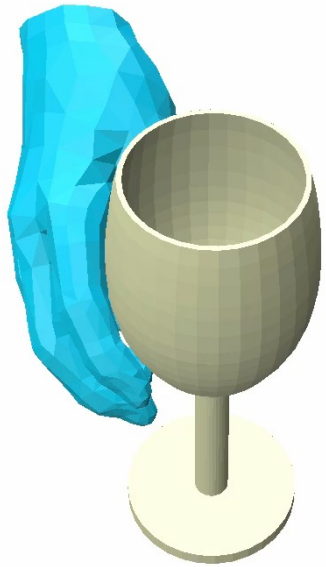
GeneOH Diffusion

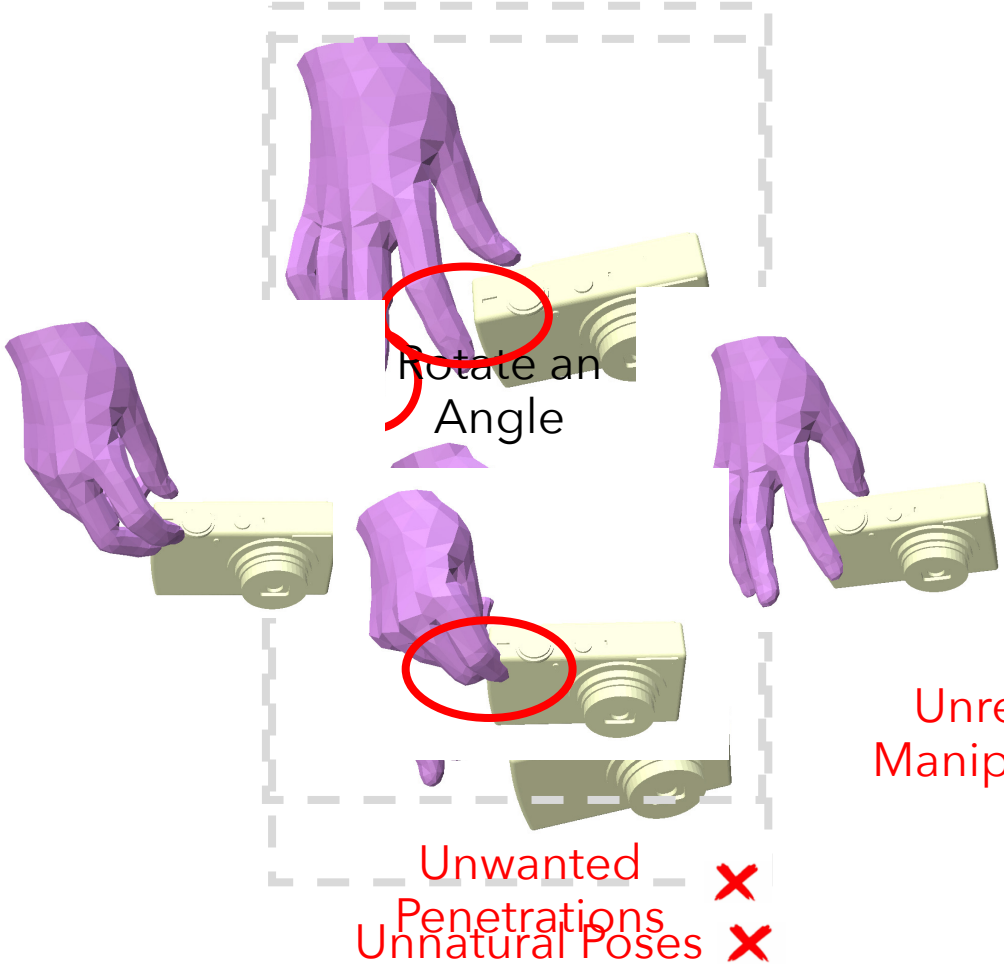
Towards Generalizable Hand-Object Interaction Denoising via Denoising Diffusion

ICLR 2024

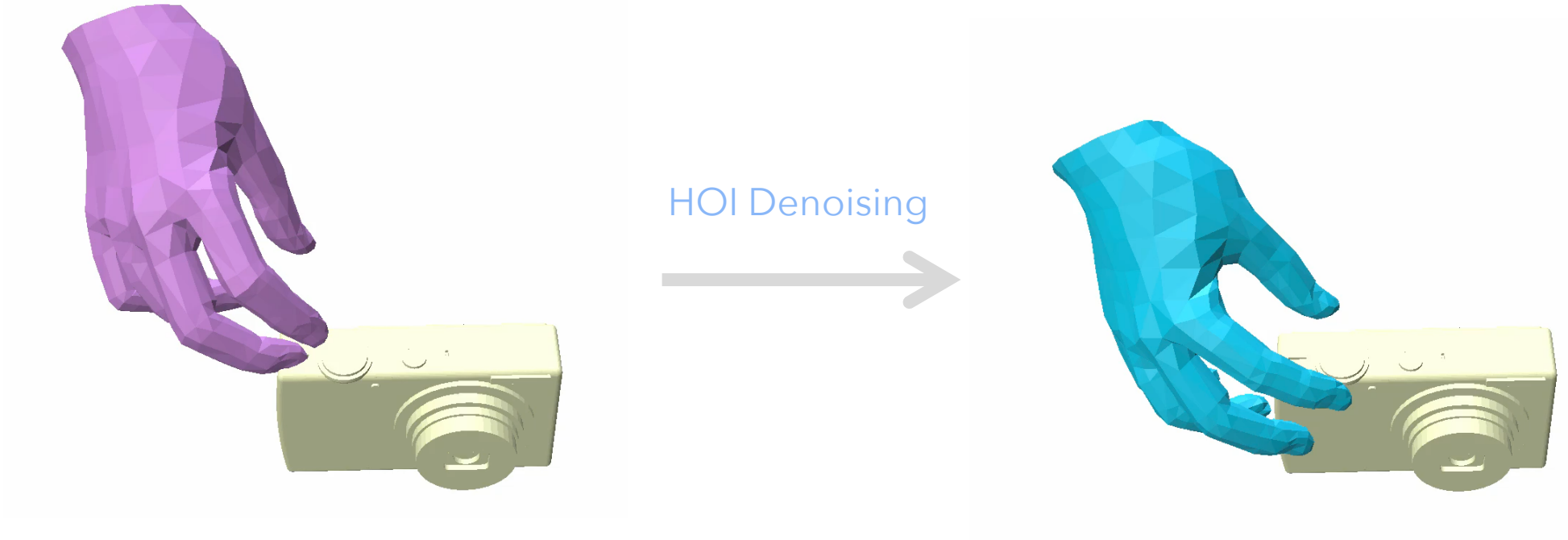
Xueyi Liu and Li Yi



Generalizable HOI Denoising



Generalizable HOI Denoising

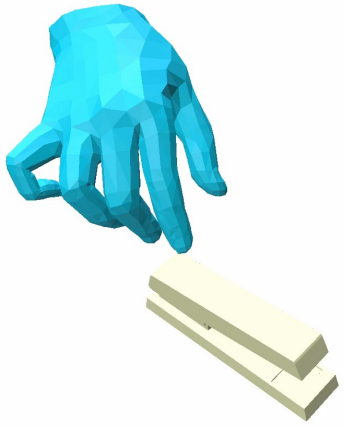


Generalizable HOI Denoising

1. Unseen Object
2. Unobserved Interactions
3. Novel Noise Patterns

Noisy Data

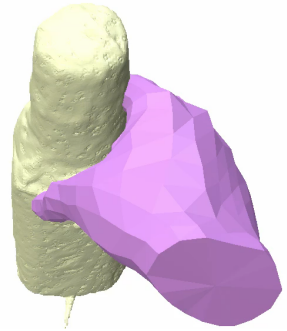
Clean Data



Train

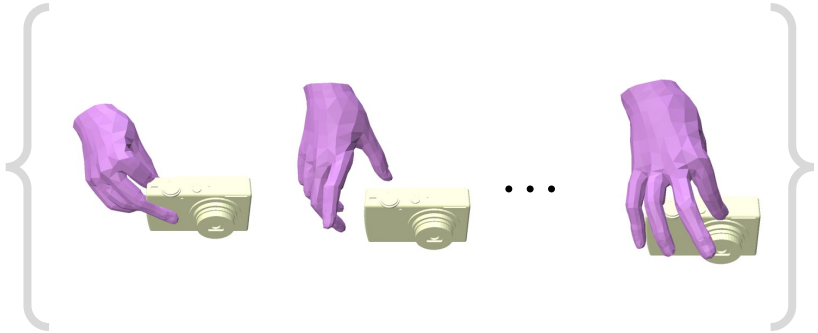
Generalizable Denoising Model

Generalize



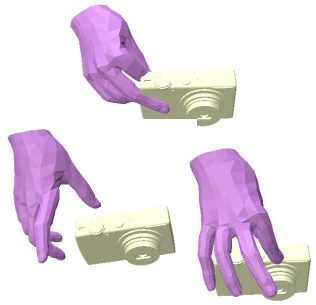
Design Philosophy

Interaction Region



Interaction Region-Centric Hand-Object Relations

An informative HOI representation that can support generalization



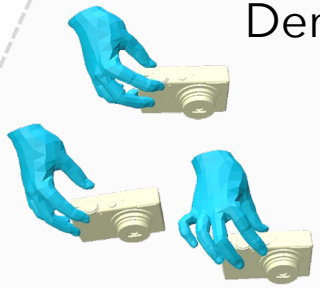
Input noisy trajectory

Diffuse

A whitened noise space

Diffused trajectory

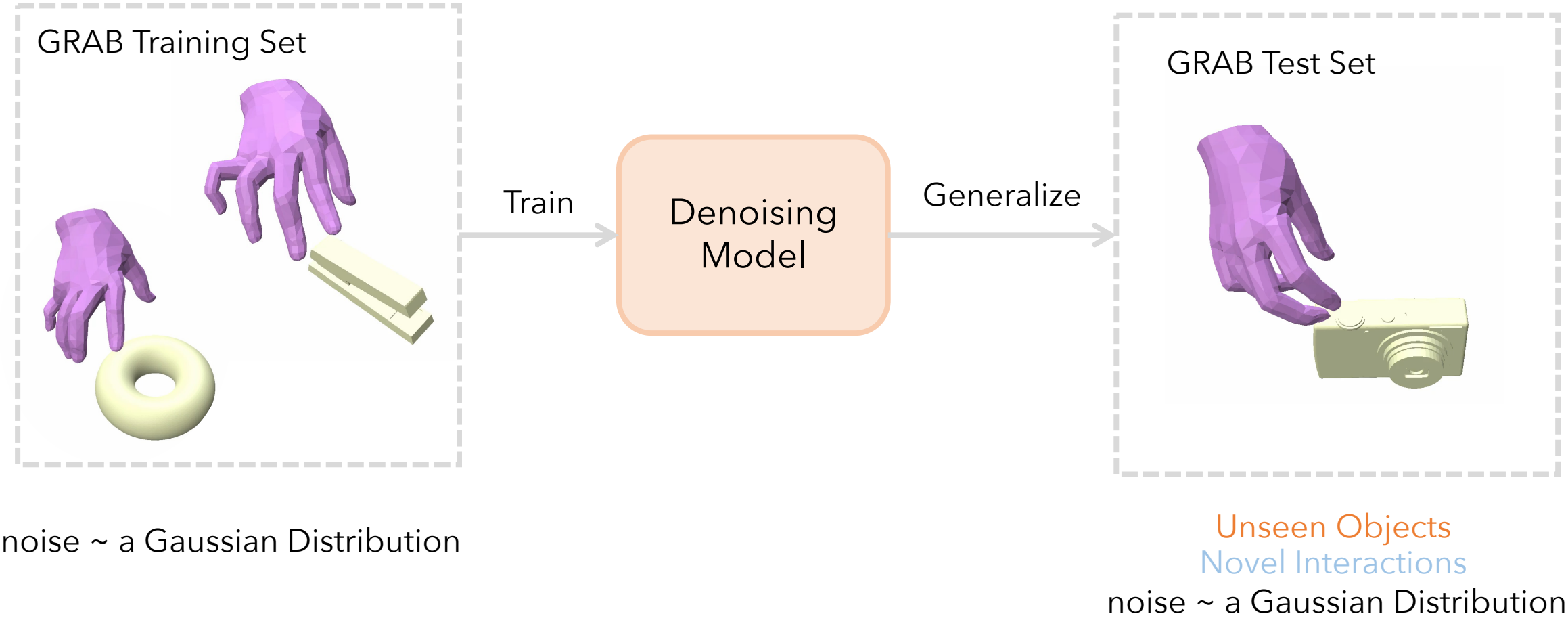
Denoise



A domain-generalizable denoising scheme

Gallery

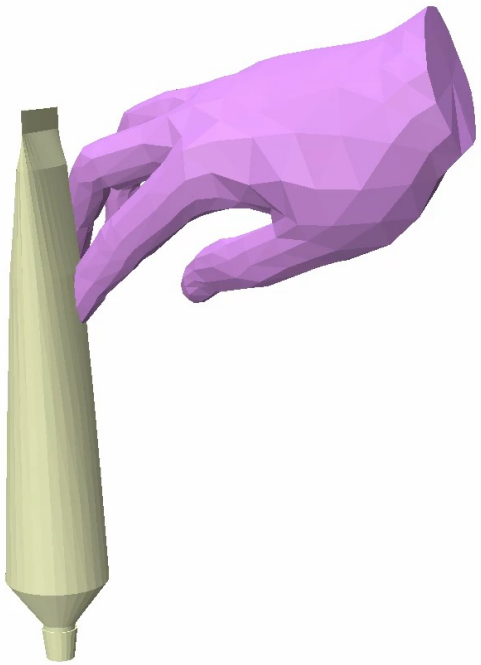
Generalizable Hand-Object Interaction Denoising

