COMP768 Final Project

Cloth Simulation &
Video-based Cloth Parameter Estimation

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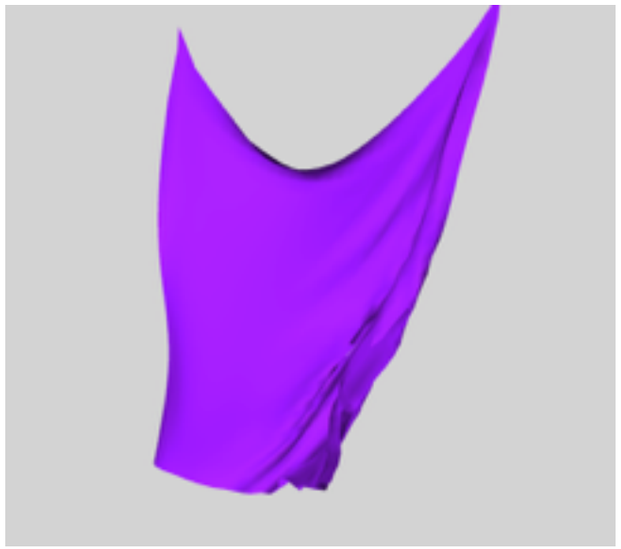
Motivation

- Cloth Simulation
  - Movie
  - Games
  - VR scene
  - Virtual Try-on

- Cloth Parameter Estimation
  - Good parameters can produce very realist appearance
  - Choosing parameters are time-consuming

Outline

- Cloth Simulation
  - Position Based Method Implementation
  - Stretching, Bending, Self-collision, Damping
- Video-based Cloth Parameter Estimation
  - Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos
    - Design a small network to learn motion feature and use a simple classifier using synthetic data
    - Collect real-life video data
      - Preprocessing and use optical flow algorithm to get flow feature
- Extension: Garment Movement with Human Motion
  - Get synthetic dataset



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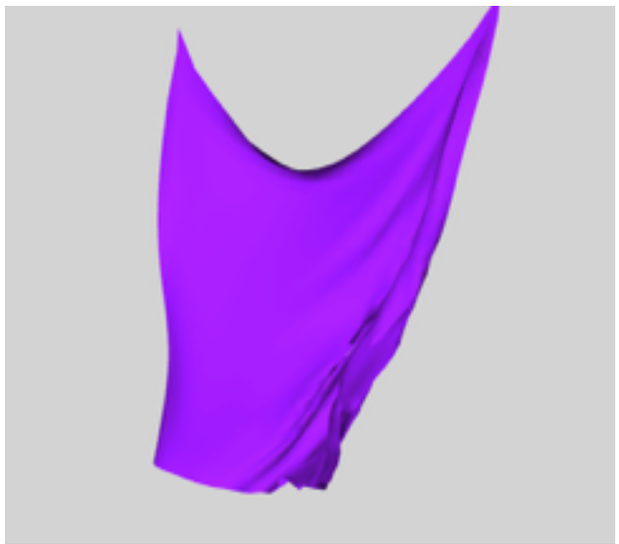

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Cloth Simulation

- Force Based Methods
  - Internal and external forces are accumulated, Newton's second law
  - Employ a time integration method, update velocities and finally positions
- Impulse Based Methods
  - Directly manipulate velocities, one layer of integration can be skipped
- Position Based Methods
  - Omit the velocity layer as well and immediately works on the positions
  - Define general constraints via a constraint function
  - Directly solve for the equilibrium configuration and project positions

Cloth Simulation

- Recall Position Based Method
  - A vertex i ∈ [1,...,N]
  - mass m_i,
  - a position x_i
  - a velocity v_i.
  - Constraint C_j

Based on this data and a time step Δt, the dynamic object is simulated as follows:

(1) **forall** vertices i
(2) initialize $\mathbf{x}_i = \mathbf{x}_i^0, \mathbf{v}_i = \mathbf{v}_i^0, w_i = 1/m_i$
(3) **endfor**
(4) **loop**
(5) **forall** vertices i **do** $\mathbf{v}_i \leftarrow \mathbf{v}_i + \Delta t w_i \mathbf{f}_{ext}(\mathbf{x}_i)$
(6) dampVelocities$(\mathbf{v}_1, \ldots, \mathbf{v}_N)$
(7) **forall** vertices i **do** $\mathbf{p}_i \leftarrow \mathbf{x}_i + \Delta t \mathbf{v}_i$
(8) **forall** vertices i **do** generateCollisionConstraints$(\mathbf{x}_i \rightarrow \mathbf{p}_i)$
(9) **loop** solverIterations **times**
(10) projectConstraints$(C_1, \ldots, C_{M+M_{coll}}, \mathbf{p}_1, \ldots, \mathbf{p}_N)$
(11) **endloop**
(12) **forall** vertices i
(13) $\mathbf{v}_i \leftarrow (\mathbf{p}_i - \mathbf{x}_i)/\Delta t$
(14) $\mathbf{x}_i \leftarrow \mathbf{p}_i$
(15) **endfor**
(16) velocityUpdate$(\mathbf{v}_1, \ldots, \mathbf{v}_N)$
(17) **endloop**

