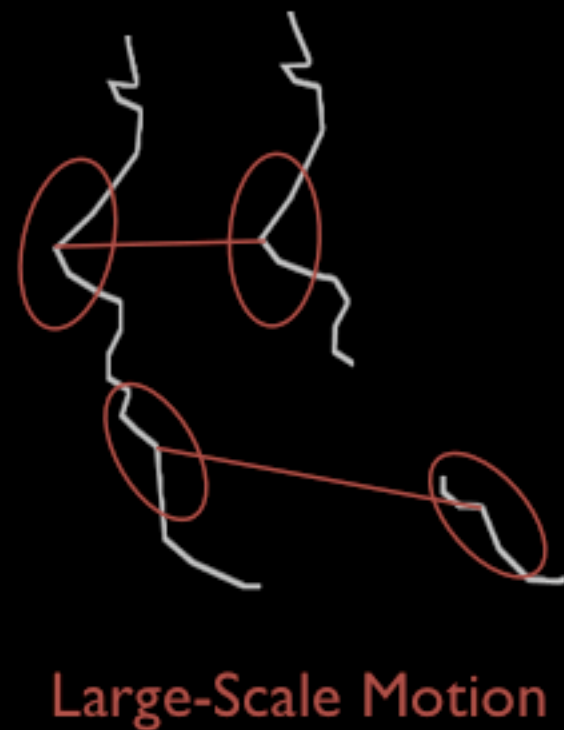
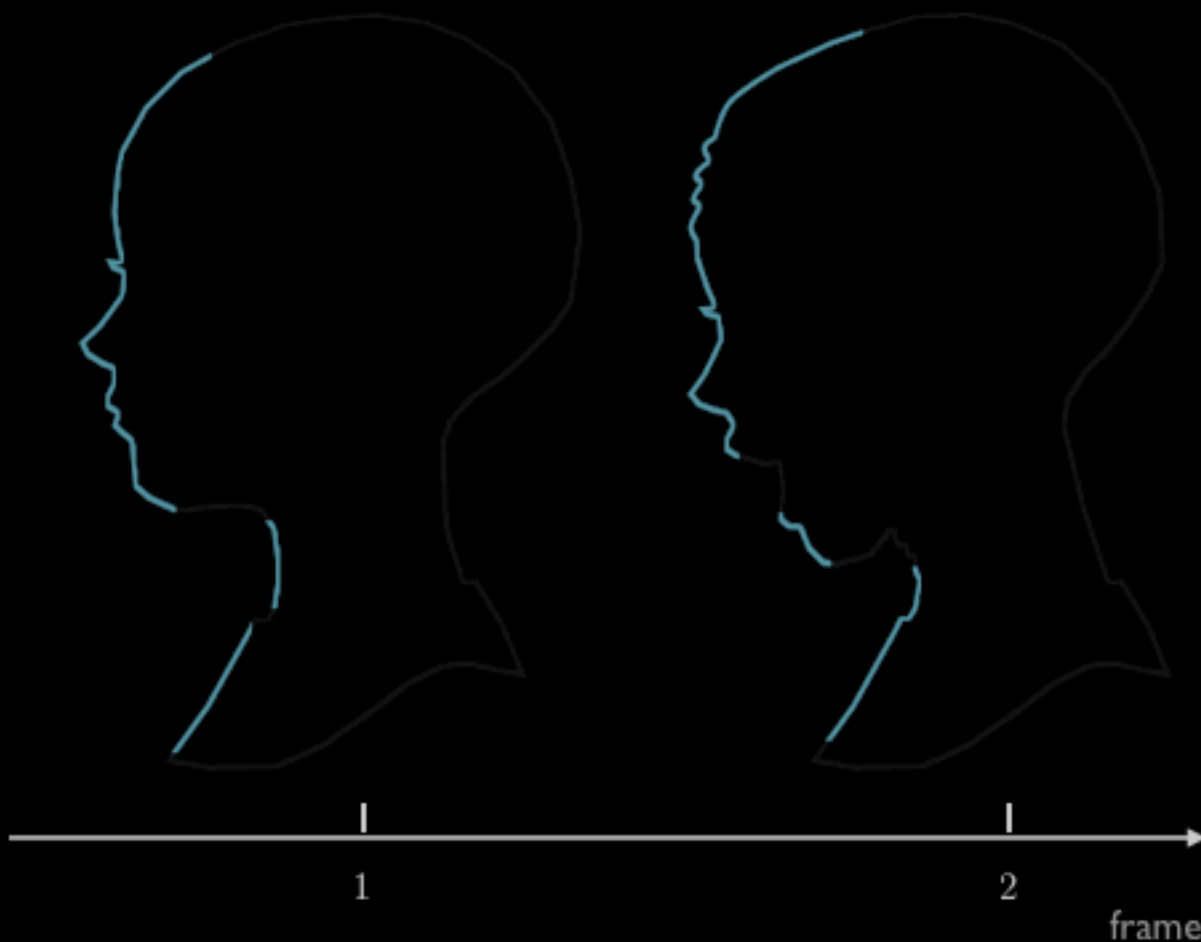
Deforming Subject