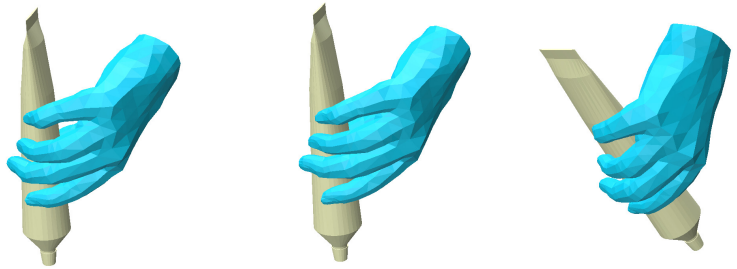

GRAB Training Set
Train
Denoising Model
Generalize
GRAB Test Set
noise ~ a Gaussian Distribution
Unseen Objects
Novel Interactions
noise ~ a Gaussian Distribution

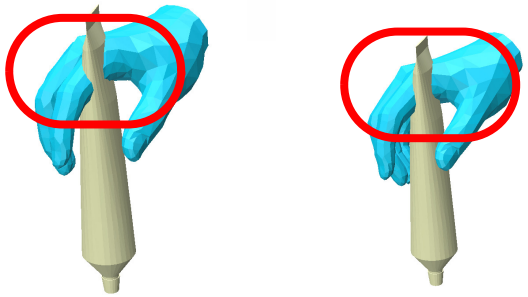
Noisy Input

Ours

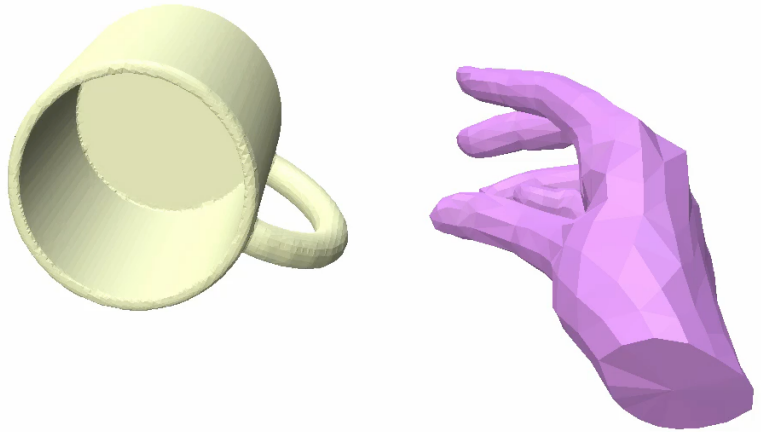
TOCH



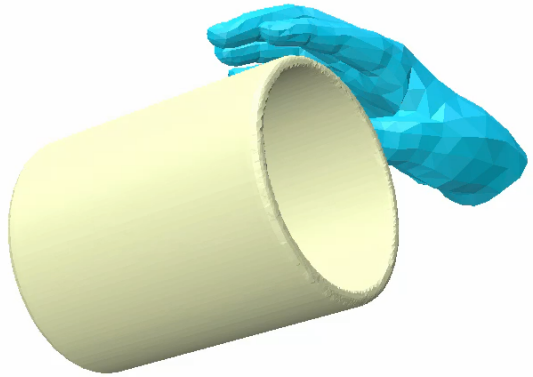




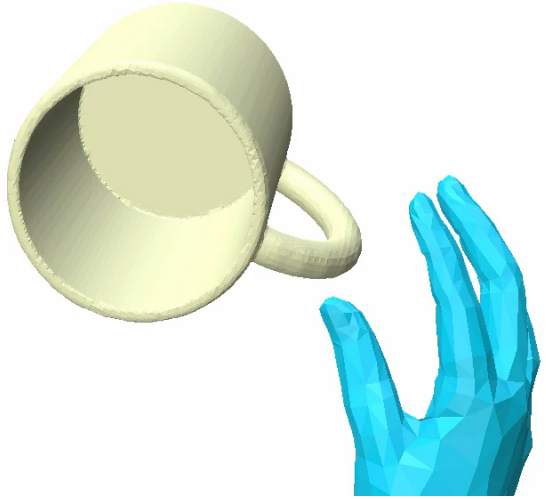
Unseen Challenging Geometry (Rings)



Noisy Input



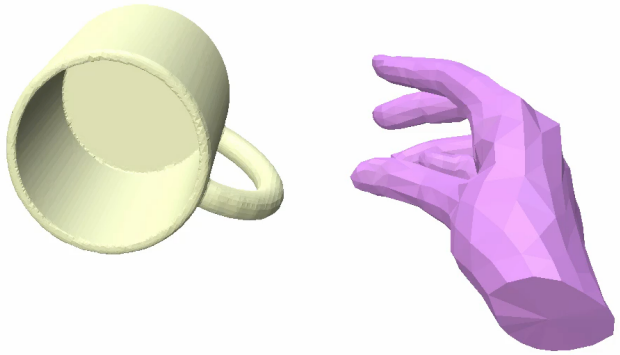
[View 1]



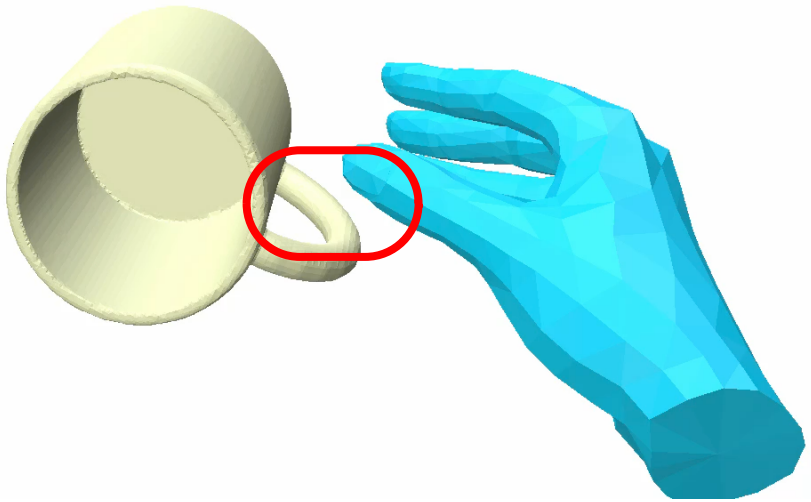
[View 3]

[View 2]

Unseen Challenging Geometry (Rings)



Noisy Input



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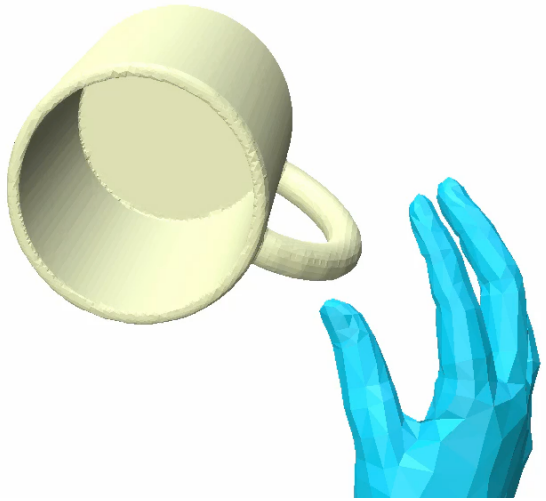
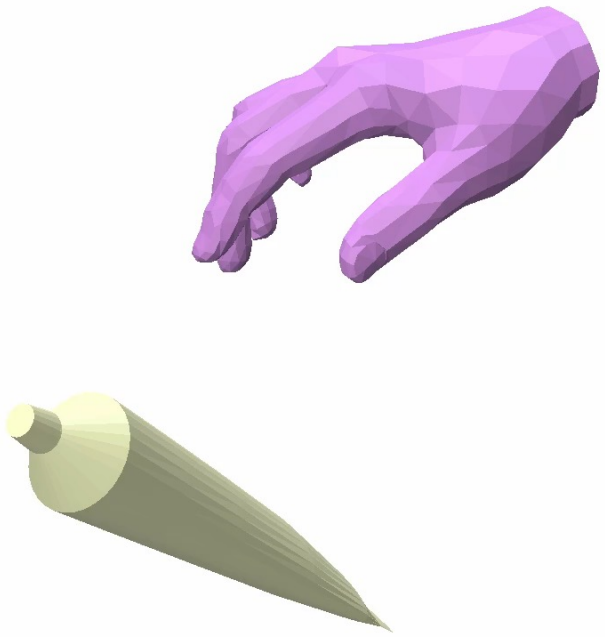


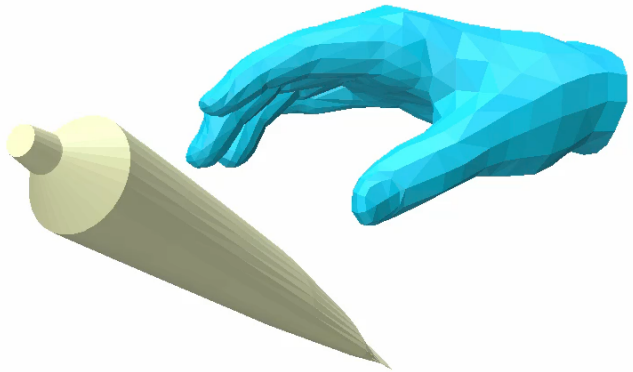
Ours

Unseen Challenging Interaction (In-Hand Manipulation)

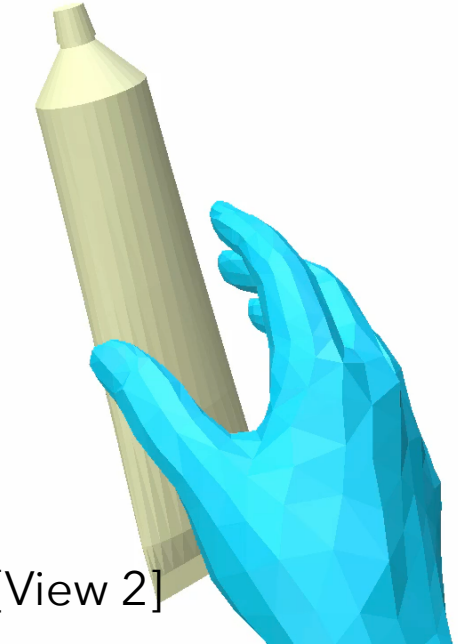


Noisy Input

[View 1]

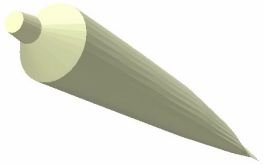


[View 3]

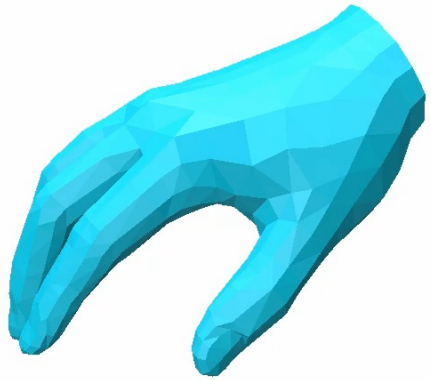


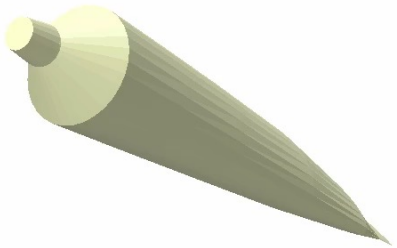
[View 2]

Unseen Challenging Interaction (In-Hand Manipulation)

