SEMANTIC PARAMETRIC BODY SHAPE ESTIMATION FROM NOISY DEPTH SEQUENCES

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SOME OF MY OTHER WORK I

Static

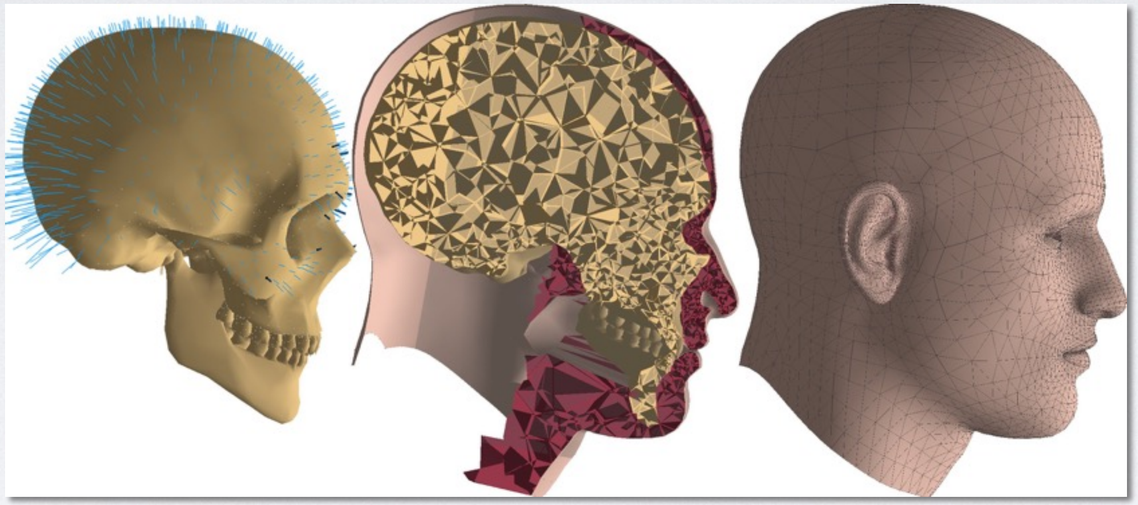
