Generalizing Statistical Body Shape Models to Alternative Avatars

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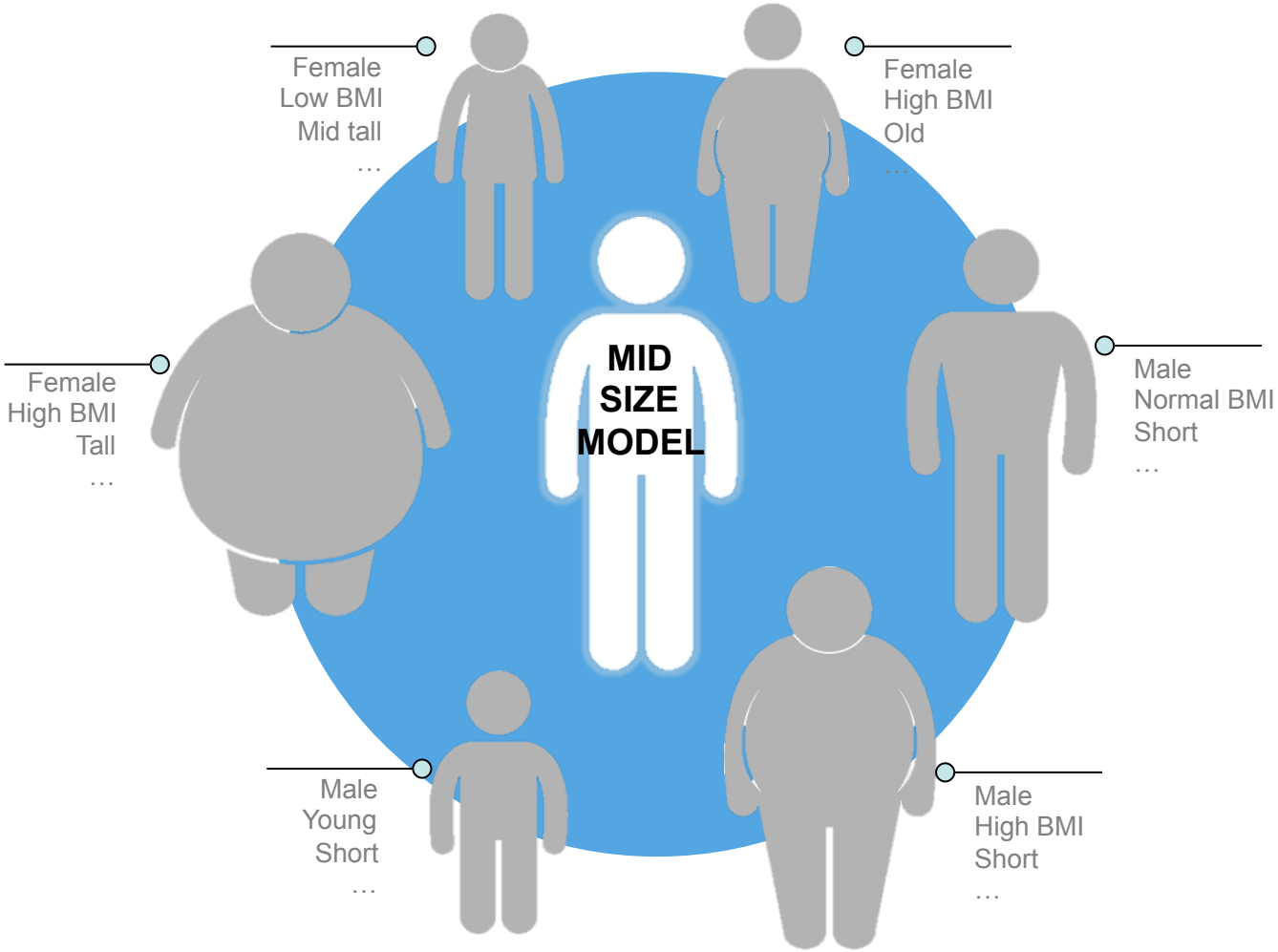
Need for Statistical Body Shape Models (SBSMs)

50th percentile model cannot represent various human body shapes



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How to generate SBSMs

Statistically analyze and parameterize variances of source data sets

1. Collect Data
Sample scans or CT images of population

2. Standardize
Fit template model to individual data

3. Analyze Data
Statistically analyze data using PCA

4. Parameterize
Associate predictors to parameters in model

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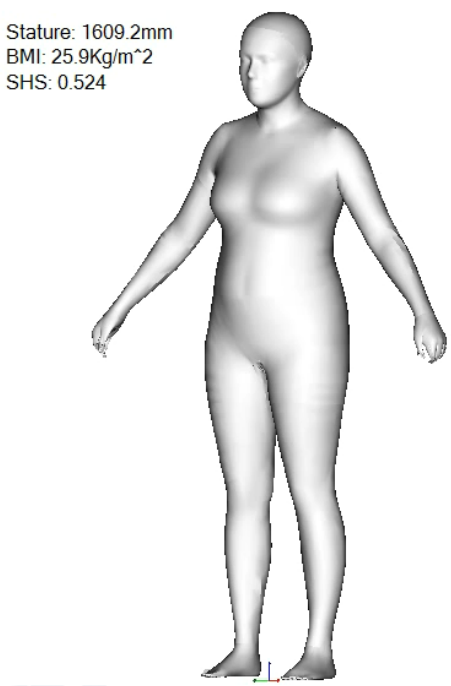
UMTRI SBSMs

