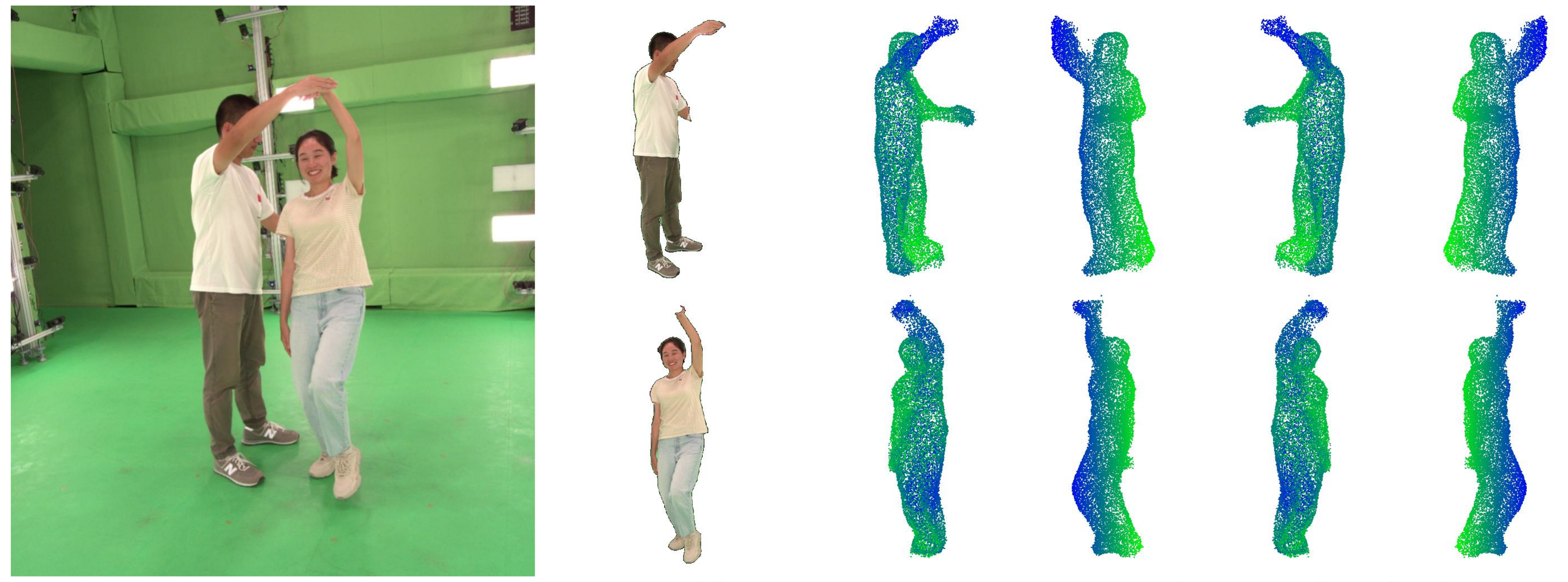
MHCDIFF: Multi-hypotheses Conditioned Point Cloud Diffusion for 3D Human Reconstruction from Occluded Images

Donghwan Kim Tae-kyun Kim

{kdoh2522, kimtaekyun}@kaist.ac.kr

Introduction

Goal: ***MHCDIFF*** predicts the ***pixel-aligned*** 3D shapes of humans ***robustly from occluded*** images.



