Keep it SMPL: Automatic Estimation of 3D Human Pose and Shape from a Single Image

MAX-PLANCK-GESELLSCHAFT

Microsoft

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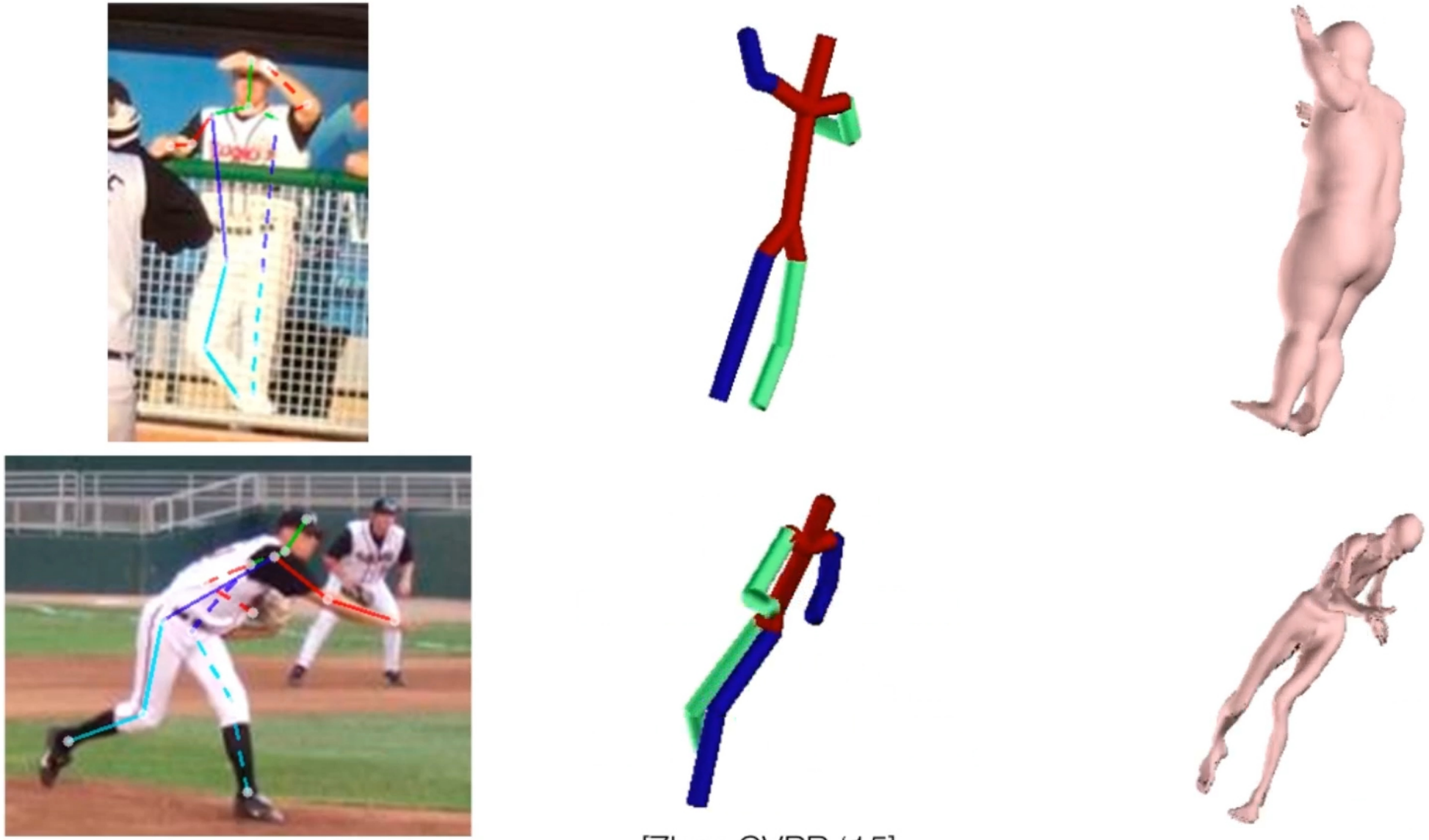
* Equal contribution

All the work was performed at MPI

3D shape and pose from a single image

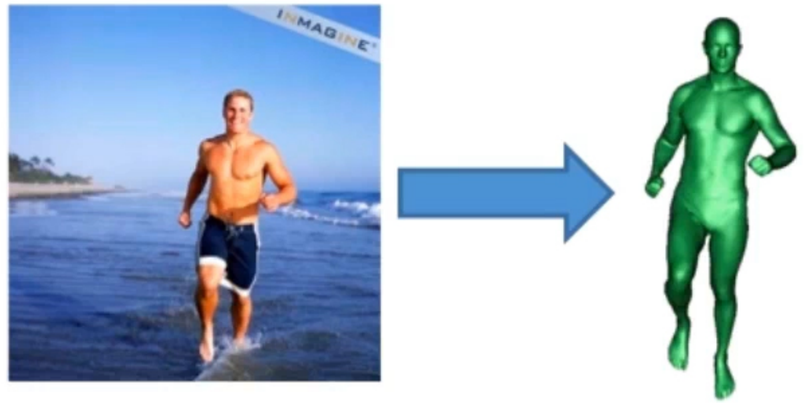
3D Pose Estimation



[Zhou CVPR '15]