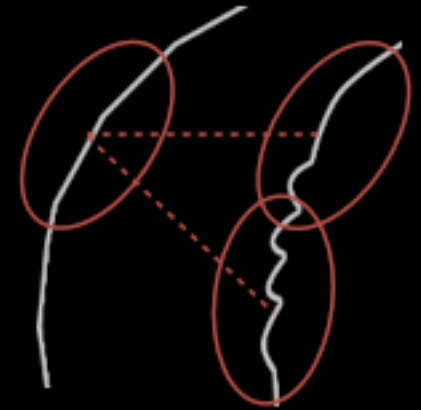
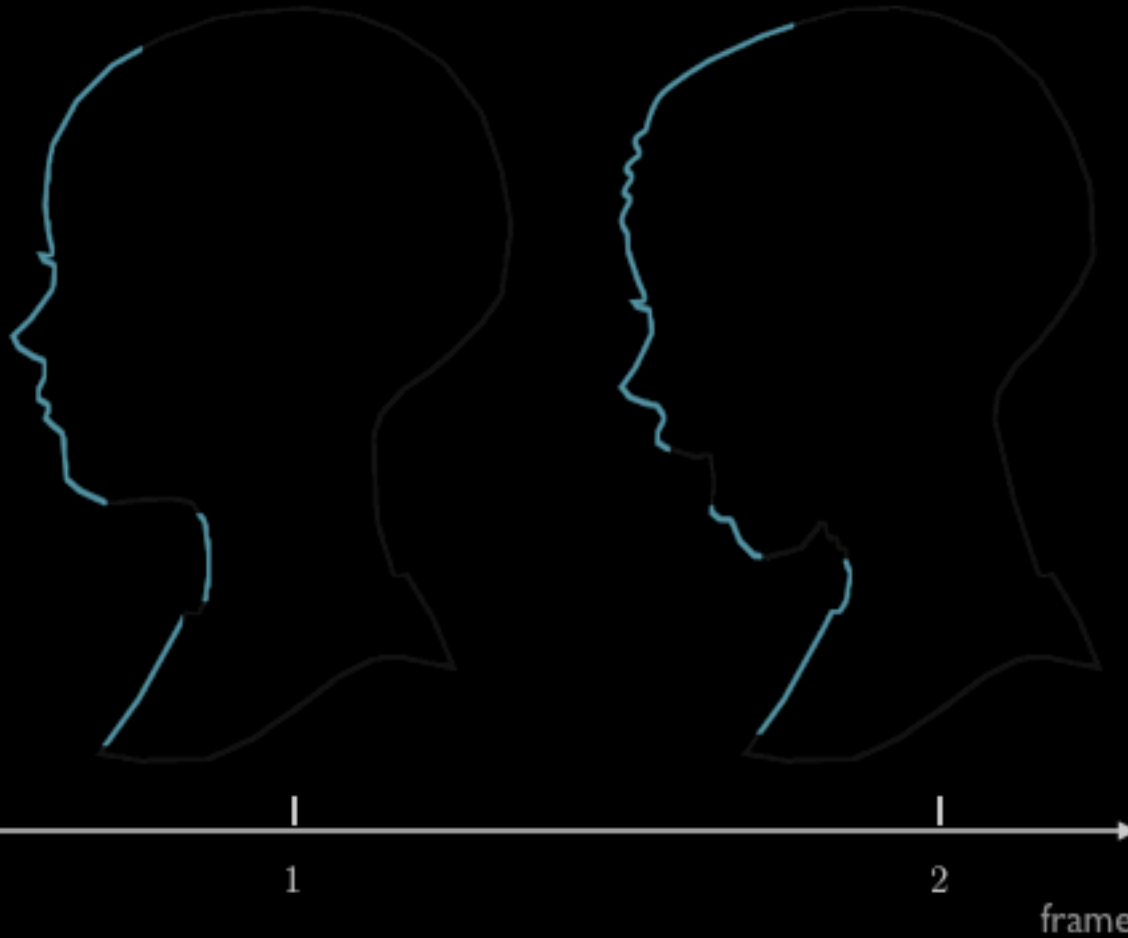
Partial Scans