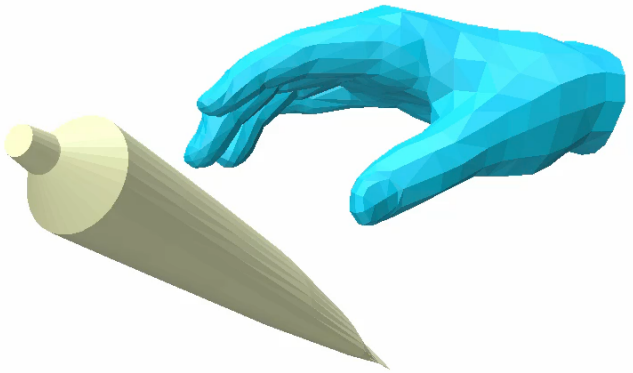


Noisy Input



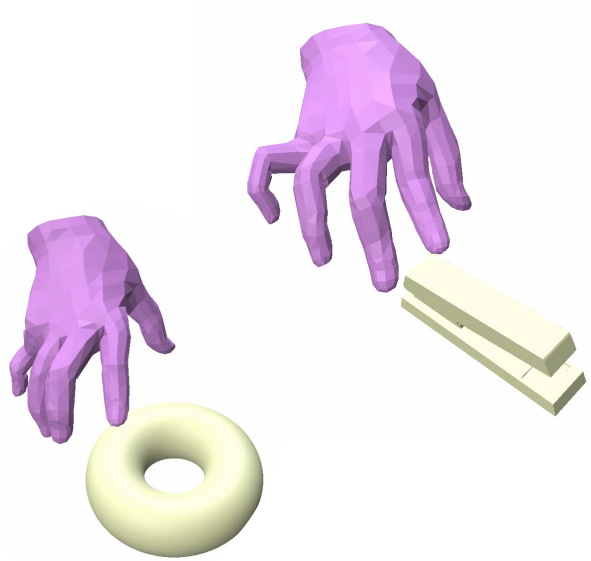


TOCH



Ours

GRAB Training Set



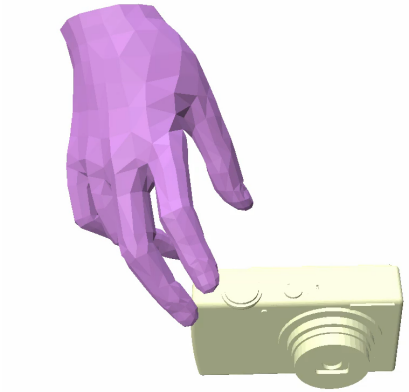
noise ~ a Gaussian Distribution

Train

Denoising Model

Generalize

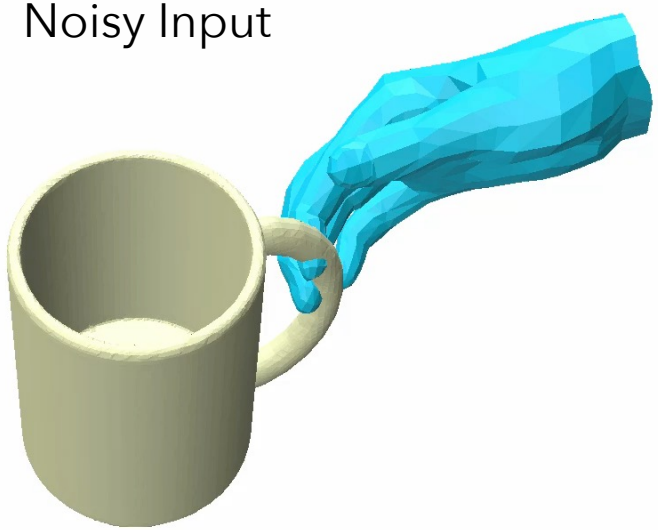
GRAB (Beta) Test Set



Unseen Objects
Novel Interactions
Novel noise ~ a Beta Distribution

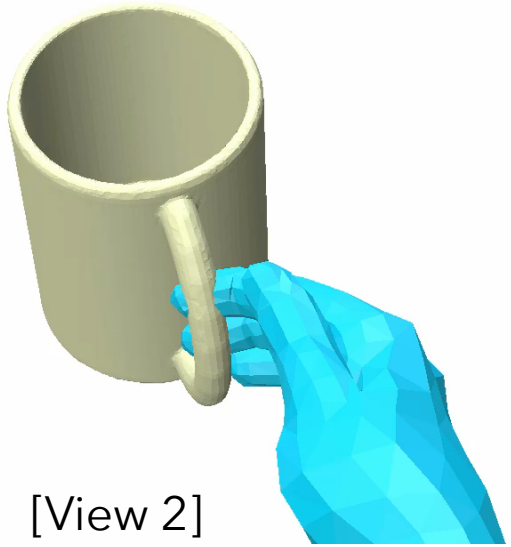
Synthetic Novel Noise

Noisy Input



[View 3]

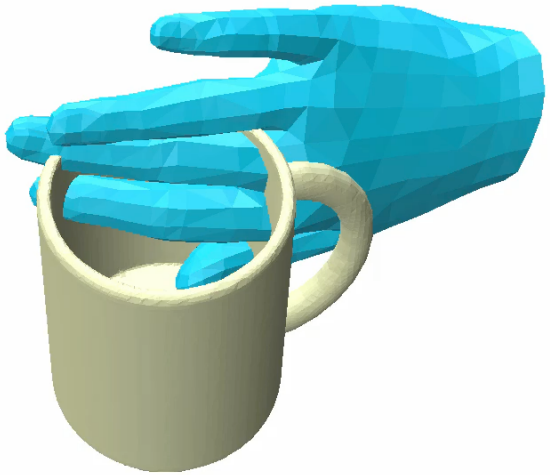
[View 1]



[View 2]

Synthetic Novel Noise

Noisy Input



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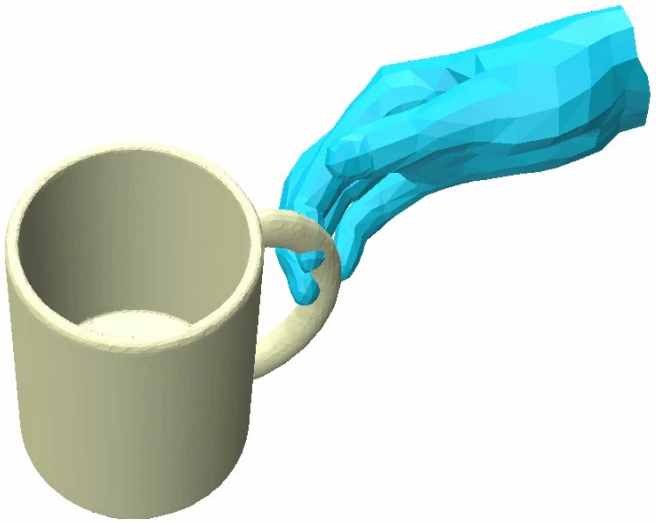
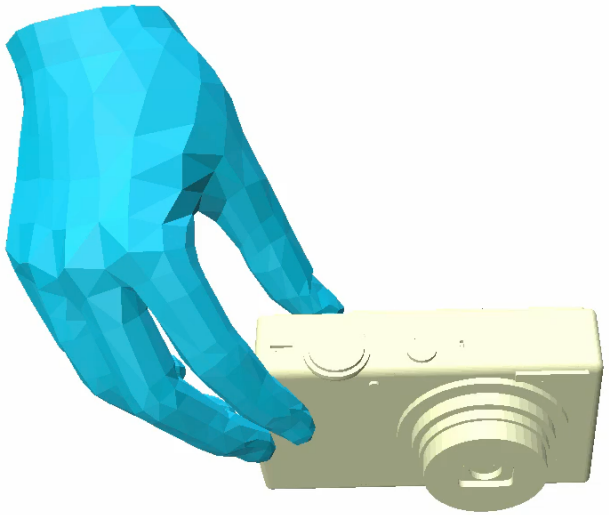


Ours

Synthetic Novel Noise

Noisy Input

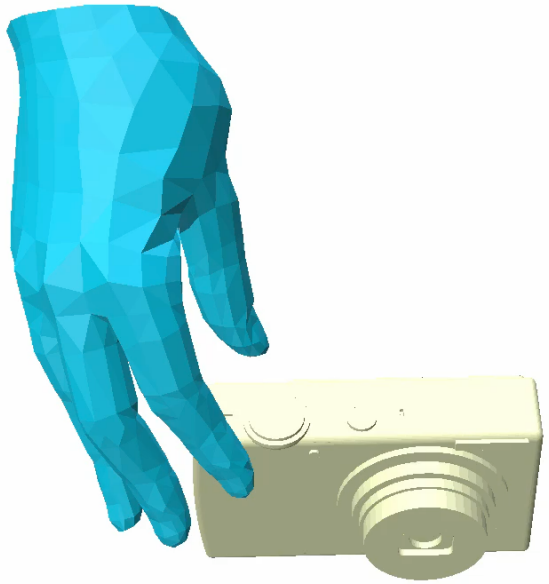
Ours



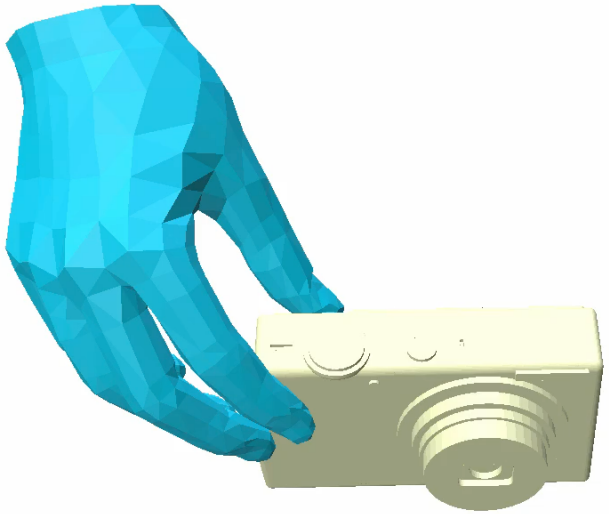
Synthetic Novel Noise

Noisy Input

TOCH

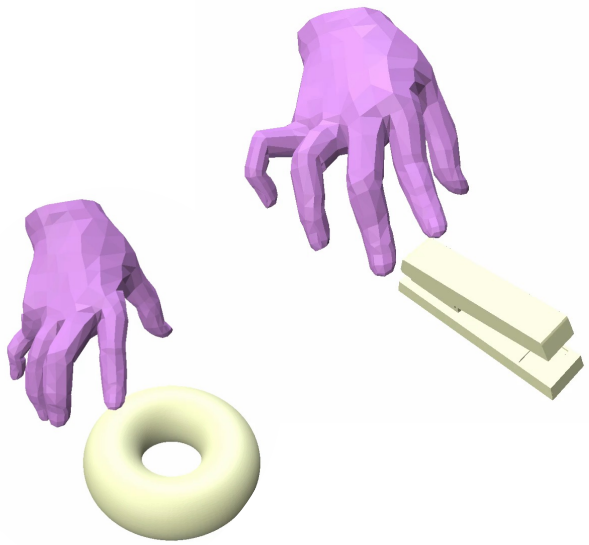


Ours



Rolling Hands!

