Animation Wrinkling

Augmenting Coarse Cloth Simulation with Realistic-Looking Wrinkles

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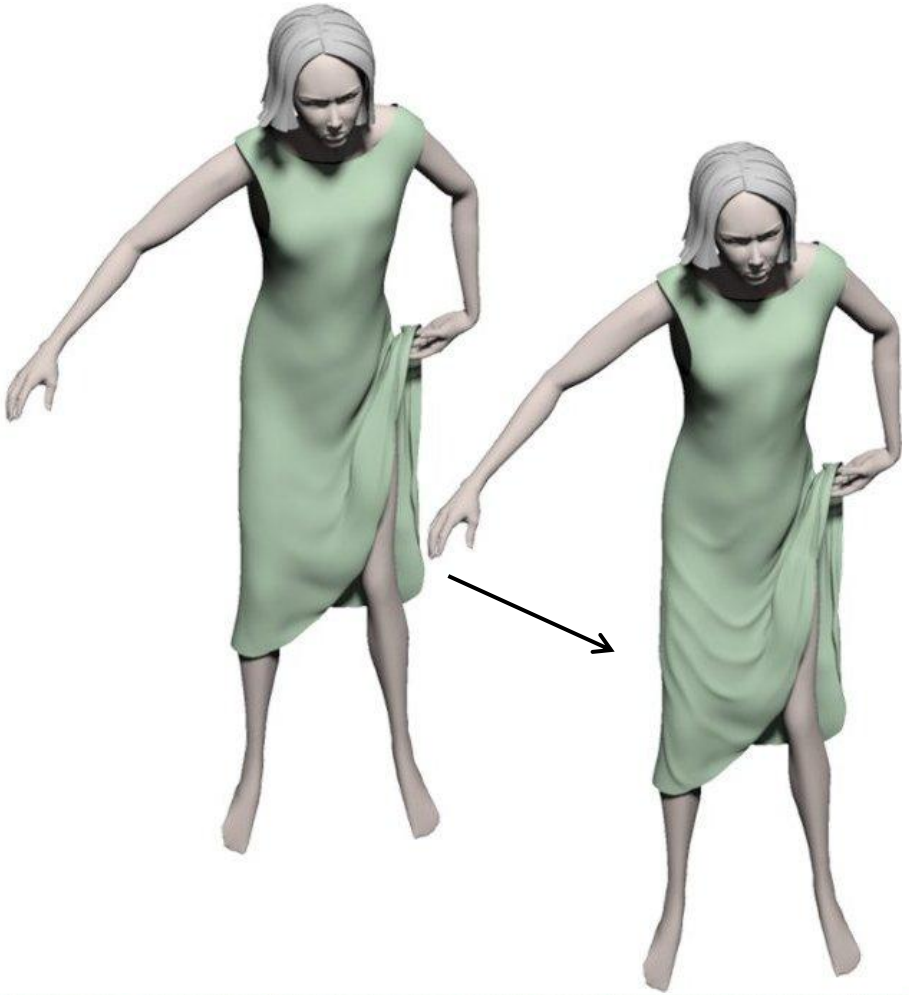


Wrinkles are critical for believable garments

No cloth wrinkle

With wrinkles

Shrek

Previous Work

Physically based

[Godenthal et al., SIGGRAPH 07]
[English & Bridson, SIGGRAPH 08]
[Thomaszewski et al, EG 09]

Expensive, Control?

Machine learning

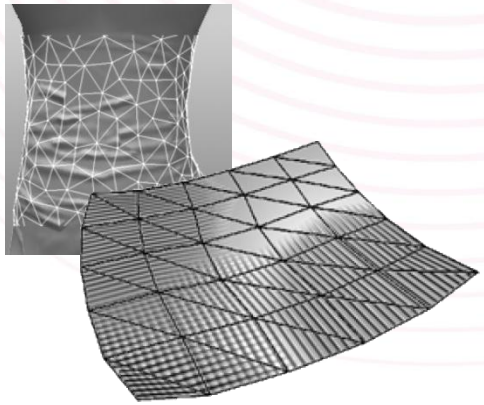
[Wang et al. SIGGRAPH 10]
[Aguiar et al. SIGGRAPH 10]

Input models, limited variations

Previous Work: Procedural Methods

Texture

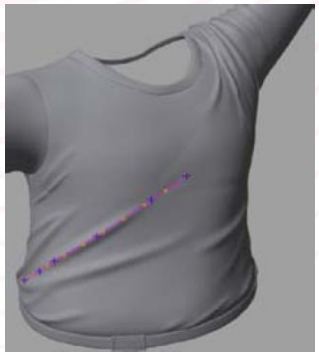
[Hadap IEEE Vis 99]



Predefined shapes

Manual settings

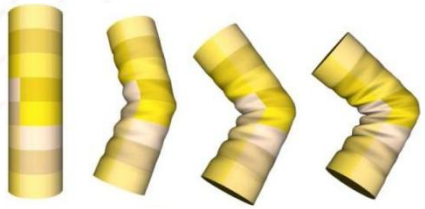
[Cutler SCA 05]



Teadius

Cylindrical shapes

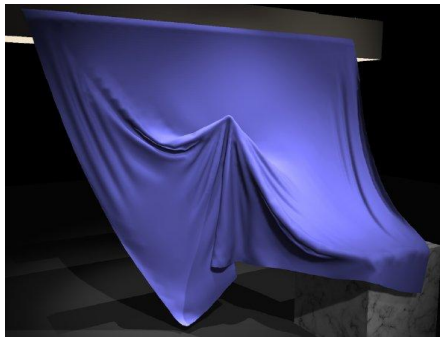
[Decaudin EG 06]