Input image Segmented images 3D reconstruction as point cloud

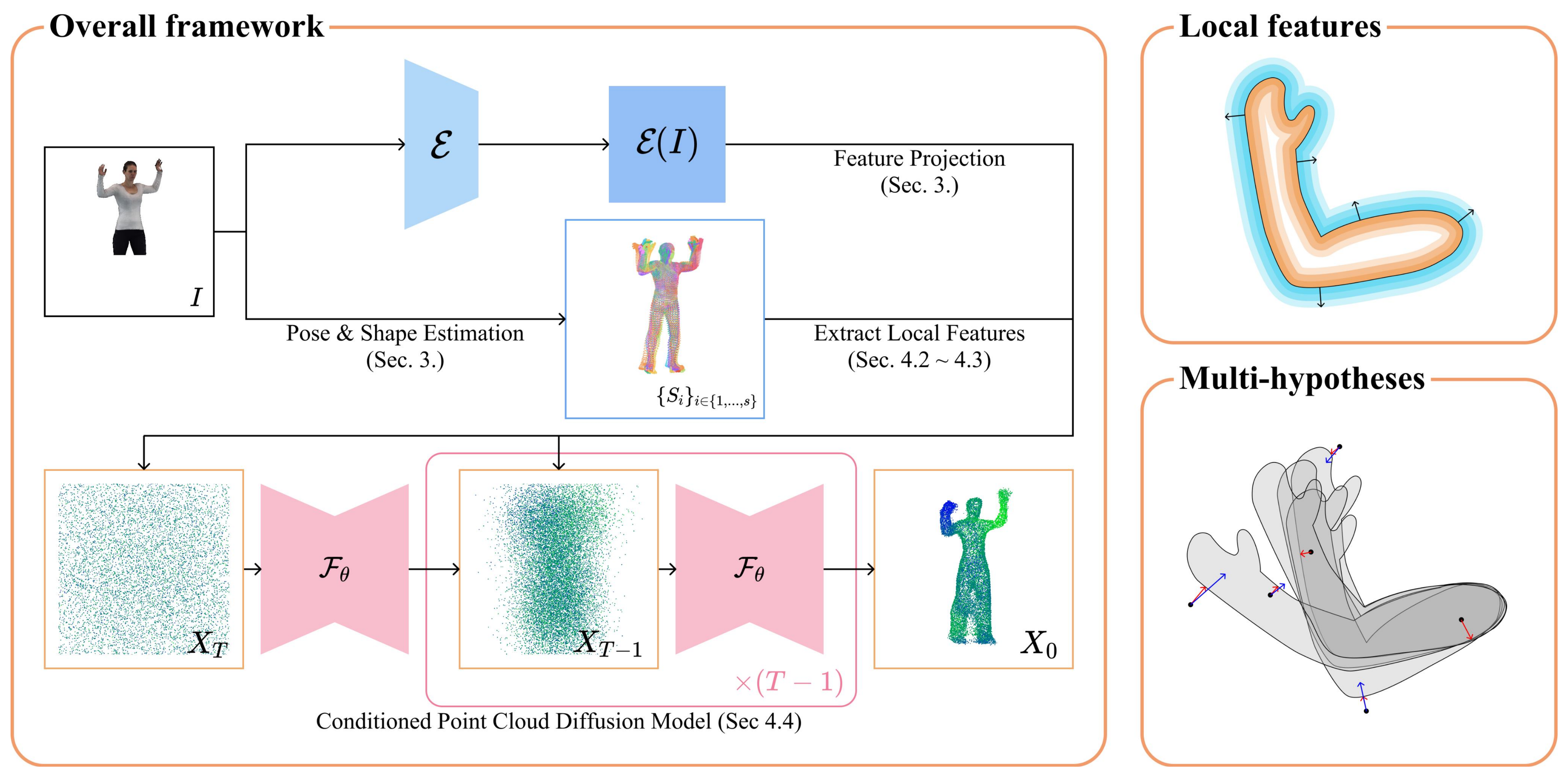
Problem:

- Parametric body models ***lack geometric details*** like clothing and hair.
- Implicit-function-based methods are ***sensitive to occlusion***.

Contributions:

- We propose a ***multi-hypotheses conditioning*** mechanism that captures the ***distribution of multi-hypotheses*** SMPL meshes to be robust to occlusion.
- We adopt ***point cloud diffusion*** model to ***inpaint the invisible parts*** with ***pixel-aligned detail shapes***.

Methods



Local features: Signed distance and normals [2]

$$X_t^{SMPL} = [\gamma(d(X_t|S)), \mathbf{n}(X_t|S)]$$

Multi-hypotheses condition:

Each point follows the ***closest SMPL mesh*** with the ***respective probability***.

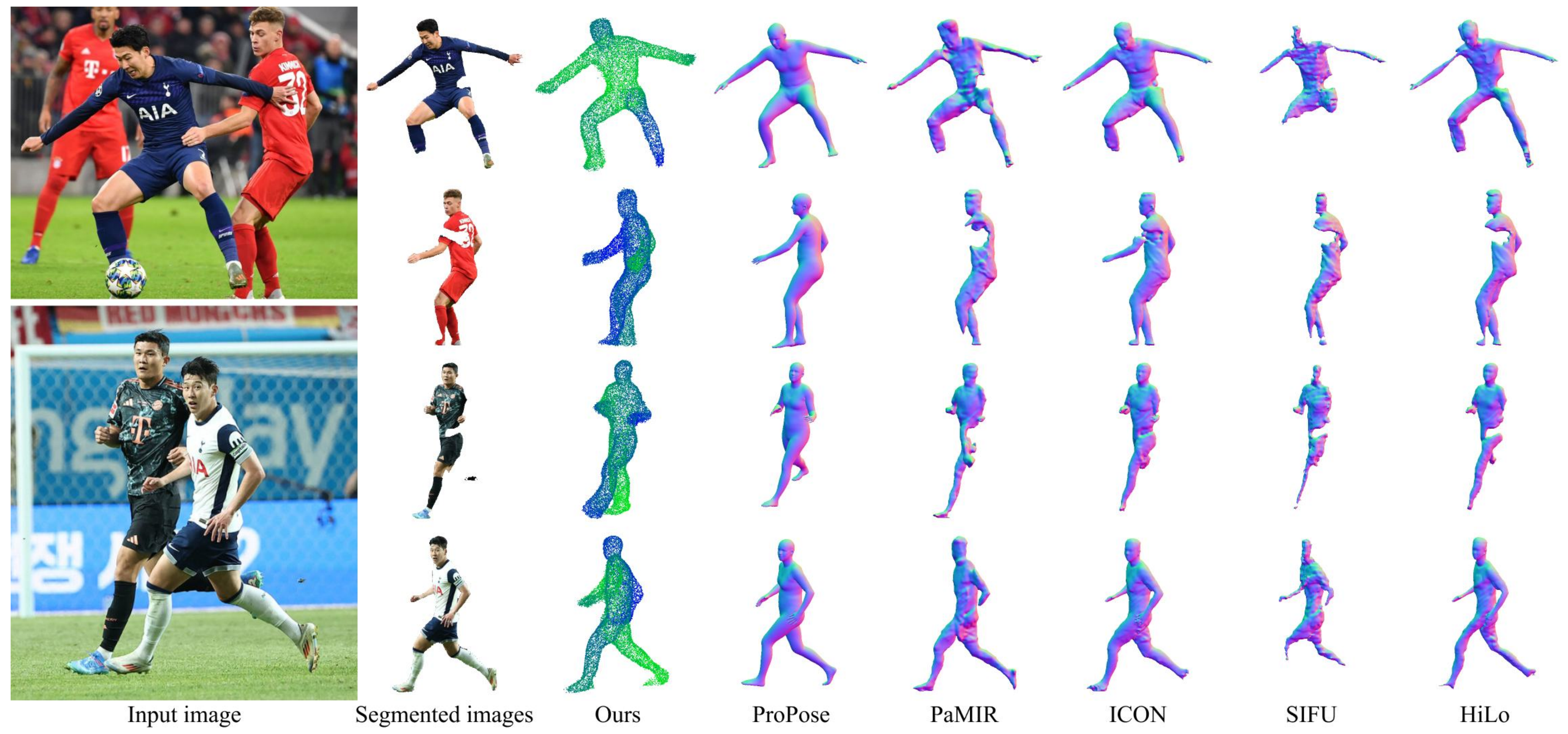
$$X_t^{SMPL} = [\frac{1}{s}\sum_{i=1}^{s}\gamma(o(X_t|S_i)), \gamma(d(X_t|S_{\bar{i}})), \mathbf{n}(X_t|S_{\bar{i}})]$$