GRAB Training Set



noise ~ Gaussian Distribution

Synthetic Noise

Train

Denoising Model

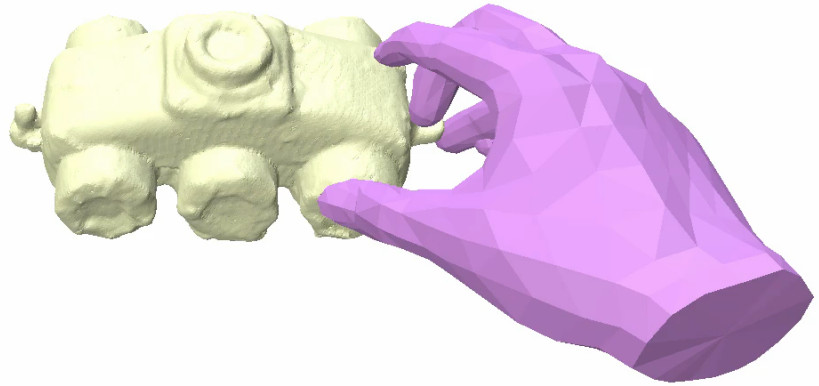
Generalize

HOI4D Dataset

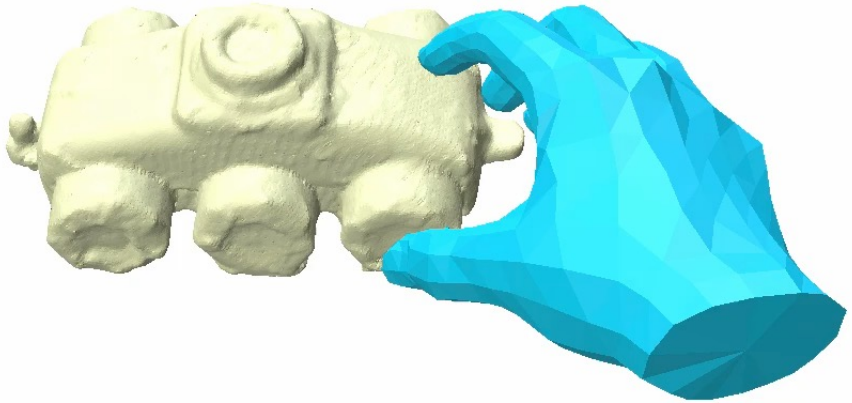
Unseen Objects

Novel Interactions

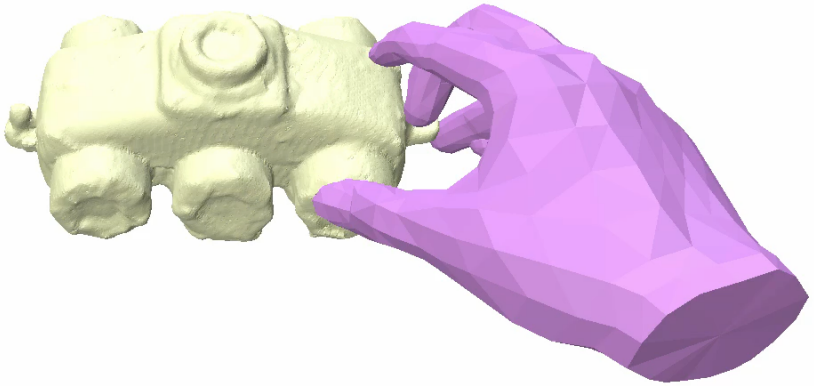
Novel noise from real noisy datasets



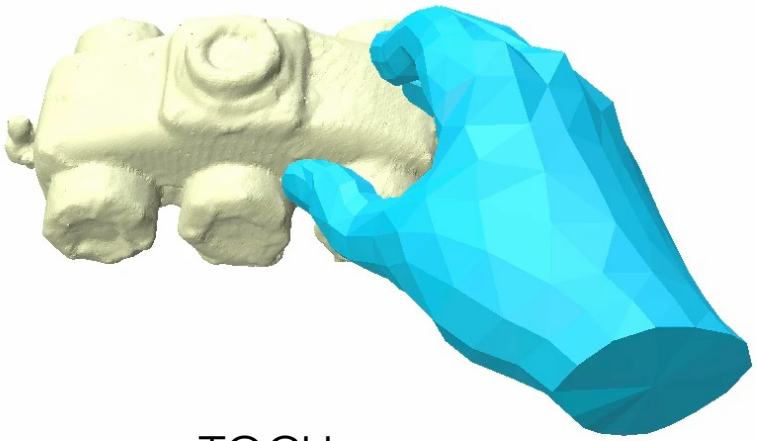
Noisy Input



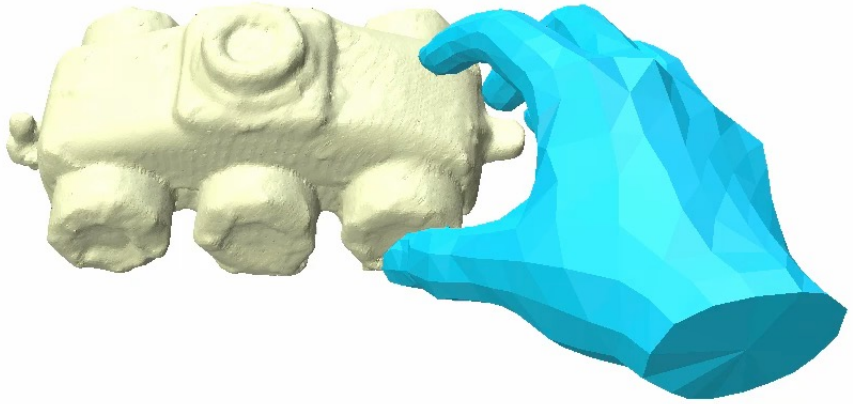
Denoised



Noisy Input

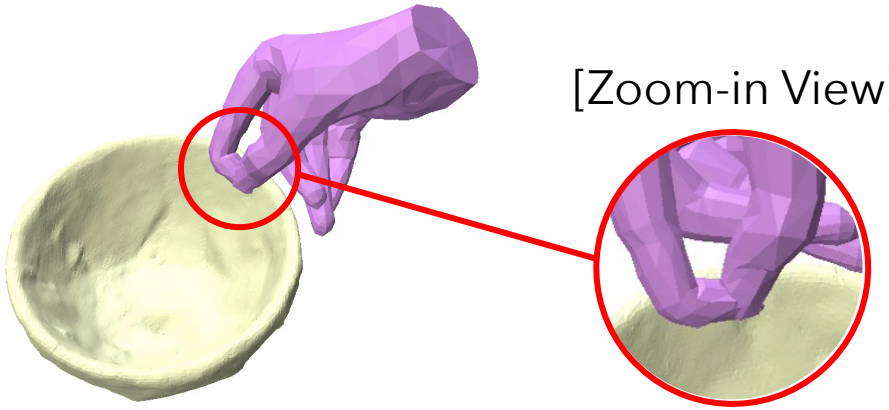


TOCH



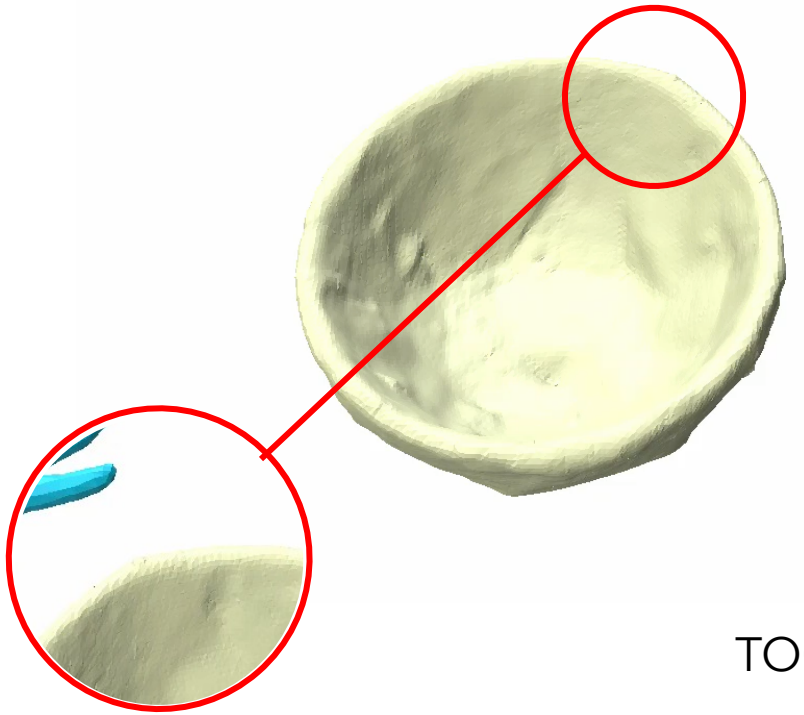
Ours

Challenging Geometry (Thin shells)



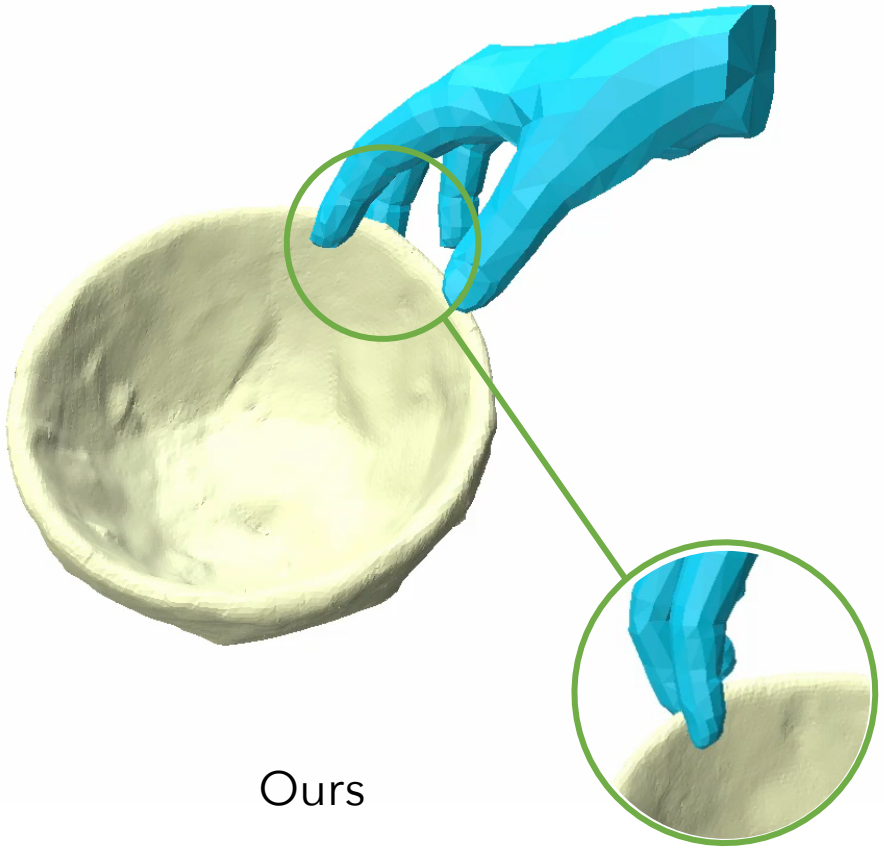
[Zoom-in View]

Noisy Input



TOCH

[Zoom-in View]

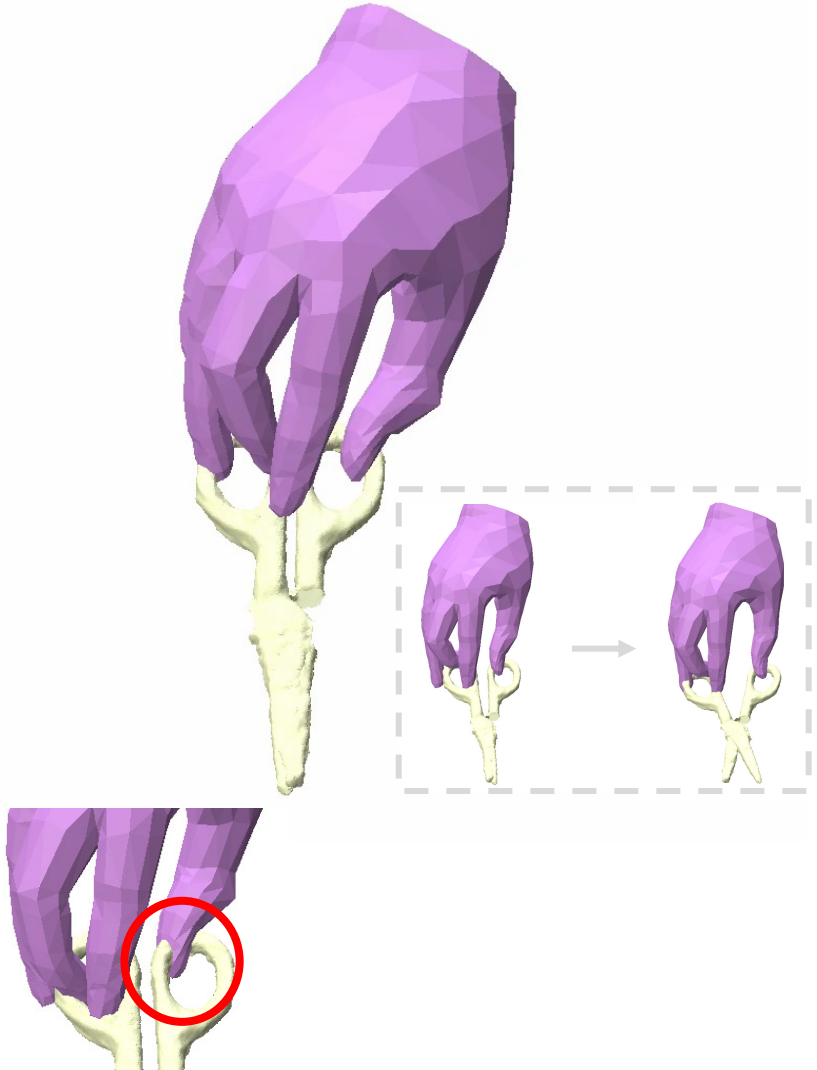


Ours

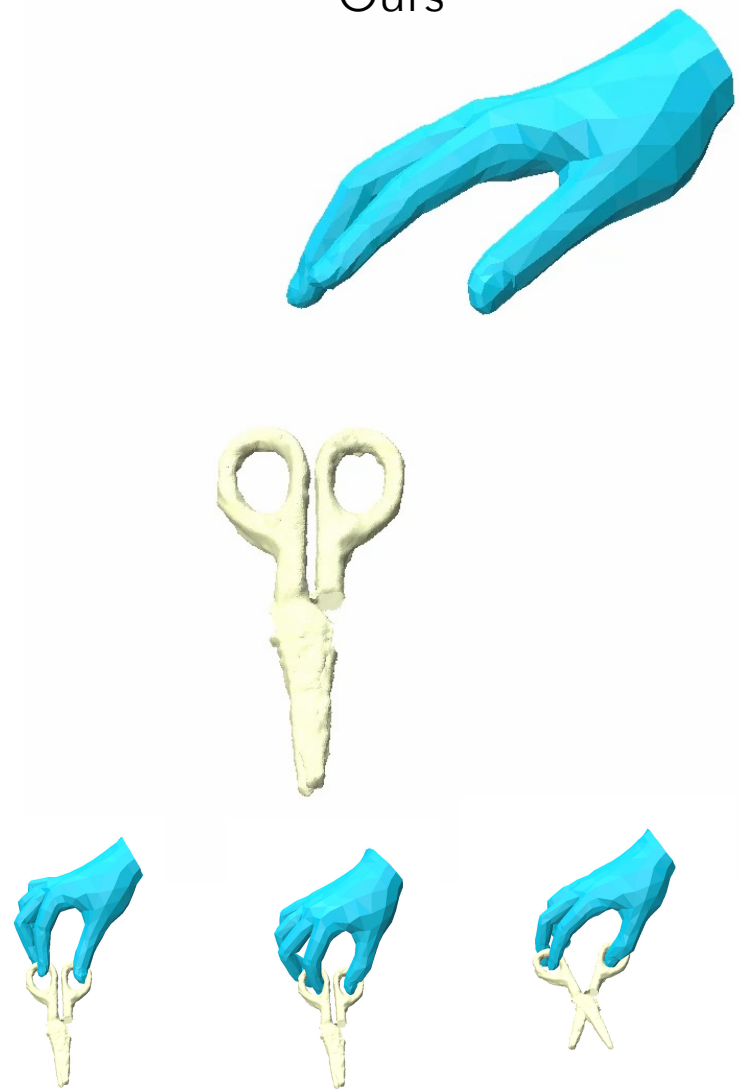
[Zoom-in View]

