

Detailed, Accurate, Human Shape Estimation from Clothed 3D Scan Sequences

Chao Zhang, Sergi Pujades, Michael Black and Gerard Pons-Moll



MAX-PLANCK-GESELLSCHAFT

Goal

Estimation of body shape and pose under clothing from scan sequences

Problem

- The body is **occluded** by clothing
- Current methods leverage body models **but lack personalized details**

Key Idea

- As people move, the cloth drapes at different body parts → our method efficiently leverages temporal information to estimate the shape

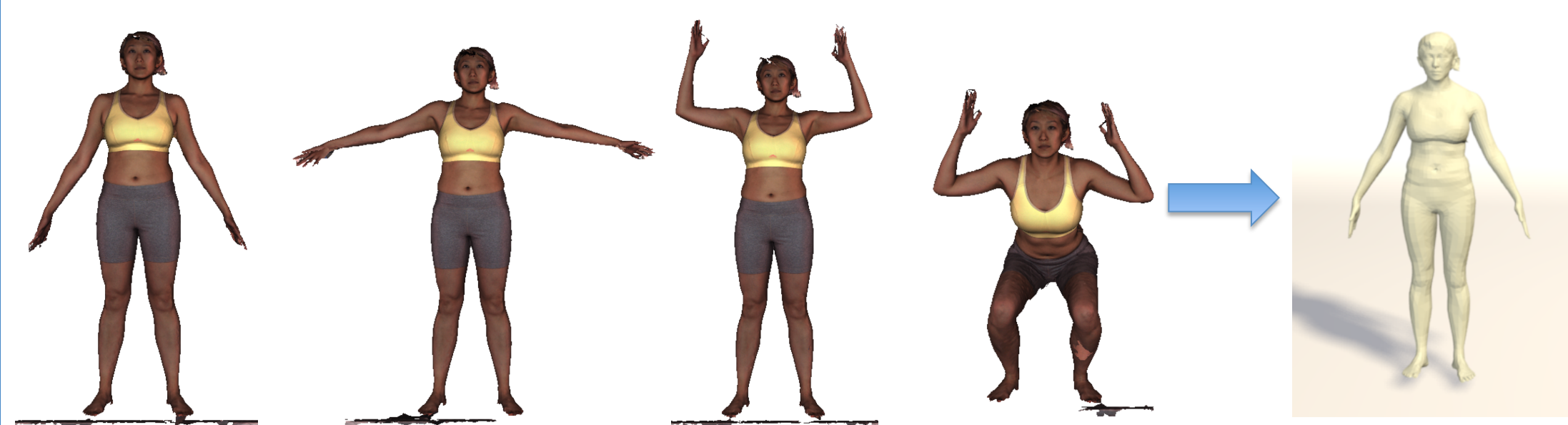
Contribution

- Our method optimizes a free-form surface and body model parameters. Thus it captures the body shape and personalized details (face, hair)

BUFF dataset



6 subjects: 3 male, 3 female
Each with 2 clothing styles performing 3 motions
Total **13,632 scans**: clothed, dynamic, with texture



