

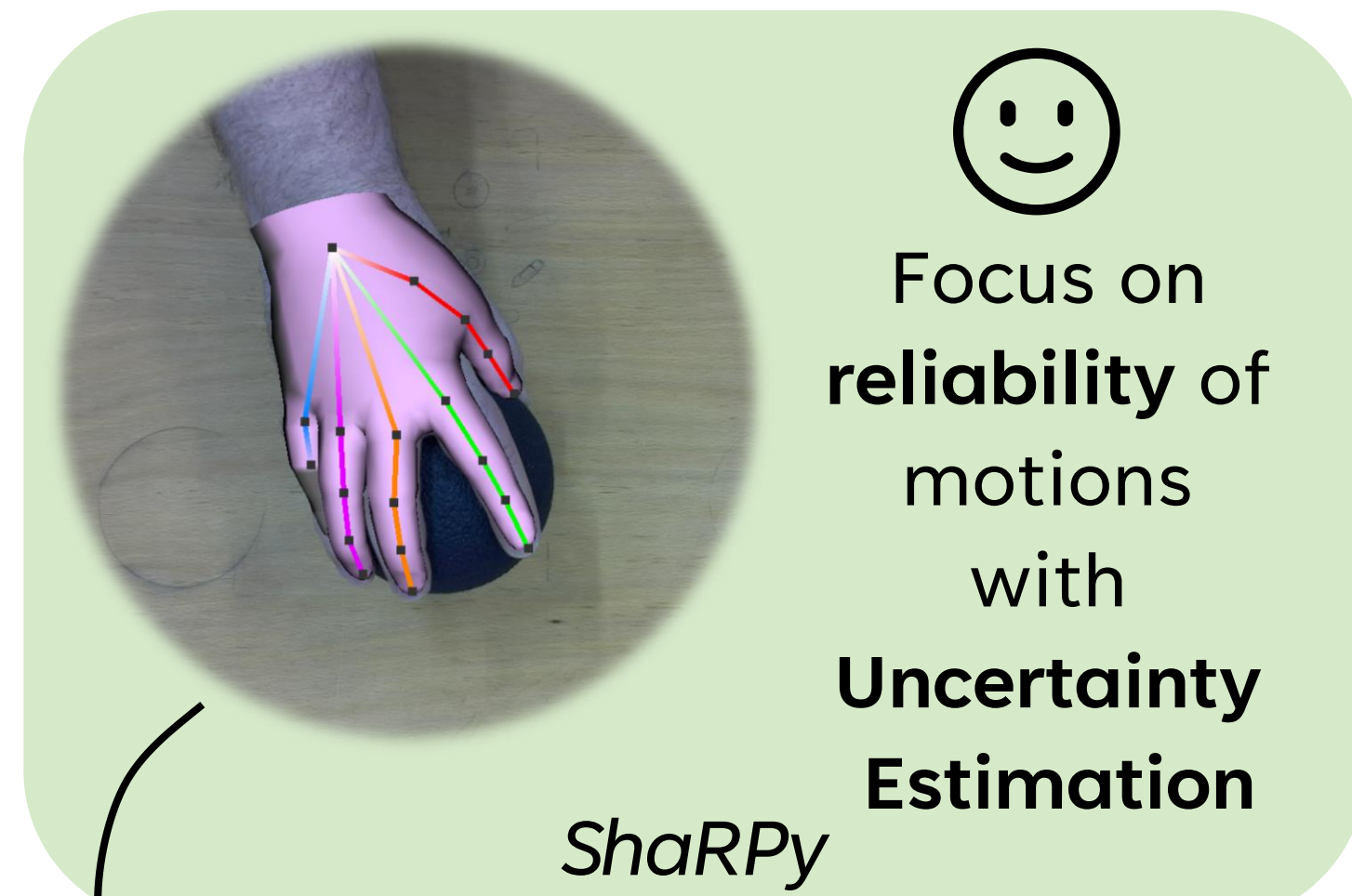