8 MP, ~100 images

Dynamic

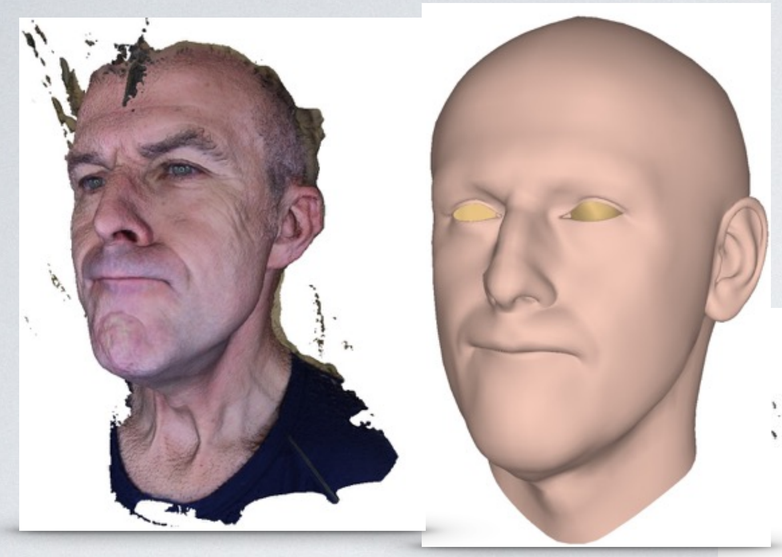
HD, ~2 min

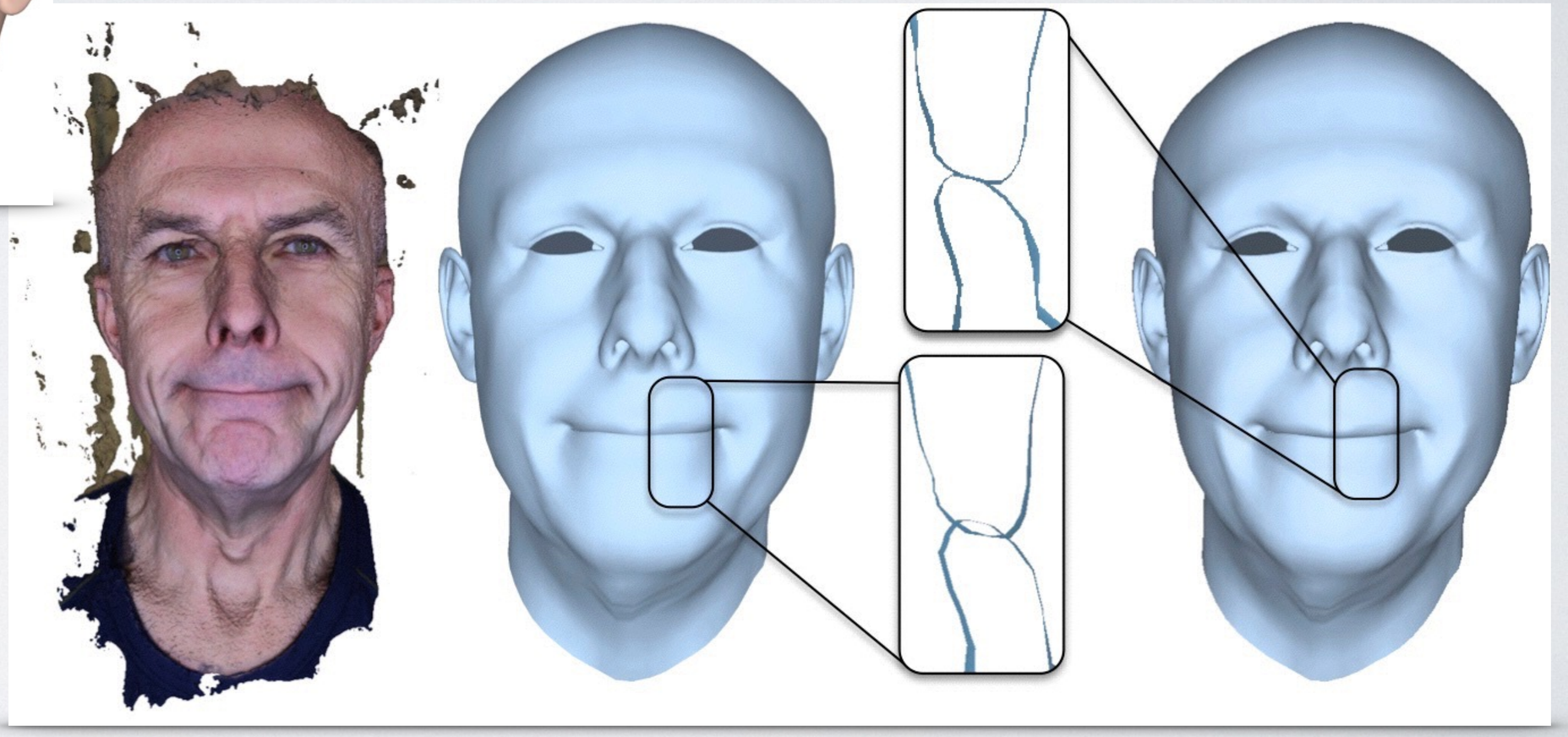
SOME OF MY OTHER WORK I

SOME OF MY OTHER WORK 2

