Modular System Design for CyberManufacturing of Customized Apparel

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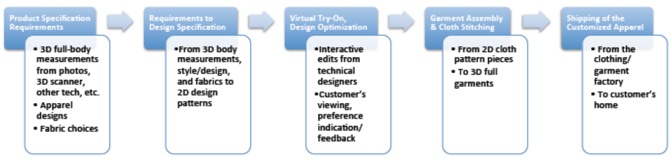
Background & Motivation

Retail is a multi-trillion dollar business worldwide, with the global fashion industry valued at $3 trillion. Approximately $1.6 trillion of retail purchasing in 2015 was done via online e-commerce sales, with growth rates in the double digits. Thus, enabling better online apparel shopping experiences has the potential for enormous economic impact.

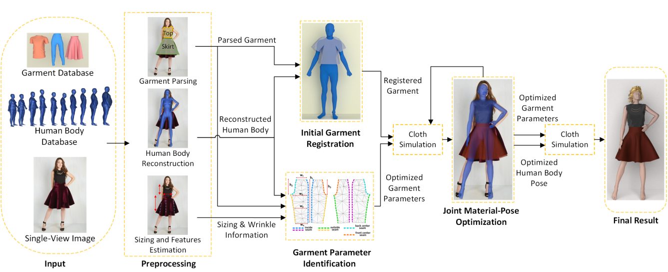


OBJECTIVES: To develop a novel computational framework and software system architecture for solving challenging cyber-manufacturing of customized apparel by offering an alternative, clean, green, and resource-efficient approach.

APPROACH: New simple-to-use 3D body measurement systems on portable devices, interactive cloud-based design optimization, reliable visual inspection, predictable virtual try-on, and adept fabrication with different fabric materials.

Method

System Overview



Preprocessing

Garment Parsing — Computer Vision Technique; Human Body Parsing — Human Input+Optimization; Sizing and Wrinkle Parsing — Optimization

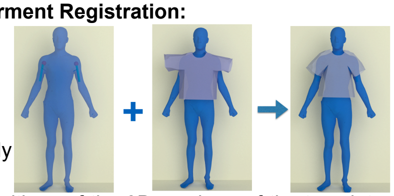
- To estimate the clothing model, we first compute a semantic parse of the garments in the image to identify and localize clothing items.

This semantic segmentation is computed automatically using a data-driven method for clothing recognition.

- To construct an accurate body model, the user indicates 14 joint positions on the image. From this information, we use a statistical human model to automatically generate a human body mesh for the image.
- We then use the semantic parsing to extract garment sizing information, such as waist girth, skirt length, and so on. We also analyze the segmented garments to identify the location and density of wrinkles and folds in the recovered garments.

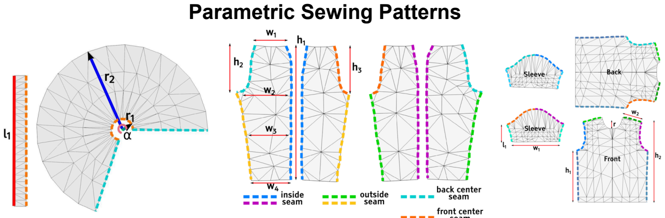
3D Garment Registration:

- **Given:**
  - Human Body
  - 3D Garment Template
- **Register:**
  - Garment -> Human Body



- We optimize the vertex positions of the 3D mesh, x, of the template clothing based on the human body mesh parameters < θ, z > to dress our template garment onto a human body mesh of any pose or shape.

Parametric Sewing Patterns



- For basic garment types, such as skirts, t-shirts, and tank tops, we use one template pattern for each. We modify the classic sewing pattern according to the parameters *G*.

Garment/Pose Parameter Extraction

- **Material Recovery**

$$\mathbf{E}_{\text{mat}} = \underset{\mathcal{C},\mathcal{G}}{\operatorname{argmin}} \|\mathcal{K}(\mathcal{C},\mathcal{G}) - \mathcal{K}(\mathcal{P})_{\text{target}}\| + \|\mathcal{S}(\mathcal{C},\mathcal{G}) - \mathcal{S}(\mathcal{L},\mathbf{z})_{\text{target}}\|.$$

- **Joint Pose Optimization**

$$\mathbf{E}_{\text{joint}} = \underset{\boldsymbol{\theta},\mathcal{C}}{\operatorname{argmin}} \|\mathcal{K}(\mathcal{C},\boldsymbol{\theta}) - \mathcal{K}(\mathcal{P})_{\text{target}}\|$$

- We characterize the wrinkles and folds using their local curvatures.

We recover the garment material parameters by minimizing the average local curvature differences between our recovered garment and the reference garment in the given input image.

Experimental Results

Application: Material Cloning

- We can predict the material type from a daily-life image of the cloth. The recovered fabric material can be "*cloned*" on another piece of cloth or garment.