Limited deformations

Wrinkling layer

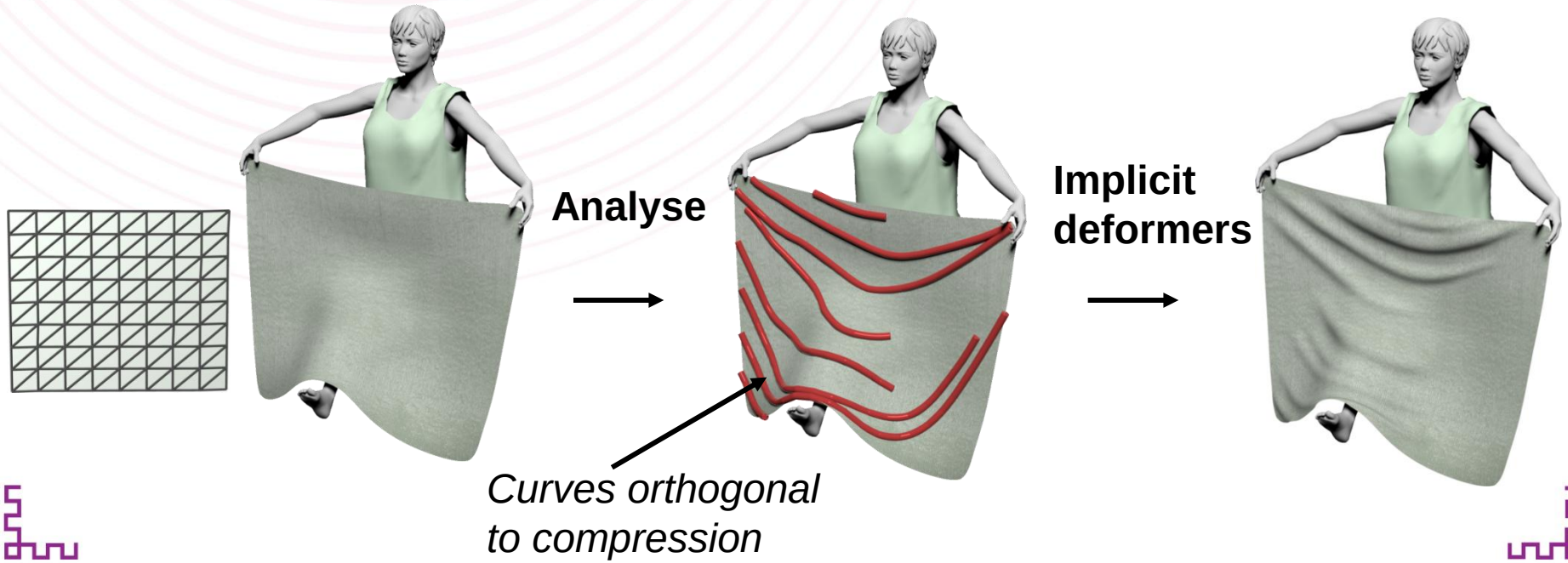
[Müller SCA 10]



Incoherent wrinkles

Key Ideas

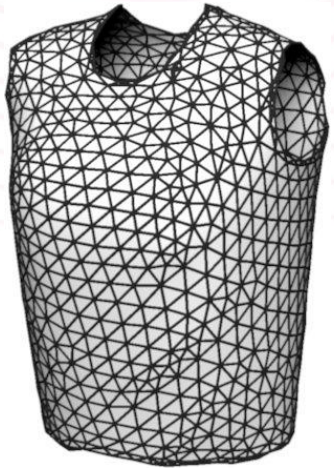
- **Analyse** coarse simulation
- New **implicit method** to generate wrinkle geometry



Overview

Perform coarse simulation

Real time !



Coarse input mesh

Overview

Perform coarse simulation

Analyze results

Trace wrinkle curves

- *Where*: Compressed regions
- *How*: Orthogonal to compression direction

Overview

Perform coarse simulation

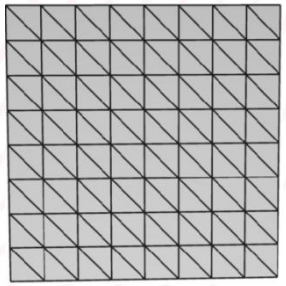
Analyze results

Generate wrinkles

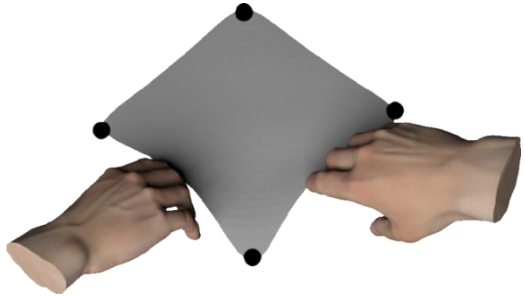
• Use smart **implicit** for wrinkles to **split & merge**

Analysing coarse animation output

Goal: Extract direction of compression



Rest mesh

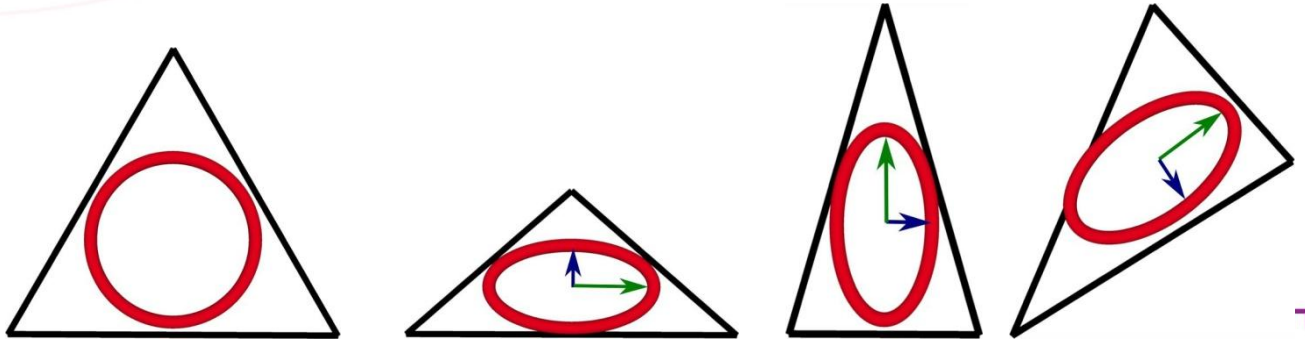


deformed mesh

M

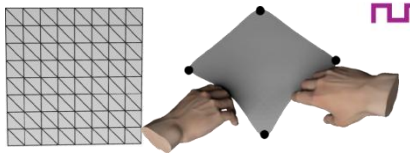
Stretch

$M M^T$: Eigenvalues = compression magnitude
Eigenvectors = compression direction



