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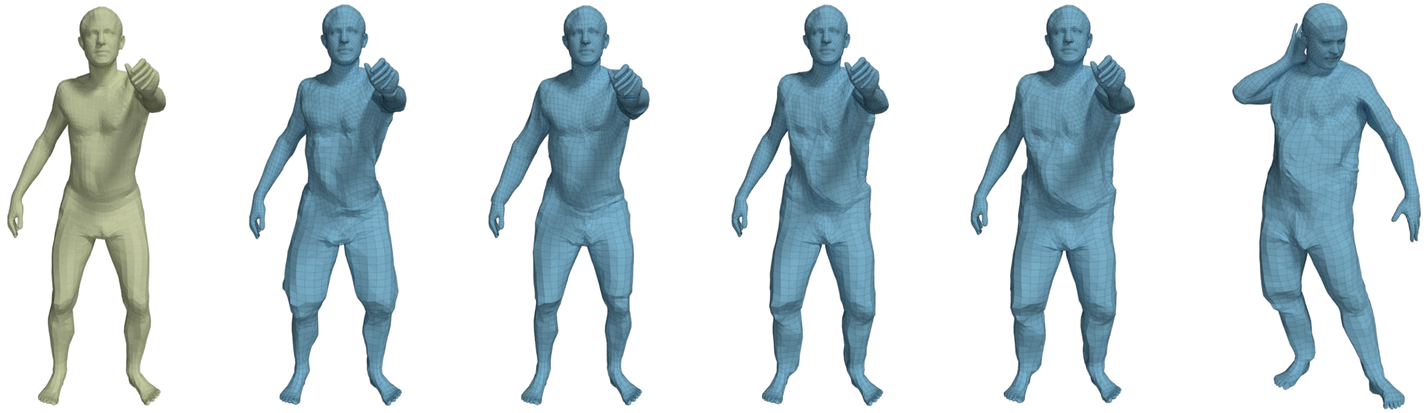
Learning to Dress 3D People in Generative Clothing

Qianli Ma[1], Jinlong Yang[1], Anurag Ranjan[1,2], Sergi Pujades[3], Gerard Pons-Moll[4], Siyu Tang[5], Michael J. Black[1]

[1] Max Planck Institute for Intelligent Systems [2] University of Tübingen
[3] Université Grenoble Alpes, Inria, CNRS, Grenoble INP, LJK
[4] Max Planck Institute for Informatics [5] ETH Zürich

Model, Data, Code:
cape.is.tue.mpg.de



CAPE: **C**lothed **A**uto **P**erson **E**ncoding

MAX PLANCK INSTITUTE FOR INTELLIGENT SYSTEMS

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

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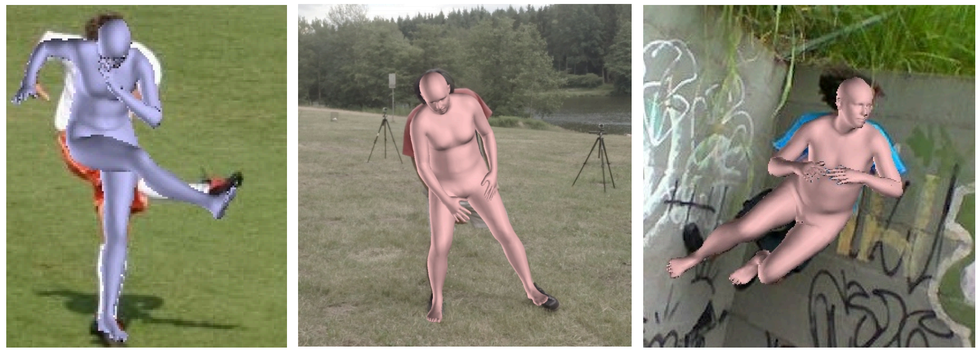
Motivation and Goal

Existing 3D human body models have limitations for various applications due to the lack of clothing geometry.
We aim to augment the popular 3D SMPL[1] body model with clothing.