"ATU-squat" minimal sequences

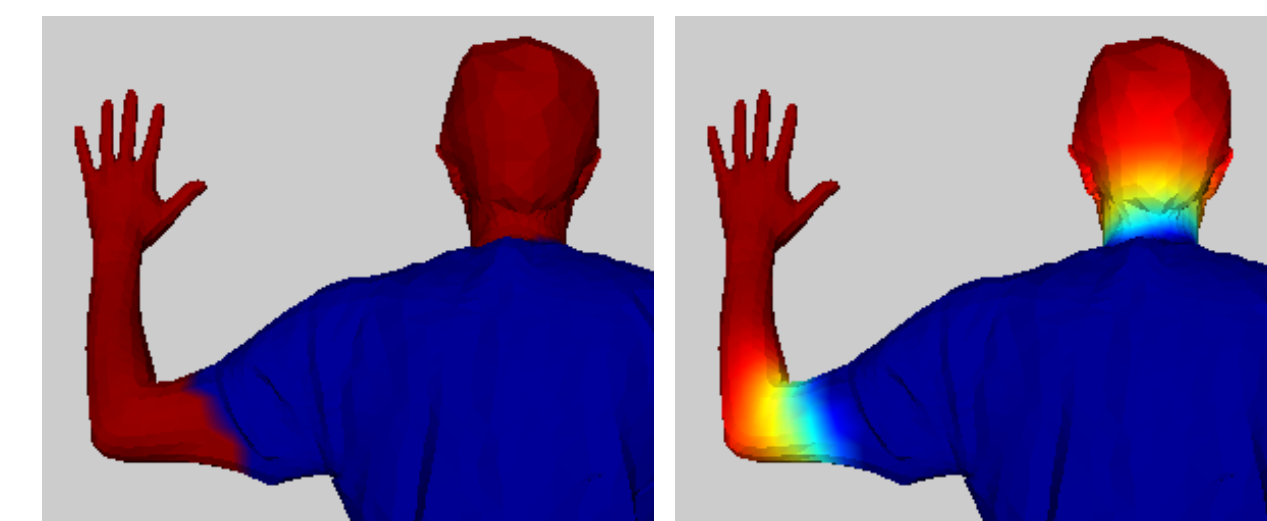
"GT" shape

Method

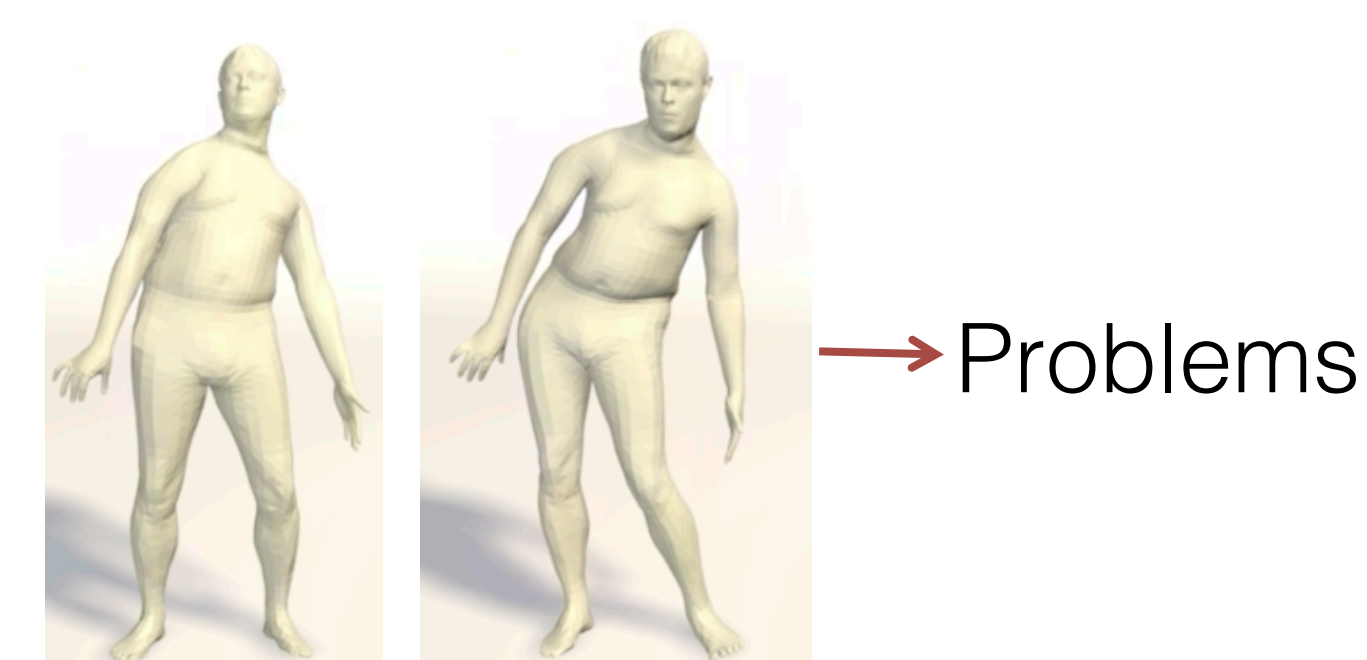
Single frame objective

$$E(\mathbf{T}_{\text{Est}}, M(\beta, 0), \theta; \mathcal{S}) = \lambda_{\text{skin}} E_{\text{skin}} + E_{\text{cloth}} + \lambda_{\text{cpl}} E_{\text{cpl}} + \lambda_{\text{prior}} E_{\text{prior}}$$