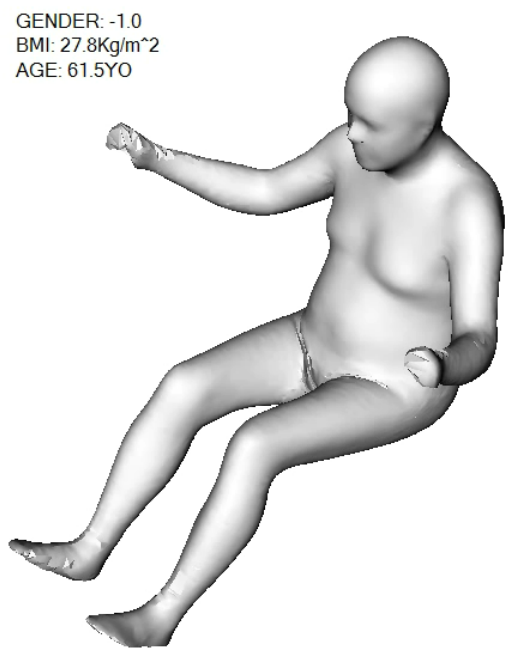
UMTRI developed various types of statistical body shape models

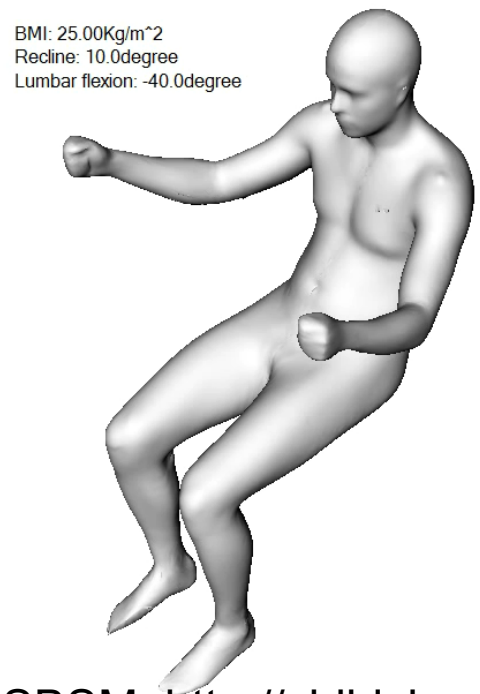
Predictors:
Body dimensions

Predictors:
+ Age and gender

Predictors:
+ and Pose!!







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*Online SBSM: http://childshape.org

Backgrounds and Objective

- **Limitation of SBSMs**
  - **Hard to convert to different mesh structure** since it is based on a specific template model

- **Main Objective**
  - To propose **a method to convert SBSM into alternative avatar that has diffrent geometric structure**, so benefits of SBSMs can be used in different software environments.
    1) Understand the discrepancy of heterogeneous geometric structures
    2) Build mapping information to store relationship of meshes
    3) Generate subject-specific avatar using mapping information

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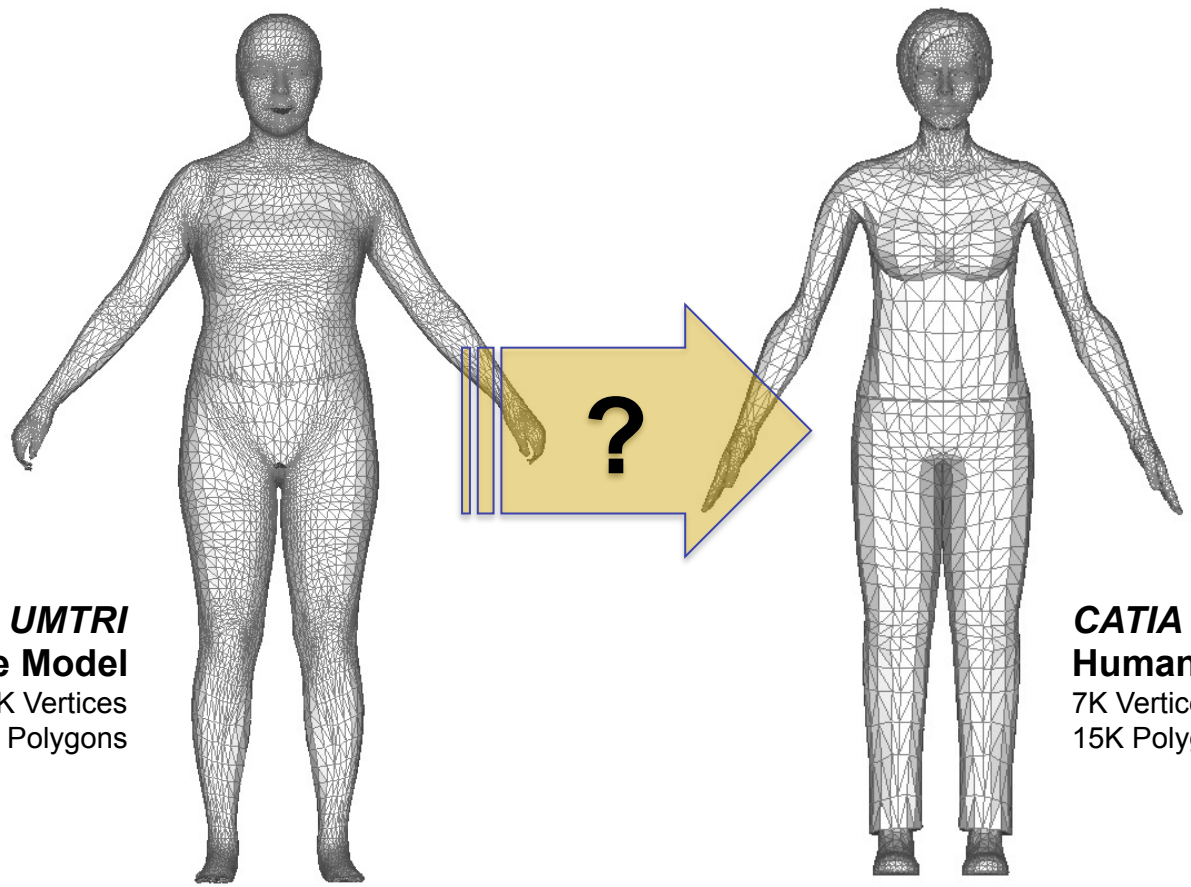
Need for Generalizing SBSMs

How can we convert a mesh structure to another kind?