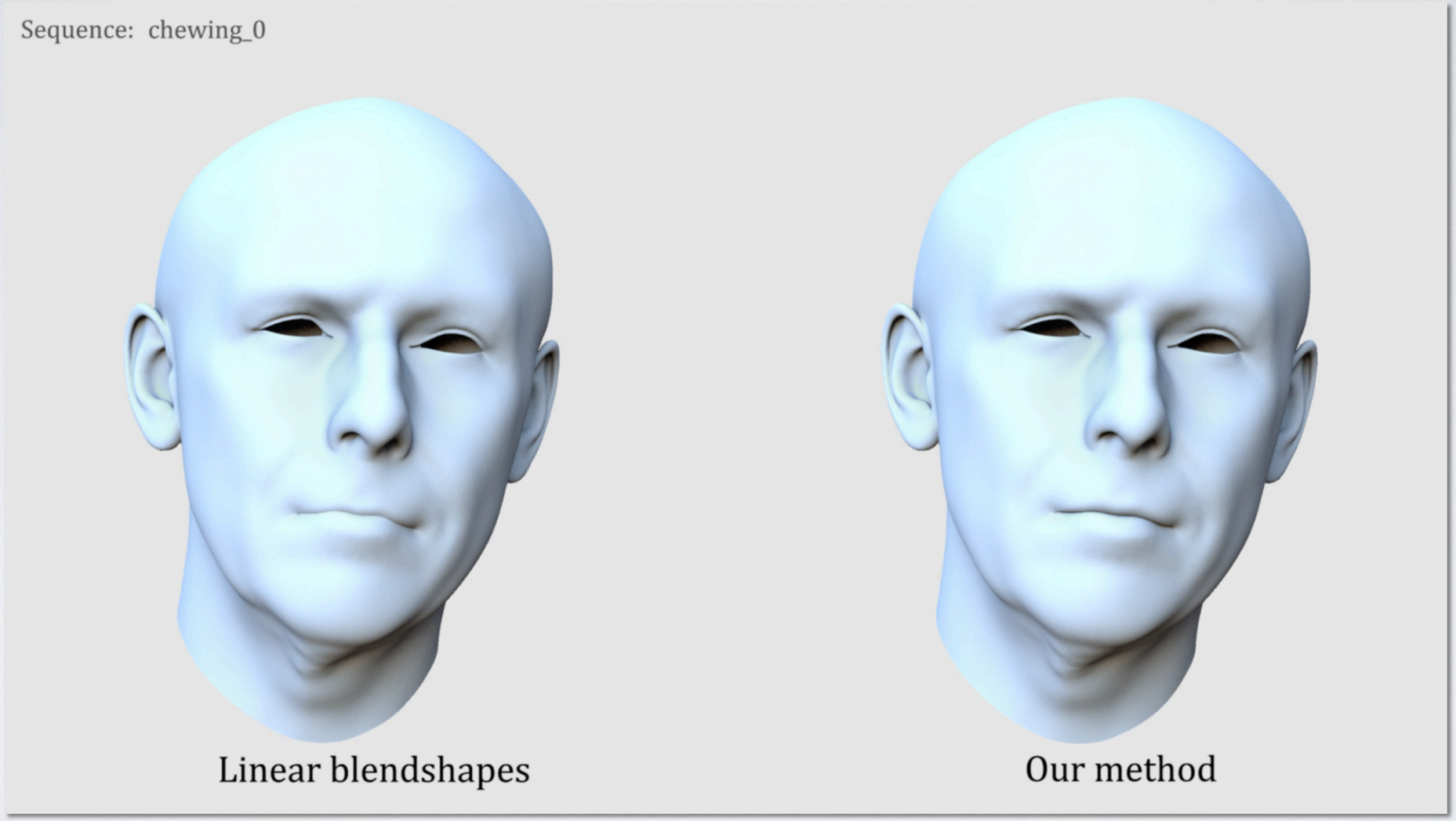


SOME OF MY OTHER WORK 2



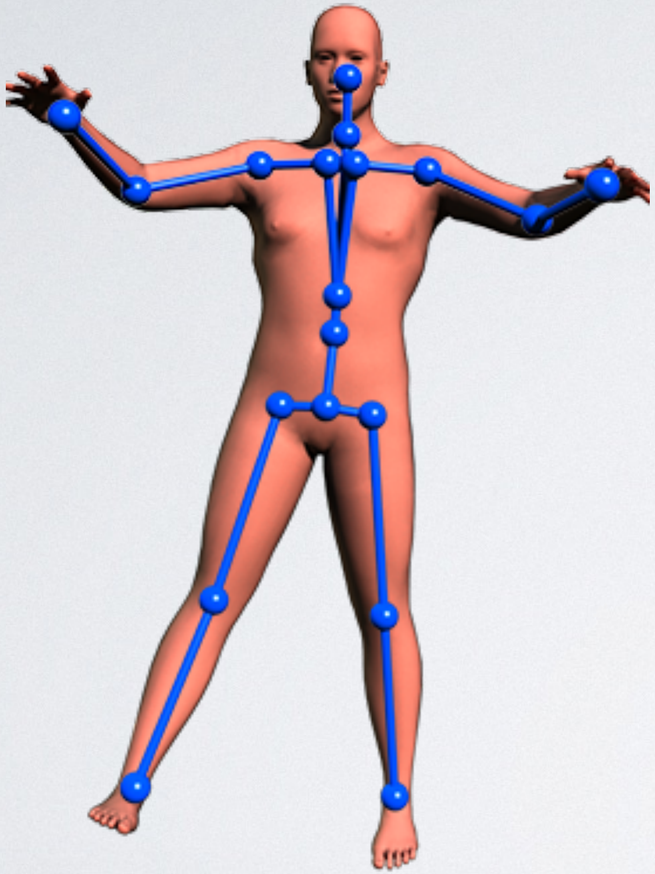


SOME OF MY OTHER WORK 2



MOTIVATION

Generic framework for tracking and