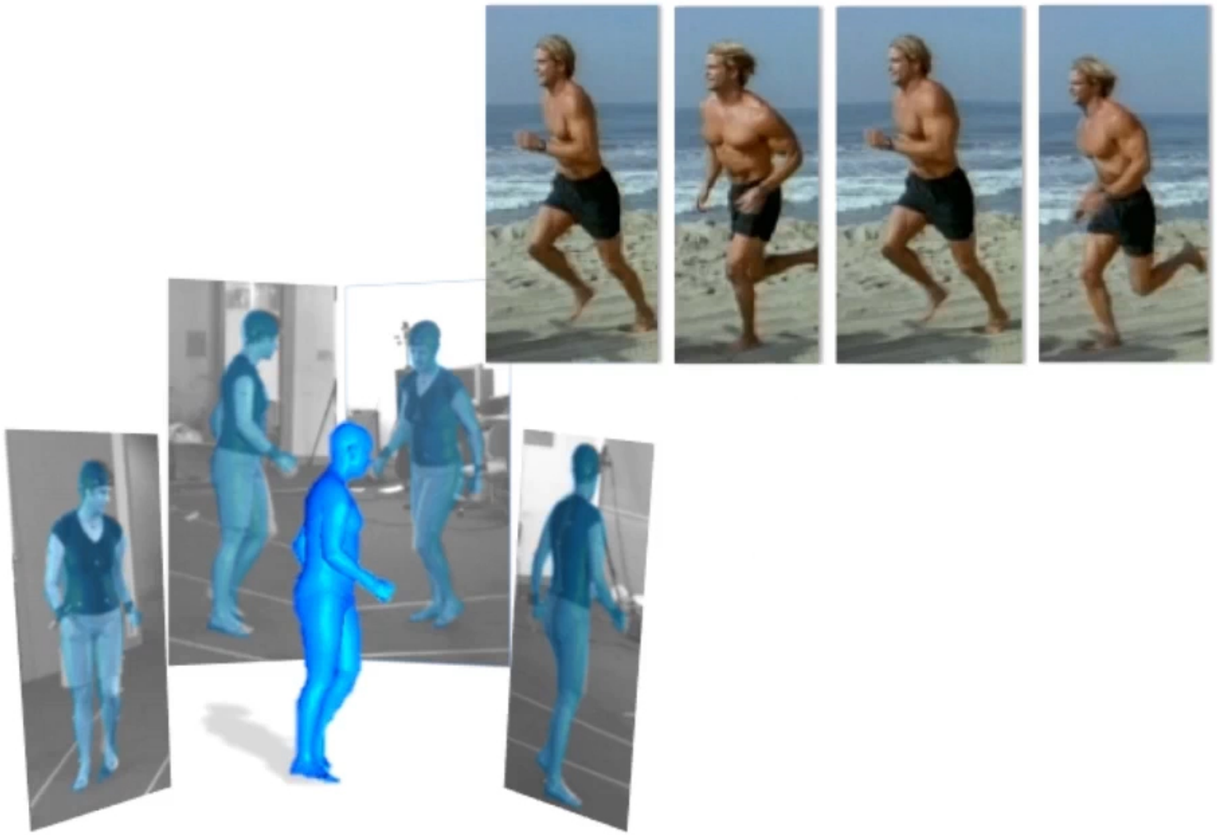
Pose and Shape, but …

Manual Intervention



[Guan et al. ICCV '09, Hasler et al. CVPR '10, Zhou et al. SIGGRAPH '10]

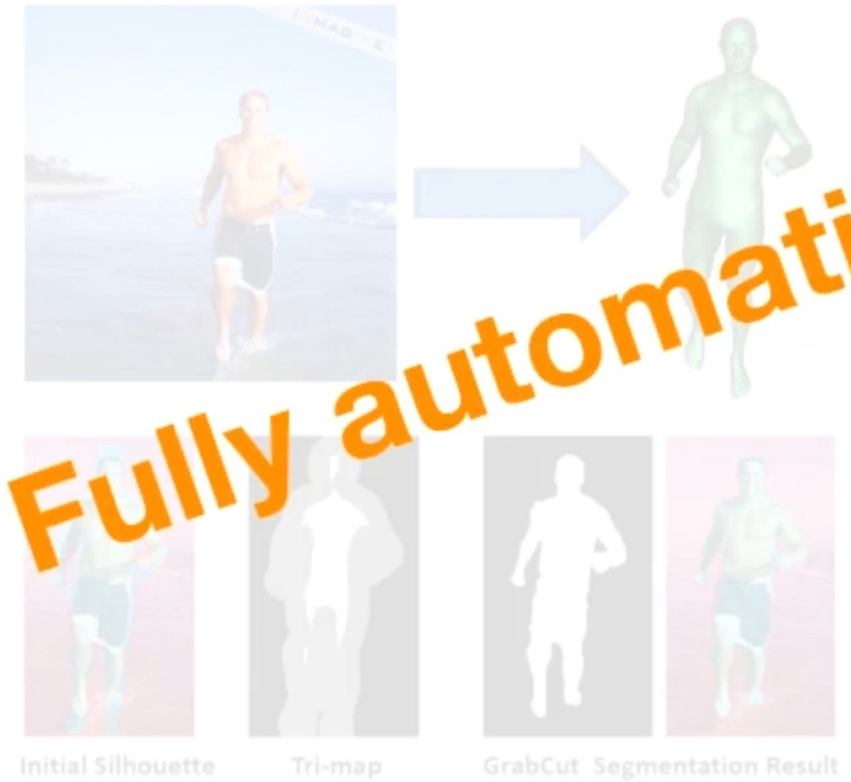
Multiview, Sequence



[Bălan et al. CVPR '07, Jain et al. SIGGRAPH '10, Rhodin et al. ECCV '16]

Pose and Shape, but …

Manual Intervention



Fully automatic

[Guan et al. ICCV '09, Hasler et al. CVPR '10, Zhou et al. SIGGRAPH '10]