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PCAR Female Model
19K Vertices
25K Polygons

***CATIA* v6**
Human Body Mesh
7K Vertices
15K Polygons

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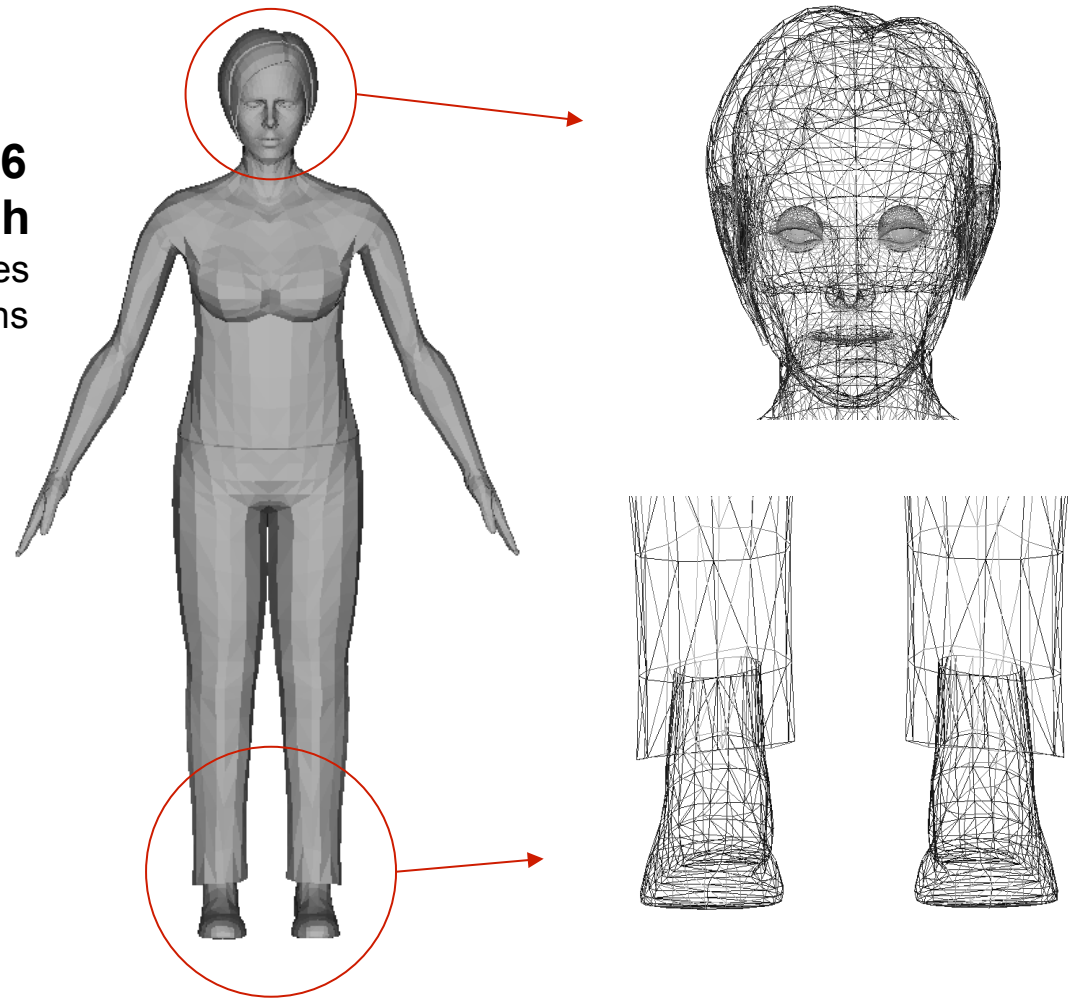
BACKGROUND

Generate a statistical model for CATIA v6 mesh

***CATIA* v6**
Human Body Mesh
7K Vertices
15K Polygons



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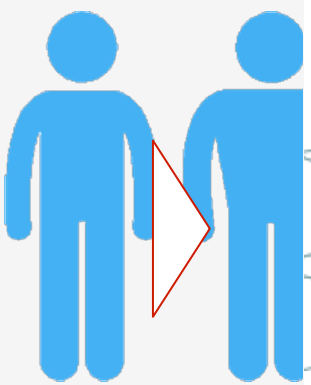
Overall Procedure

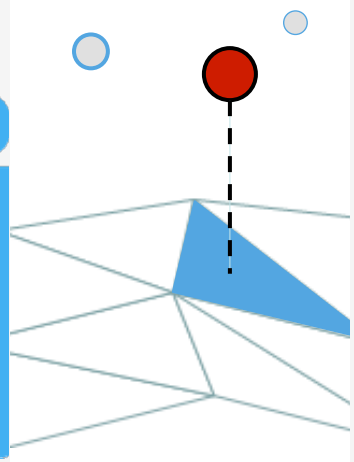
Five steps to convert SBSM to arbitrary avatar

Step 1. Fit SBSM Model to Avatar

in the body shape space of SBSM

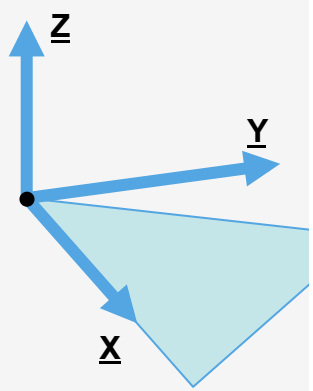


Step 2. Find Corresponding Elements for Each Vertex



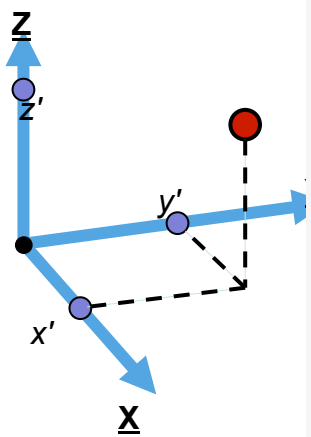
Step 3. Define Local Coordinate System (LCS)