Partial and Non-Rigid Registration

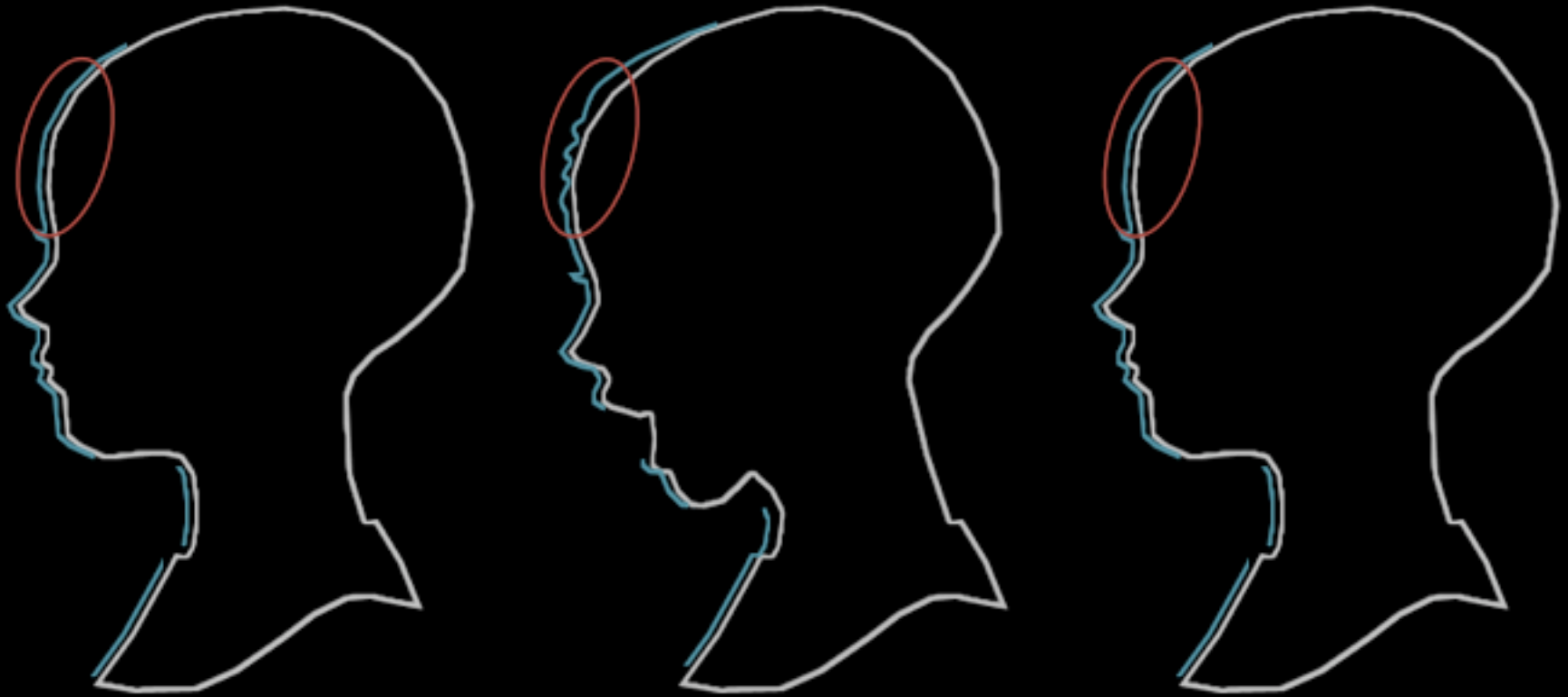


Partial and Non-Rigid Registration



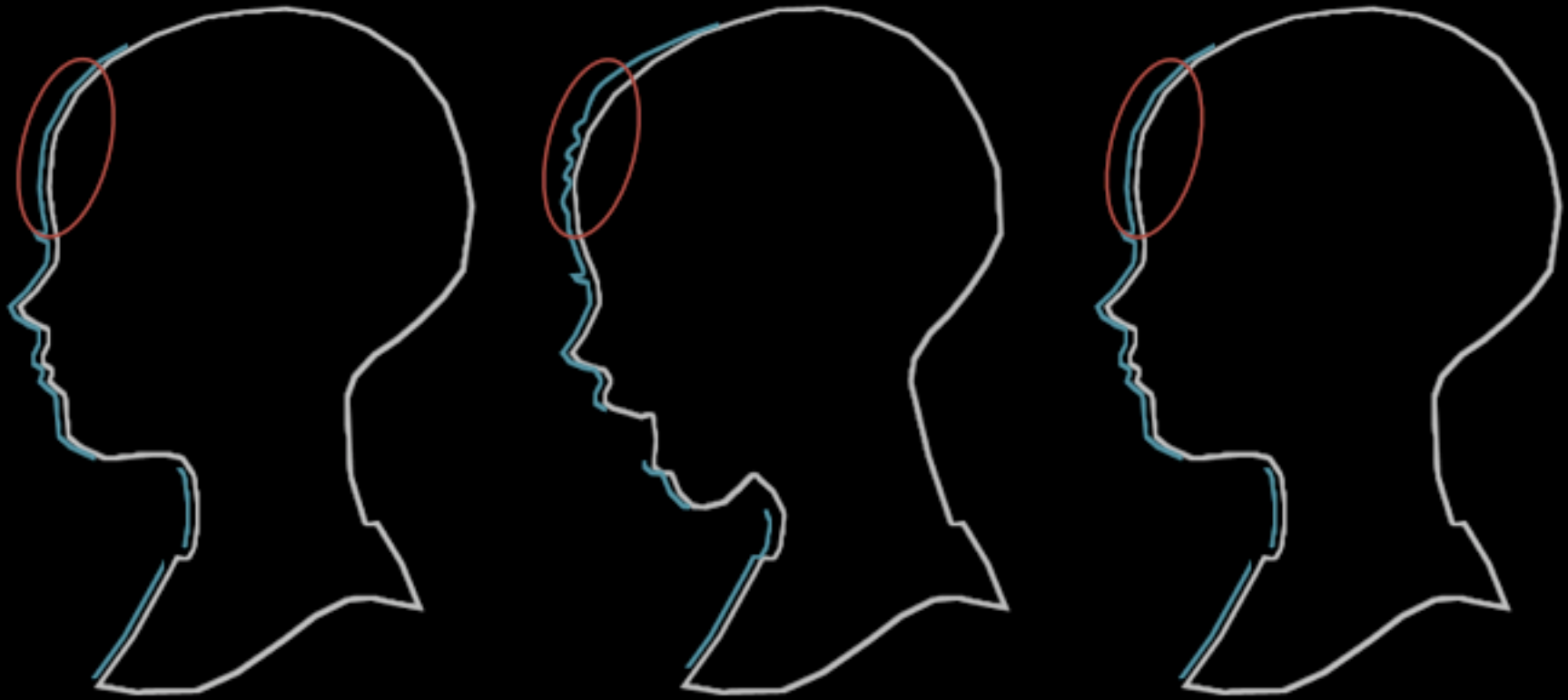
Small-Scale Dynamics

Bi-Resolution Approach