Multiview, Sequence

Only requires a single view

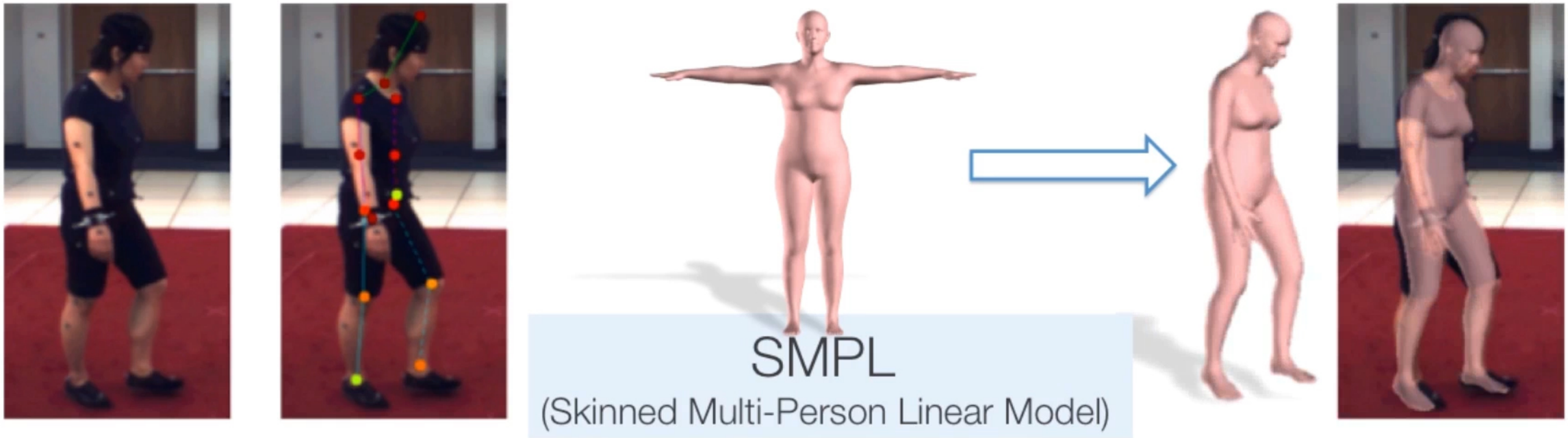
[Bălan et al. CVPR '07, Jain et al. SIGGRAPH '10, Rhodin et al. ECCV '16]

Our results

Overview

1. Automatic joint detection via CNNs

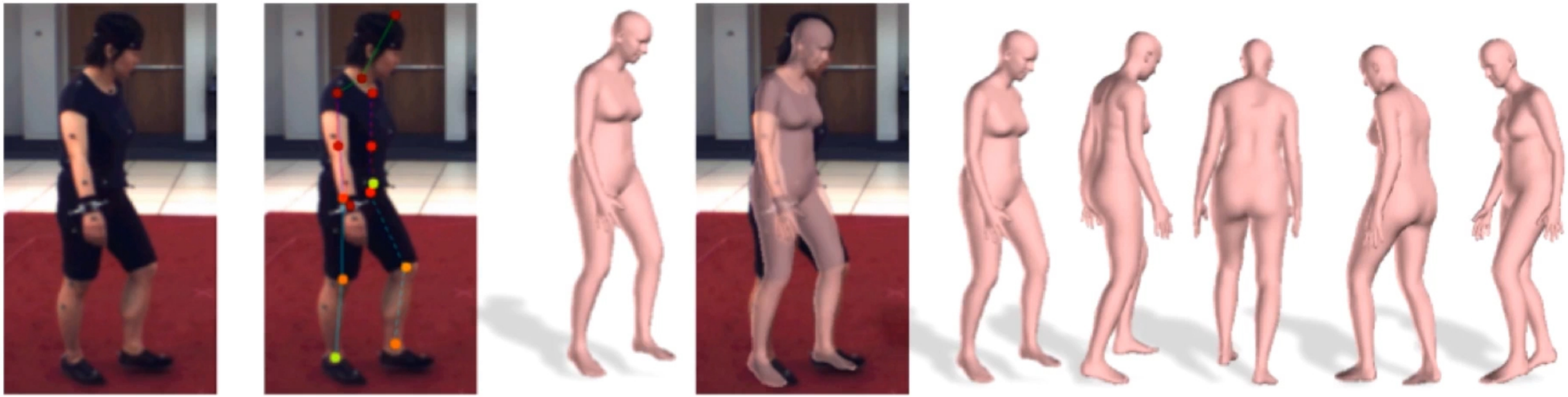
2. A good generative model of 3D pose and shape



Overview

1. Automatic joint detection via CNNs — BOTTOM UP

2. A good generative model of 3D pose and shape — TOP DOWN



SMPLify

1. Automatic joint detection via CNNs — BOTTOM UP

2. A good generative model of 3D pose and shape — TOP DOWN

2D joint detection

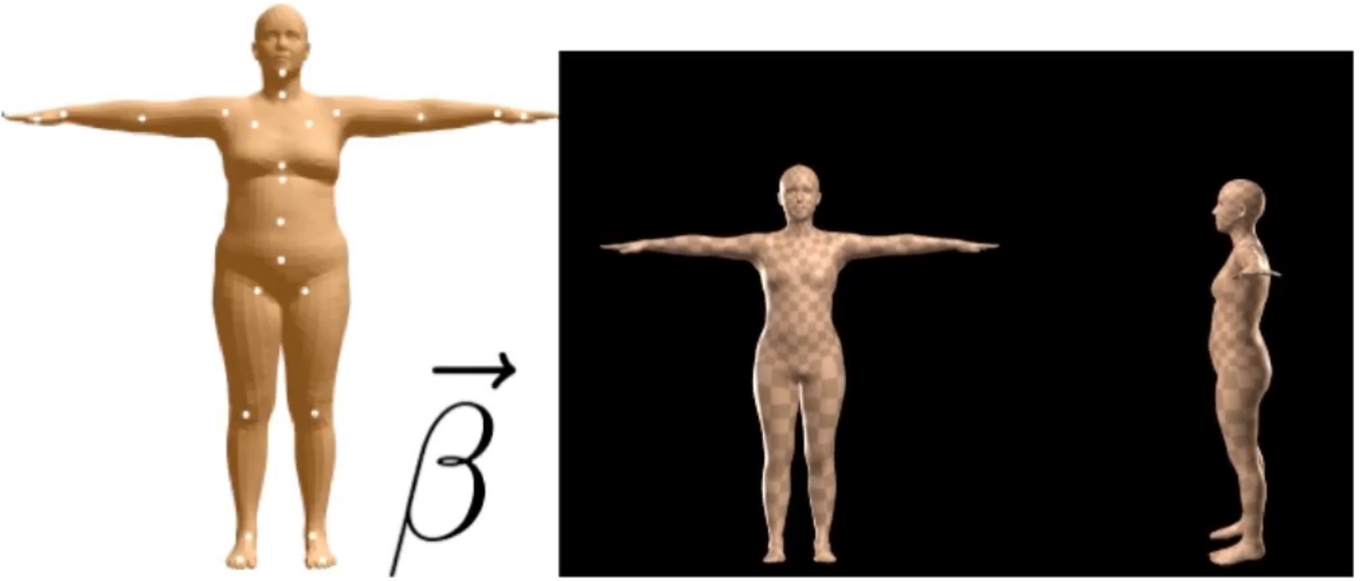
Supervised end-to-end training to detect joints with confidence values.