1. Challenging Geometry (Rings)
2. Articulation Variation

Noisy Input



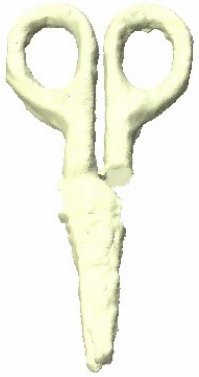
Ours



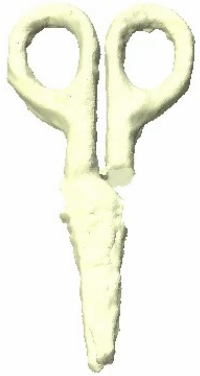
1. Challenging Geometry (Rings)
2. Articulation Variation

Noisy Input

TOCH

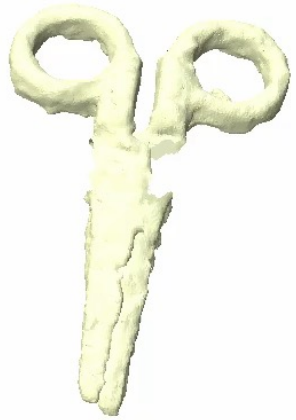


Ours



1. Challenging Geometry (Rings)
2. Articulation Variation

Noisy Input

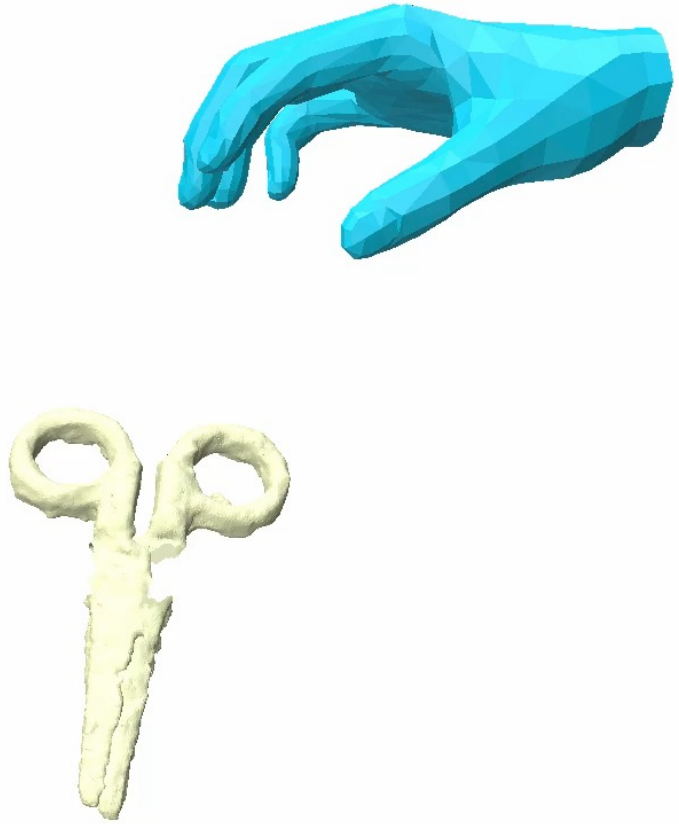


Ours

1. Challenging Geometry (Rings)
2. Articulation Variation

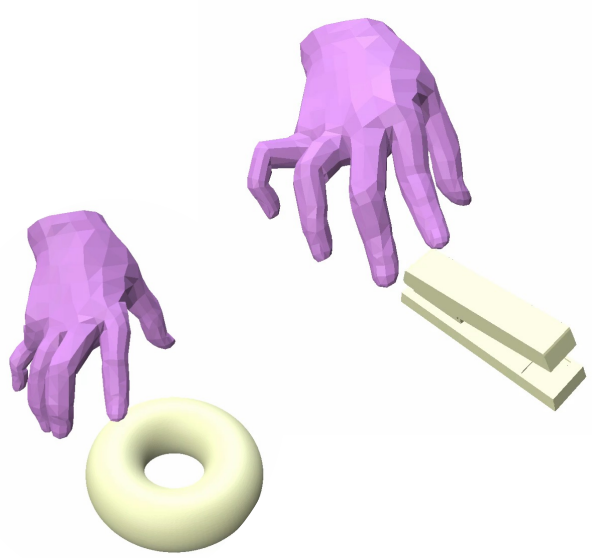
Noisy Input

TOCH



Ours

GRAB Training Set

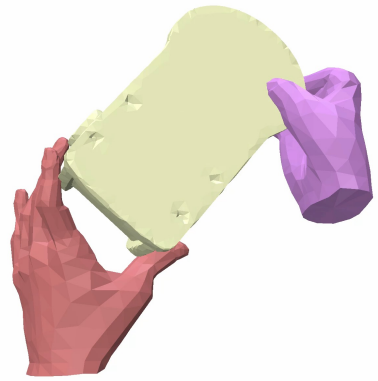


Train

Denoising Model

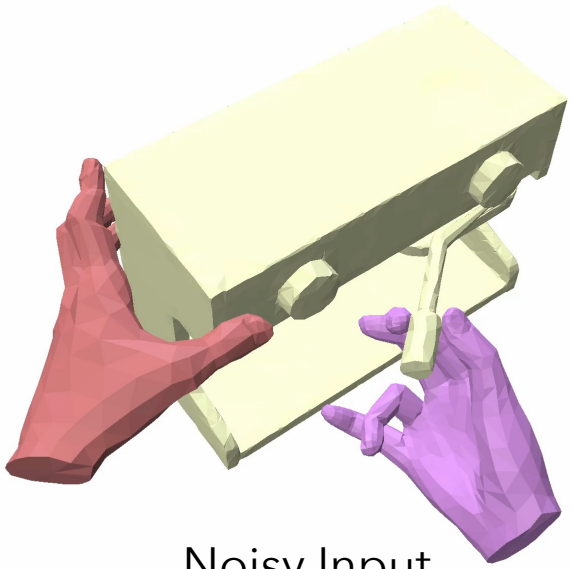
Generalize

ARCTIC Dataset

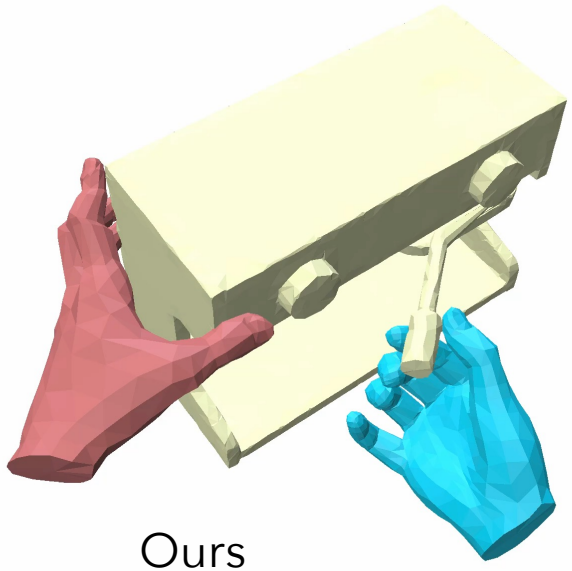


noise ~ a Gaussian Distribution

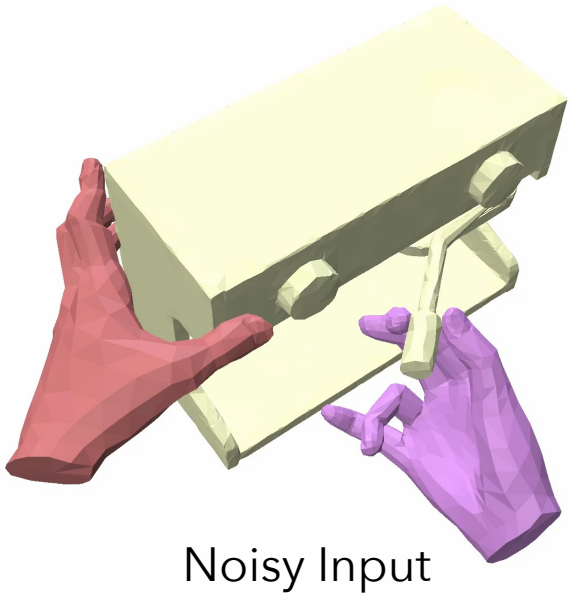
Unseen Objects
Novel Interactions
Dynamic Motions with Changing Contacts