based on the matched element

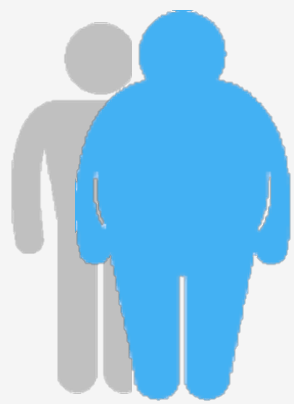


Step 4. Convert Coordinates using LCSs

By projecting the coordinates to the system



Step 5. Apply Converted Coordinates to a Model



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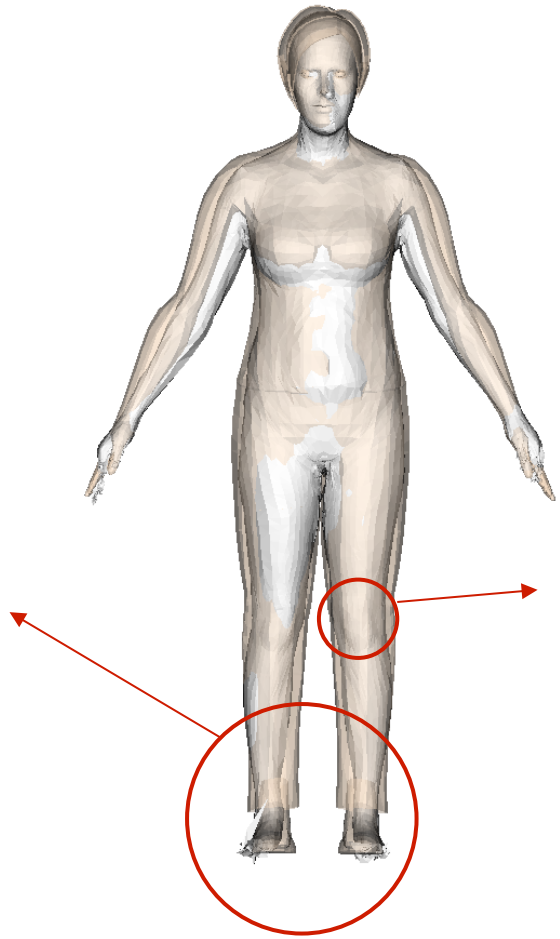
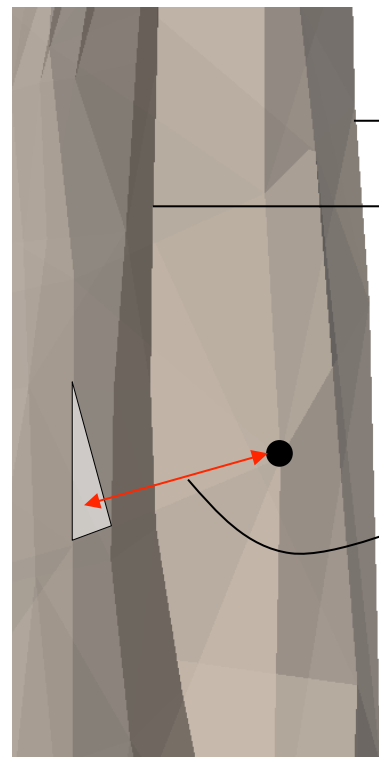
Step 1 & 2. Fit Model and Find Correspondences

- Fit a SBSM to the original mesh of CATIA manikin in body shape space
- Find the nearest SBSM triangle for each vertex on CATIA mesh

Account for clothing effect





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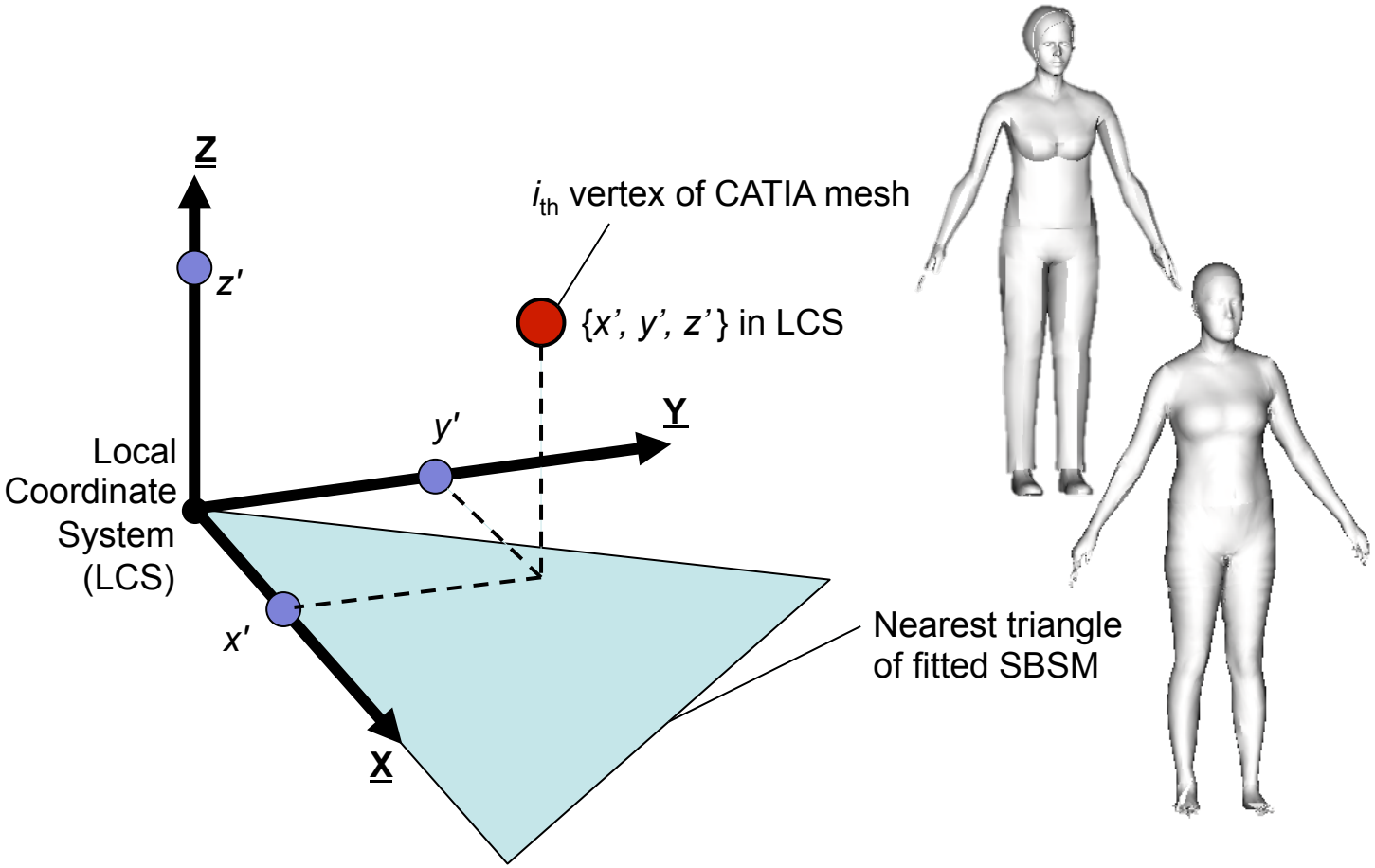
Step 3 & 4. Define LCS and Map Coordinates