[Pishchulin et al. DeepCut CVPR 2016.]

SMPL body model

Shape: PCA coefficients

Pose: Rotation of 23 joints



[Loper et al. SIGGRAPH Asia '15]

SMPLify Objective Function

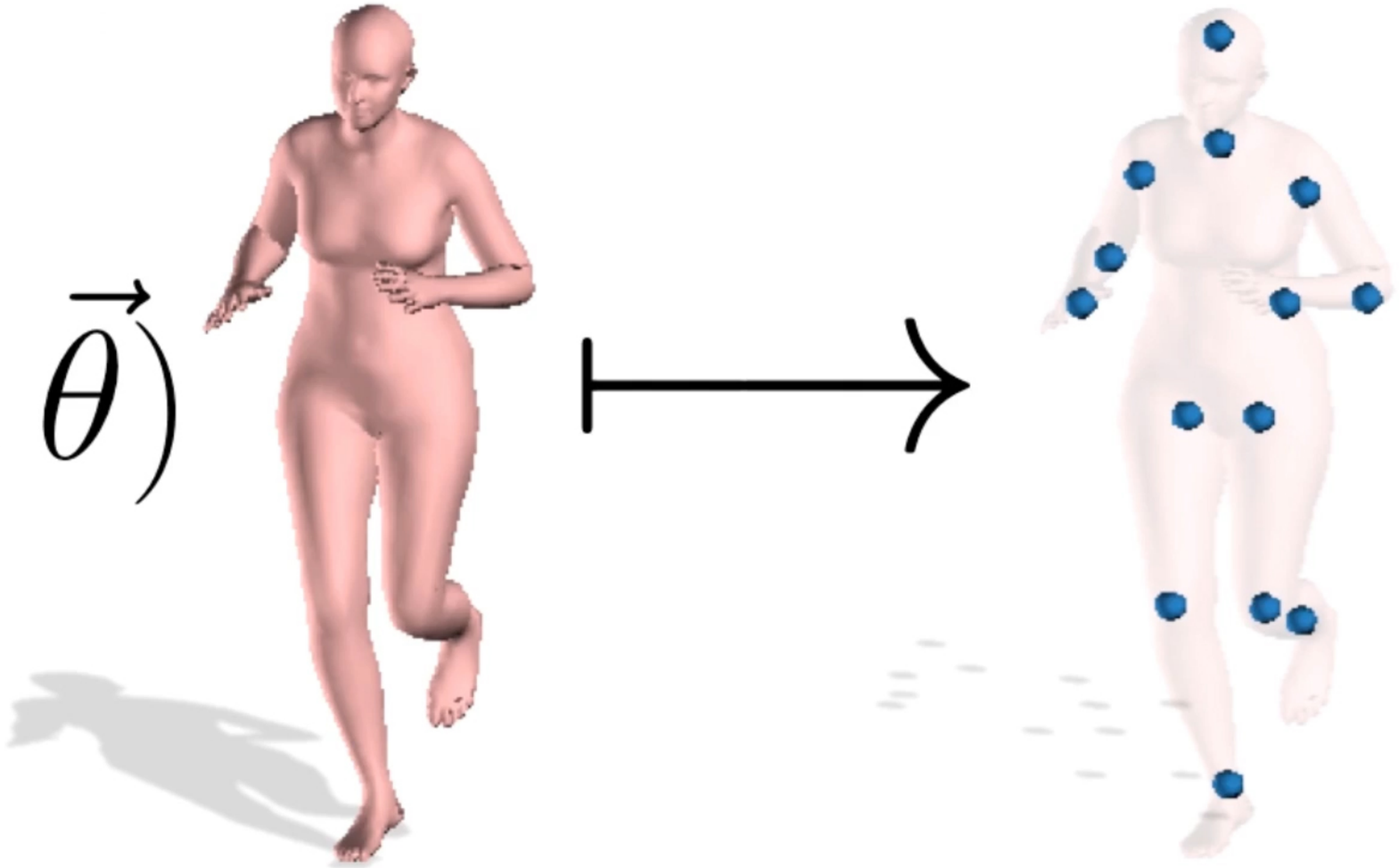
camera joints

$$E(\vec{\beta}, \vec{\theta}, K; J_{est}) =$$

$$E_J(\vec{\beta}, \vec{\theta}, K; J_{est}) + E_a(\vec{\theta}) + E_\theta(\vec{\theta}) + E_{sp}(\vec{\theta}, \vec{\beta}) + E_\beta(\vec{\beta})$$