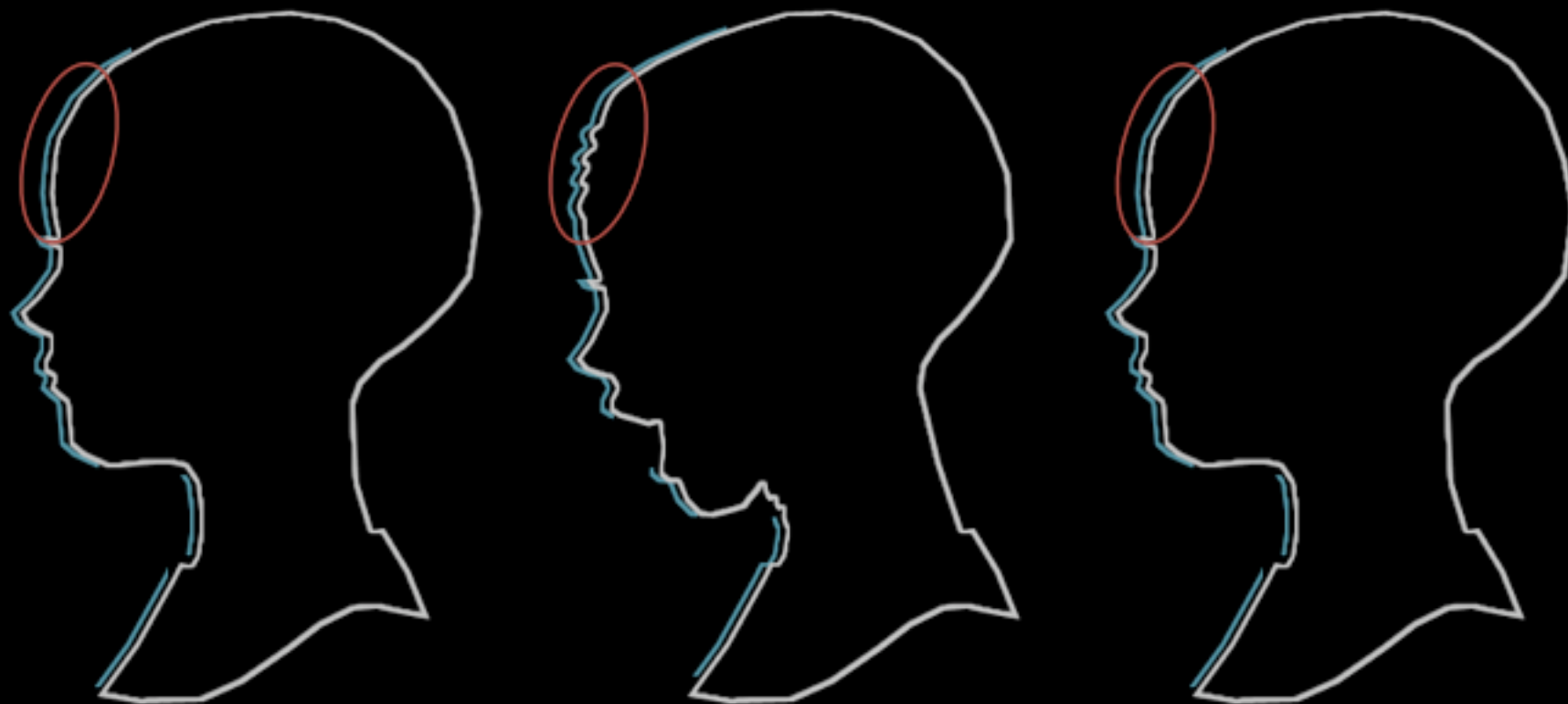
Warping a **coarse** template

Bi-Resolution Approach



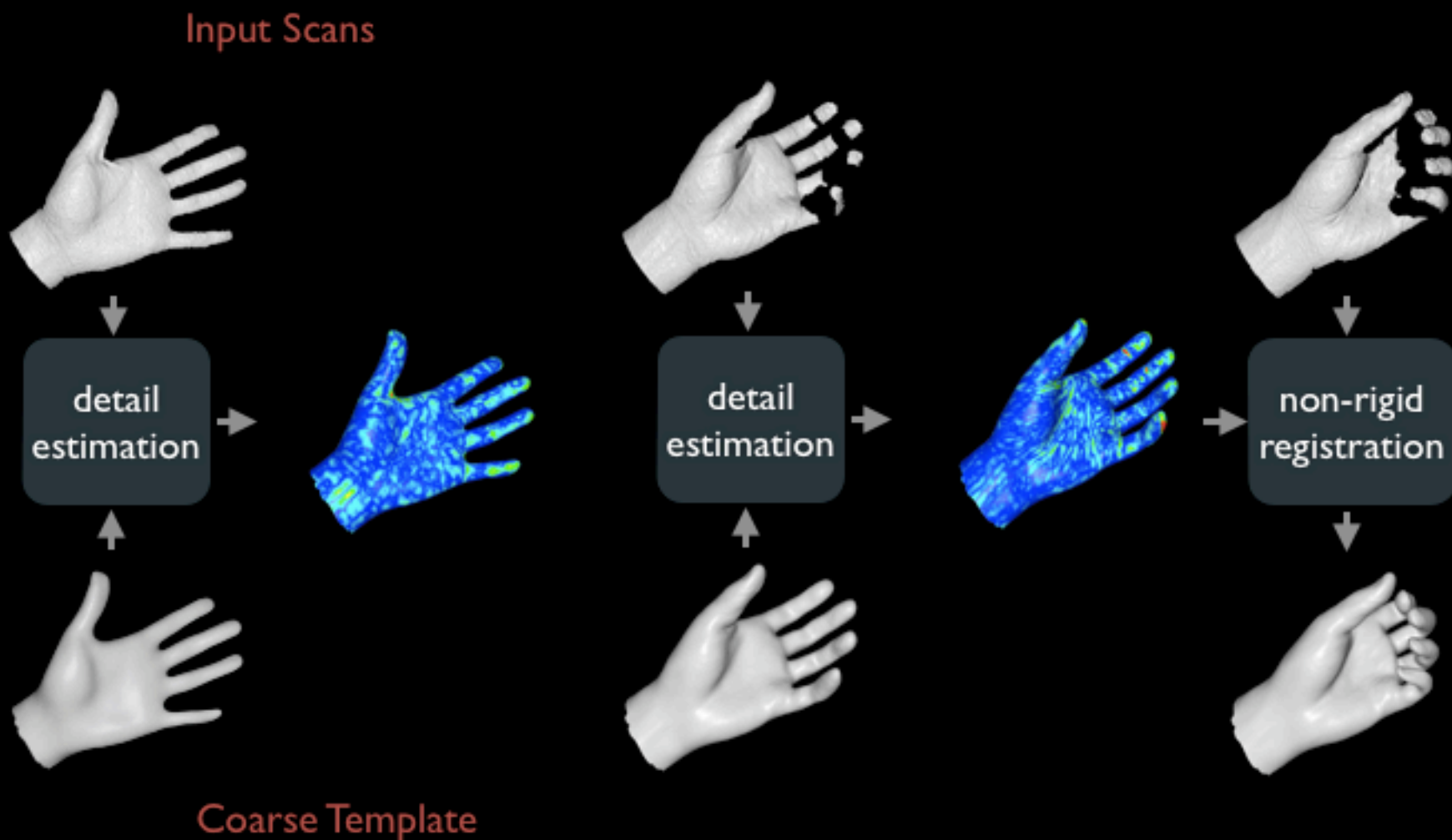
Warping a **coarse** template

Bi-Resolution Approach