Continuous compression field

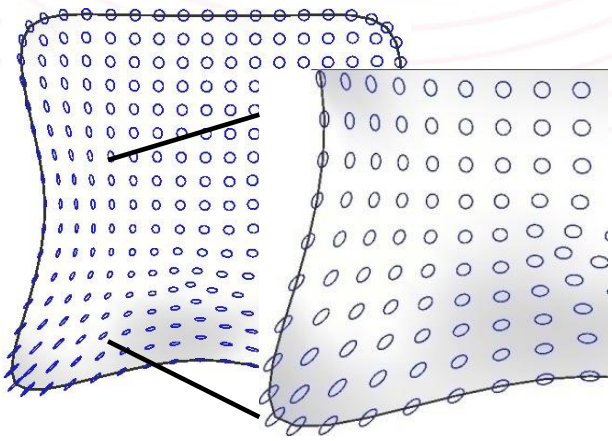
Anisotropy preserving interpolation



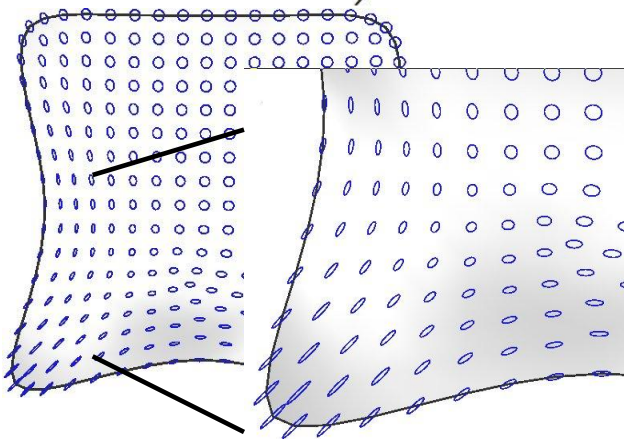
Per vertex tensor field

=> Tensor space interpolation *[Pennec et al. 06]*

$$\mathbf{U} = \mathbf{U}^{1/2} \exp\left(\sum_j \omega_j \log\left(\mathbf{U}^{-1/2}\mathbf{U}_j\mathbf{U}^{-1/2}\right)\right)\mathbf{U}^{1/2}$$

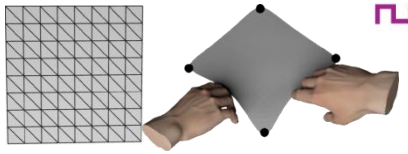


Linear interpolation



Tensor space interpolation

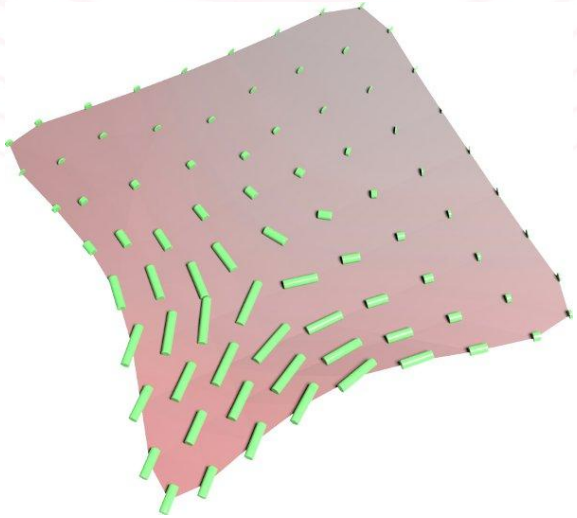
Tracing Wrinkle Curves

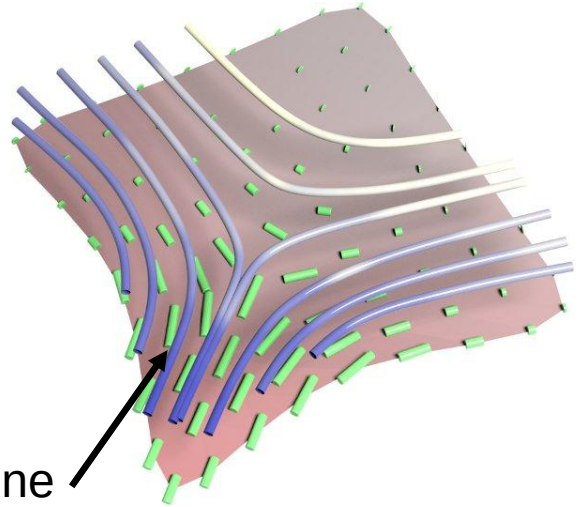


Wrinkle vector field

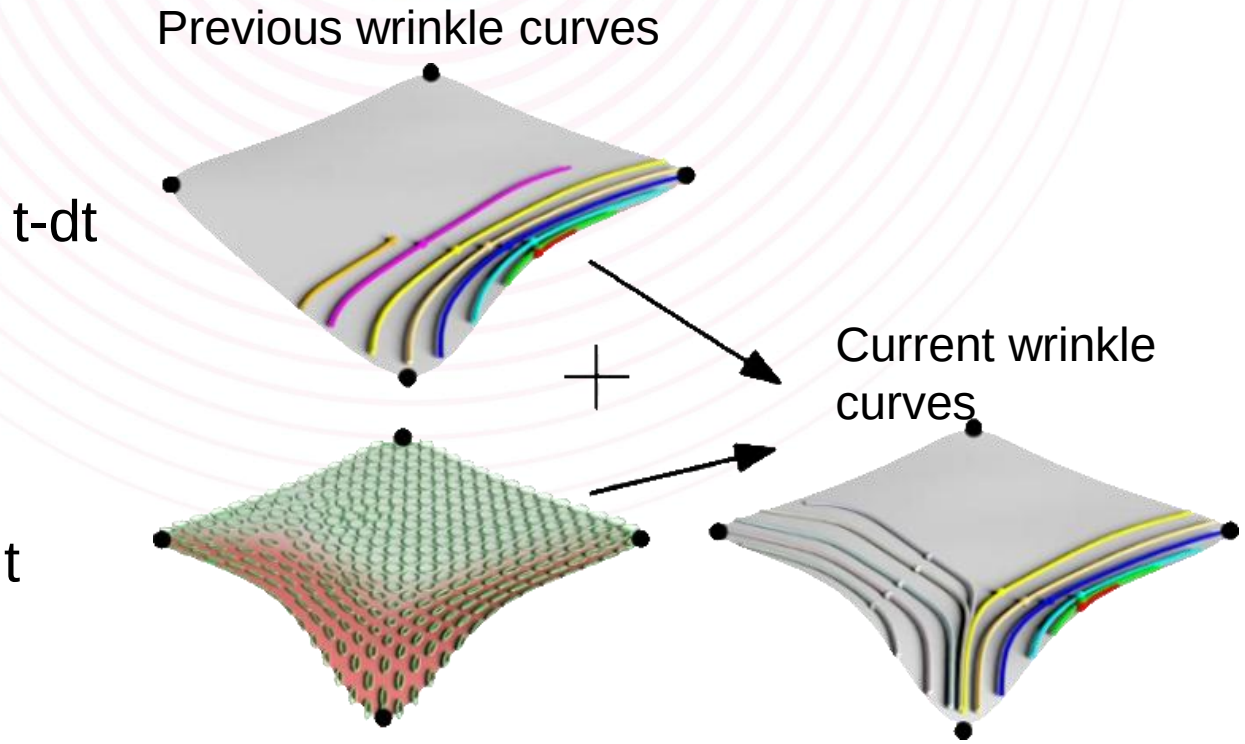
Magnitude: *Rate of compression*
Orientation: ⊥ *Main shrinkage direction*