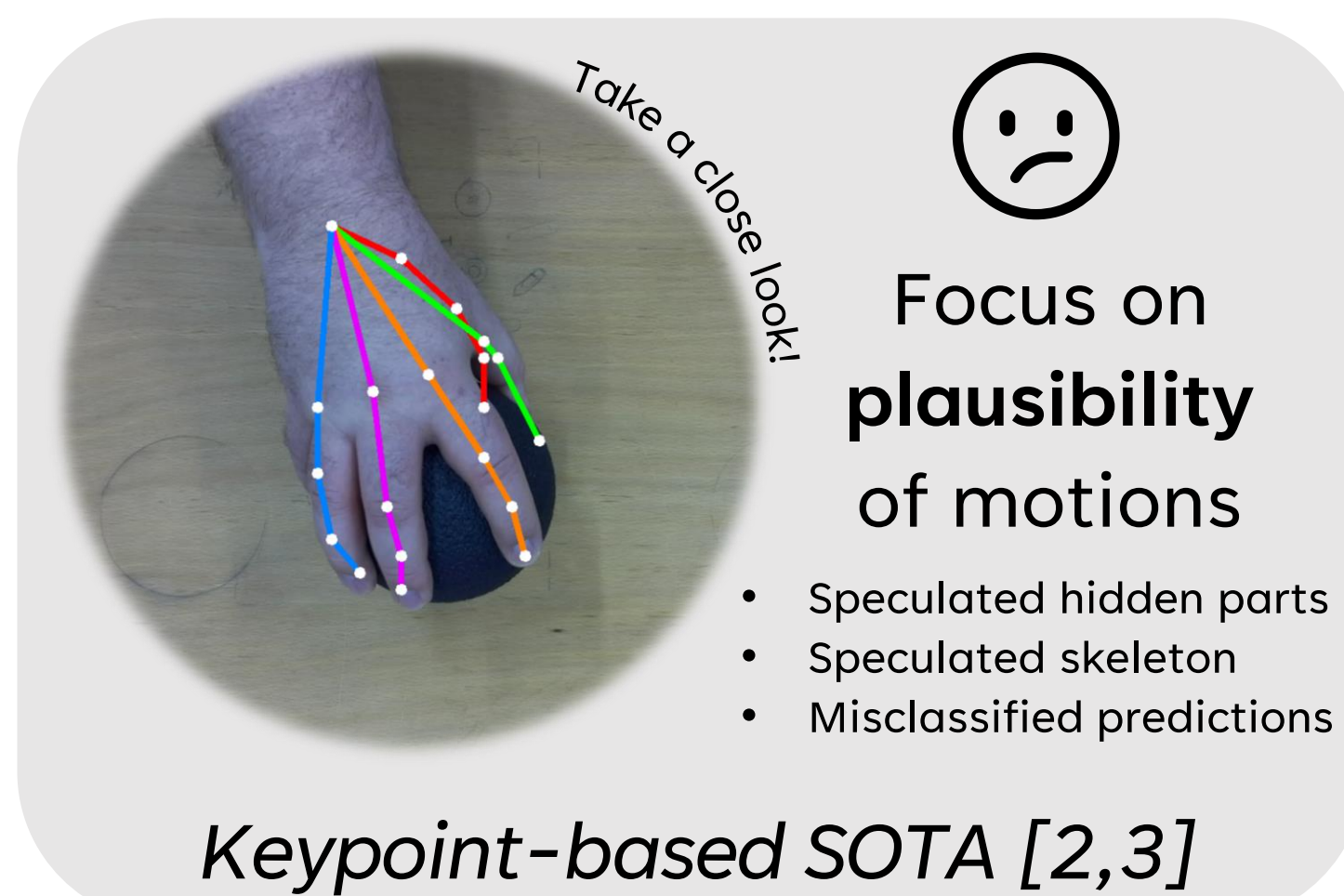