Data Term: Joint Projection Error

$$(\vec{\beta}, \vec{\theta})$$



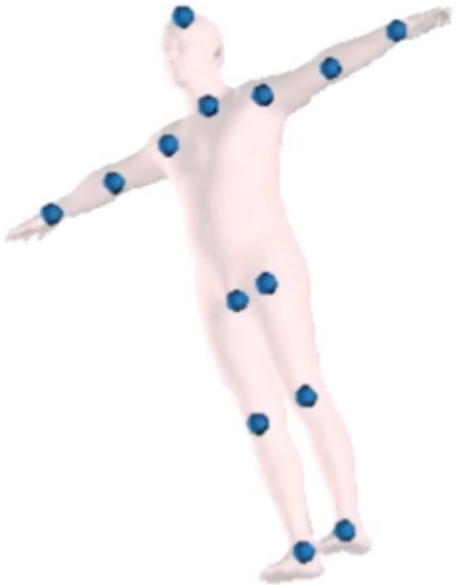
Data Term: Joint Projection Error

$$E_J(\vec{\beta}, \vec{\theta}, K; J_{est}) =$$

Camera Projection

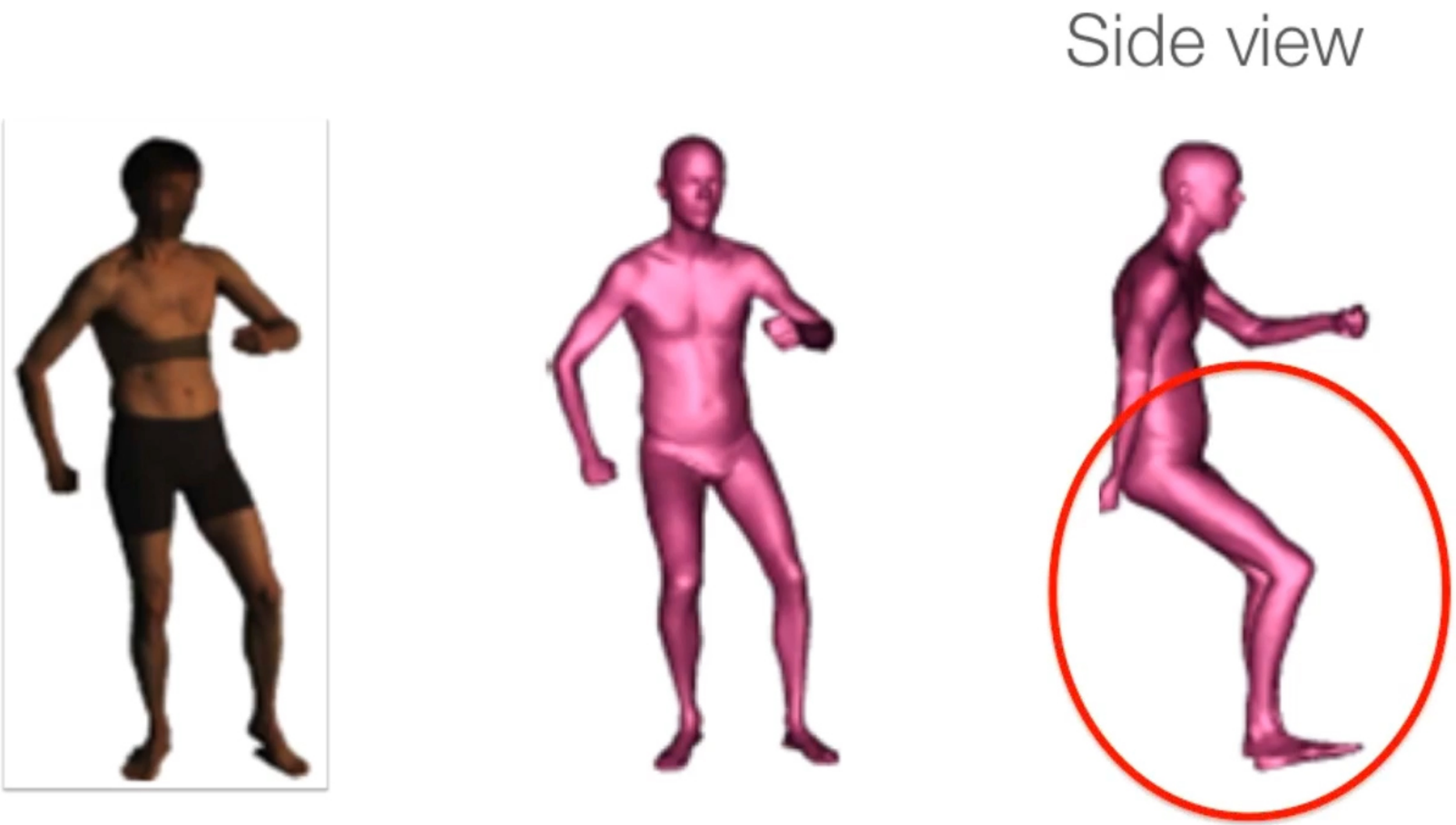
$$\Big|\Big|$$

$$- \Pi_K \Big($$



$$\Big) \Big|\Big|_2^2$$

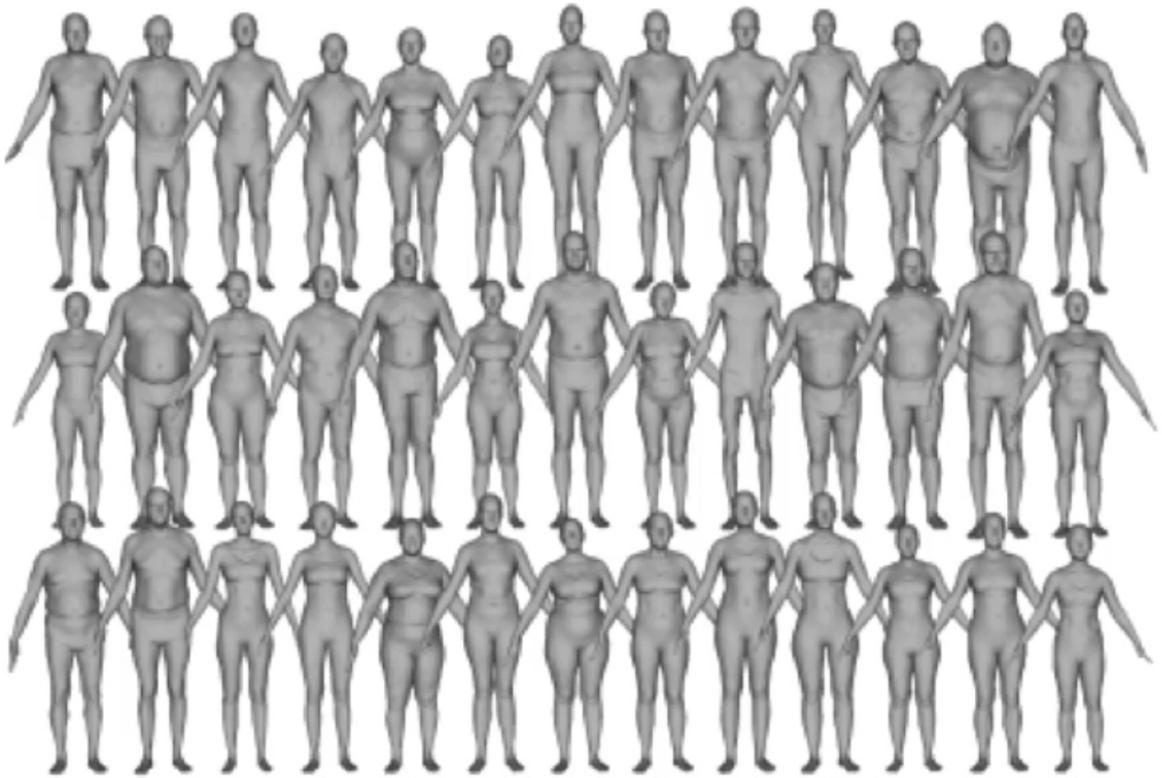
Depth Ambiguity



[Guan et al., Estimating human shape and pose from a single image. ICCV 2009.]