Wrinkle curve =
Guide for wrinkle placement

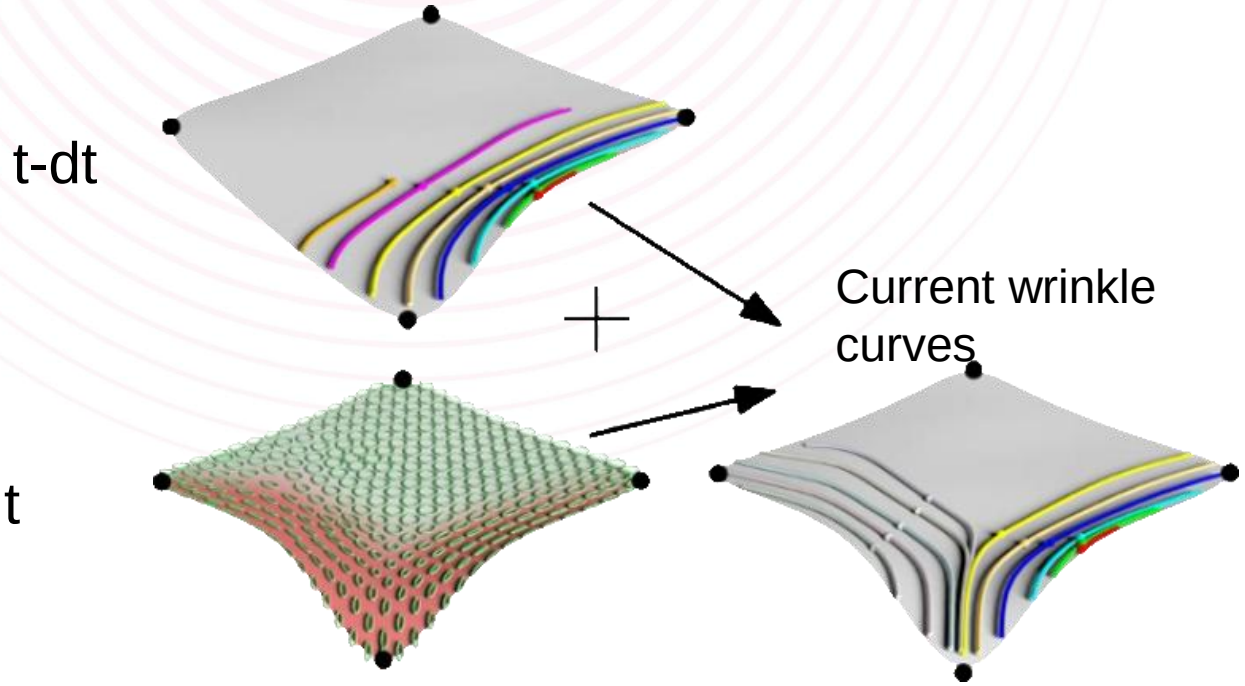




Time coherent wrinkle curve animation

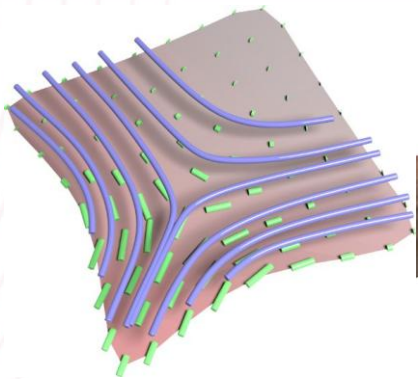


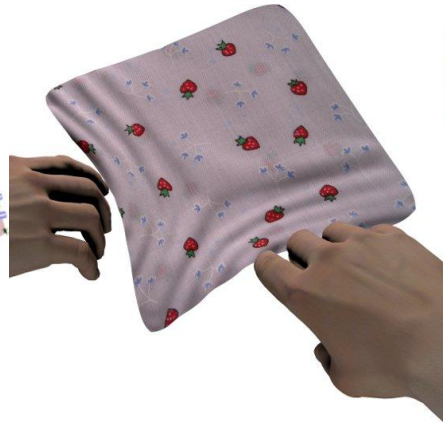
Time coherent wrinkle curve animation



Wrinkle geometry: Challenges

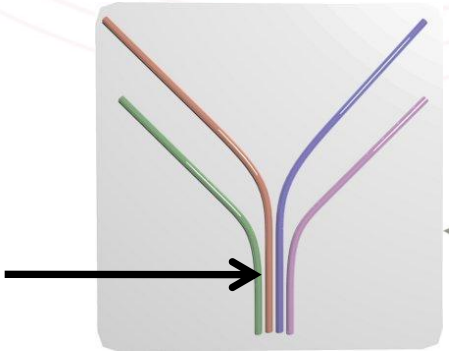
Goal: Seamless wrinkle **merge & split**

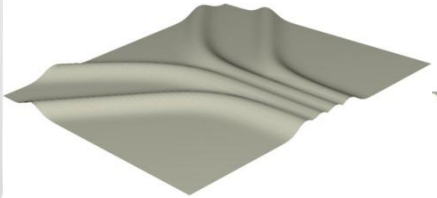




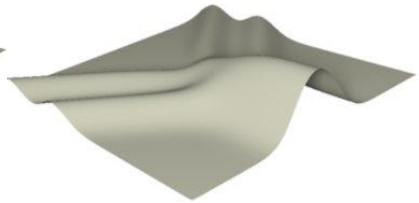
Challenge: Close-by curves

- No collisions bw wrinkles
- No bulges

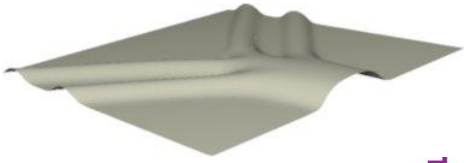




Max



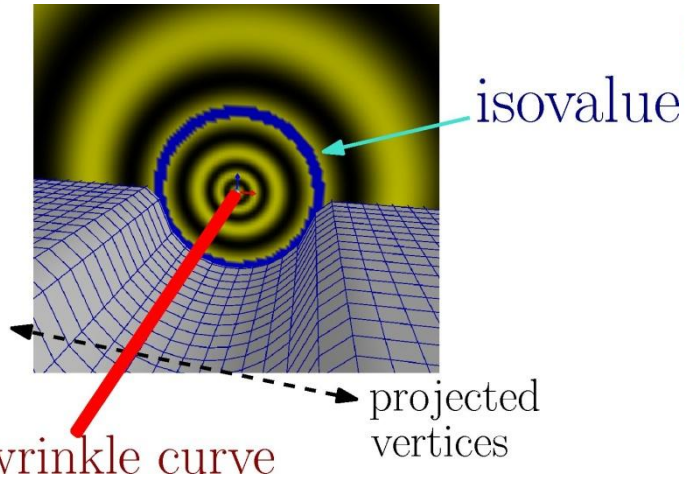
Sum of displacements



Our solution

Wrinkle geometry: Implicit deformers

Wrinkle curve generates **field function**



How: Vertices **projected** onto the **isosurface**

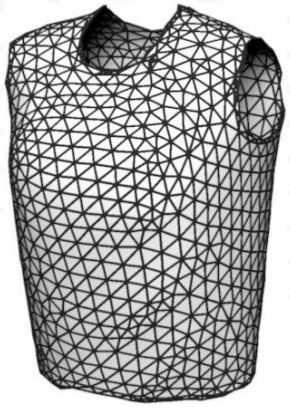
What: **Convolution surfaces**
- Blend using sum of fields
- No bulging artifact

No collision bw wrinkles
- They just **merge** !!