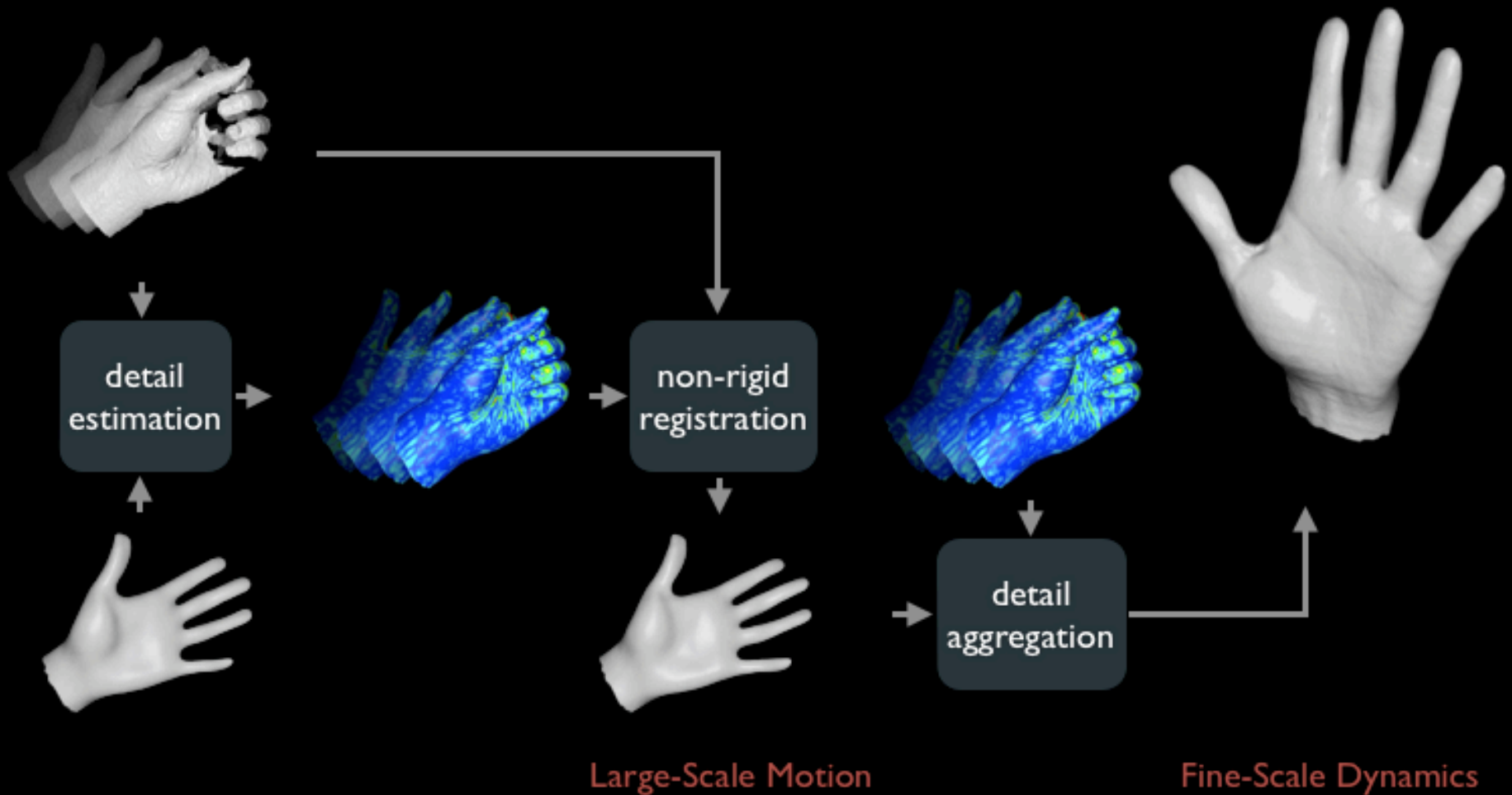


Synthesizing **small scale** details

Reconstruction Framework



Reconstruction Framework



Non-Rigid ICP

Non-Linear Optimization

$$E_{\text{tot}} = \alpha_{\text{fit}} E_{\text