modeling articulated bodies



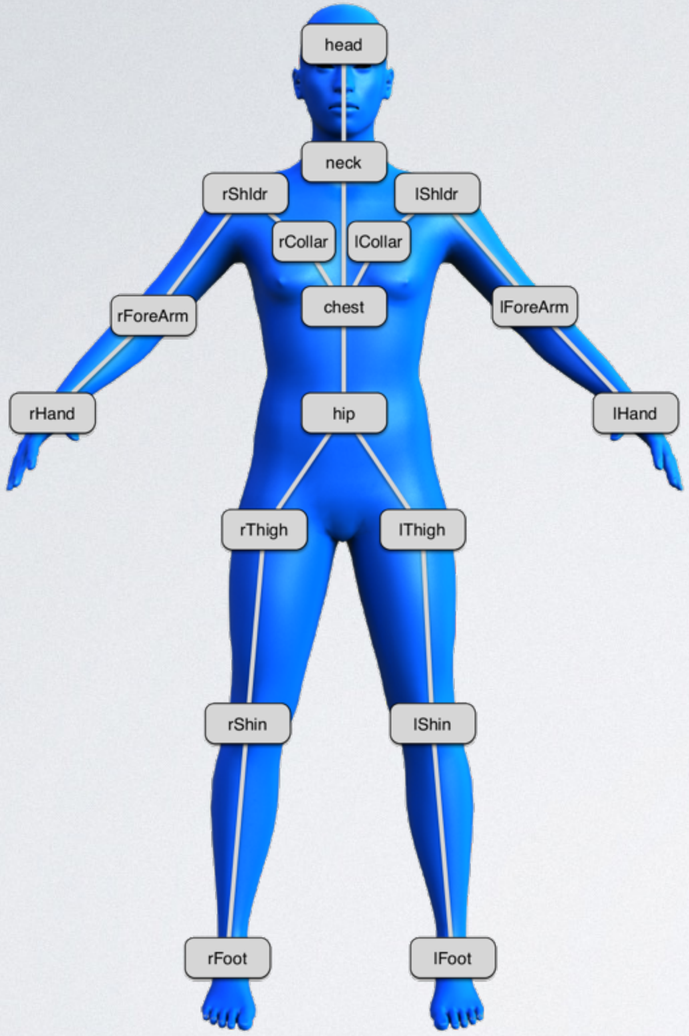
in our experiments:

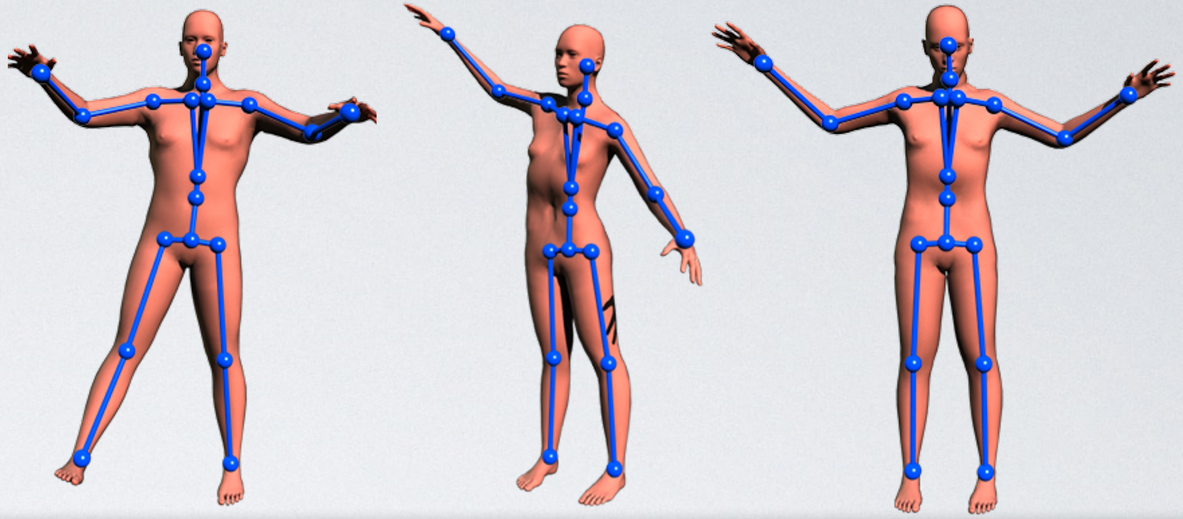
- human bodies
- RGB-D input

can be applied to:

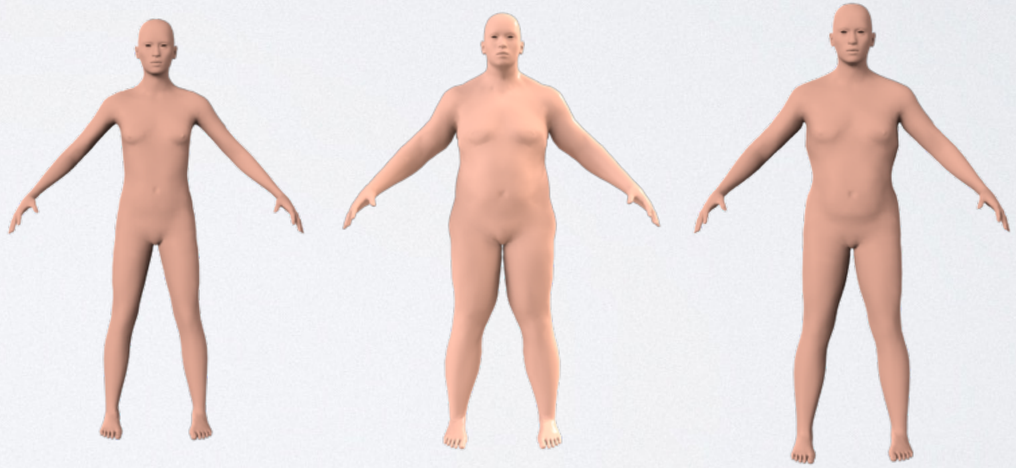
- hand tracking
- animal tracking

BODY REPRESENTATION



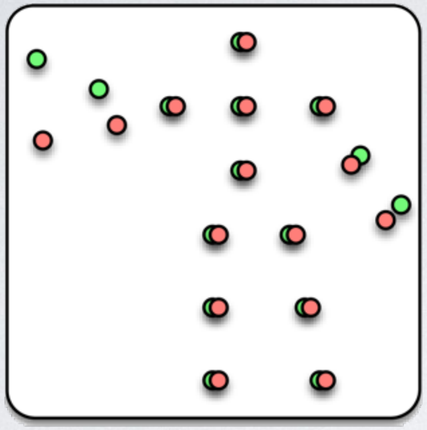


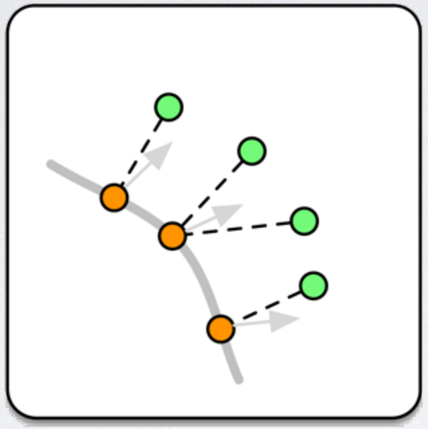
Pose variations - skeleton + linear blend skinning

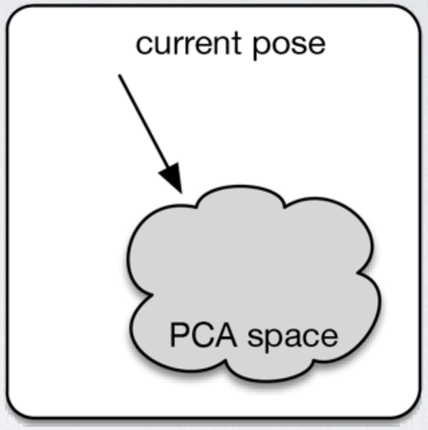


Rest pose variations - blendshapes + bone lengths

REGISTRATION ENERGY







$$E_{total} = \lambda_1 E_{features} + \lambda_2 E_{surface} + \lambda_3 E_{contour} + E_{prior} + \lambda_4 E_{smoothness}$$