Results

Results

1.5s/frame



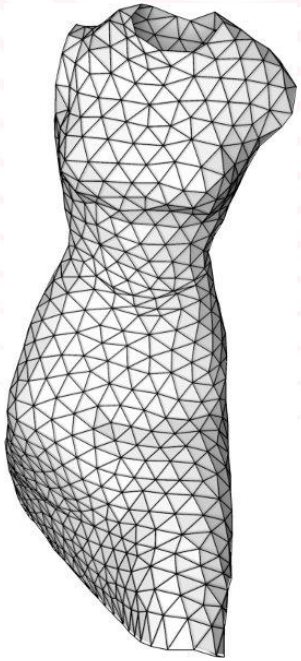
Rest mesh

Input simulation

With our wrinkles

Results

1.5s/frame



Rest mesh

Input simulation

With our wrinkles

Results

- Control of cloth thickness

Results

Adding wrinkles on skinning input

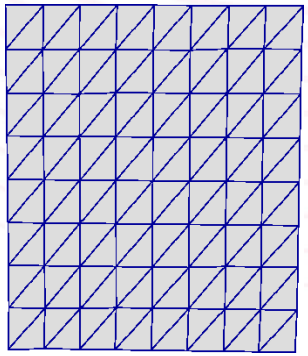
Rest mesh

Input simulation

With our wrinkles

Results

- Very coarse input

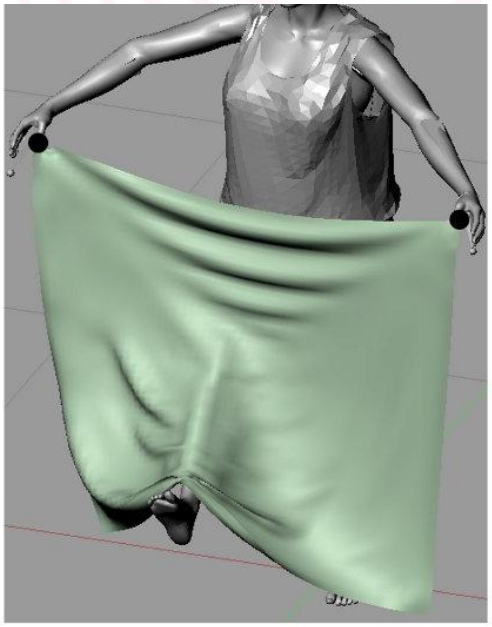


Rest mesh

Input simulation

With our wrinkles

Results: Comparison



High res simulation

25s/frame

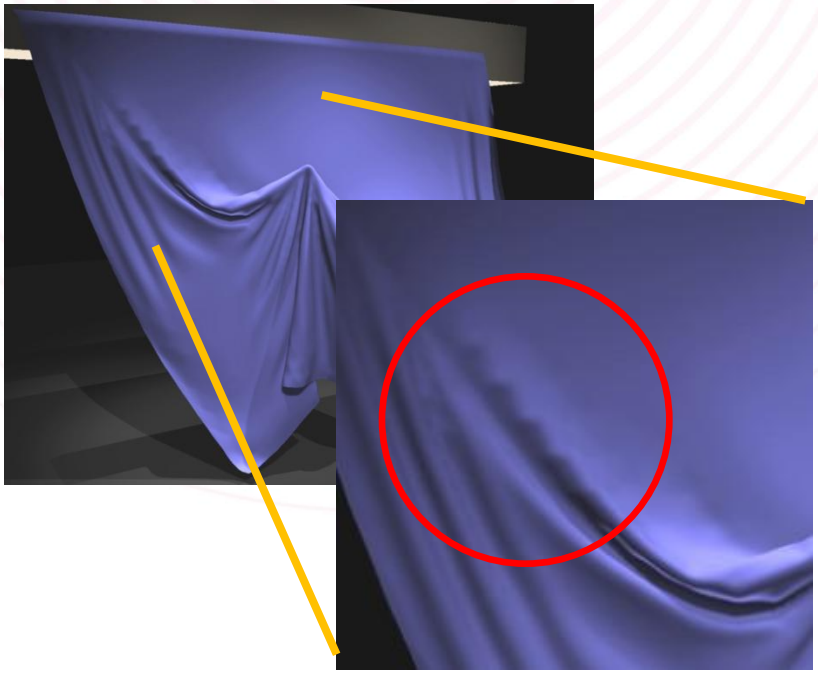
Our result

2s/frame

Real cloth

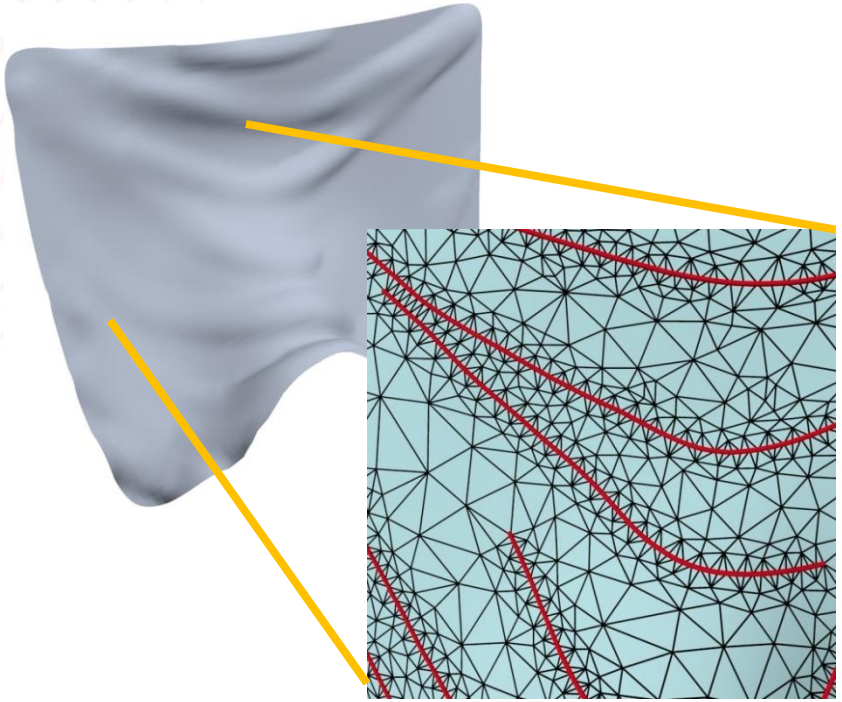
Results: Mesh sampling

[Müller *et al.* SCA 10]