- Makes the estimated body $\mathbf{T}_{\text{Est}}$ be tight to the skin parts
- Constrains scan cloth points to remain outside of the body
- Penalizes deviations from the SMPL[3] body model $M(\beta, 0)$

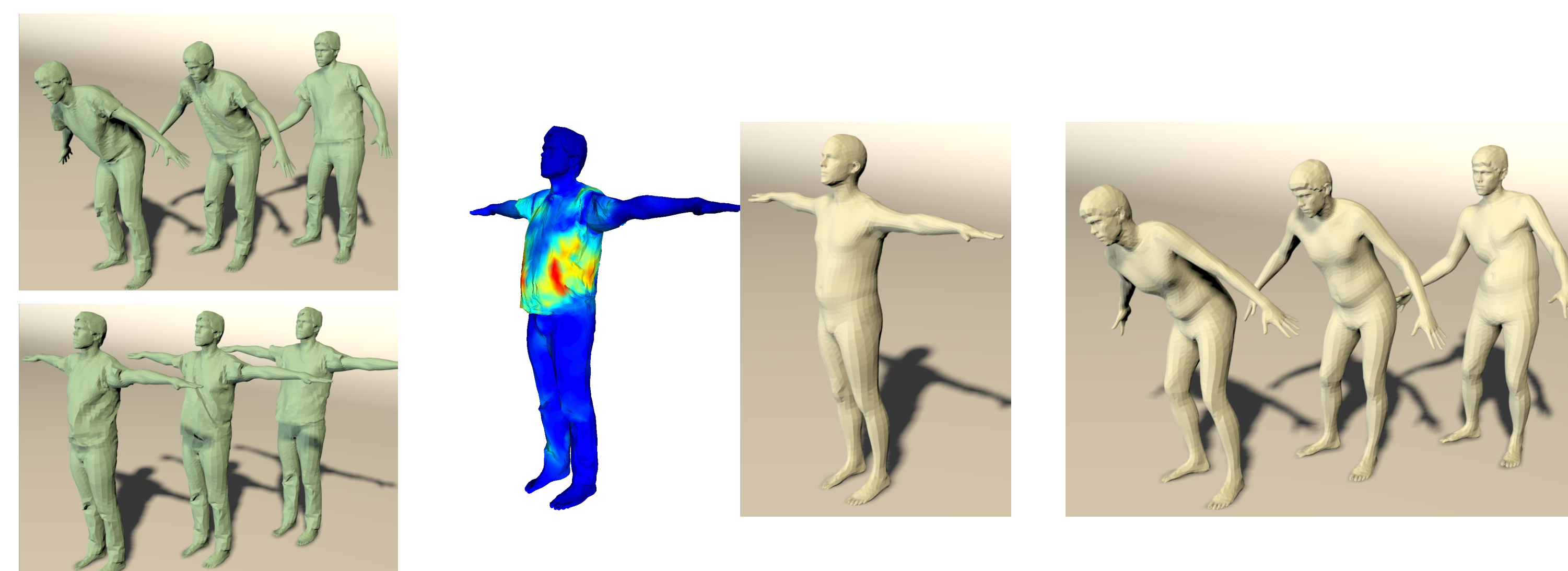


Skin/cloth segmentation from [2]