- Define local coordinate system (LCS) based on nearest triangle
- Store local coordinates of the CATIA vertices using the LCS (Figure)



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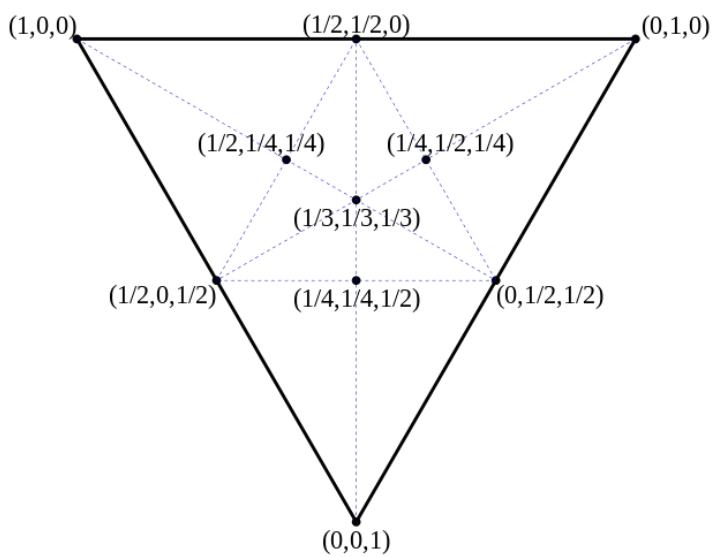
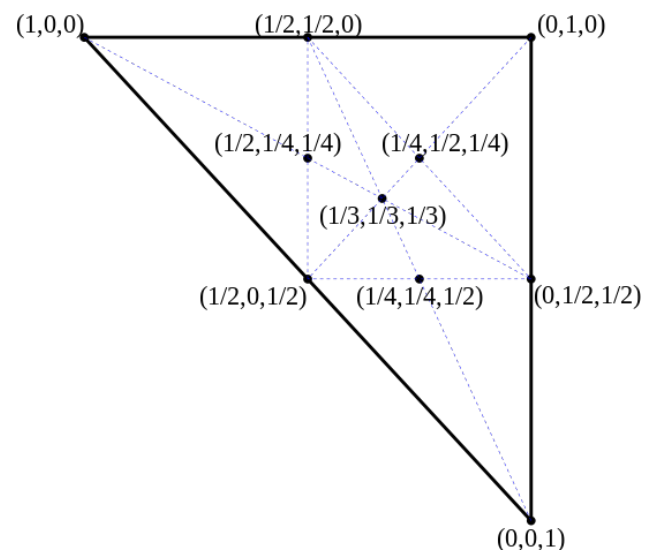
Step 3 & 4. Define LCS and Map Coordinates