{fit}} + \alpha_{\text{rigid}} E_{\text{rigid}} + \alpha_{\text{smooth}} E_{\text{smooth}}$$



Too few nodes:

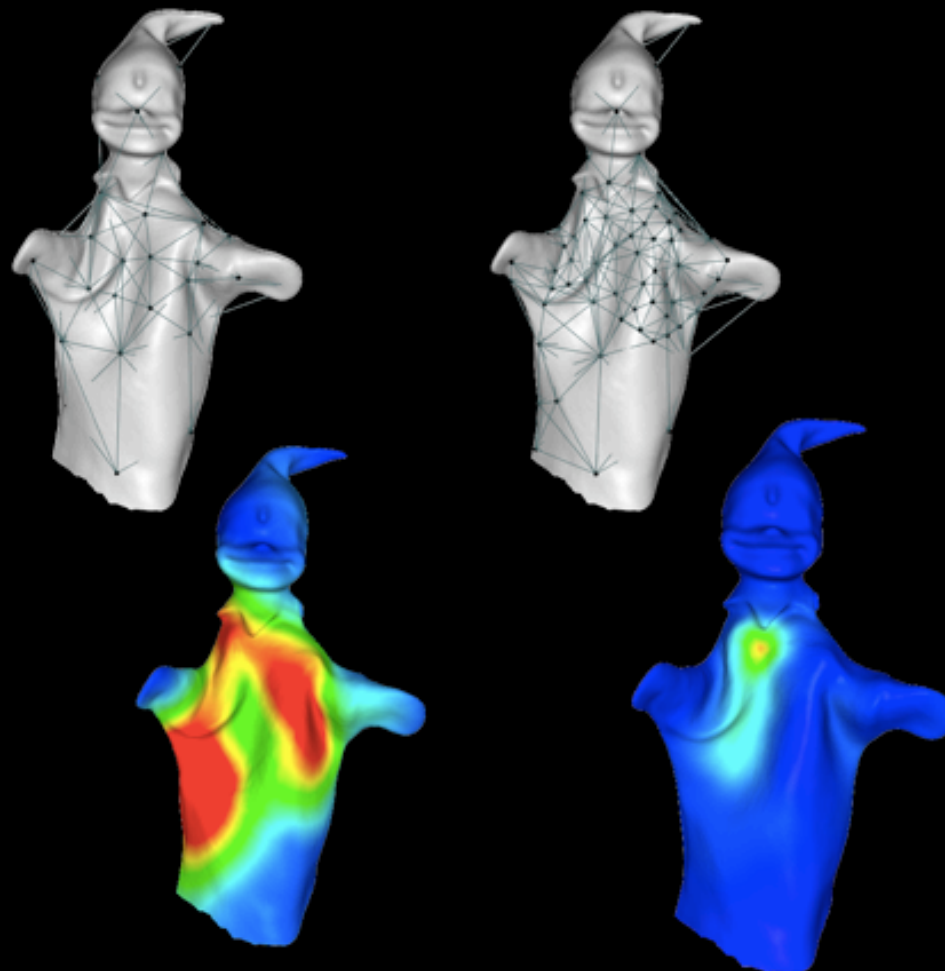
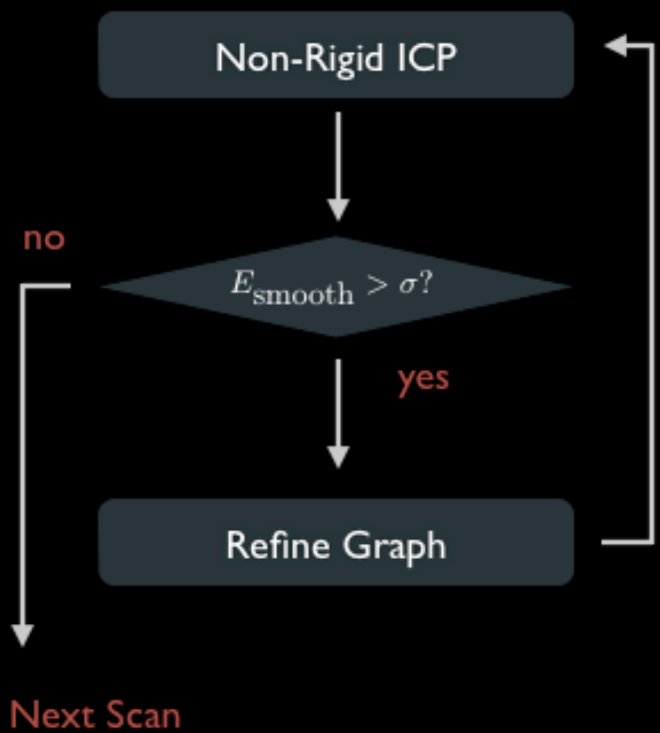
- inaccurate