Fusion shape estimation

Fuse all the temporal constraints given by cloth dynamics in a single scan and optimize a single shape for all frames



1) Registration

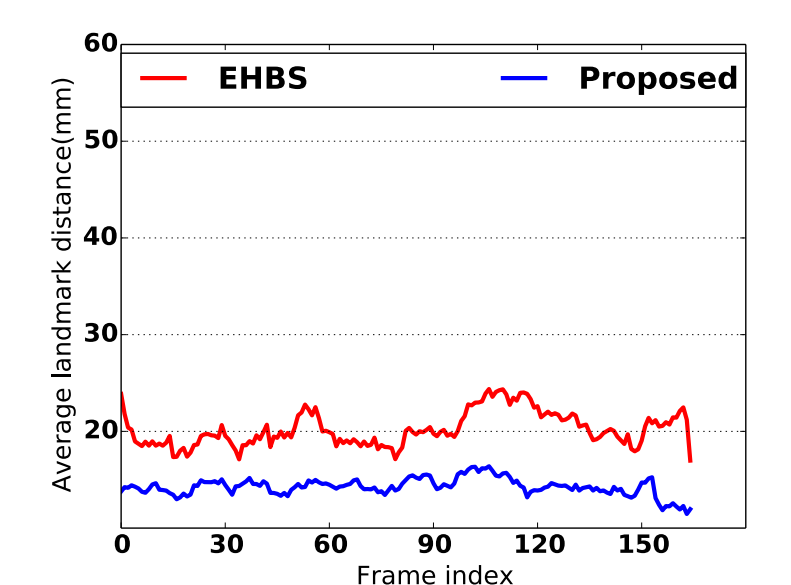
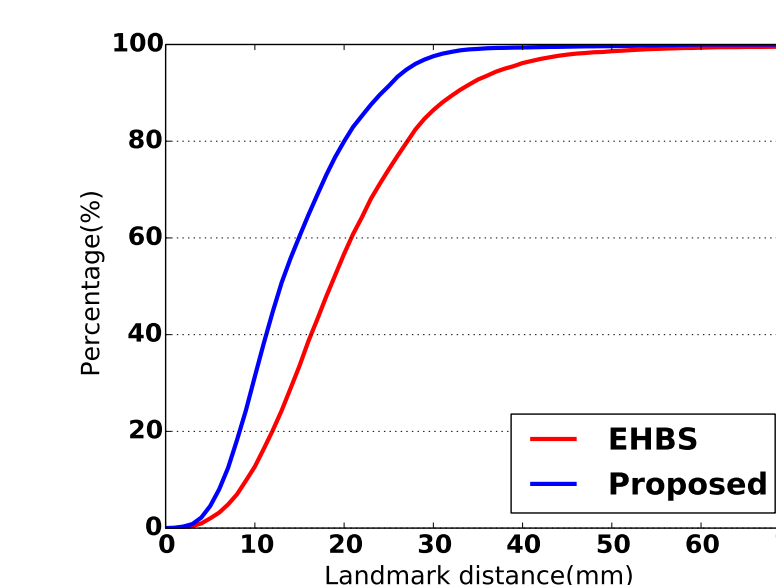
2) Shape estimation