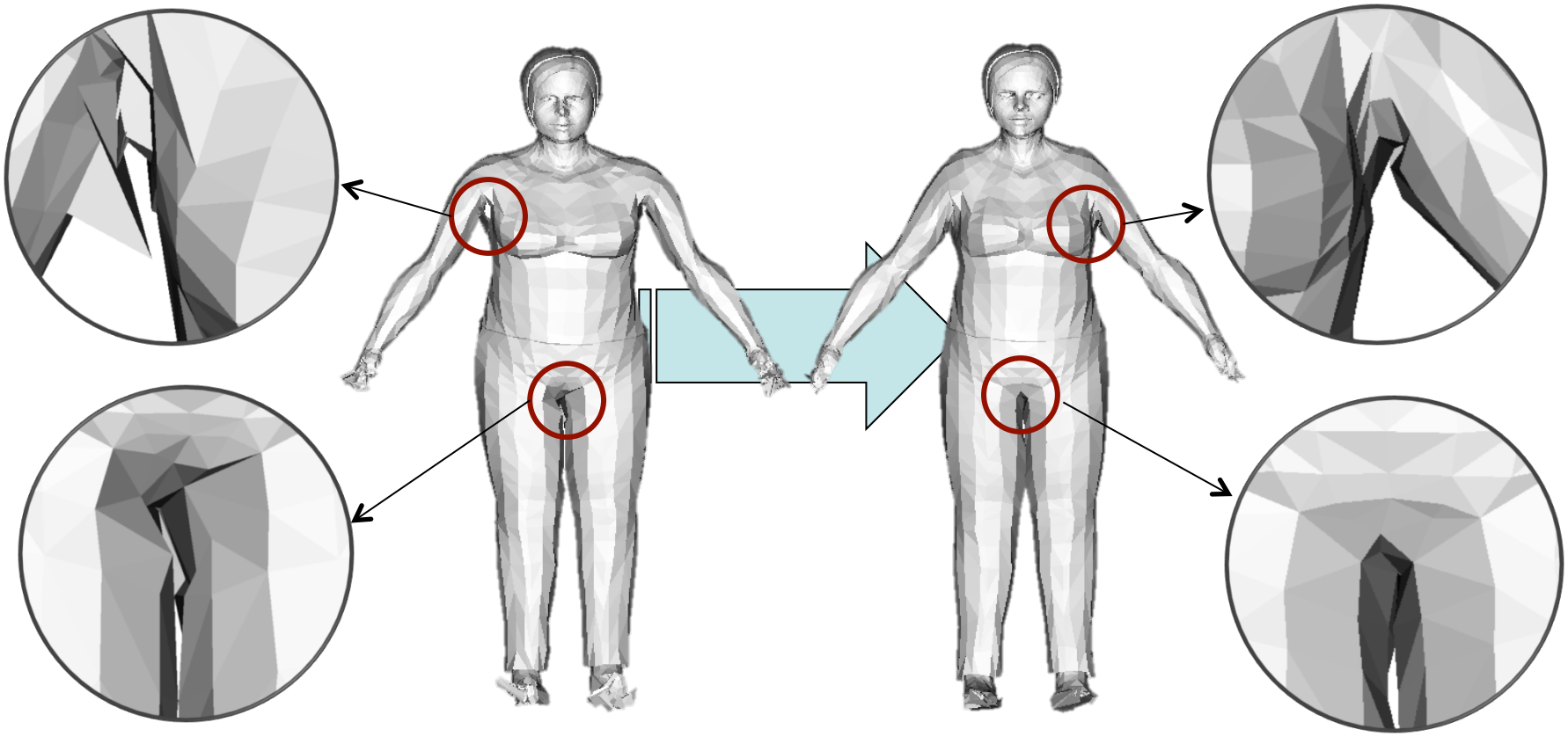
- Problems of LCS using Cartesian coordinates
  - Badly-conditioned triangles yield distortions on converted surface
  - Solved by applying Barycentric coordinate system to define a point on a triangle





Step 3 & 4. Define LCS and Map Coordinates

Comparison between Cartesian and Barycentric LCSs



Cartesian LCS

Barycentric LCS

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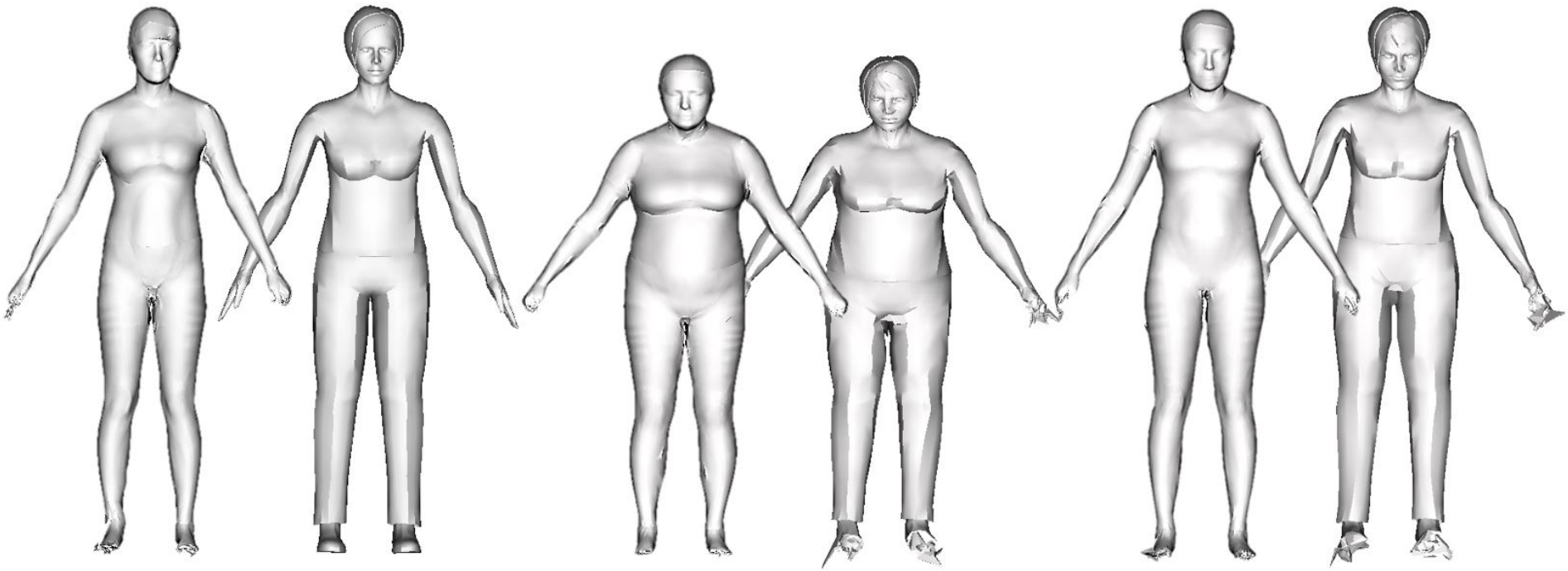
Step 5. Apply Mapping to Subject-specific SBSMs