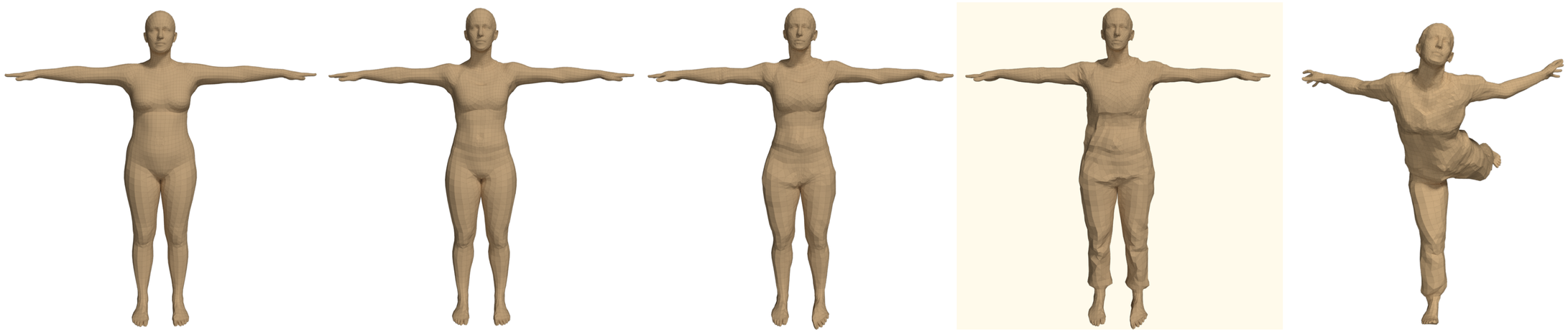


Body shape and pose reconstruction from images[2] using the SMPL body model. The minimally-clothed body geometry often does not match the observed clothed humans.

Synthetic human dataset[3] created by applying clothing textures on SMPL bodies. The mismatch between the texture and minimal body geometry results in unrealistic visual effect.

[1] Loper *et al*., SMPL: a skinned multi-person linear model, SIGGRAPH Asia 2015
[2] Kolotouros *et al*., Learning to Reconstruct 3D Human Pose and Shape via Model-fitting in the Loop, ICCV 2019
[3] Varol *et al*., Learning from Synthetic Humans, CVPR 2017

Dress up SMPL



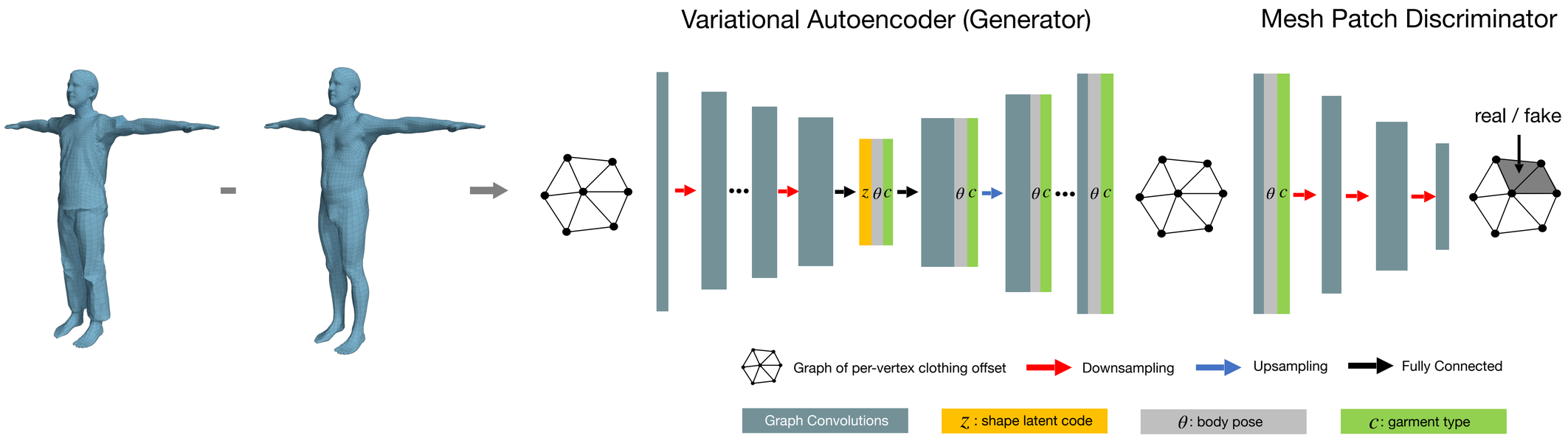
(a) (b) (c) (d) (e)

The SMPL body model:
(a) starts from template mesh
(b) adds body shape blend shapes
(c) adds pose corrective blend shapes.