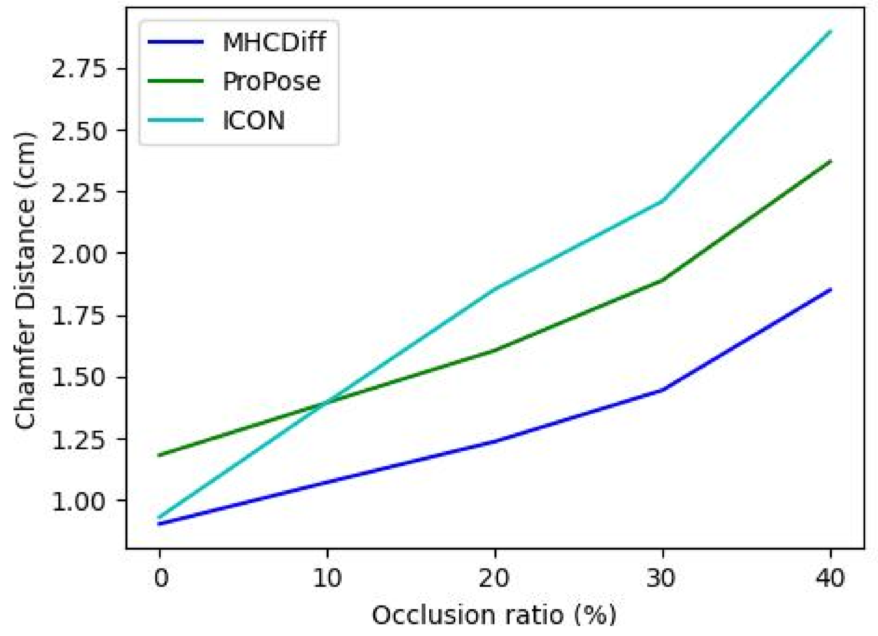
$$\bar{i} = argmin_{i\in\{1,\dots,s\}}|d(X_t|S_i)|$$

Conditioned point cloud diffusion

$$\mathcal{F}_\theta(\cdot) : \mathbb{R}^{(3+c+4L+3)N} \rightarrow \mathbb{R}^{3N}$$

Experiments





- comparable performance on full-body images
- outperforms other SOTAs on occluded images
- as robust as parametric body models on occlusion

[1] Melas-Kyriazi et al. "**PC2**: Projection-conditioned point cloud diffusion for single-image 3d reconstruction." CVPR 2023
[2] Xiu et al. "**ICON**: Implicit clothed humans obtained from normals." CVPR 2022
[3] Fang et al. "**ProPose**: Learning analytical posterior probability for human mesh recovery." CVPR 2023
[4] Zheng et al. "**PaMIR**: Parametric model-conditioned implicit representation for image-based human reconstruction." TPAMI 2021
[5] Zhang et al. "**SIFU**: Side-view conditioned implicit function for real-world usable clothed human reconstruction." CVPR 2024
[6] Yang et al. "**HiLo**: Detailed and robust 3d clothed human reconstruction with high-and low-frequency information of parametric models." CVPR 2024