REGISTRATION ENERGY

$$E_{total} = \lambda_1 E_{features} + \lambda_2 E_{surface} + \lambda_3 E_{contour} + E_{prior} + \lambda_4 E_{smoothness}$$

$$E_{features} = \sum_j \left|\left| \boldsymbol{t}_j^{pose} - \boldsymbol{\chi}_j \right|\right|_2^2$$

Features

NiTE landmarks - replaceable

$$E_{surface} = \sum_i \left|\left| \boldsymbol{n}_i^T (\boldsymbol{x}_i - \boldsymbol{v}_i) \right|\right|_2^2$$

Point-to-plane dense closeness

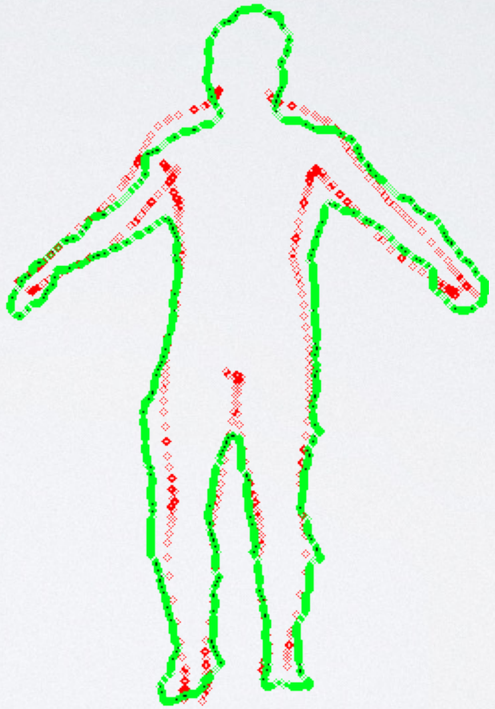
ICP iterations

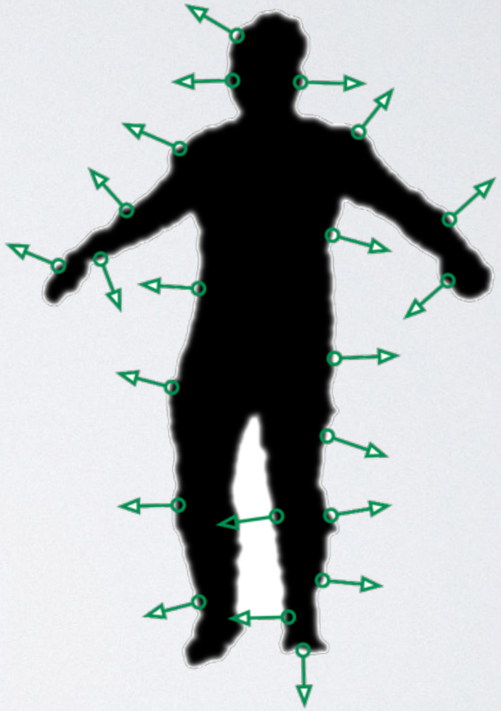
REGISTRATION ENERGY

$$E_{total} = \lambda_1 E_{features} + \lambda_2 E_{surface} + \lambda_3 E_{contour} + E_{prior} + \lambda_4 E_{smoothness}$$

$$\boldsymbol{n} = \frac{(\nabla x \bar{\boldsymbol{I}}_{contour}, \nabla y \bar{\boldsymbol{I}}_{contour}, 0)^T}{||(\nabla x \bar{\boldsymbol{I}}_{contour}, \nabla y \bar{\boldsymbol{I}}_{contour}, 0)||}$$