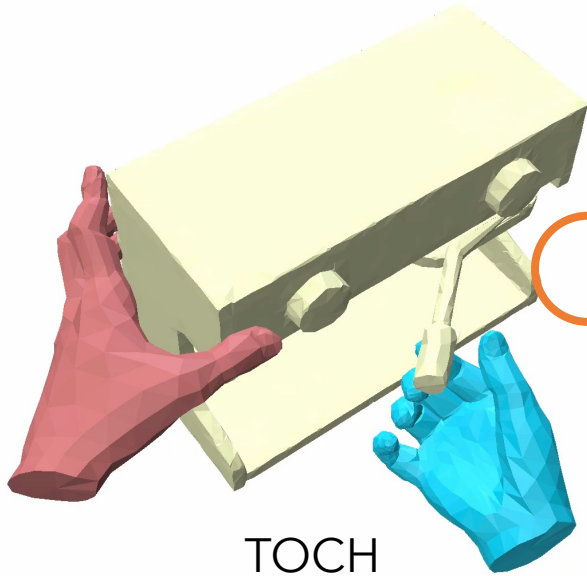
Noisy Input



Ours

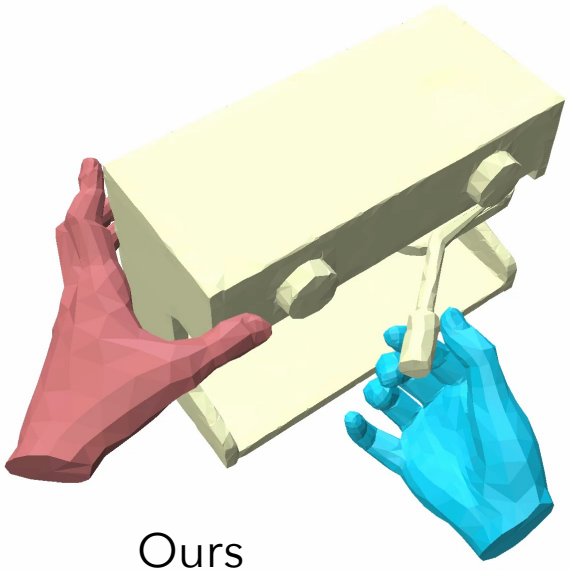


Noisy Input

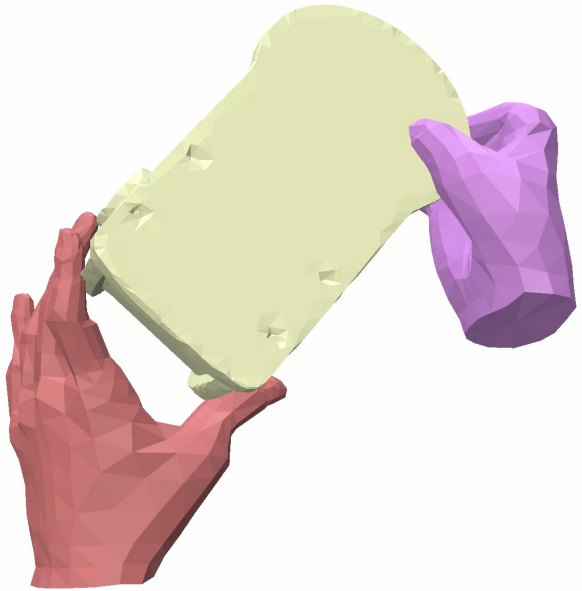


TOCH

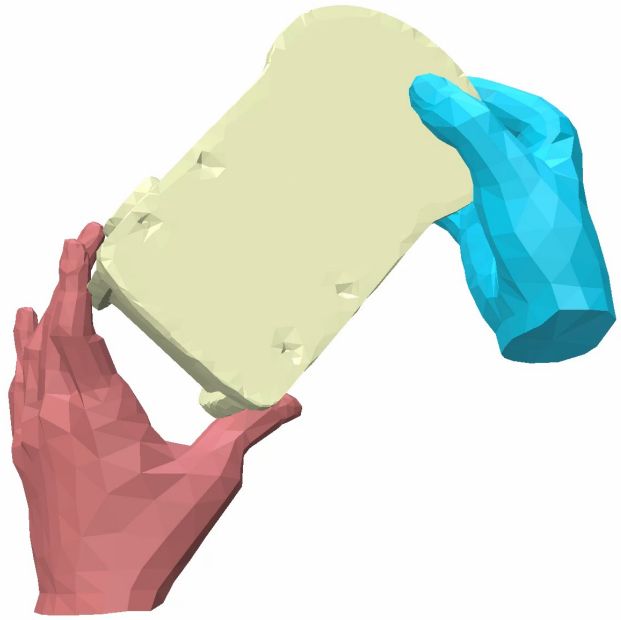
Missing Contacts



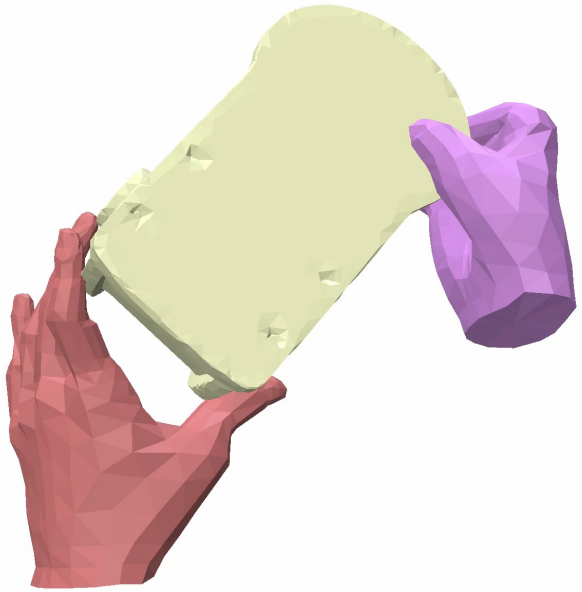
Ours



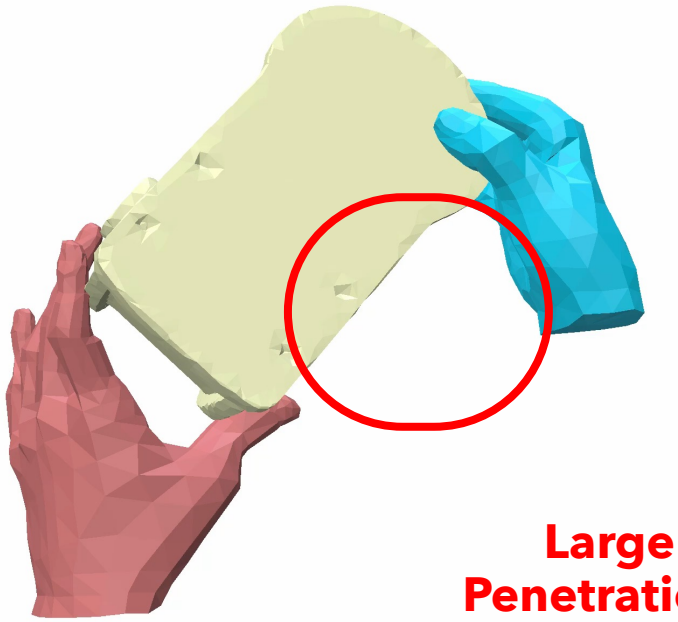
Noisy Input



Ours

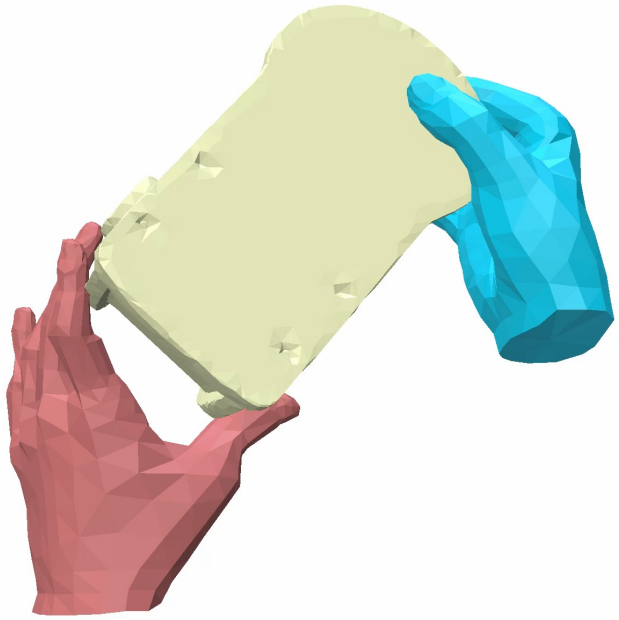


Noisy Input



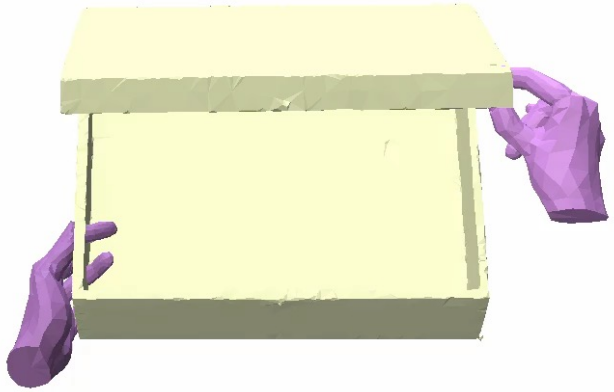
Large Penetrations

TOCH



Ours

Long sequences with bimanual manipulation



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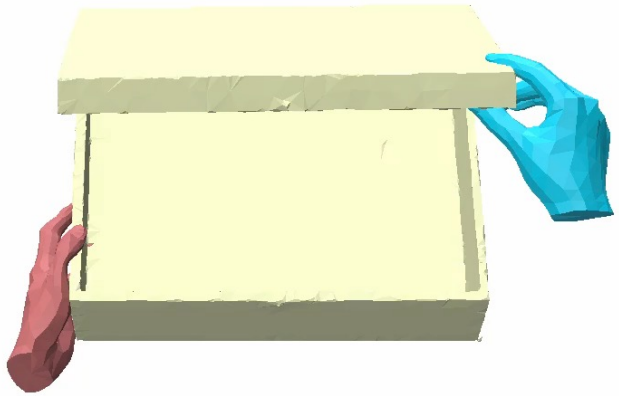
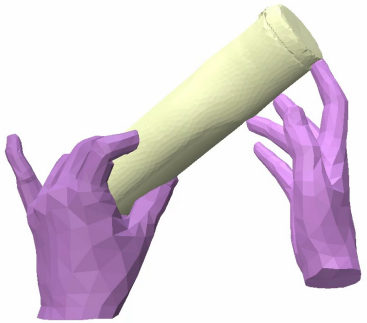
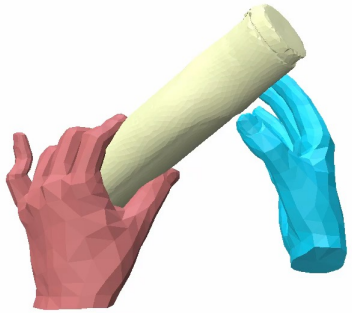


Ours

Long sequences with bimanual manipulation



Noisy Input



Ours

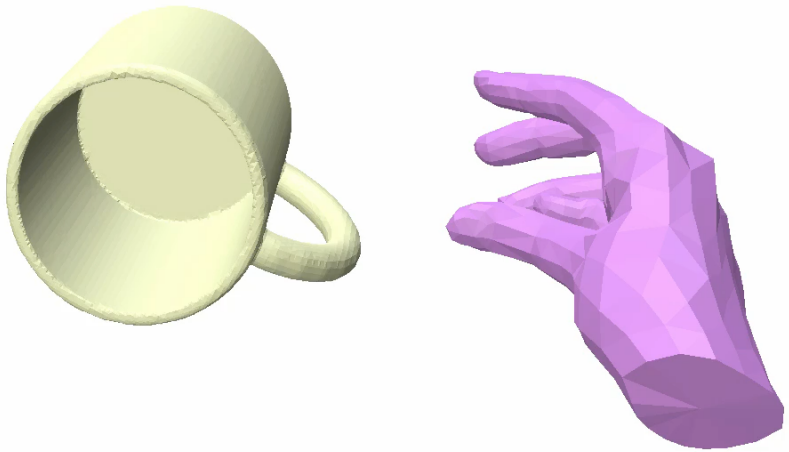
Long sequences with bimanual manipulation

Noisy Input

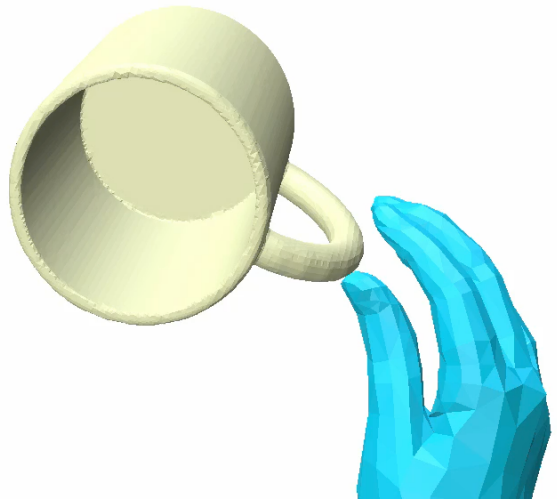
Ours

Stochastic HOI Denoising

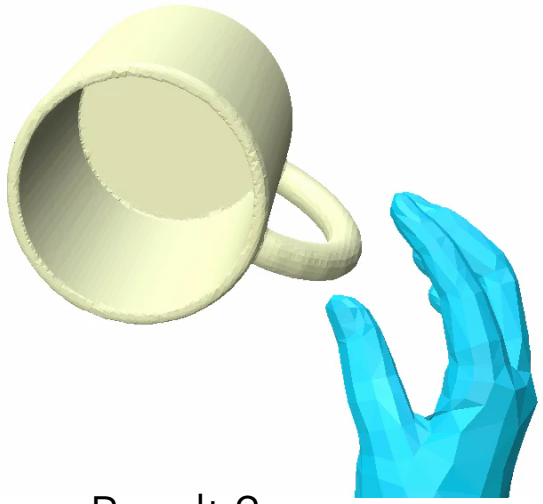
Challenging Geometry (Rings)