# ShaRPy: Shape Reconstruction and Hand Pose Estimation From RGB-D with Uncertainty

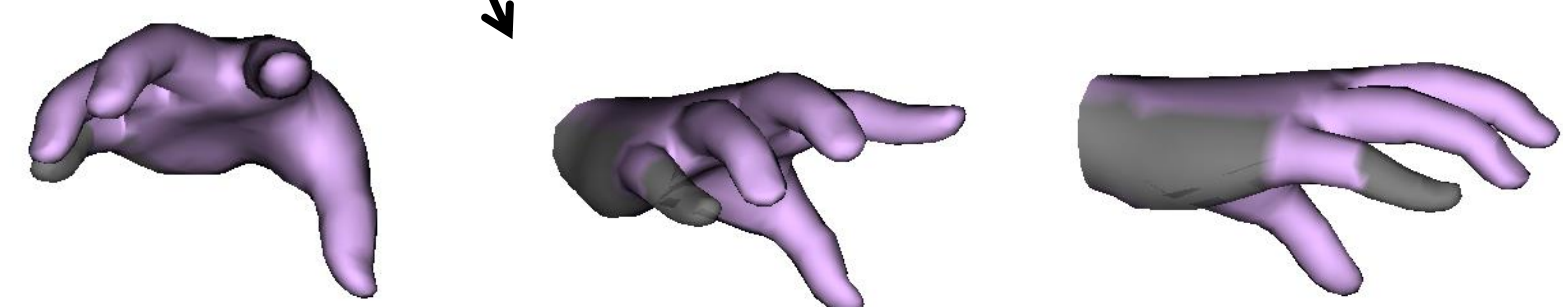
Vanessa Wirth, A. Liphardt, B. Coppers, J. Bräunig, S. Heinrich, S. Leyendecker, A. Kleyer, G. Schett, M. Vossiek, B. Egger, and M. Stamminger

## Contributions

First markerless RGB-D approach tailored to medical applications



Single RGB-D Camera  
(arbitrary model)



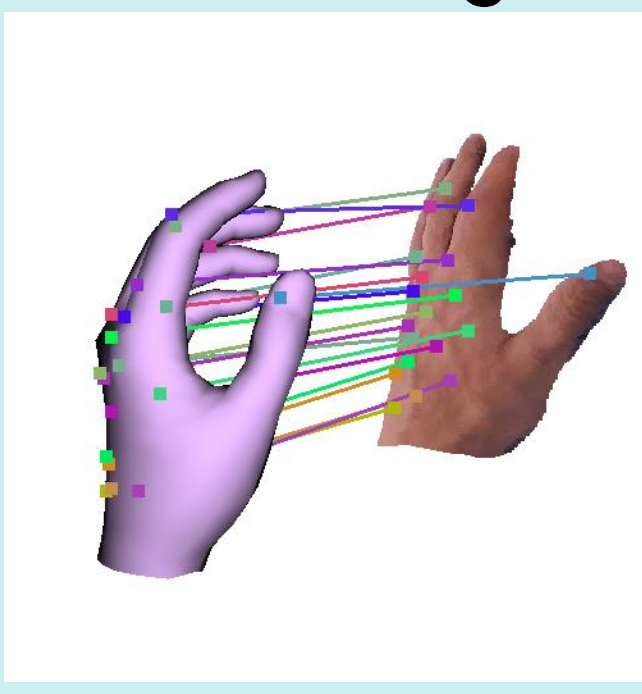
Intuitive 3D visualization of **pose** and **personalized** hand **shape**