Contour





extracted from the 2D depth image

can be extended to RGB-segmentation

REGISTRATION ENERGY

$$E_{total} = \lambda_1 E_{features} + \lambda_2 E_{surface} + \lambda_3 E_{contour} + E_{prior} + \lambda_4 E_{smoothness}$$

$$E_{prior} = \lambda_5 E_{prior\_proj} + \lambda_6 E_{prior\_dev}$$

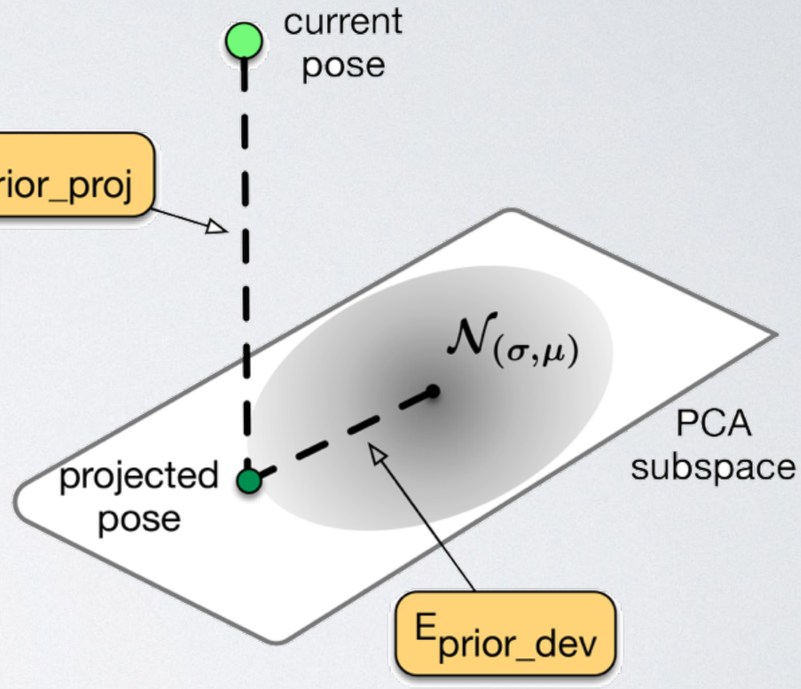
$$E_{prior\_proj} = \left|\left|(\boldsymbol{\beta} - \boldsymbol{\mu}) - \boldsymbol{M}\boldsymbol{M}^T(\boldsymbol{\beta} - \boldsymbol{\mu})\right|\right|_2^2$$

distance to projection

$$E_{prior\_dev} = \left|\left|\boldsymbol{\Sigma}^{-1/2}\boldsymbol{M}^T(\boldsymbol{\beta} - \boldsymbol{\mu})\right|\right|_2^2$$

std-dev-weighting of the projection

Statistical Pose Prior



REGISTRATION ENERGY

$$E_{total} = \lambda_1 E_{features} + \lambda_2 E_{surface} + \lambda_3 E_{contour} + E_{prior} + \lambda_4 E_{smoothness}$$

$$E_{smoothness} = \left|\left|\boldsymbol{\beta}_{(t)} - \boldsymbol{\beta}_{(t-1)}\right|\right|_2^2$$

Smoothness term

MODELING ENERGY

$$E_{modeling} = \gamma_1 E_{surface} + \gamma_2 E_{contour} + \gamma_3 E_{bs\_reg}$$