3) Refinement

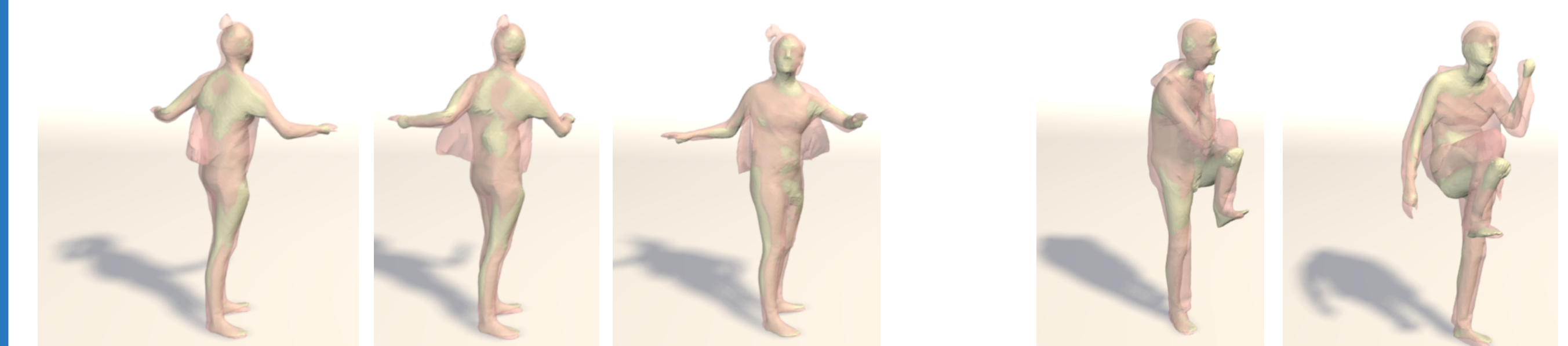
Results

INRIA Dataset

Pose estimation



Overlay of estimation and scan



Yang et al. [1]



Ours

BUFF Dataset

Body shape

	t-shirt, long pants						soccer outfit						Avg.
	00005	00096	00032	00057	03223	00114	00005	00032	00057	03223	00114		Avg.
Yang et al. [45]	17.29	18.68	13.76	17.94	17.90	15.42	16.77	16.96	18.52	20.41	16.40		17.27
fusion mesh	2.58	2.89	2.39	2.53	2.43	2.38	2.50	2.63	2.37	2.28	2.28		2.47
detailed	2.52	2.83	2.36	2.44	2.27	2.31	2.44	2.59	2.28	2.17	2.23		2.40
	00005	00096	00032	00057	03223	00114	00005	00032	00057	03223	00114		Avg.
hips	21.02	21.66	15.77	17.87	21.84	18.05	22.52	16.81	19.55	22.03	17.54		19.51
Yang et al. [45]	2.81	2.71	2.66	2.66	2.54	2.65	2.65	2.63	2.58	2.50	2.57		2.63
fusion mesh	2.75	2.64	2.63	2.55	2.40	2.56	2.58	2.59	2.50	2.38	2.51		2.55
detailed													
	00005	00096	00032	00057	03223	00114	00005	00032	00057	03223	00114		Avg.
shoulders mill	18.77	19.02	18.02	16.50	18.15	14.78	18.74	17.88	15.80	19.47	16.37		17.59
Yang et al. [45]	2.56	2.92	2.74	2.46	2.42	2.69	2.89	2.87	2.37	2.44	2.58		2.63
fusion mesh	2.49	2.85	2.72	2.37	2.26	2.59	2.83	2.82	2.28	2.33	2.51		2.55
detailed													

Body pose and shape



GT

Yang et al.[1].

Ours

GT

Yang et al.[1].

Ours

References

- [1] J. Yang, J.-S. Franco, F. Hétroy-Wheeler and S. Wuhrer. "Estimation of Human Body Shape in Motion with Wide Clothing" ECCV'16 [2] G. Pons-Moll, S. Pujades, S. Hu, and M. Black. "Clothcap: Seamless 4d clothing capture and retargeting." *ACM Transactions on Graphics (Proc. SIGGRAPH)* (2017).
[3] M. Loper, N. Mahmood, J. Romero, G. Pons-Moll, and M. Black. "SMPL: A skinned multi-person linear model." *ACM Transactions on Graphics (Proc. SIGGRAPH ASIA)* (2015).