CAPE: adds a layer of per-vertex clothing offsets on top of SMPL in the canonical pose space.

The clothed body can be posed with the same linear blend skinning as SMPL.

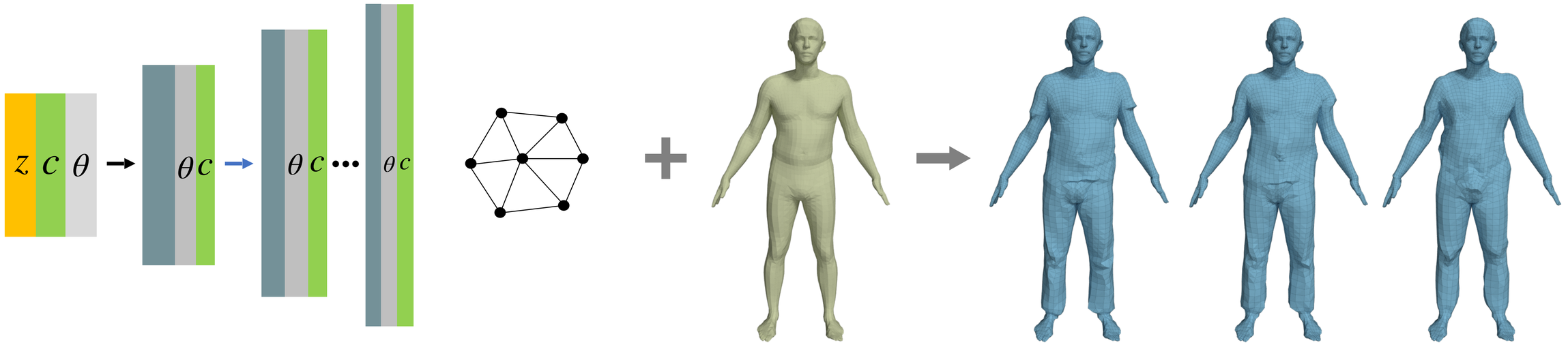
The CAPE Model: Training



Compute the graph of per-vertex offset from clothed body and minimally-clothed body, in the canonical pose space.

Train the VAE-GAN for the offset graph. The model is conditioned on body pose and clothing type, and the clothing shape is encoded into a low-dimensional latent space, z.

The CAPE Model: Sampling and Generation



Variables to be sampled

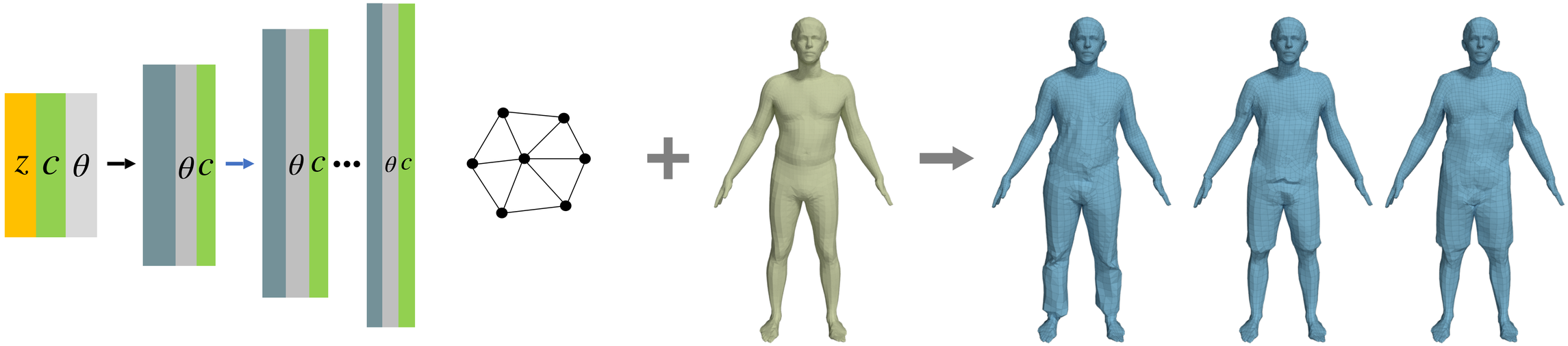
Trained generator (VAE decoder)

Graph of per-vertex clothing offset

SMPL body

Sample different **shape latent codes** (z): get clothing of the same type (here: short T-shirt + long pants), but of different styles