Apply mapping information based on subject-specific SBSMs' Meshes



Fitted PCA | CATIA Mesh | PCA 1 | Recon. CATIA 1 | PCA 2 | Recon. CATIA 2

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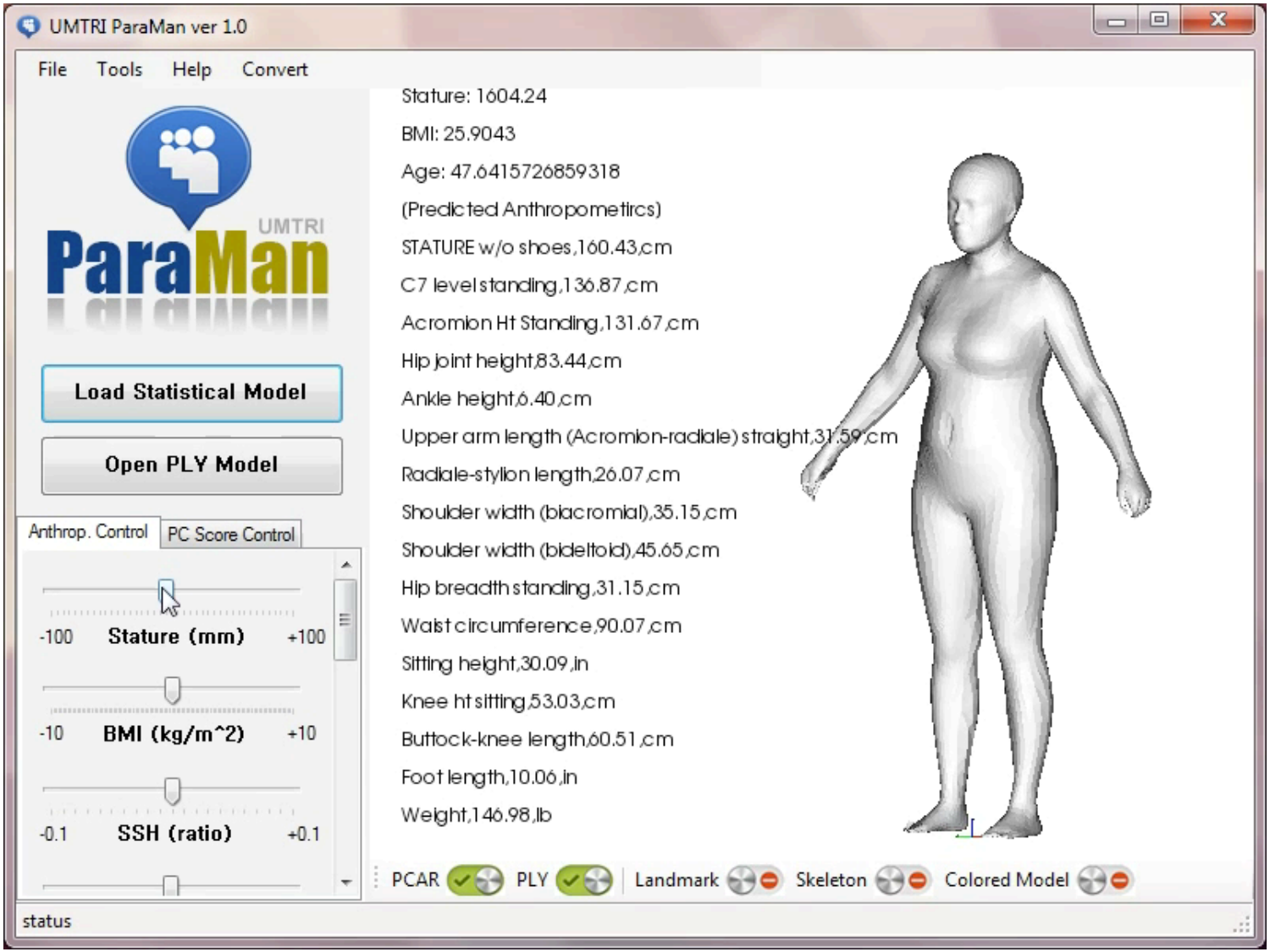
Result: Implementation Demo



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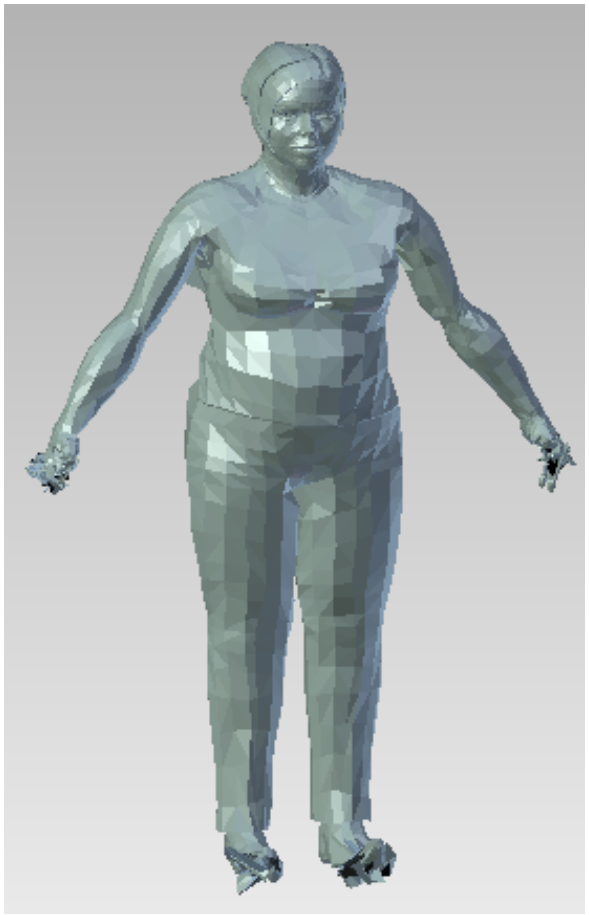
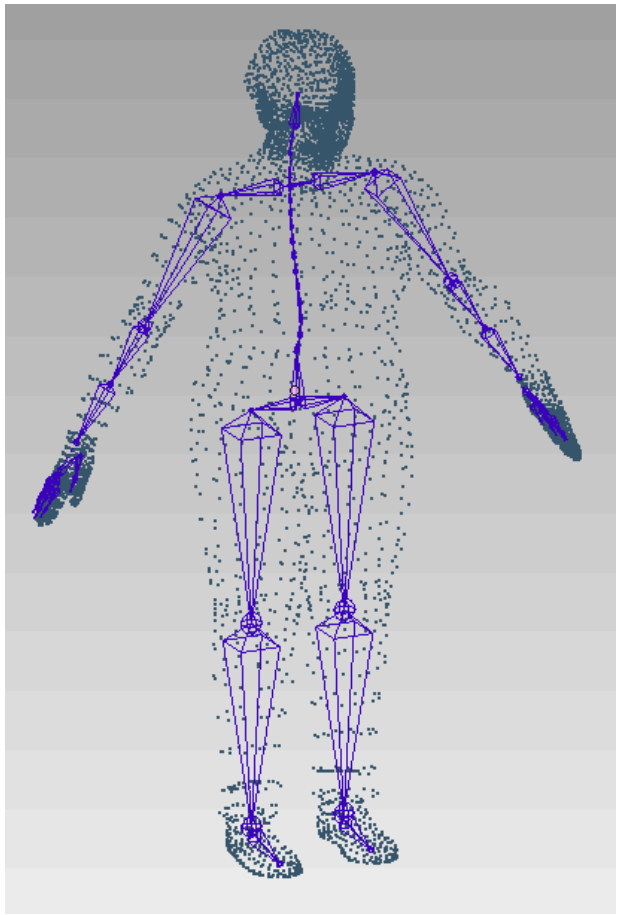
Result: Segmentation and Rigging