## Methods



Neural Object Detector

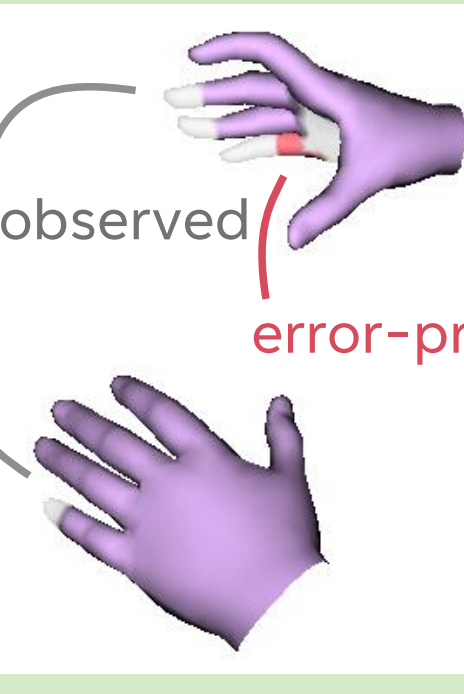
Correspondence Matching



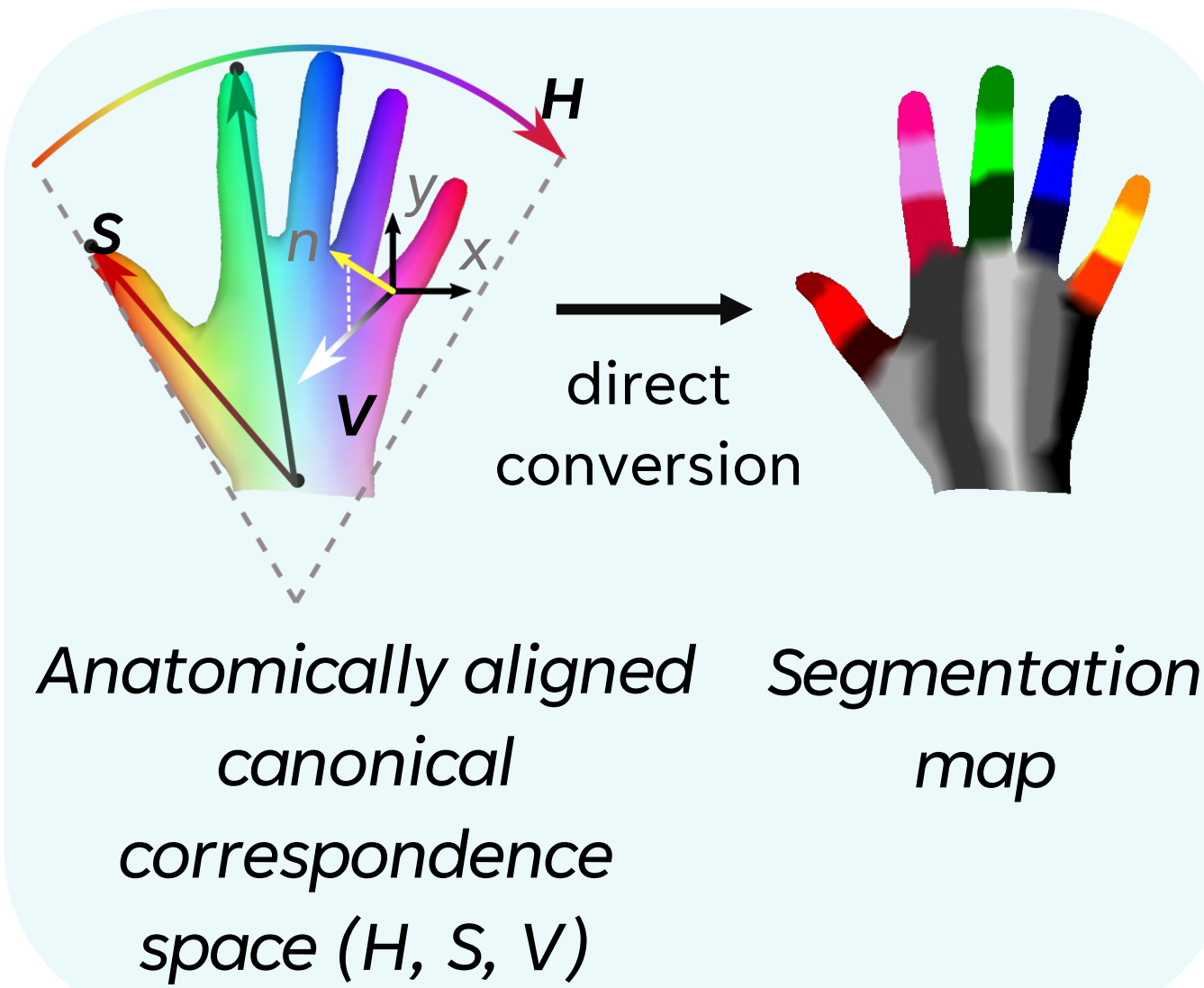
Pose and Shape Tracking



Uncertainty Estimation

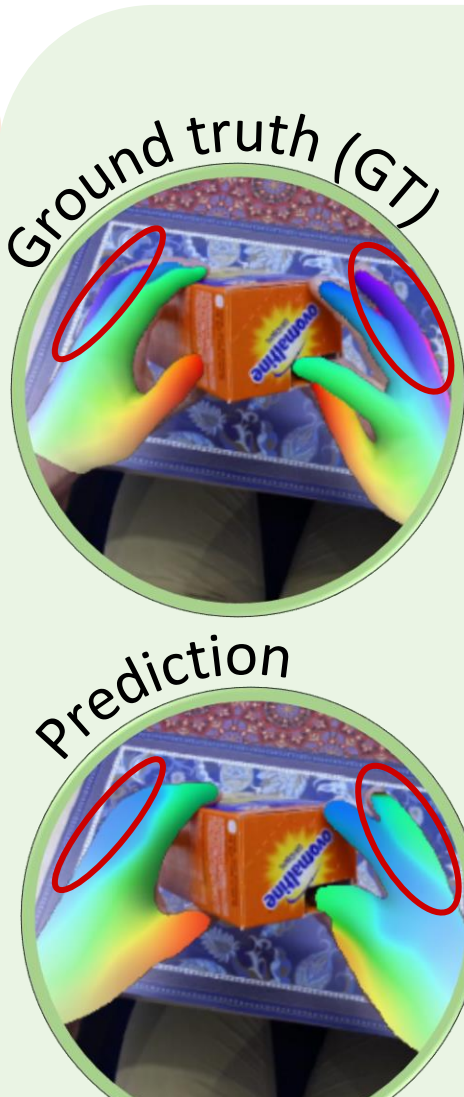


re-use temporal information  $k-1 \rightarrow k$



Optimal Params

$$\Omega^k = (R^k, t^k, \theta^k, \beta^k)$$
$$\arg \min_{\Omega^k}$$
$$\begin{bmatrix} E_{3d}(C_{3d}) \\ + E_{2d}(C_{2d}) \\ + E_{shape}(\beta) \\ + E_{pose}(\theta) \\ + E_{temp}(\theta^{t-1}, \theta^t) \end{bmatrix} \text{data}$$



