Im2Hands: Learning Attentive Implicit Representation of Interacting Two-Hand Shapes

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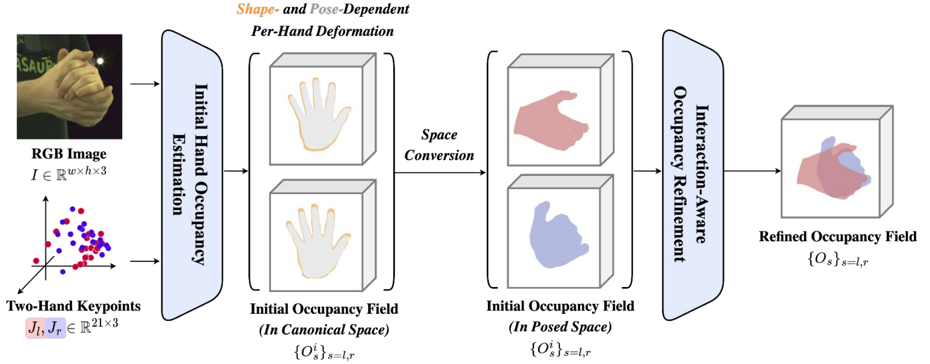
Motivation & Challenges

- **Existing two-hand reconstruction methods** model hands with low-resolution meshes with a fixed MANO[1] topology (|V| = 778).
- **Neural implicit representation** can model continuous shapes. It is also known to reconstruct shapes that are well-aligned to the input images.

➔ However, implicitly modeling **complex articulations and interaction contexts between two hands** is highly challenging.

Method

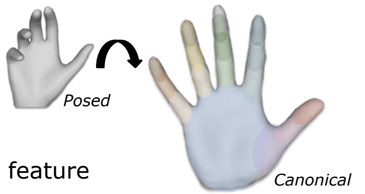
- We propose two novel attention-based modules designed for:
  1) **Initial per-hand occupancy estimation in canonical space**, and
  2) **Interaction-aware two-hand occupancy refinement in posed space**.



Initial Per-Hand Occupancy Estimation

$$\mathcal{I}(x\,|\,I,\,J) = \max_{b=1,\dots,B} \{\bar{\mathcal{H}}_b(\mathbf{T}_b x,\; f_b^{\phi}, f_x^{\phi}, f_b^{\omega})\}$$

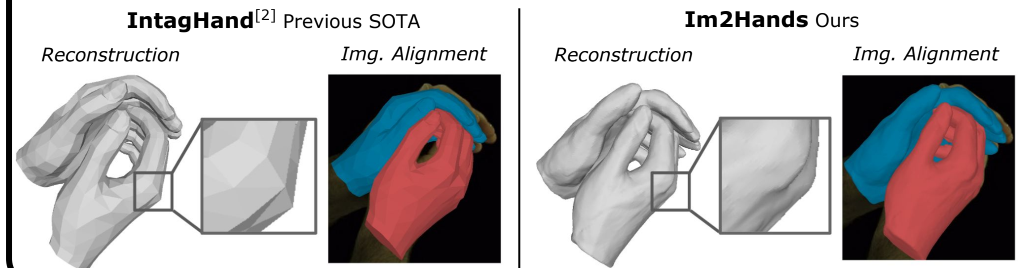
- $\bar{\mathcal{H}}_b$: Part occupancy network for bone b
- $\mathbf{T}_b x$: Canonicalized query point for bone b
- f_b^{ϕ}, f_b^{ω}: Per-bone shape and pose features
- f_x^{ϕ}: Per-query shape (**query-image attention**) feature



Overview

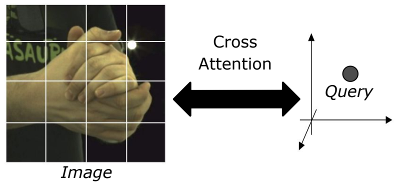
We propose **Im2Hands (Implicit Two Hands)**, the first neural implicit representation for two interacting hands.