Homogeneous tesselation
=> Sampling artifacts

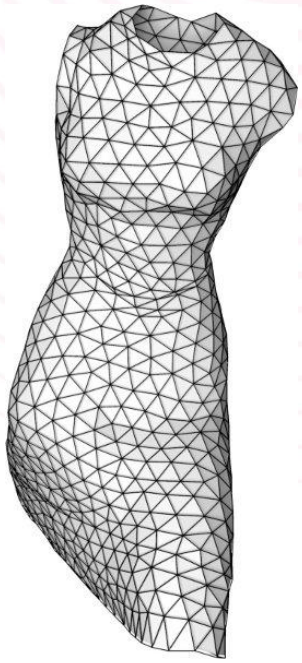
Our result



Adapted triangulation

Results

1.5s/frame



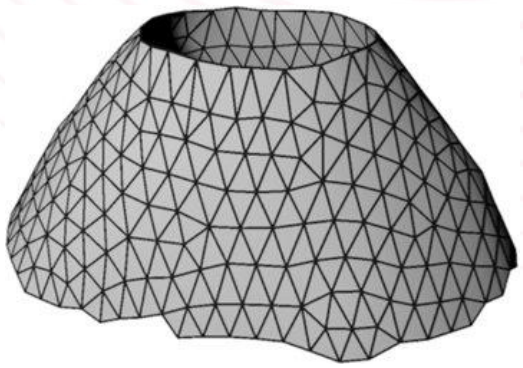
Rest mesh

Input simulation

With our wrinkles

Results

- 1 s/frame



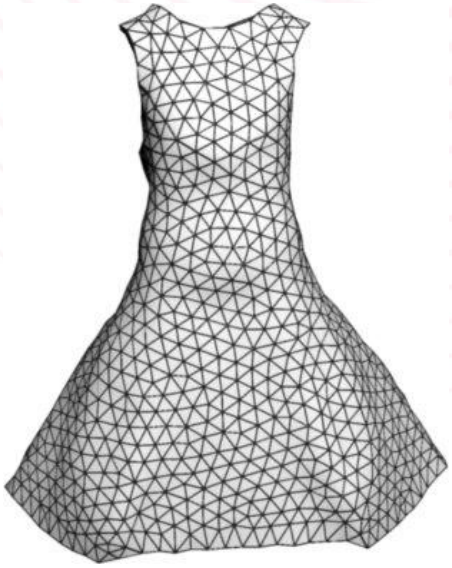
Rest mesh

Input simulation

With our wrinkles

Results

3.5s/frame



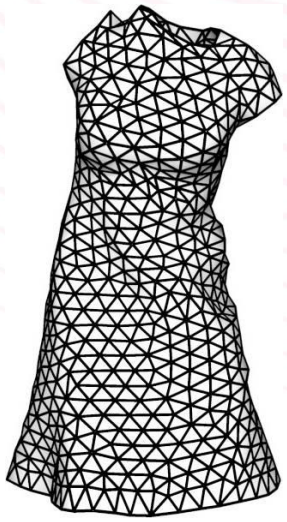
Rest mesh

Input simulation

With our wrinkles

Results

1.5s/frame



Rest mesh

Input simulation

Our results

Results

- 1.5s/frame

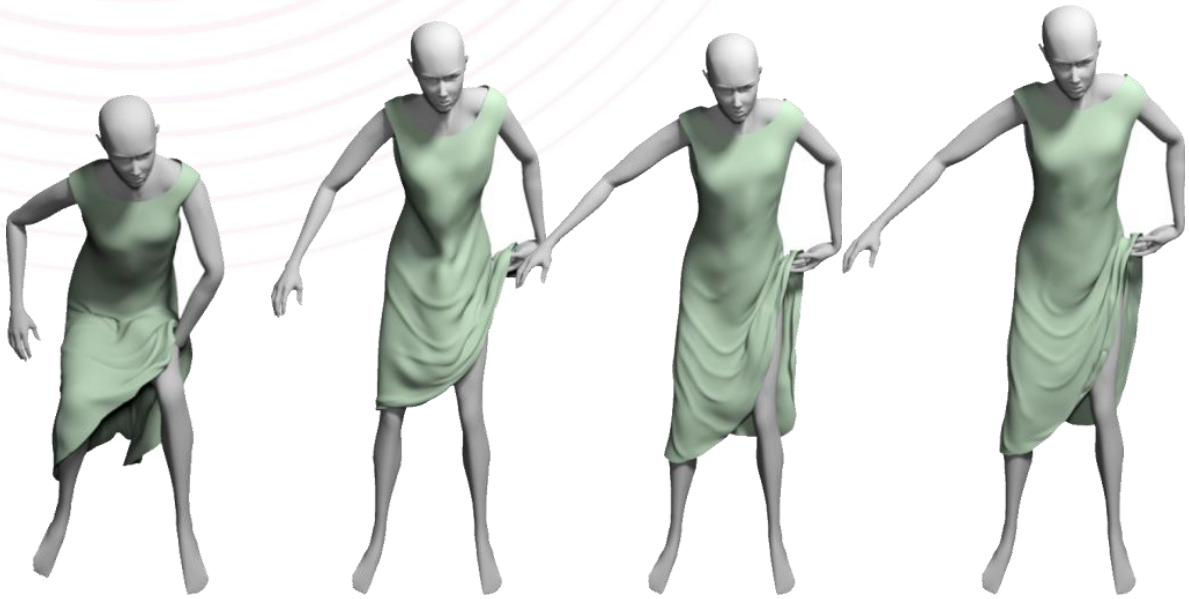
Input meshes

Our results

Summary:

Augment coarse animation with automatic wrinkles

- **Analyse directional stretch** from coarse animation
- Use new implicit deformers to seamlessly **blends wrinkle geometry**