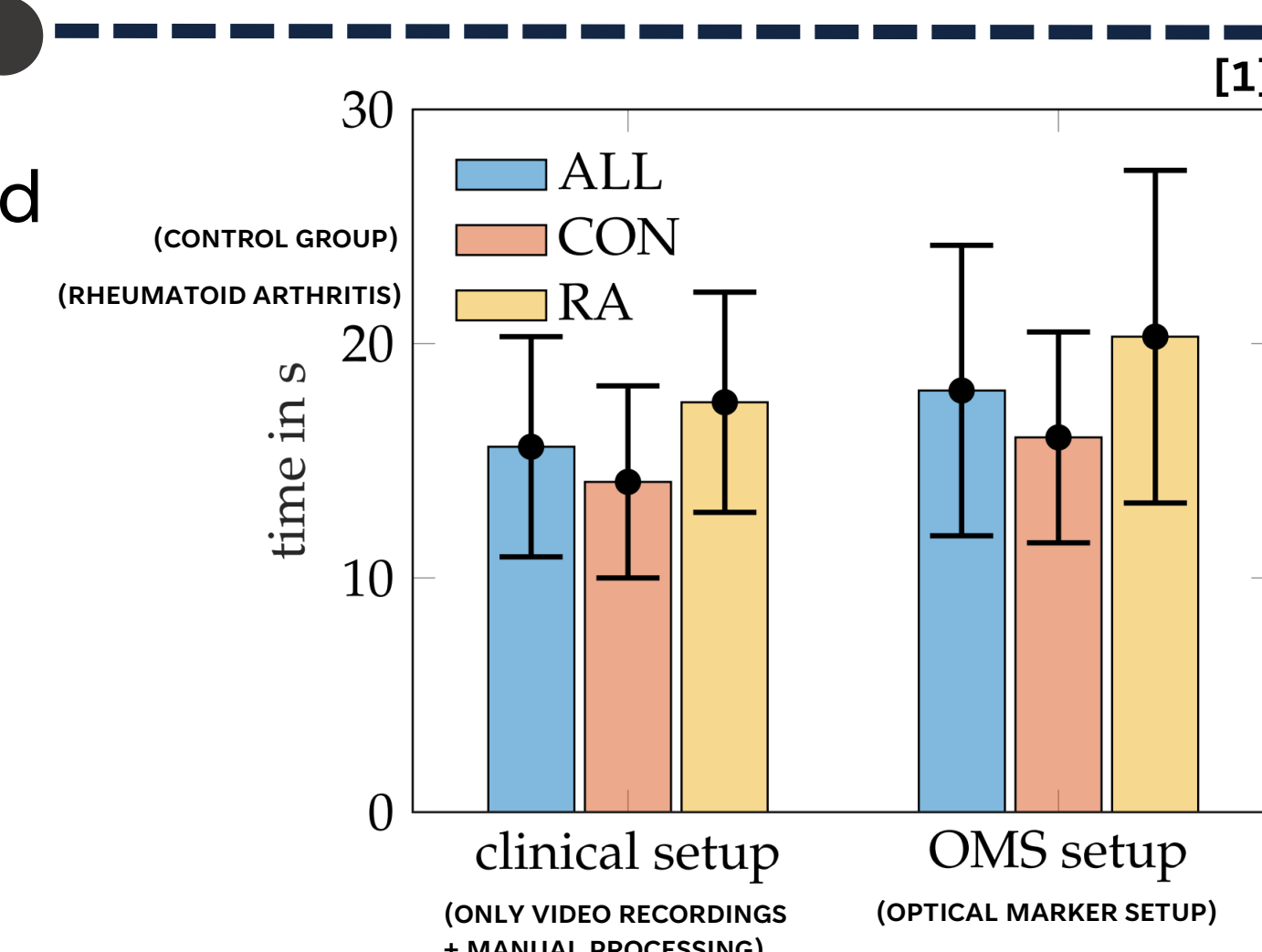
Predicted Inconsistencies yield **high or no residuals**

- Cluster residuals per segment
- Thresholding
- Error-prone** & **unobserved** segments

## Motivation

Musculoskeletal **diseases** on the hand can be detected through **motion**.  
How can we objectively evaluate the **hand function** of a patient?  
Current SOTA with **OMS** is **time-consuming** and **not intuitive**  
→ **Markerless methods**