Too many nodes:

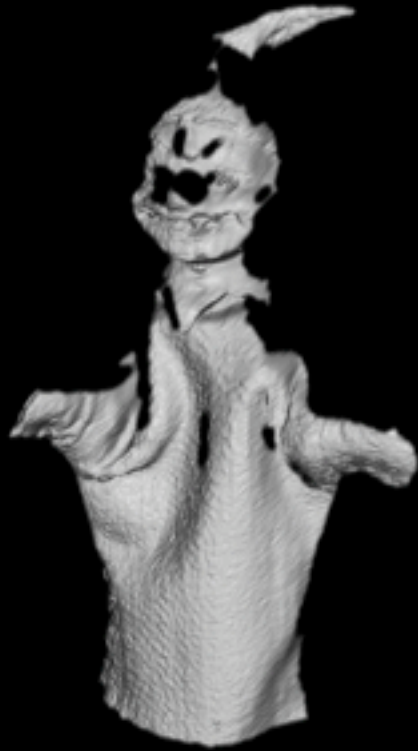
- inefficient
- less robust

Extension of [Li et al. '08]

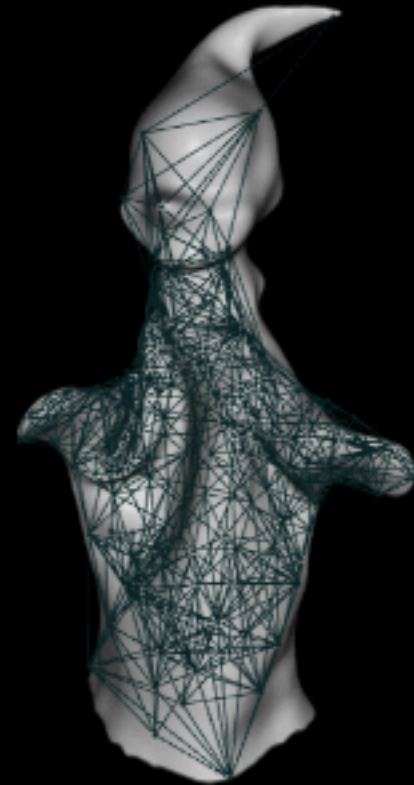
Adaptive Deformation Model



Adaptive Deformation Model



Input Scans

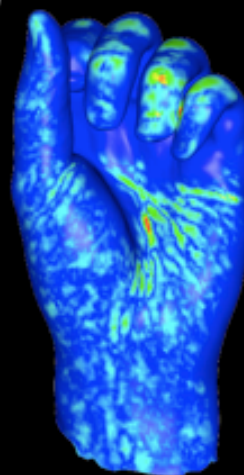


Warped Template with Graph

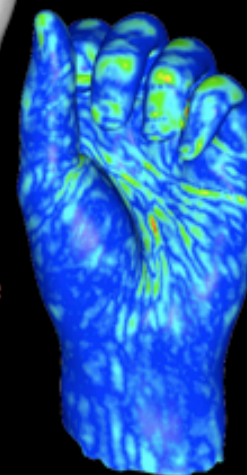
Detail Aggregation



Single Frame
Synthesis



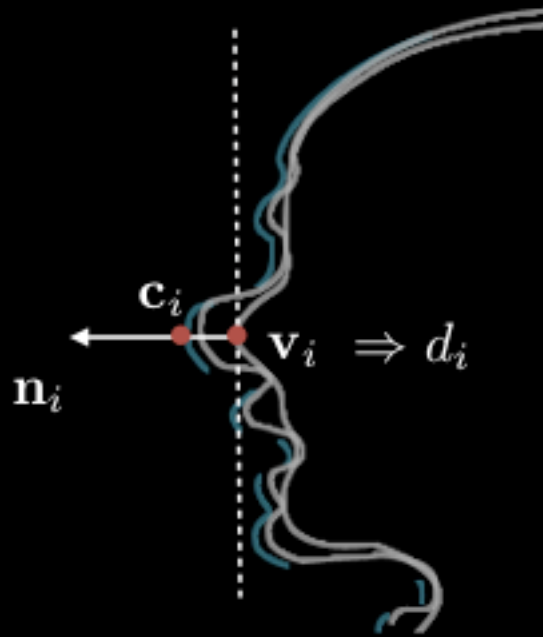
Multi-Frame
Aggregation



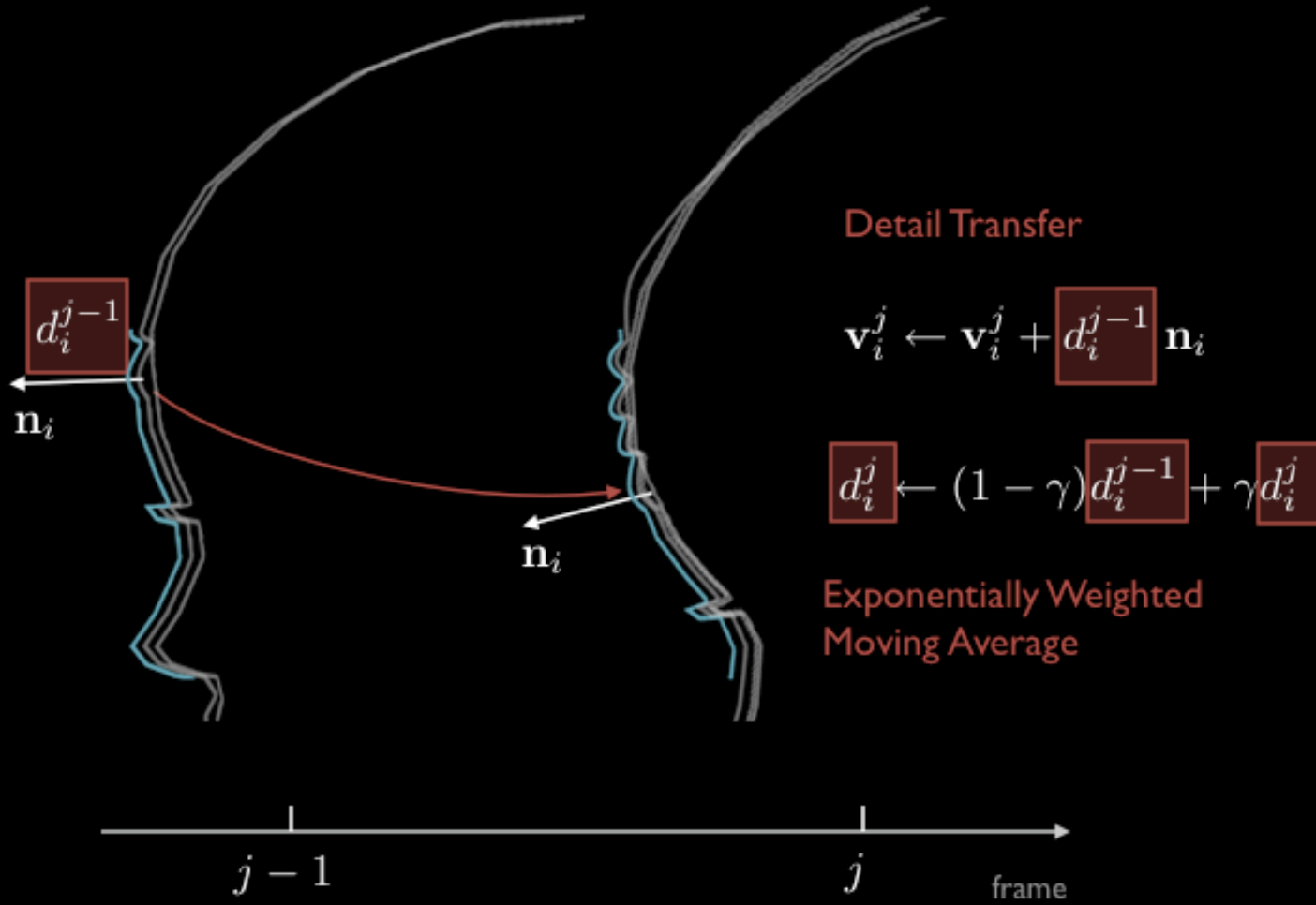
Detail Estimation

$$E_{\text{detail}} = \sum_{i \in \mathcal{V}} \|\mathbf{v}_i + d_i \mathbf{n}_i - \mathbf{c}_i\|^2 + \beta \sum_{(i,j) \in \mathcal{E}} |d_i - d_j|^2$$