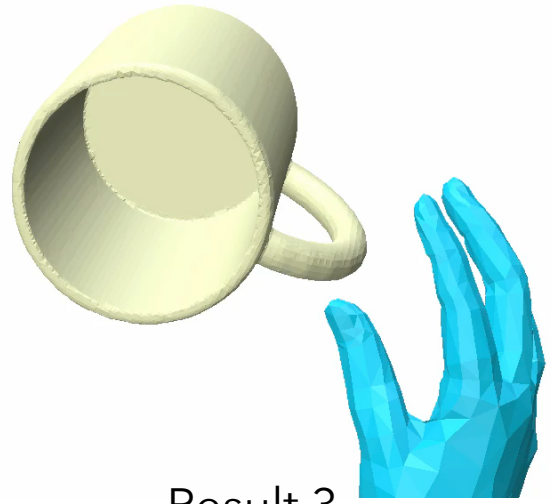
Noisy Input



Result 1

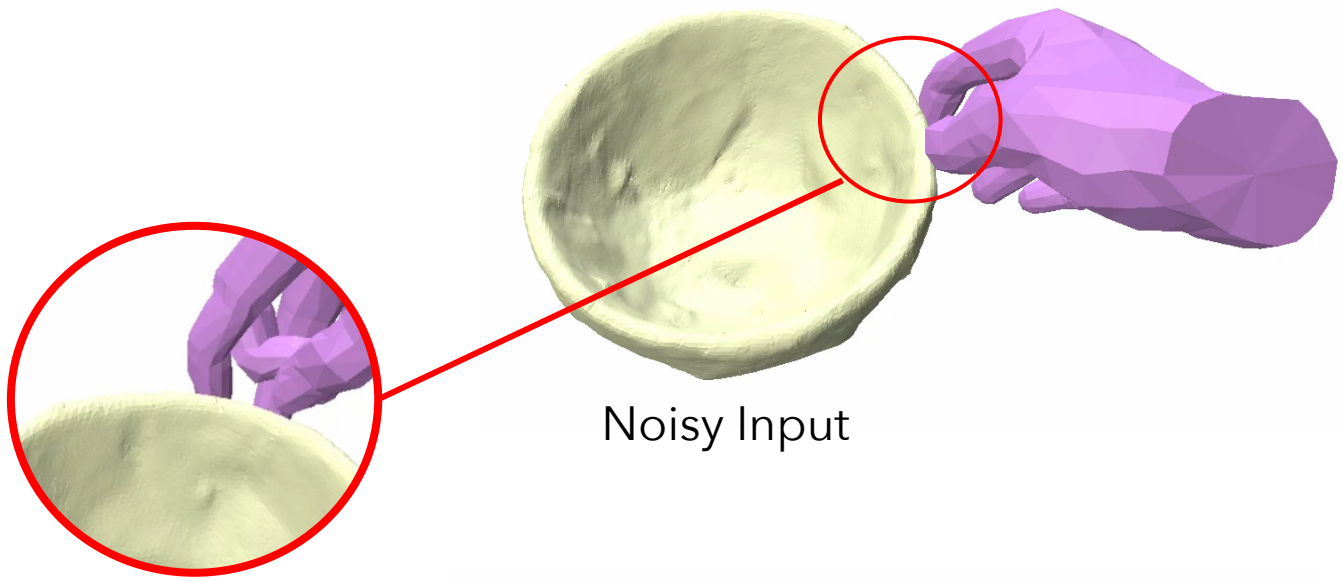


Result 2

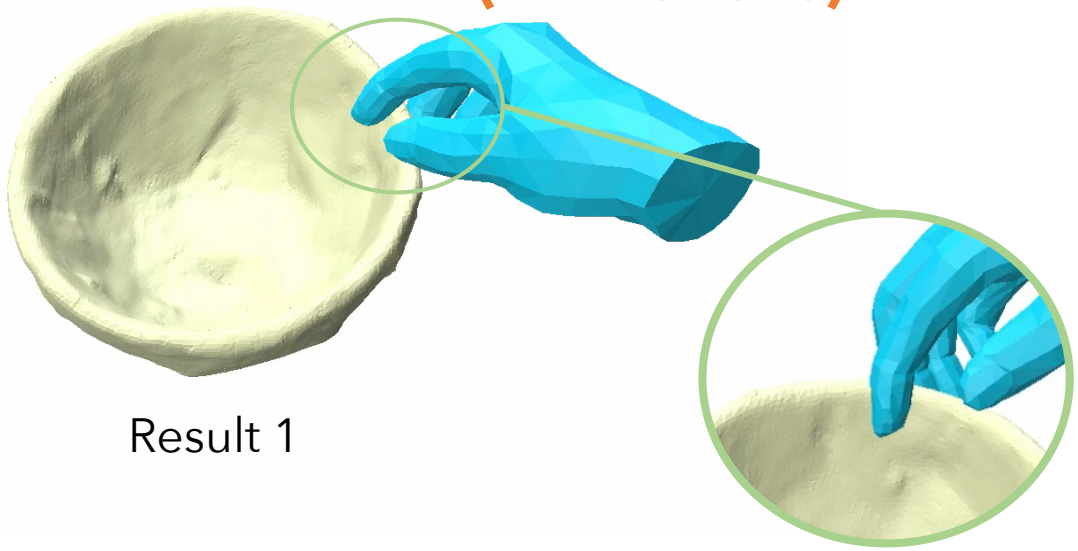


Result 3

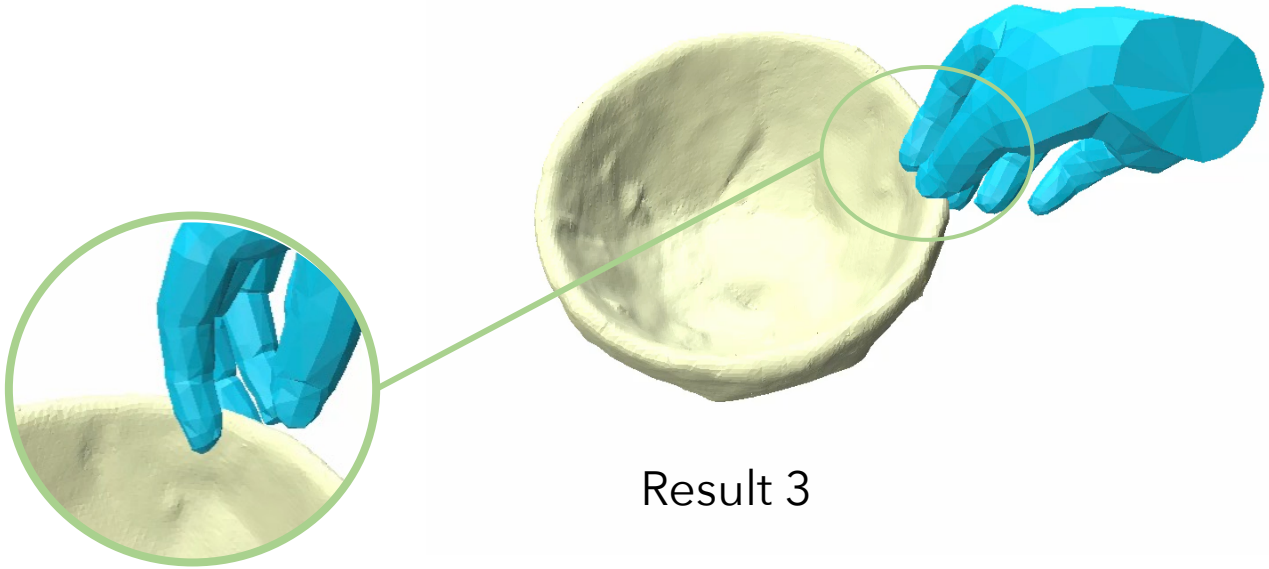
Challenging Geometry (Thin shells)



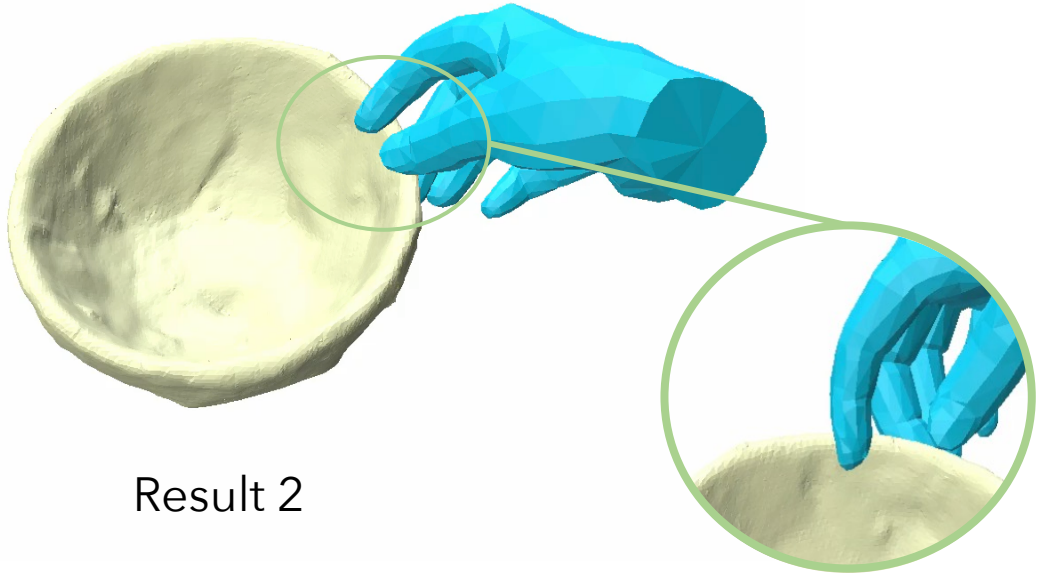
Noisy Input



Result 1



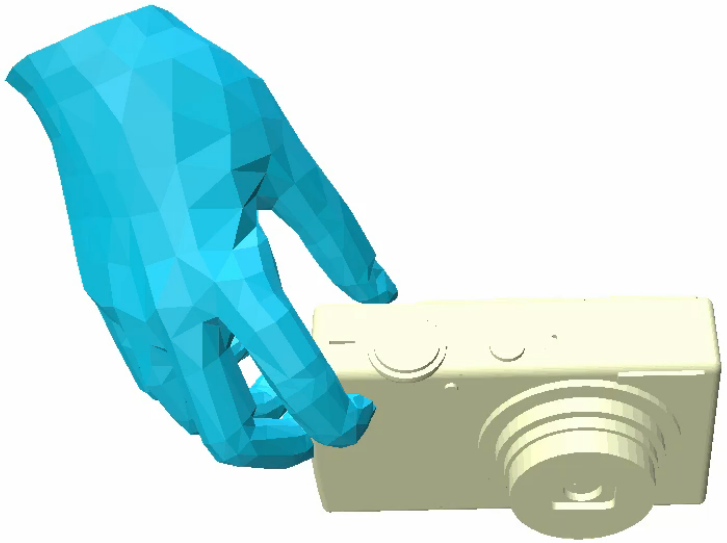
Result 3



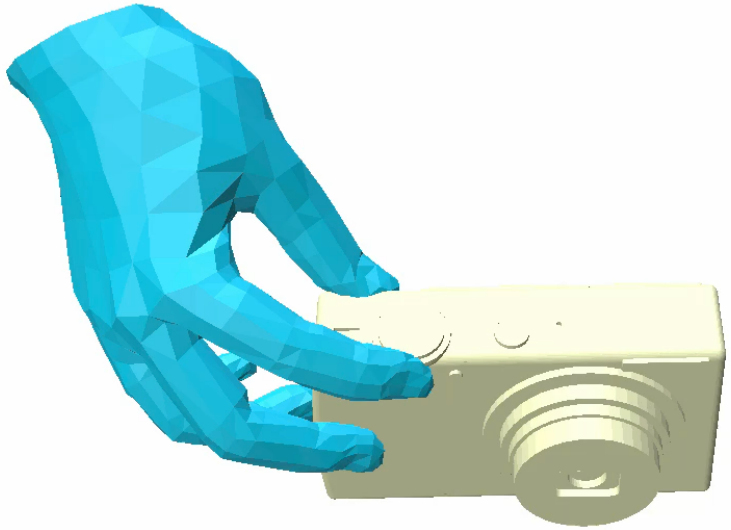
Result 2

[View 1]

Noisy Input

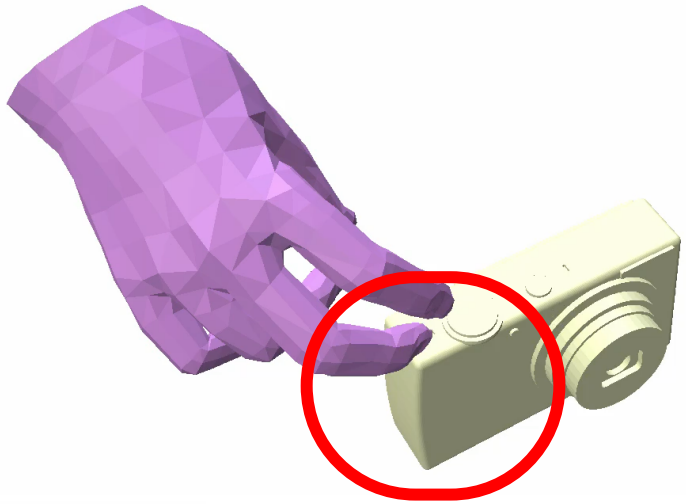


Result 1

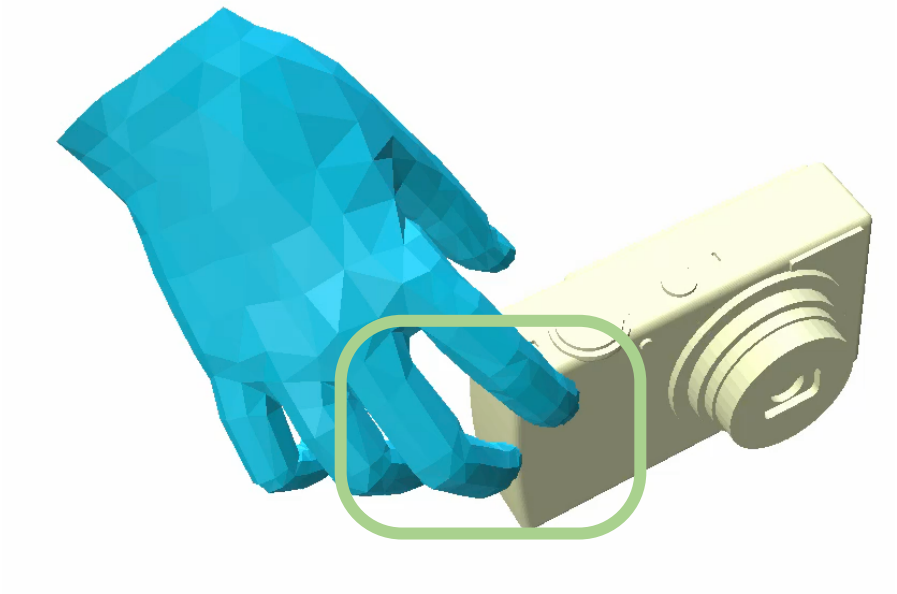


Result 2

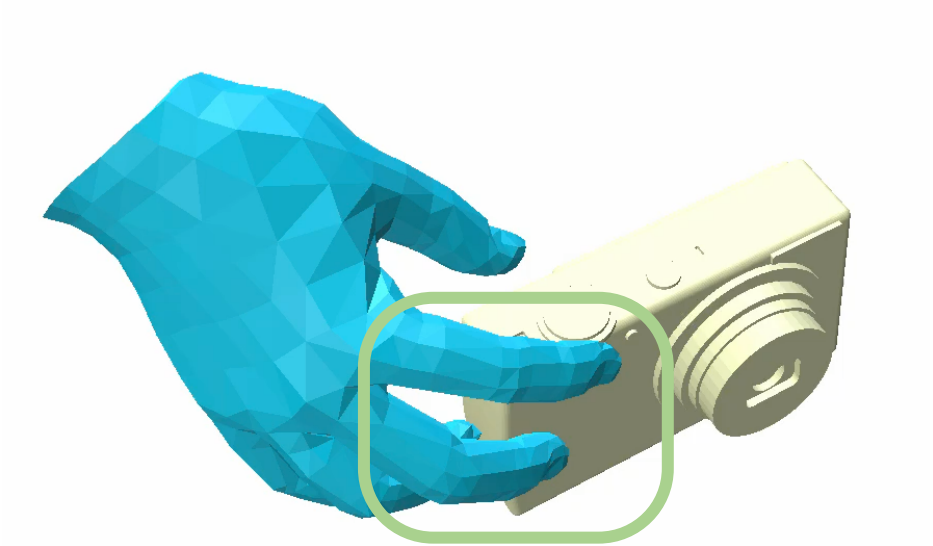
[View 2]