START HERE



## Results

Evaluation on H2O Pose Estimation

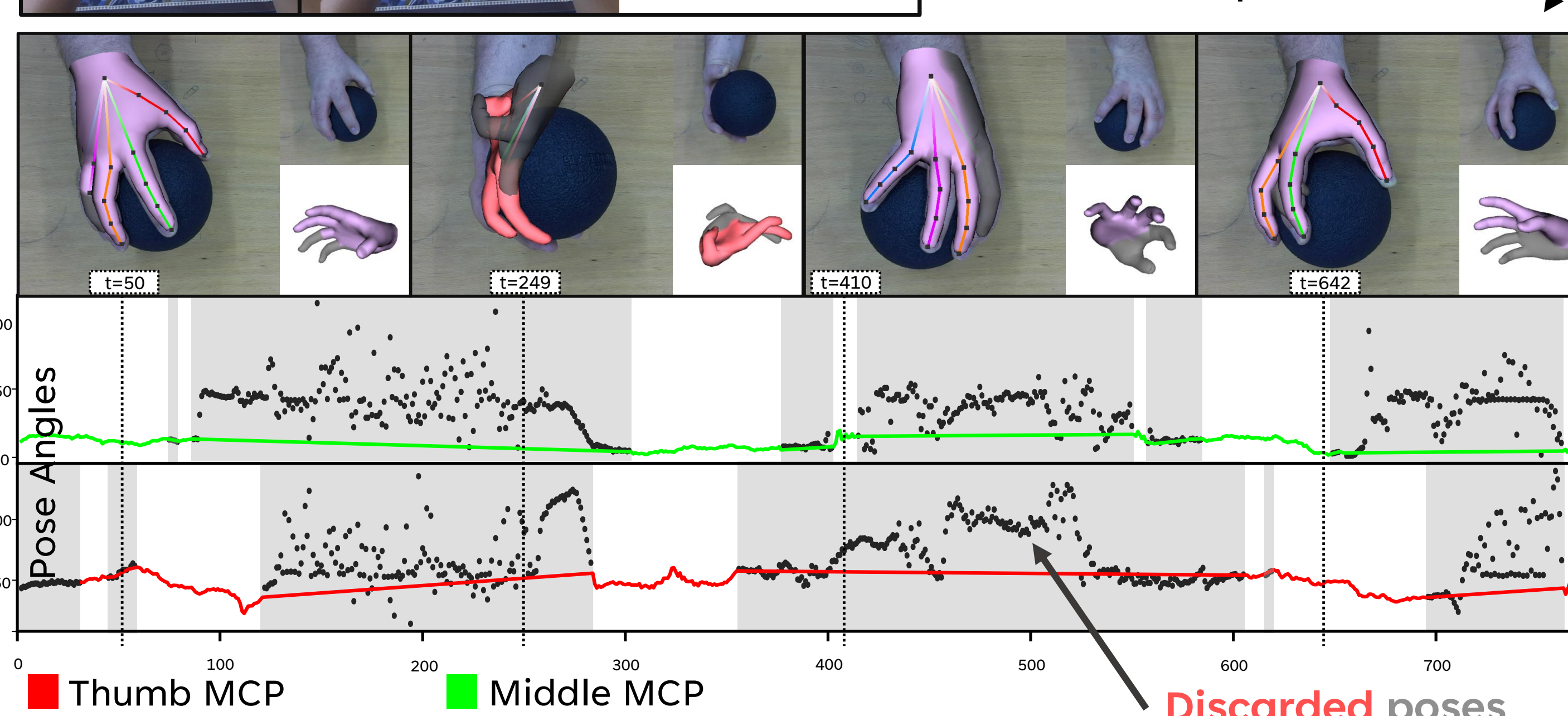
	MEPE (mm) ↓		3D PCK@15mm ↑	
	Left	Right	Left	right
Hasson et al. (CoRR 2020)	39.56	41.87	-	-
Tekin et al. (CVPR 2019)	41.32	38.86	-	-
Kwon et al. (ICCV 2021)	41.45	37.21	-	-
Aboukhandra et al. (WACV 2023)	36.80	36.50	-	-
Cho et al. (CVPR 2023)	24.40	25.80	-	-
Wen et al. (CVPR 2023)	35.02	35.63	12.67	2.98
Cho et al. (HBHA@ECCV 2022)	14.40	15.90	70.75	54.61
Luo et al. (HBHA@ECCV 2022)	20.80	24.70	40.77	32.29
Ours	20.47	19.07	21.04	27.81

ShaRPy achieves **2nd place** w.r.t. MEPE



Qualitative Evaluation with **OpenPose**

Hand function tests on PsA patient → discard unreliable poses



[1] U. Phutane et al.: Evaluation of Optical and Radar Based Motion Capturing Technologies for Characterizing Hand Movement in Rheumatoid Arthritis—A Pilot Study (Sensors 2021)

[2] Z. Cao et al.: OpenPose: Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields (TPAMI 2019)

[3] T. Simon et al.: Hand Keypoint Detection in Single Images using Multiview Bootstrapping (CVPR 2017)



THE END