Cloth Simulation

- Recall Position Based Method
  - Stretching Constraints
  - Bending Constraints
  - Self Collision Handling

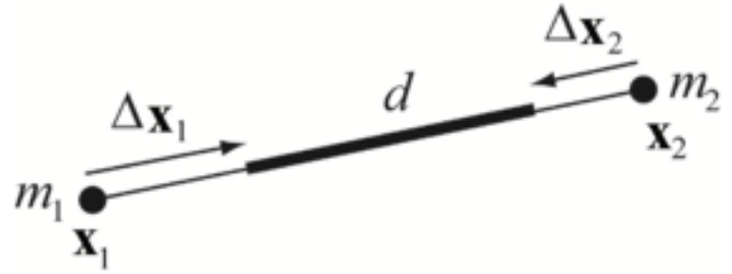

Figure: Streching [Bender 15]

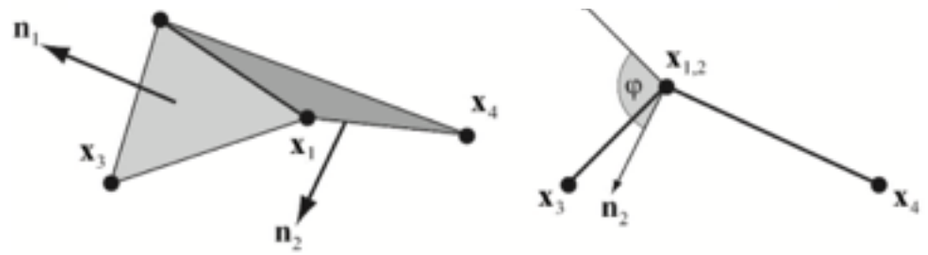

Figure: Bending [Bender 15]

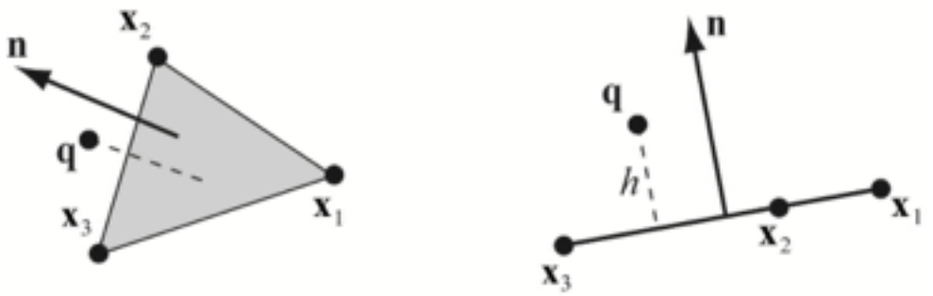

Figure: Collision [Bender 15]

Cloth Simulation

- Position Based Method
  - Stretching Constraints
  - Bending Constraints
  - Self Collision Detection
  - Damping
- Other: GUI
  - Drag a point of the cloth

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Video Demo Link: http://cs.unc.edu/~zhenni/courses/UNC/COMP768/project/cloth-sim.mov

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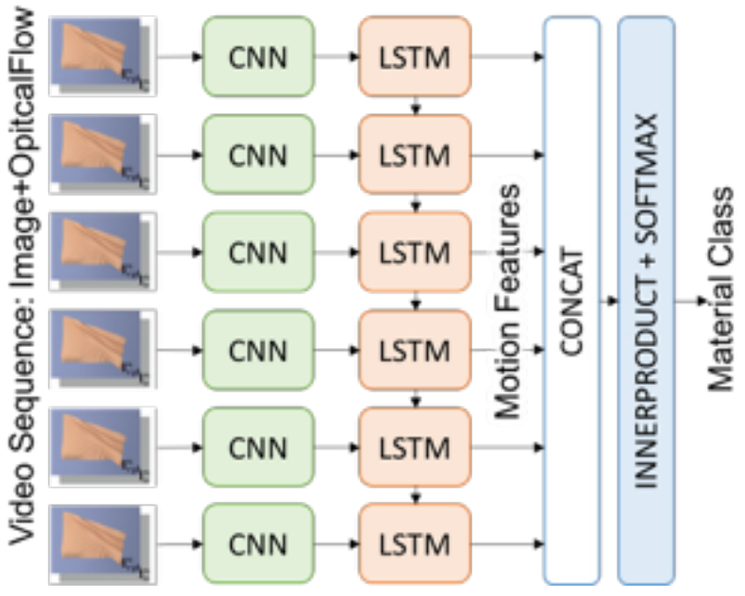