The CAPE Model: Sampling and Generation



Variables to be sampled

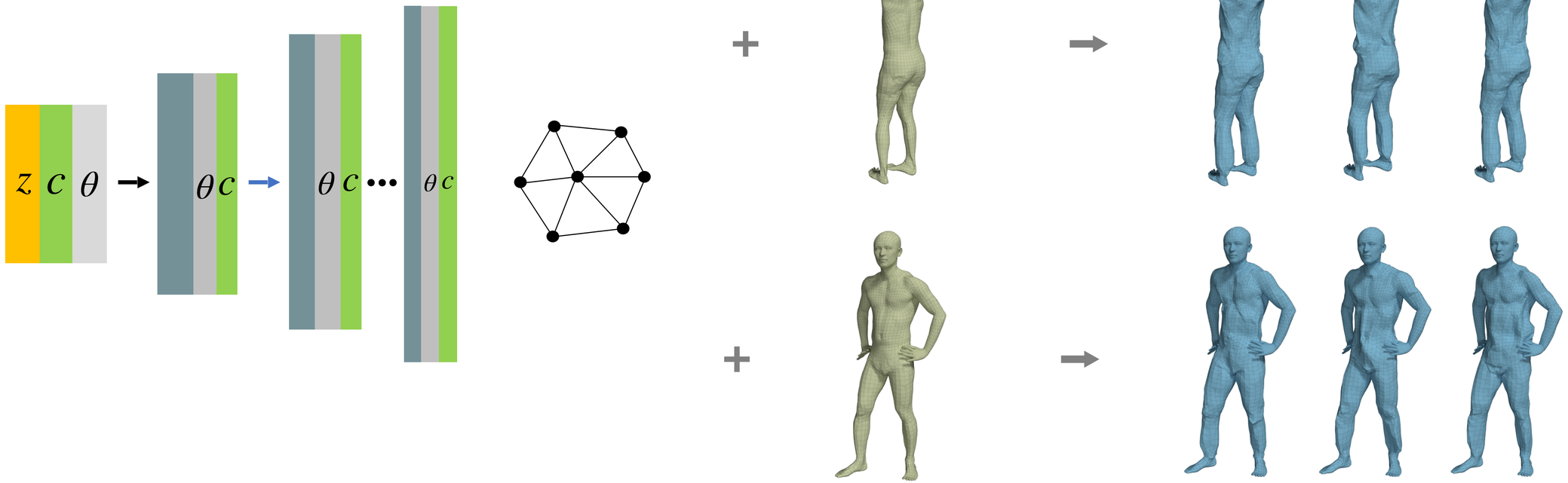
Trained generator (VAE decoder)

Graph of per-vertex clothing offset

SMPL body

Sample different **clothing types** (c):
left: short T-shirt + long pants
middle: short T-shirt + short pants
right: long T-shirt + short pants

The CAPE Model: Sampling and Generation



Variables to be sampled

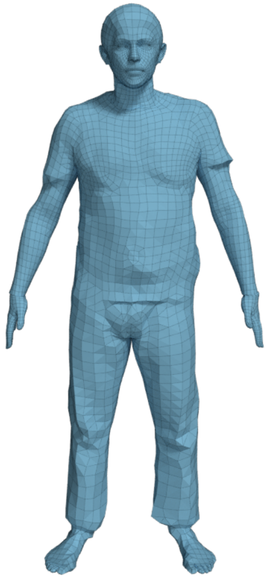
Trained generator (VAE decoder)

Graph of per-vertex clothing offset

SMPL body

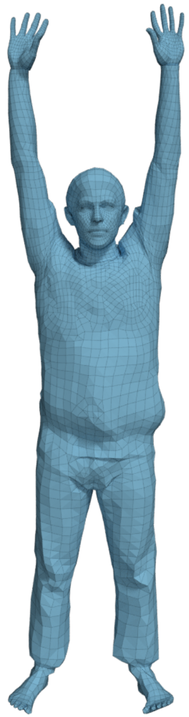
Generalization to different body poses (θ) and shapes