Limitations & Future work

Modeling tension wrinkles

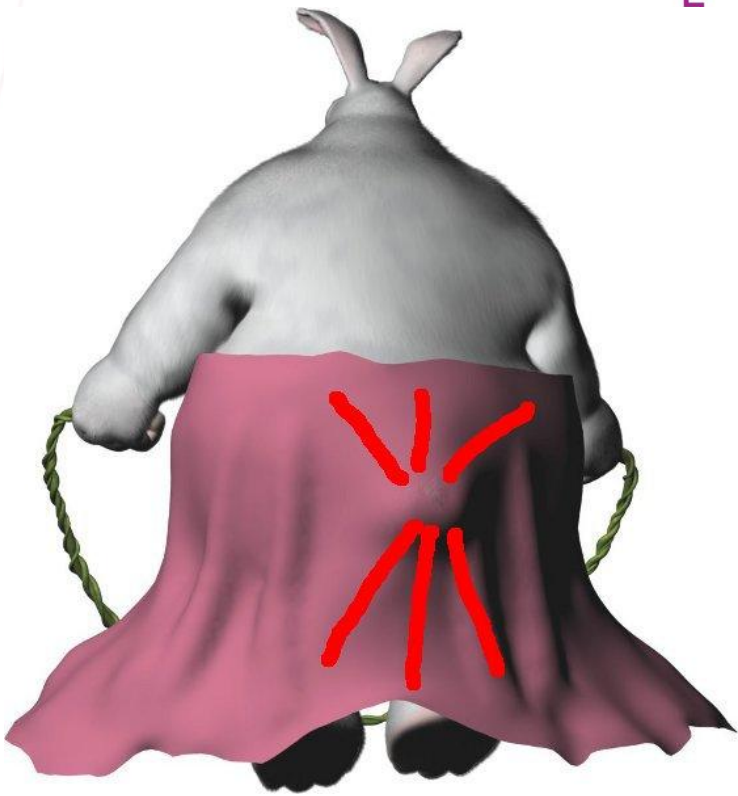
- Detect elongation in coarse animation.

Computation time: GPU, Bump mapping

Limitations & Future work

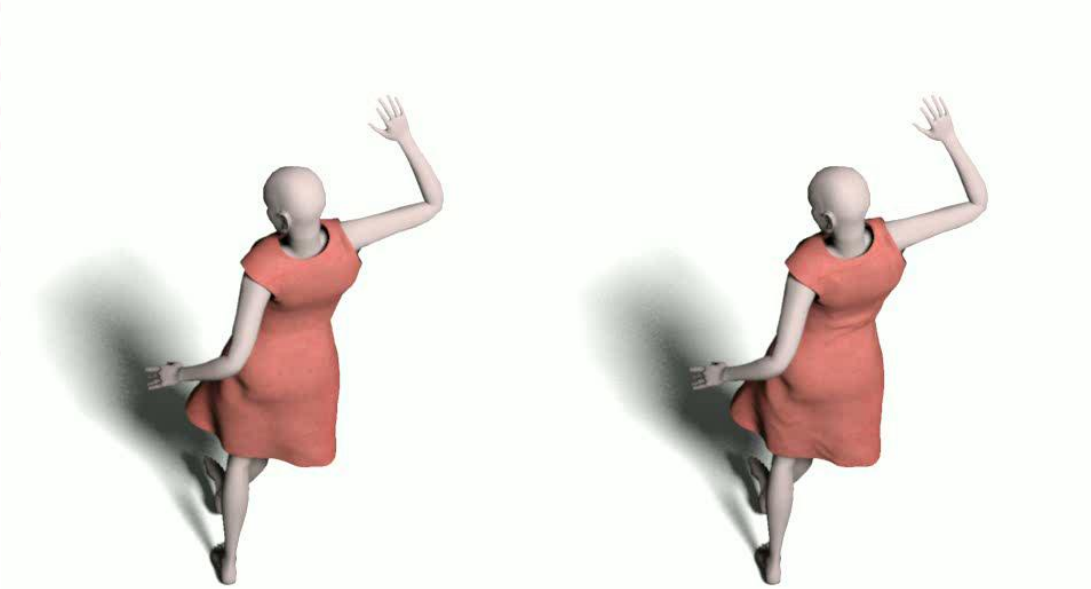
Modeling tension wrinkles

- Detect elongation in coarse animation.