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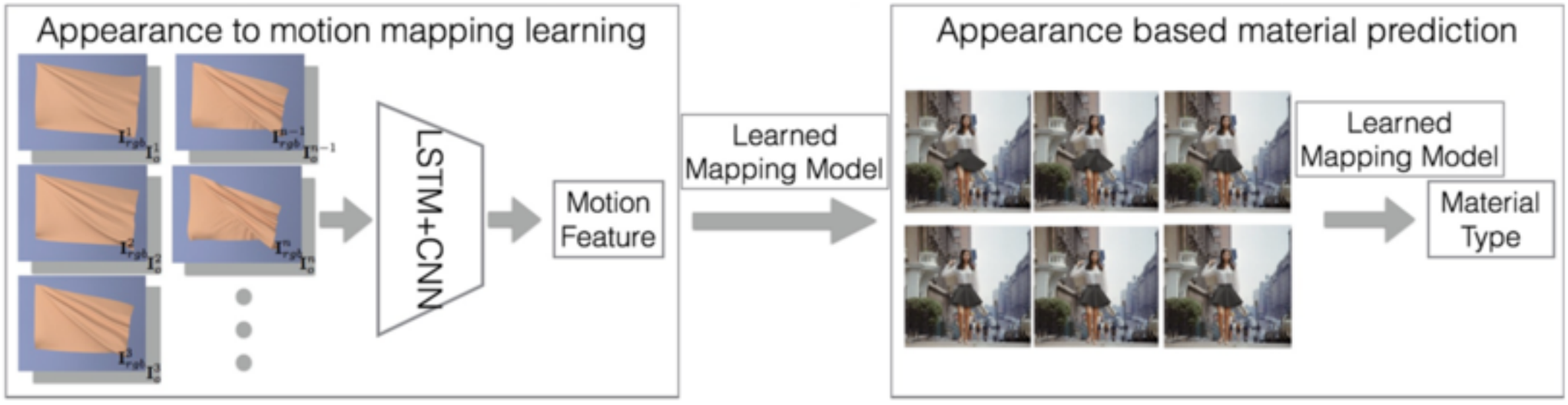
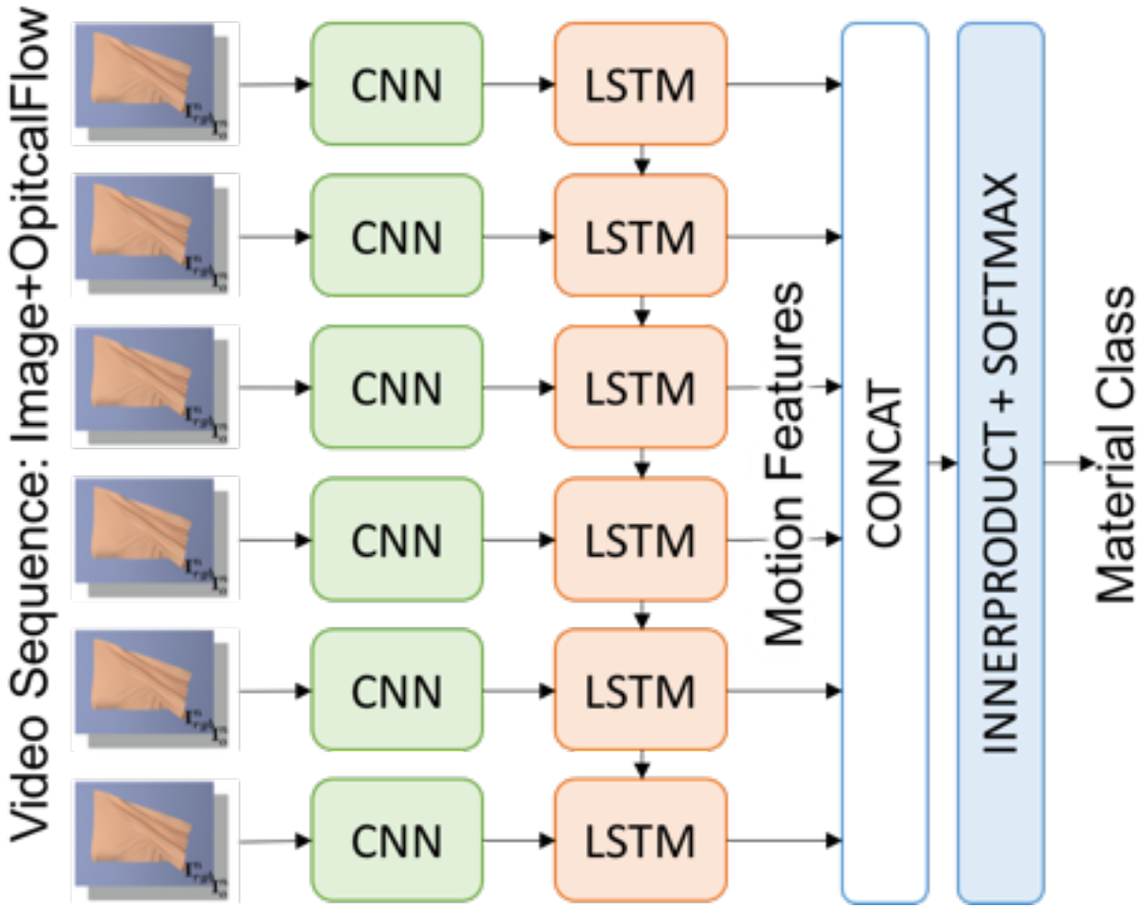
Video-based Cloth Parameter Estimation

- Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos:



Video-based Cloth Parameter Estimation

- Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos:
  - Design a small network to get motion feature and use simple the classifier to get material class
  - Toy dataset: synthetic data
    - Train: ~10k sequences
    - Test: ~1k sequences
  - Result:
    - Accuracy:
      ~2% higher than random
  - Analysis and modification:
    - use trained model to finetune
    - more data & longer sequence
    - More meaningful classifier



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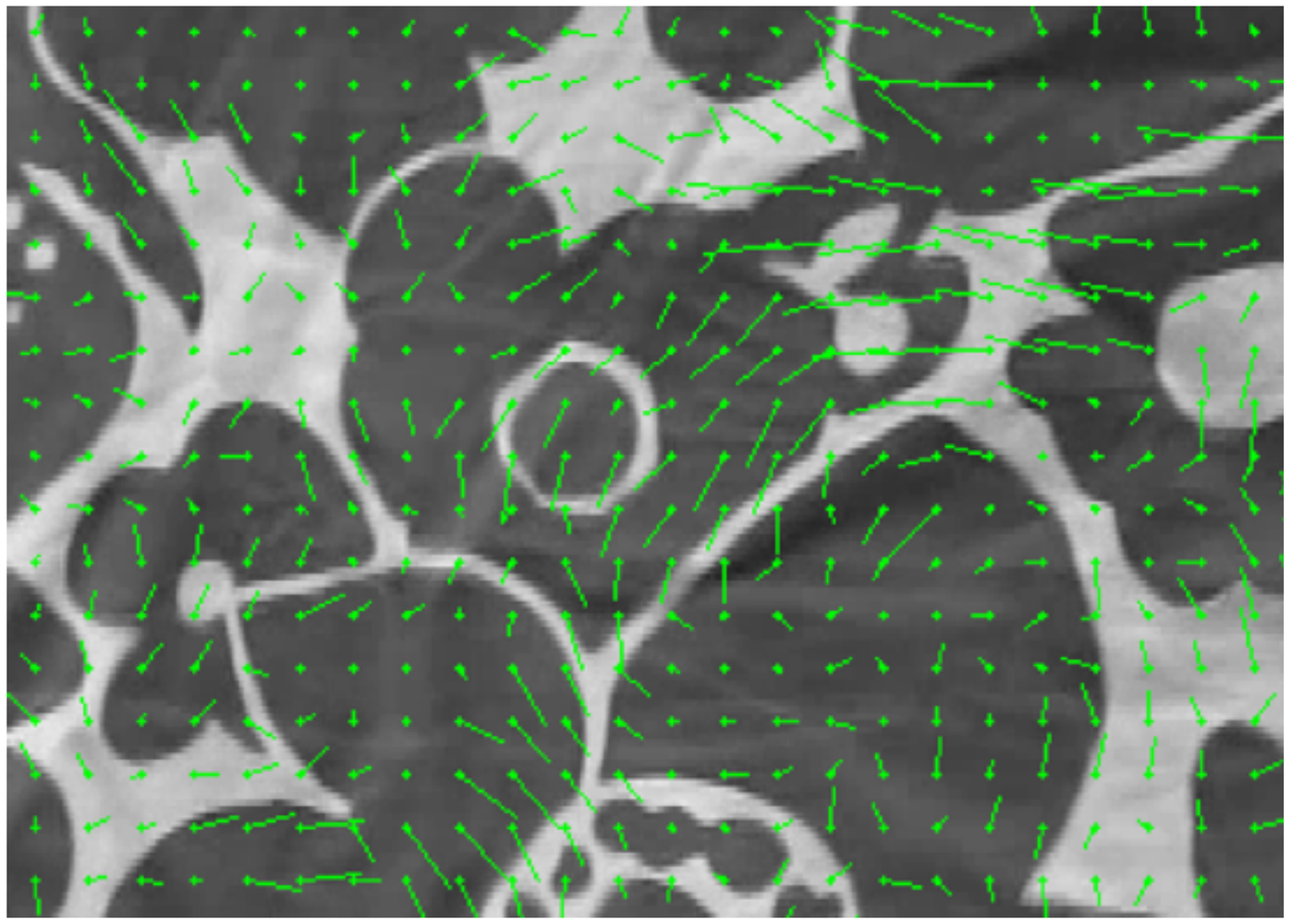
Video-based Cloth Parameter Estimation

- Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos:
  - Collect real-life cloth moving videos.



Video-based Cloth Parameter Estimation

- Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos:
  - optical flow algorithm for generating features of real-life videos



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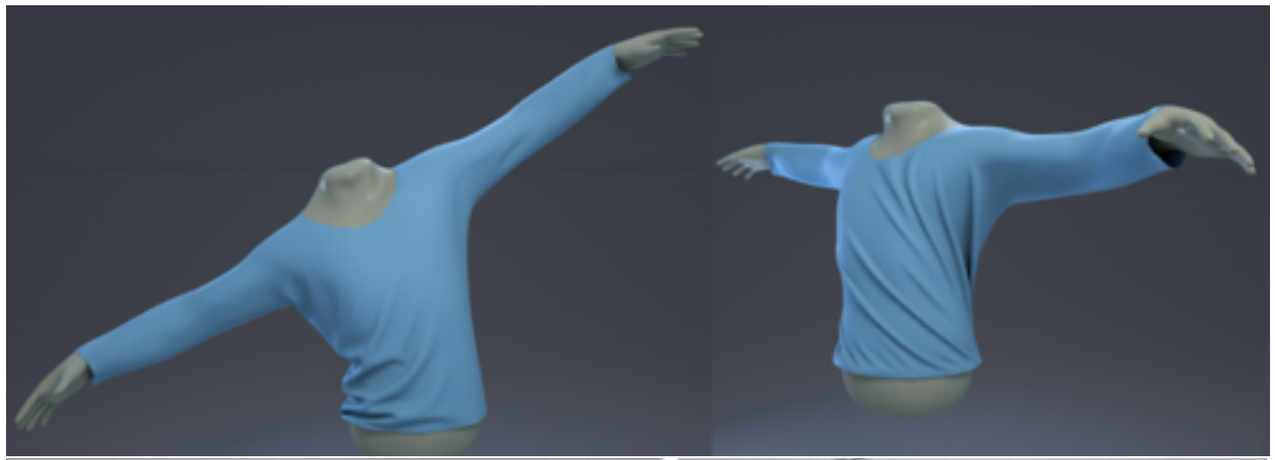
Video-based Cloth Parameter Estimation

- Extension:
  Garment movement
  - not only considering material
    - Cloth movement vs. Garment movement
    - Human motion



Video-based Cloth Parameter Estimation

- Extension: Garment movement:
  - Data Collection
  - Generate synthetic dataset for garment movement
    - ArcSim
    - Blender
    - Make human

Milestone Comparison & Future Work

- Machine-Learning-Based Cloth Material Retrieval in Real-Life Videos:
  - Oct.: Collect real-life cloth moving videos.
  - Oct.: Write an optical flow algorithm for generating features of real-life videos
  - ~~Oct.: Run testing on the real-life videos~~
- Extension: Garment movement:
  - Nov.: Generate synthetic dataset for garment movement
  - Nov.-Dec.: Do clustering ~~on the motion subspace for the garment movement~~
  - ~~Dec.: Testing and Comparison~~

  - Design and train a small network

- Cloth Simulation
  - Position Based Method Implementation

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Thank you.

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