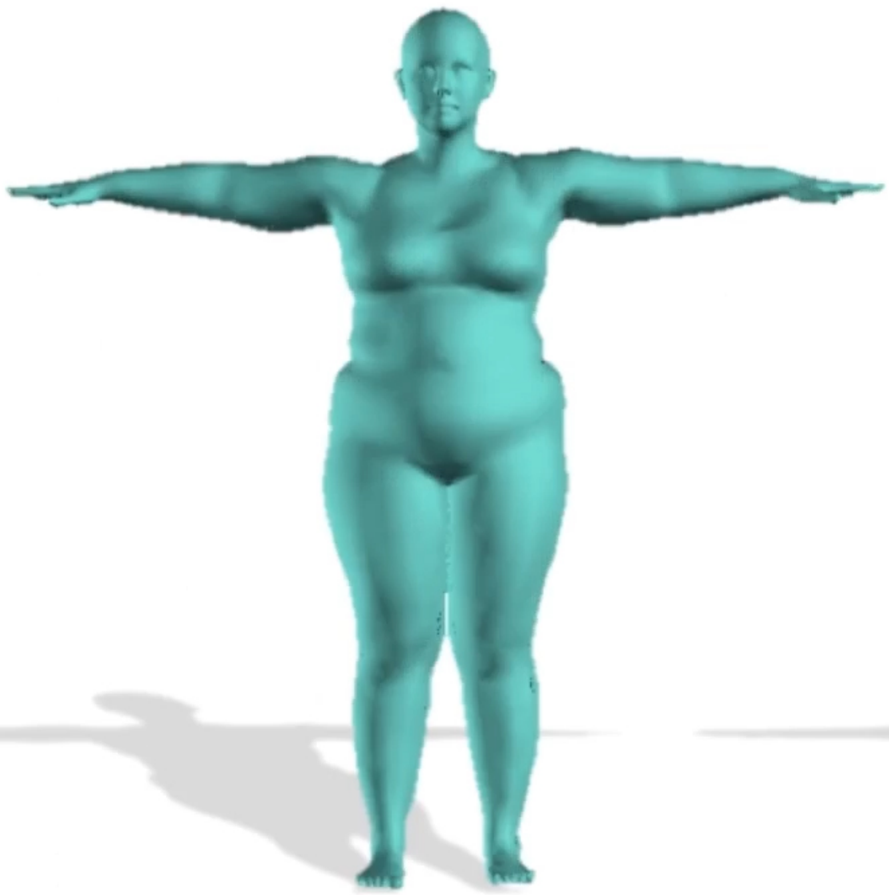
Pose and shape priors

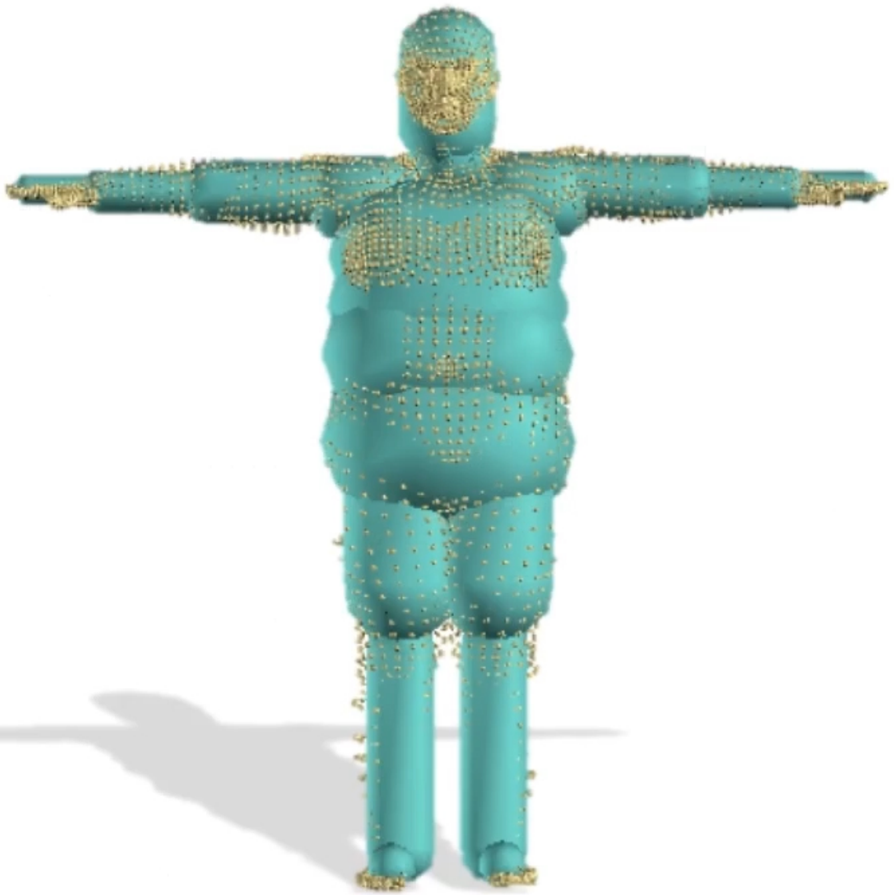
$E_\theta(\vec{\theta})$ Pose Prior



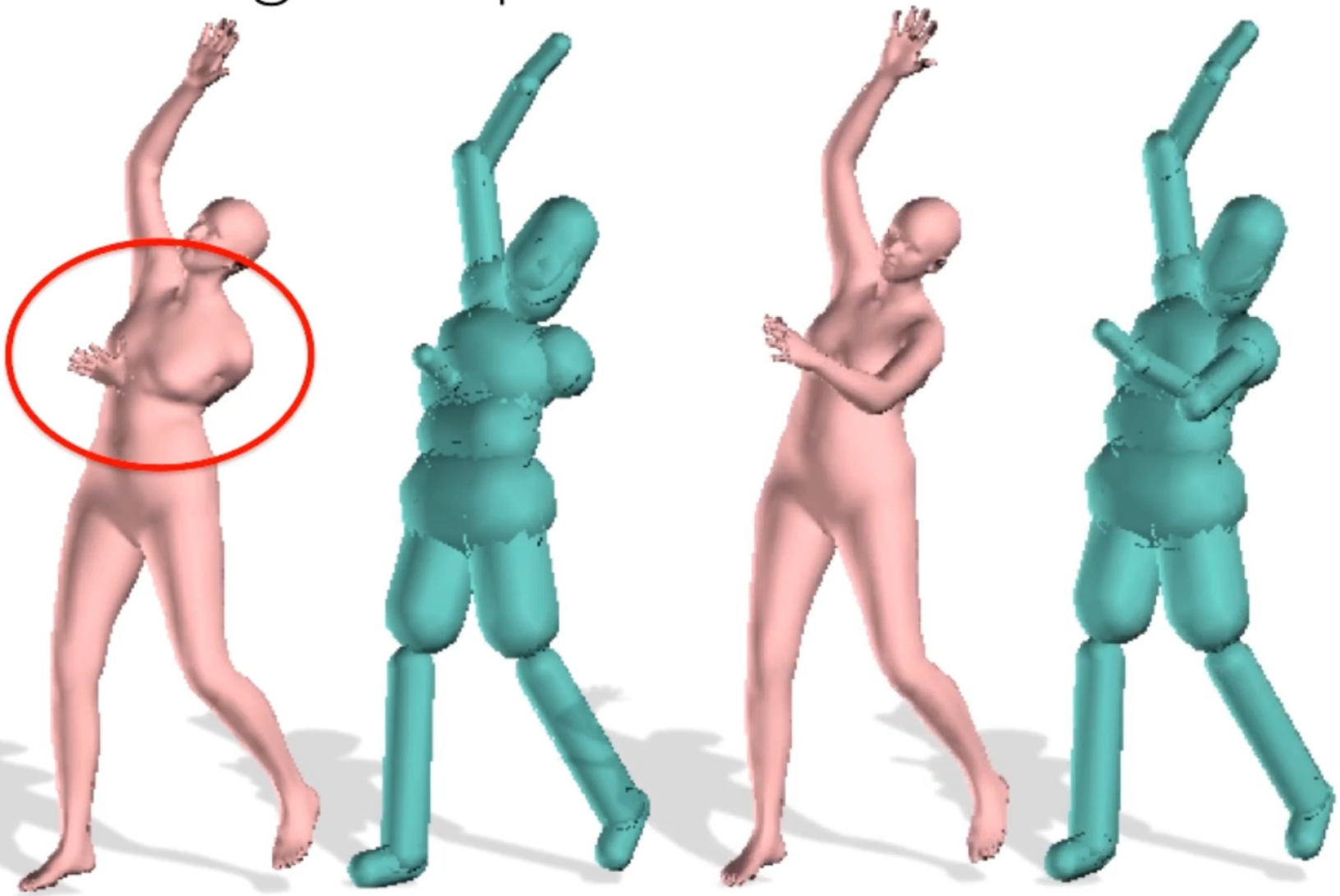
$E_\beta(\vec{\beta})$ Shape Prior

Preventing interpenetration





Preventing interpenetration



Before

After

SMPLify Objective Function

$$E(\vec{\beta}, \vec{\theta}, K; J_{est}) =$$

pose and shape priors

$$E_J(\vec{\beta}, \vec{\theta}, K; J_{est}) + E_a(\vec{\theta}) + E_\theta(\vec{\theta}) + E_{sp}(\vec{\theta}, \vec{\beta}) + E_\beta(\vec{\beta})$$

Joint projection error

interpenetration

Results on Leeds Sports Poses (LSP)