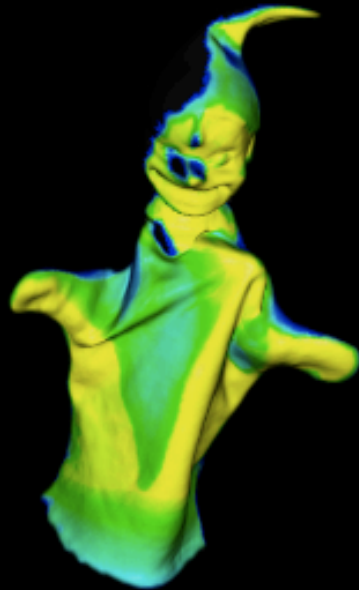
Point Constraint Regularization



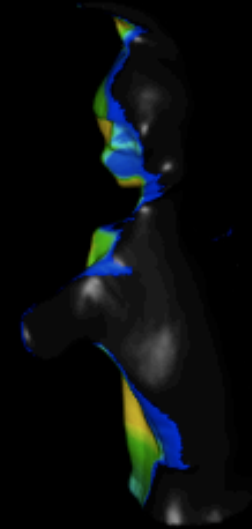
Detail Estimation



Forward-Backward Propagation



Coverage



Coverage

Reconstruction Process

The Puppet

3D Acquisition – 100 Frames

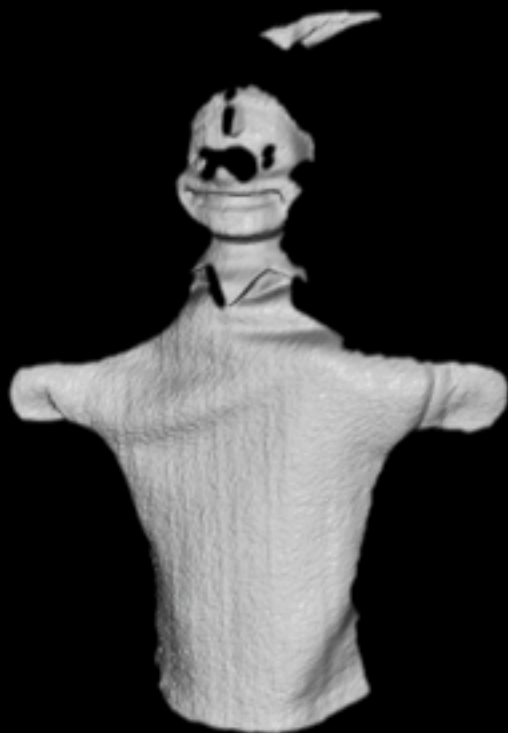


Input Scan Sequence

Initial Registration



Template Warping

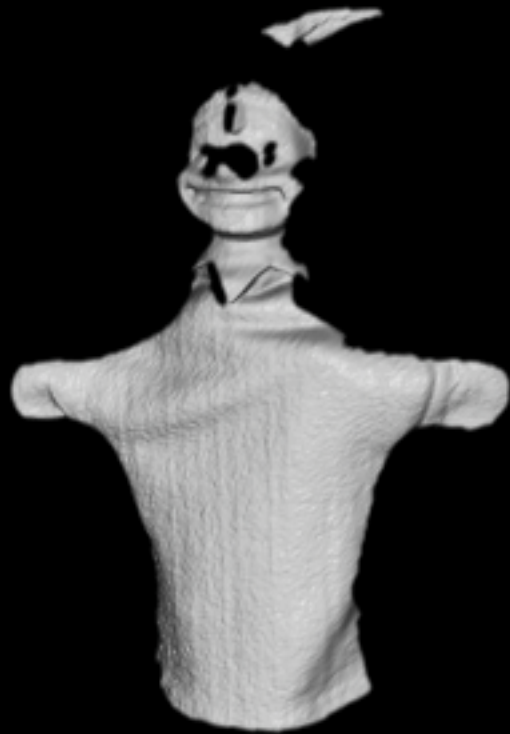


Input Scans



Warped Template

Final Reconstruction – 100 Frames



Input Scans



Reconstruction

Correspondence Visualization



Reconstruction

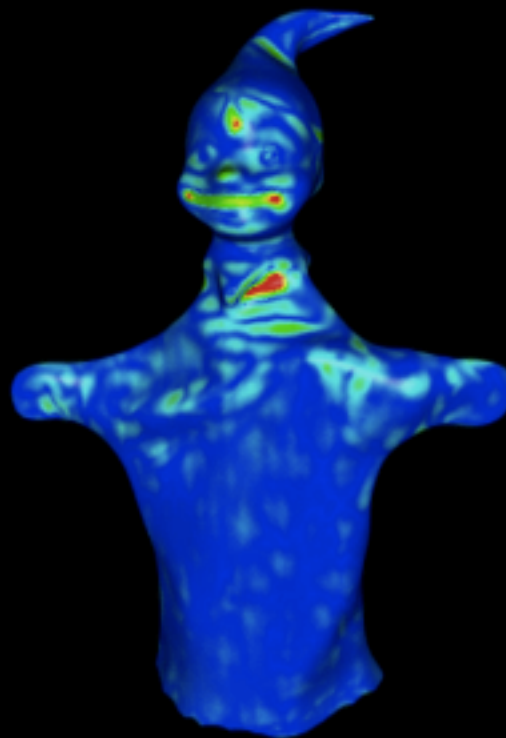


Textured Reconstruction

Detail-Coefficient Stability



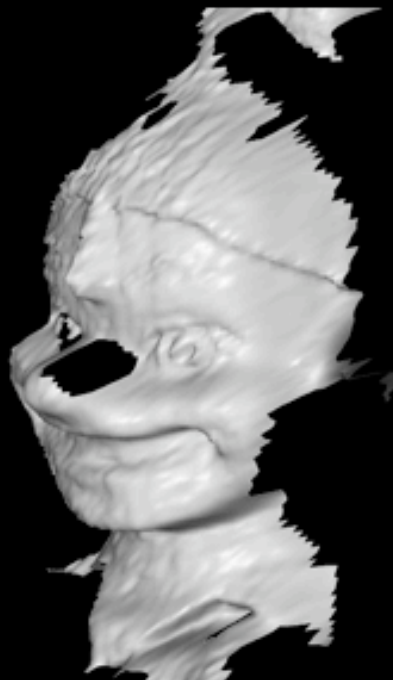
Reconstruction



Detail Coefficients

Close-up Comparison

Input Scan



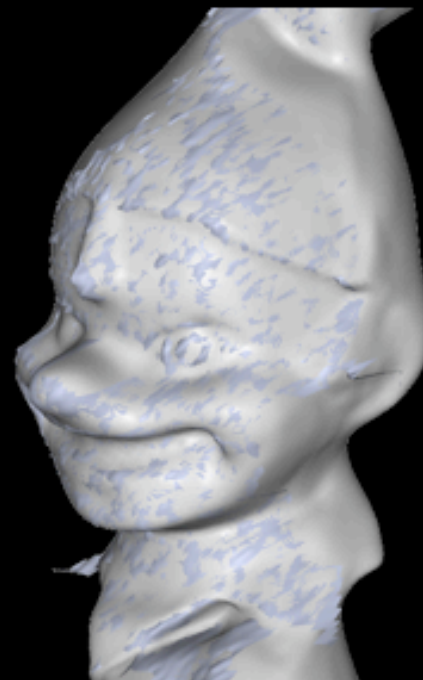
Warped Template



Reconstruction



Overlaid Scan



More Results

Grasping Hand – 34 Frames



Input Scans

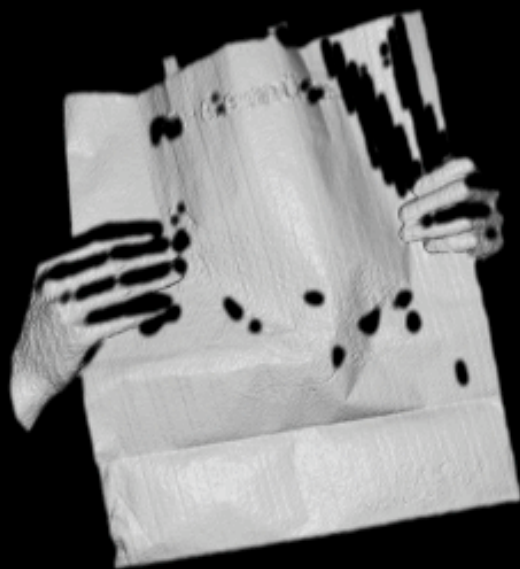


Reconstruction



Textured Reconstruction

Crumpling Paper Bag – 85 Frames



Input Scans



Reconstruction



Textured Reconstruction

Facial Expressions – 200 Frames



Input Scans



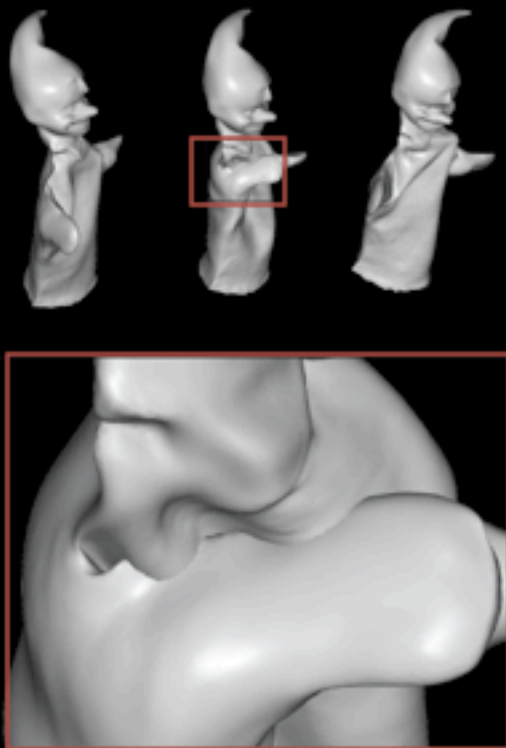
Reconstruction



Overlaid Scans

Limitations

Self-Intersection



Large Motion



Varying Topology



What's Next?

Multi-View and Textures



[Vlasic et al. '09], Princeton, ICT

Complex Materials



National Geographic

Surface Segmentation



WordPress

www.hao-li.com