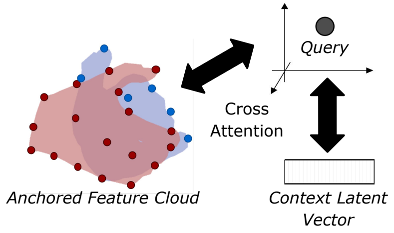
- ✅ Learns resolution-free two-hand geometries with high hand-hand and hand-image coherency
- ✅ Does not require dense vertex correspondences or MANO[1] parameter annotations for training
- ✅ Achieves state-of-the-art accuracy on two-hand reconstruction



Two-Hand Occupancy Refinement

- To encode the initial geometry of two hands, we represent them as anchored feature cloud (*i.e.* feature vectors of points evaluated to be on surface by our initial occupancy network).
- We then apply **cross-attention between (1) a query, (2) anchored features, and (3) a context latent vector** to estimate the refined occupancy.





📌 We also proposed an **optional keypoint refinement module** for image-based reconstruction scenario.

Please check the paper for more details.

Experiments

- Im2Hands achieves SOTA reconstruction results on InterHand2.6M[4].

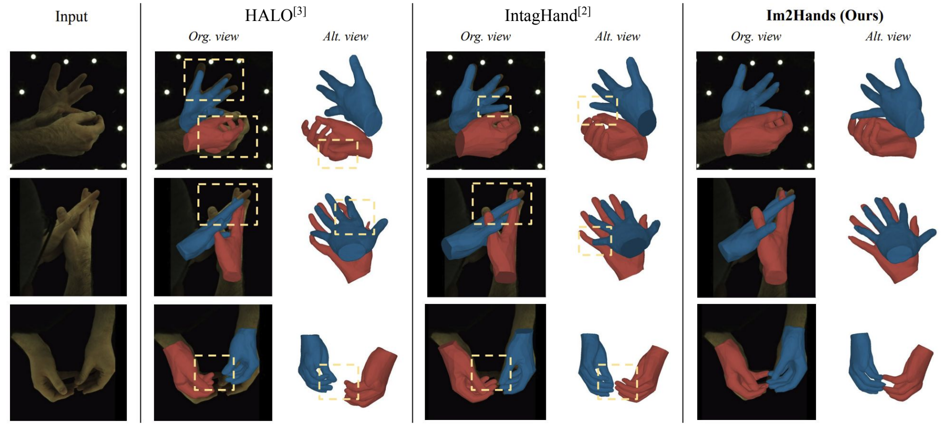
Using Image and Keypoint Inputs

Method	Inputs	IoU (%) ↑	CD (mm) ↓
Two-Hand-Shape-Pose[5]	$\mathcal{I}, \mathcal{L}$	54.8	5.51
IntagHand[2]	$\mathcal{I}, \mathcal{L}$	67.0	3.88
HALO[3]	$\mathcal{J}$	74.7	2.62
HALO*[3]	$\mathcal{I}, \mathcal{J}$	75.8	2.51
Im2Hands (Ours)	$\mathcal{I}, \mathcal{J}$	**77.8**	**2.30**

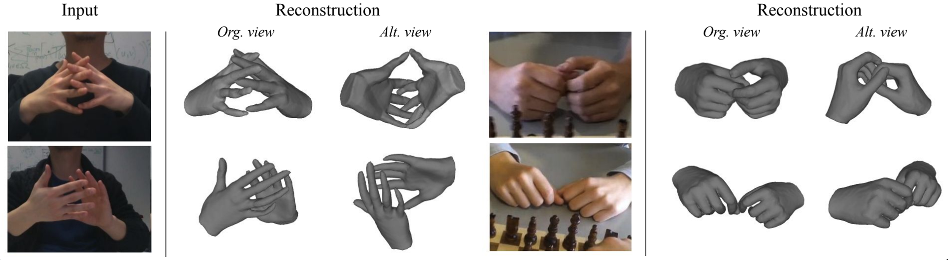
Using Image Inputs Only (+ Predicted Keypoints)

Method	IoU (%) ↑	CD (mm)↓
Two-Hand-Shape-Pose[5]	48.4	6.09
IntagHand[2]	59.0	4.69
DIGIT[6]+ HALO[3]	45.1	7.64
IntagHand[2]+ HALO[3]	53.8	5.38
DIGIT[6]+ Im2Hands (Ours)	**59.4**	**4.75**
IntagHand[2]+ Im2Hands (Ours)	**62.1**	**4.35**

Qualitative Results on Image-Based Two-Hand Reconstruction



- We also show generalization test results on RGB2Hands[6] and EgoHands[7] datasets.



References

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