$$E_{bs\_reg\_L2} = ||\boldsymbol{s}||_2^2$$

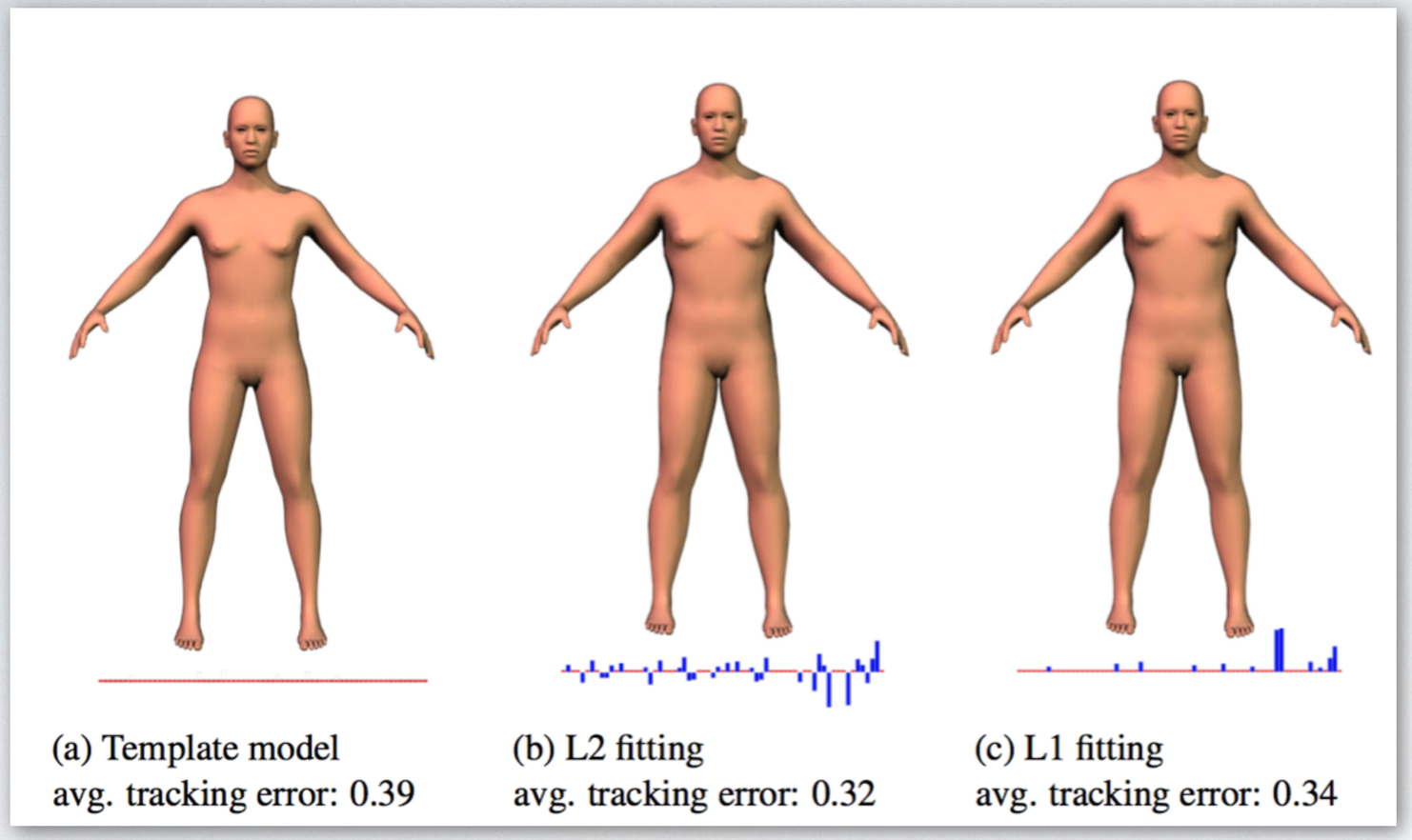
$$E_{bs\_reg\_L1} = ||\boldsymbol{s}||_1$$

Regularization terms

accumulate constraints over windows of frames - performance trade-off

solve and update the body template shape

MODELING ENERGY



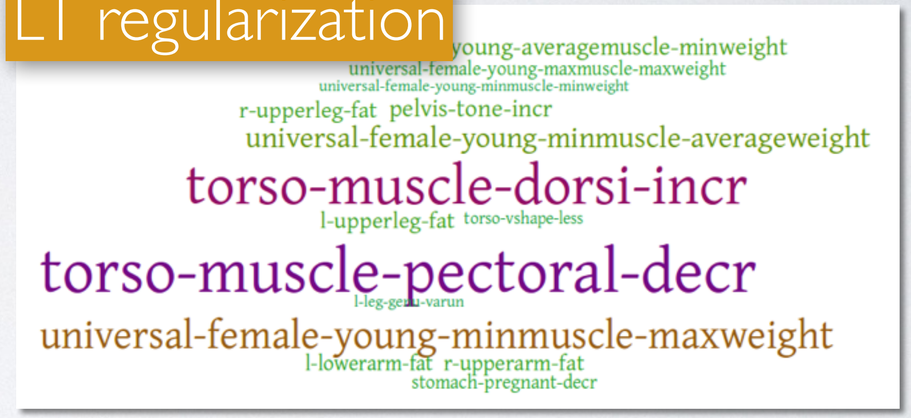
(a) Template model
avg. tracking error: 0.39

(b) L2 fitting
avg. tracking error: 0.32

(c) L1 fitting
avg. tracking error: 0.34

L2 regularization

L1 regularization



word cloud visualizations

RESULTS

Semantic Parametric Body Shape Estimation from Noisy Depth Sequences

Alexandru E. Ichim Federico Tombari

project webpage: http://lgg.epfl.ch/~ichim/bodies_ras_2015/

Supplementary video

Thank you!