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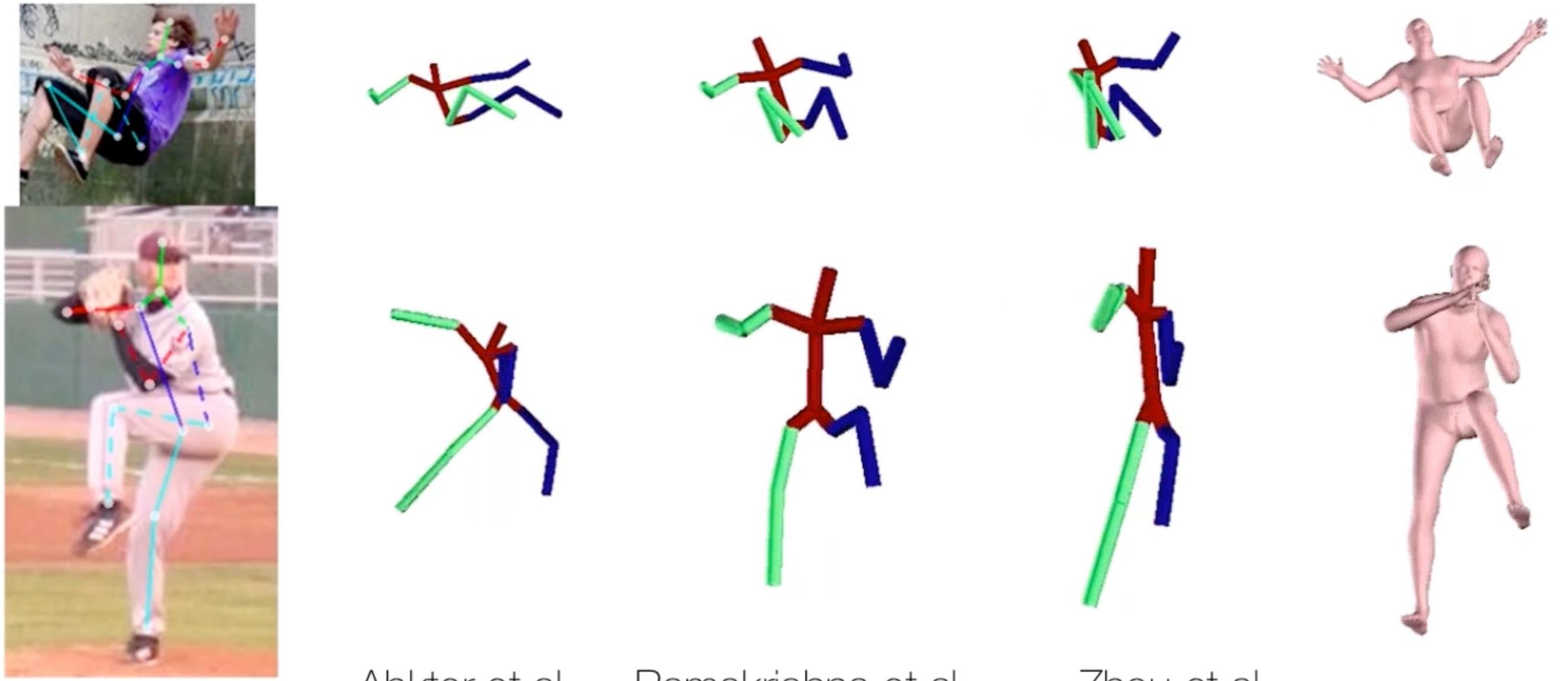


Input

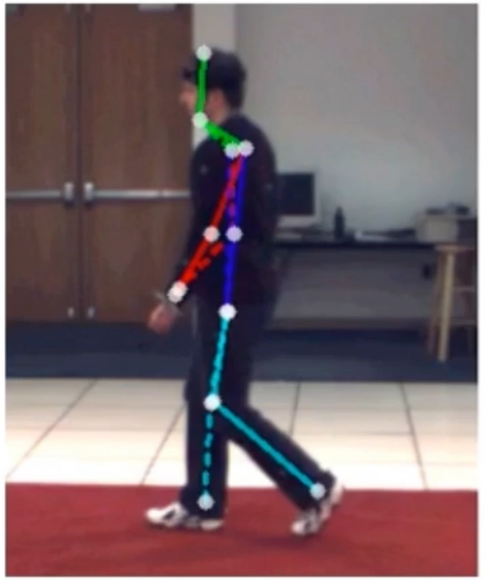
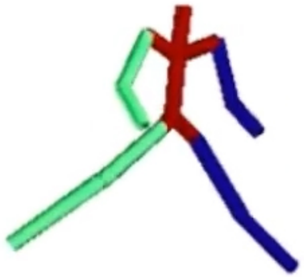
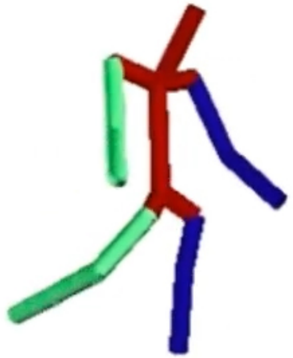
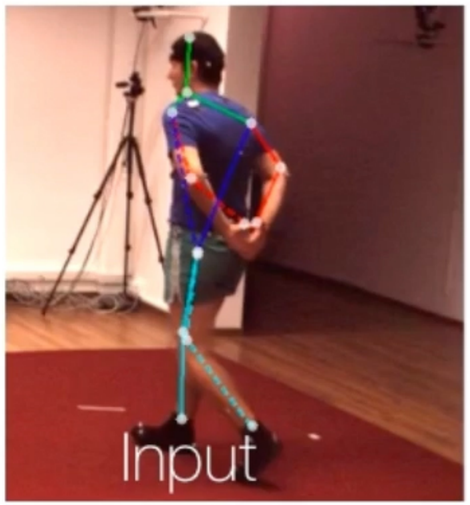
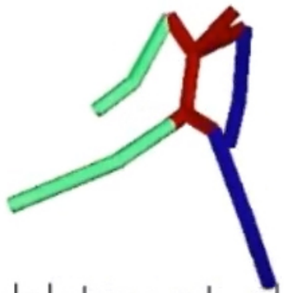
Ahkter et al
CVPR '15

Ramakrishna et al
ECCV '12

Zhou et al
CVPR '15

SMPLify

Quantitative Evaluation

	Mean error:	181mm	157mm	106mm	**82mm**
HumanEva					
Human3.6M		 Ahkter et al CVPR '15	 Ramakrishna et al ECCV '12	 Zhou et al CVPR '15	 SMPLify

Future work

- Silhouettes
- Multiple camera views
- Video

- Occlusion reasoning in image understanding
- Generate training data

Thanks and see you at Poster #8!

Code and results available at
smplify.is.tue.mpg.de

Acknowledgements: We thank M. Al Borno for inspiring the capsule representation, N. Mahmood for help with the figures, I. Akhter for helpful discussions.