Noisy Input



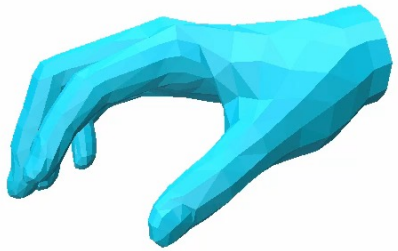
Result 1

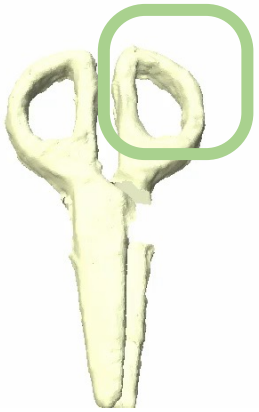


Result 2

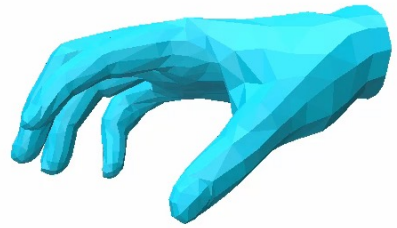
Challenging Geometry (Rings)

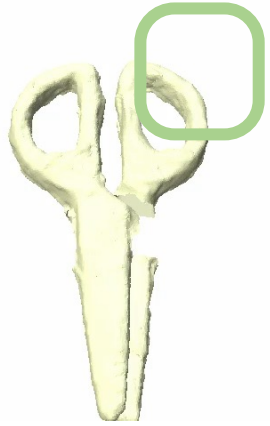
Noisy Input





Result 1

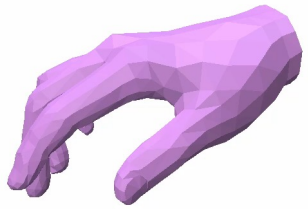


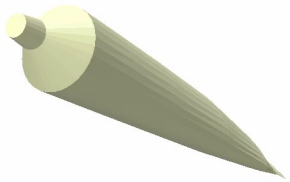


Result 2

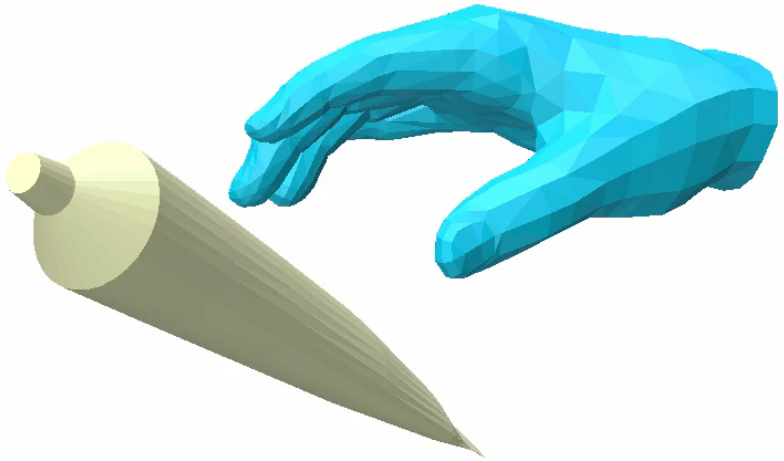
Ablation Studies

In-Hand Manipulation

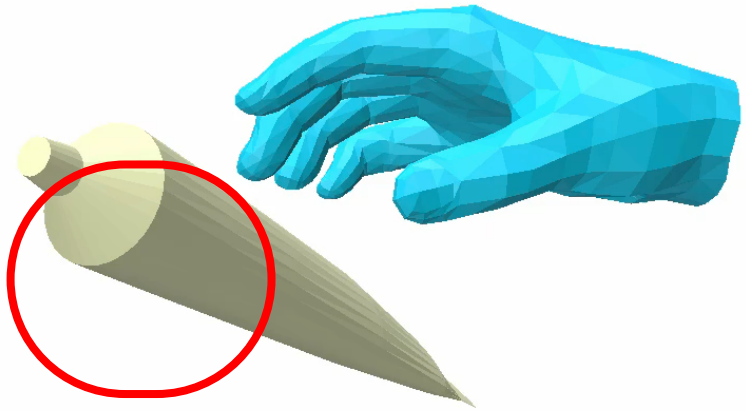




Noisy Input

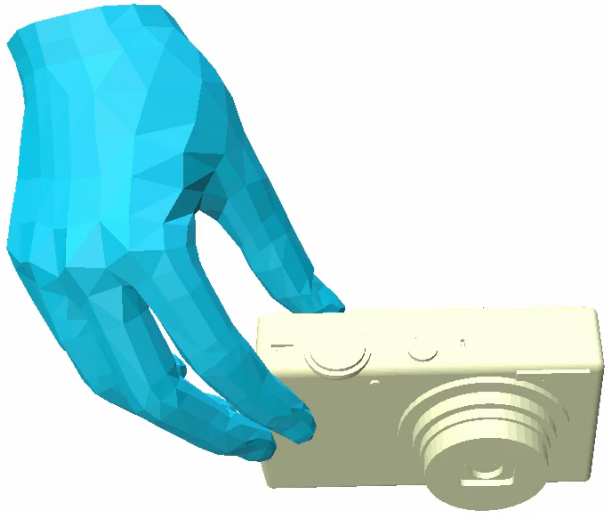


Ours

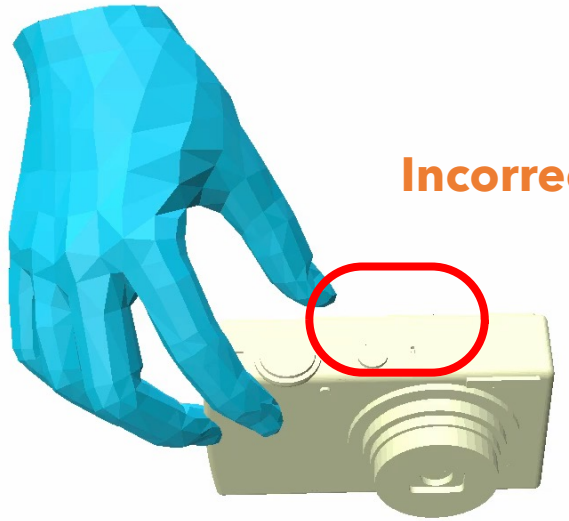


Ours w/o Interaction Region-Centric Canonicalization

Noisy Input



Ours



Incorrect Contacts

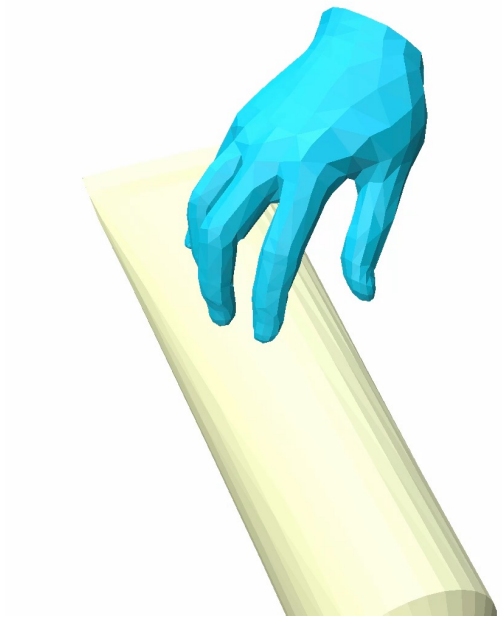
Ours w/o Denoising via Diffusion

Application 1: Motion Retargeting

Source Motion

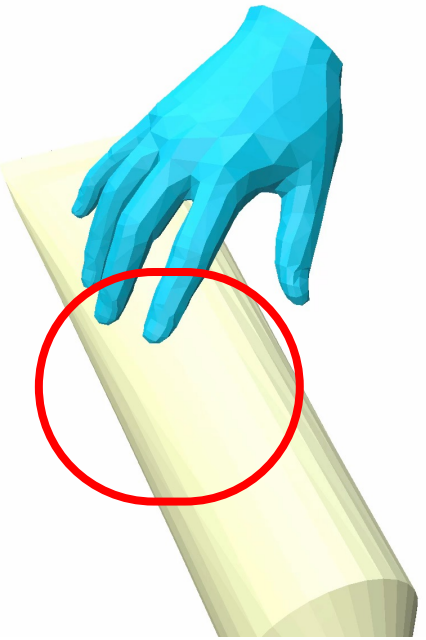
Scale the object up by 2x

w/o Denoising



Ours

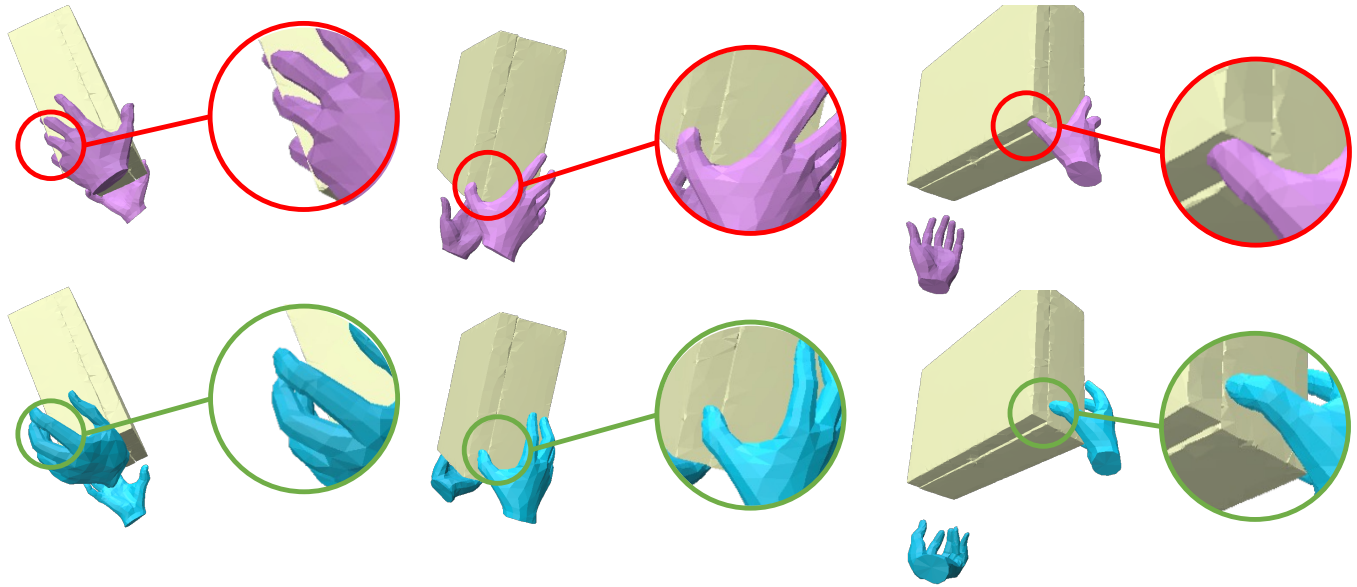
TOCH



Application 2: Cleaning Motion Estimations

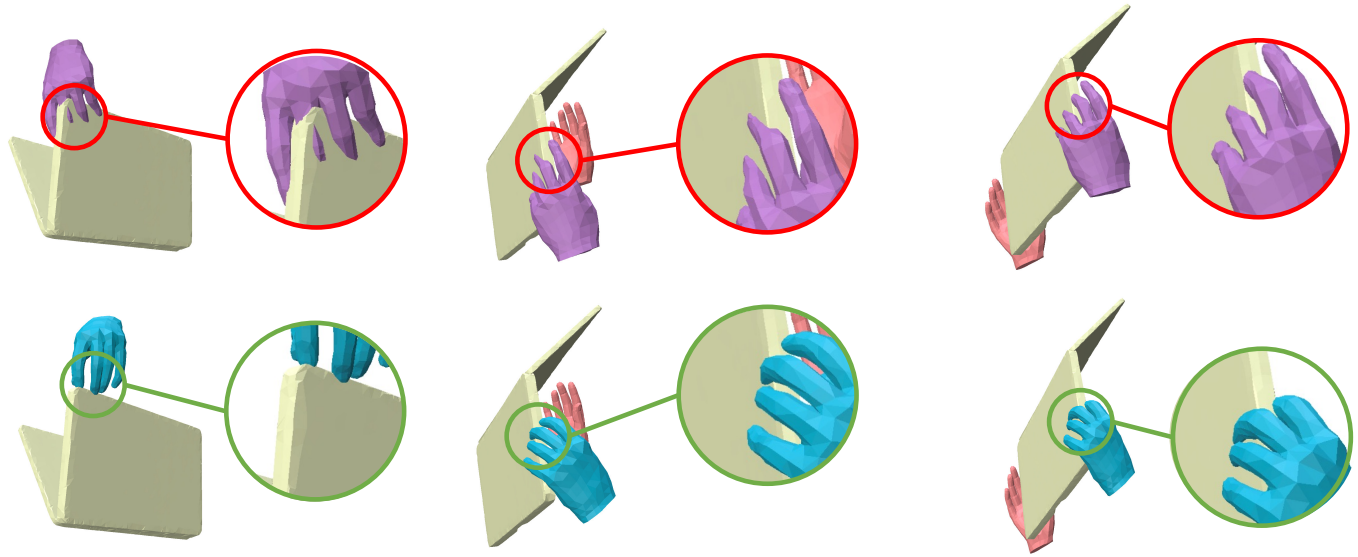
ArcticNet-LSTM

Ours-Denoised



ArcticNet-LSTM

Ours-Denoised



GeneOH Diffusion

Towards Generalizable Hand-Object Interaction Denoising via Denoising Diffusion

Thanks you!