Computation time: GPU, Bump mapping

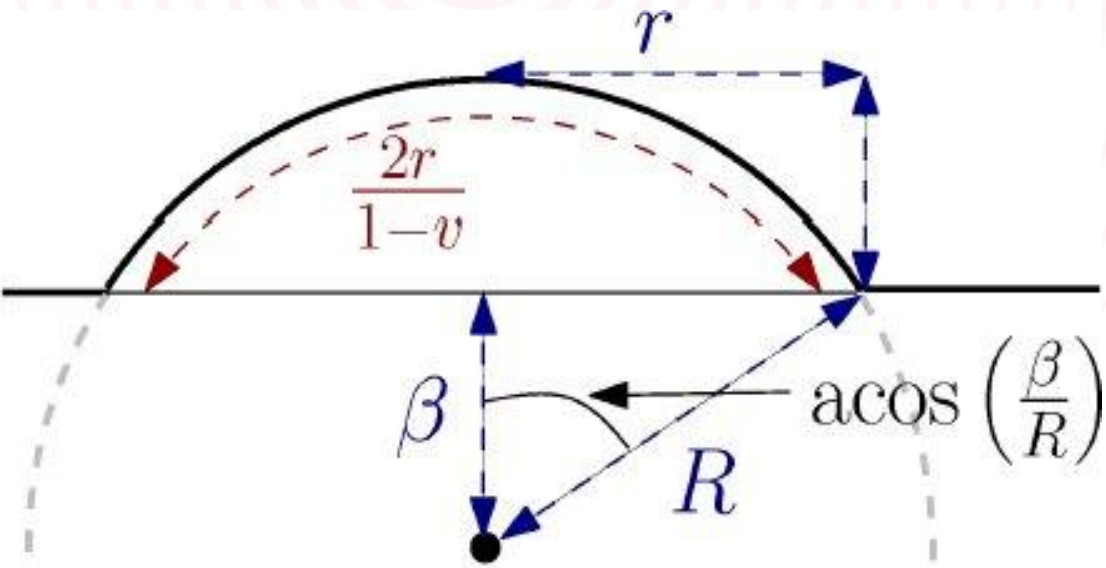
Thank you

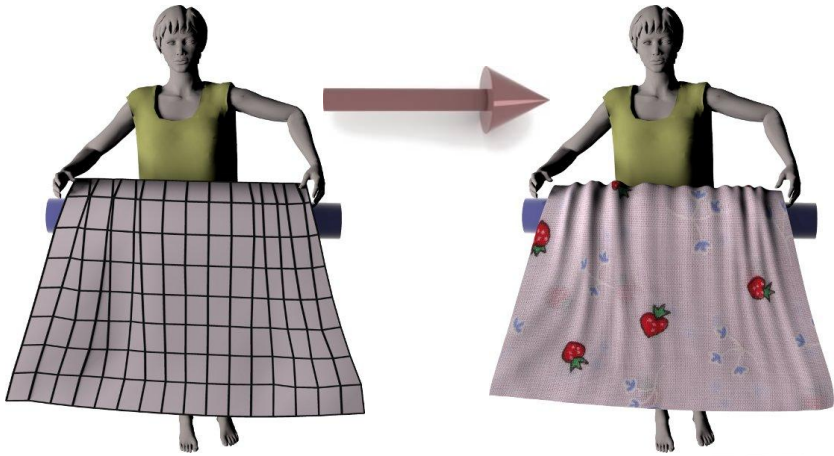


Input meshes

Our results

Wrinkle geometry

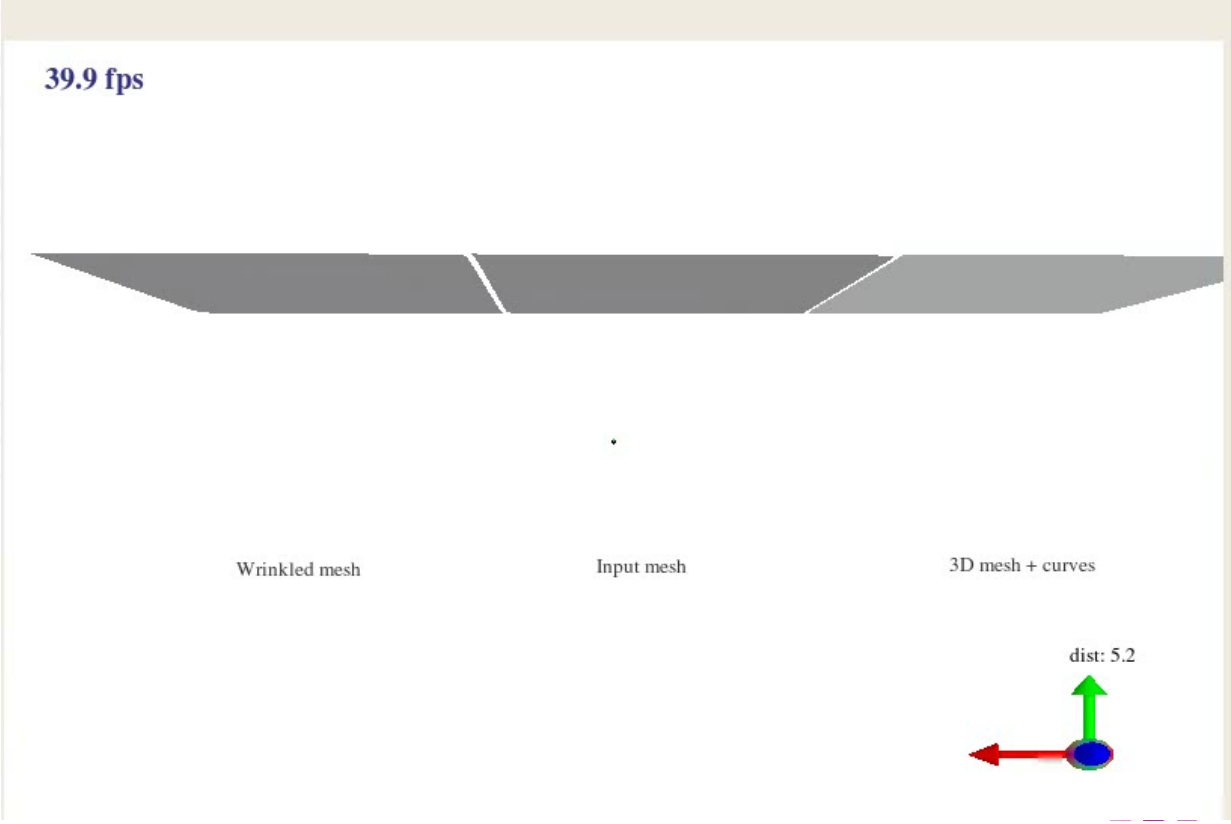




4. Results

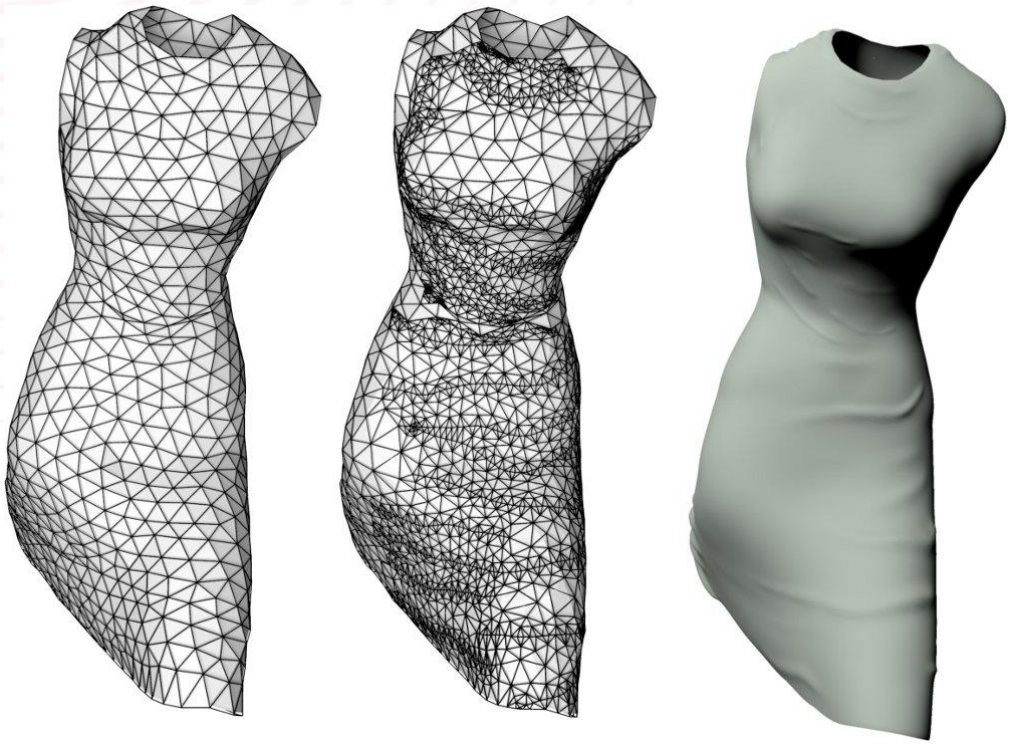
Computational times

~1fps (mostly projection)



Adapted mesh subdivision

Local subdivision



Motivation