The CAPE Model: Pose-dependent Deformation



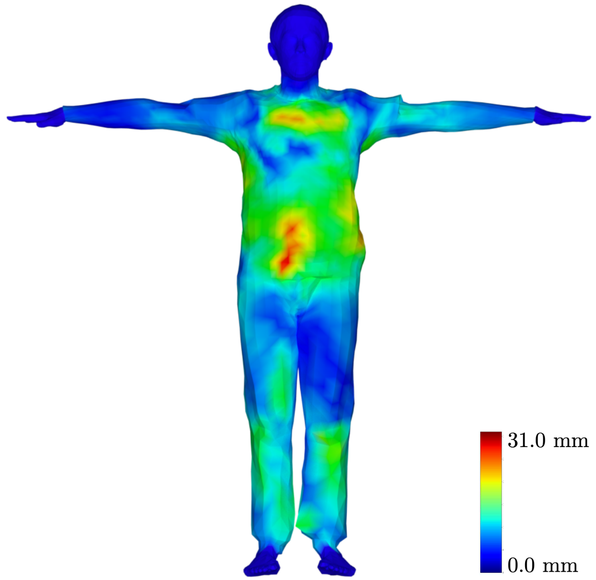
(a)

Generated clothing shape at the A-pose



(b)

Generated clothing shape at the Y-pose



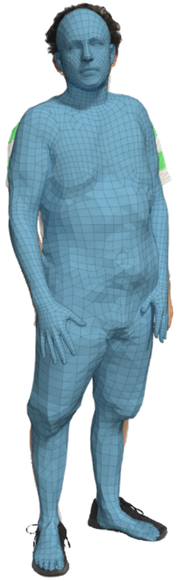
(c)

Color-coded difference between the offset clothing layers in (a) and (b), in the canonical pose space

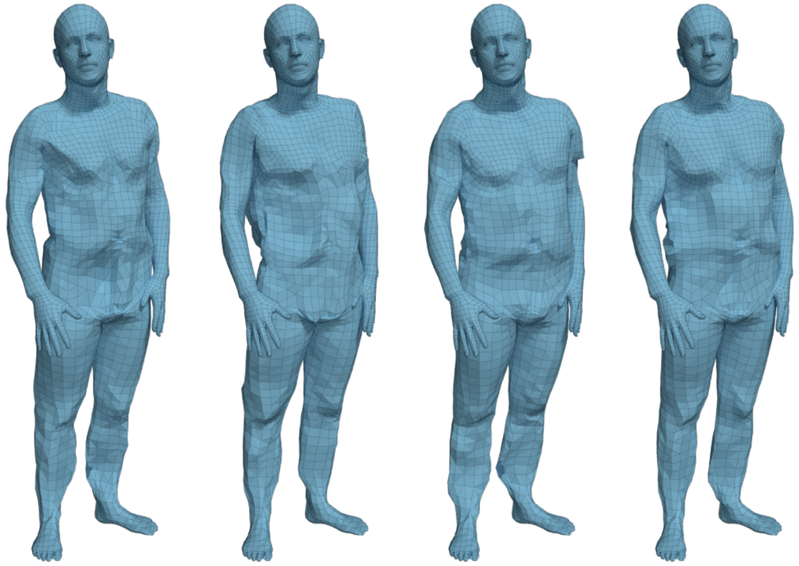
An Application in Image Fitting

Original image

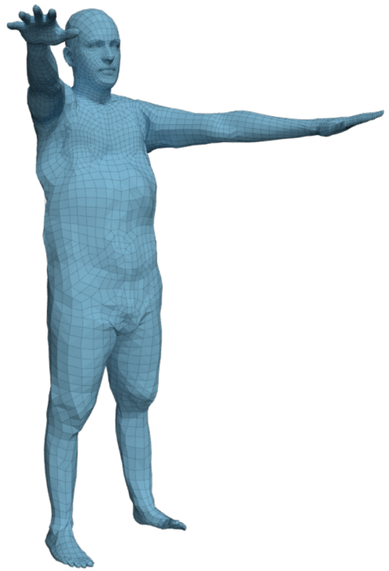
SMPL body fit



CAPE clothed body fit



Sample new clothes using CAPE



Change pose

CAPE Dataset

- 3D mesh registrations of accurate scans of clothed people in motion
- Consistent SMPL mesh topology
- Ground truth body shapes under clothing from scans
- 80K+ frames of data
- Various potential applications:
  - Clothing modeling
  - Dynamic 3D shape modeling
  - Training and evaluation of graph neural networks …

Thank you!

Paper, Model, Data, Code:

https://cape.is.tue.mpg.de