Converted Avatar



Estimated Skeleton



Adjusted Posture in CATIA

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Result: Key Frame Animation Example

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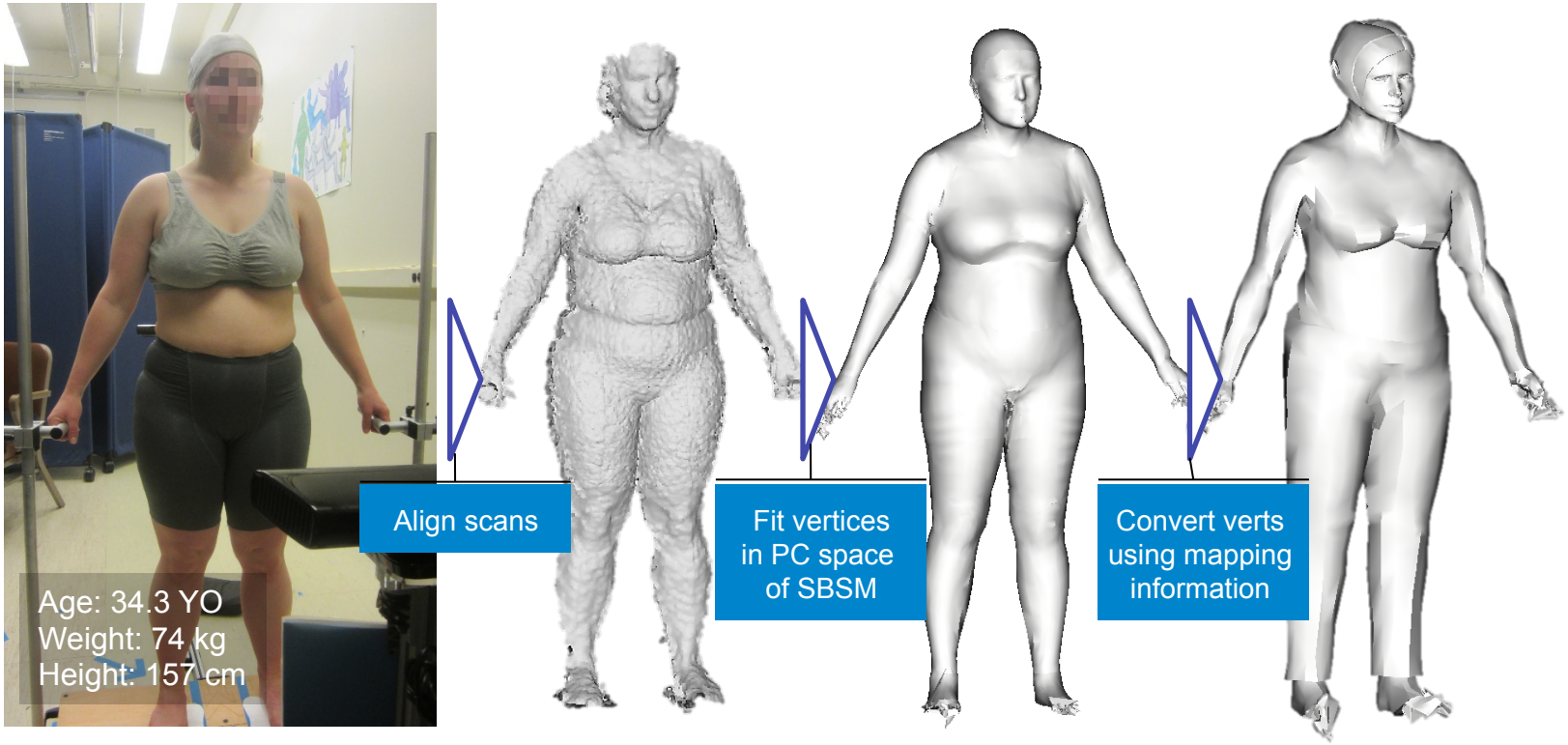
Application: Subject-specific CATIA Manikin Generation using MS Kinect

Kinect-scan data conversion



Scanning using Kinect | Scan data | Fitted SBSM to Scan | Converted to CATIA Manikin

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Conclusions

- Generalizing SBSM to alternative avatars
  - Subject-specific SBSMs were converted to alternative avatars using mapping information that explains discrepancy of two geometric structures
  - Barycentric local coordinate system was used for reliable conversion
  - Building mapping information takes a few seconds, and mesh conversion is in real time
- Limitation
  - Badly-conditioned mesh might result in anomalies
- Future Works
  - Apply to various types of commercial software systems
  - 3D finite elemental model conversion

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THANK YOU!

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