

Stereo Hand-Object Reconstruction for Human-to-Robot Handover

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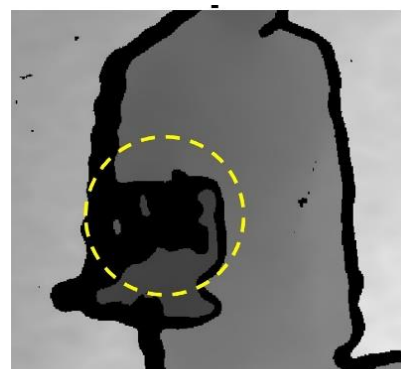


Motivation

Depth based sensing

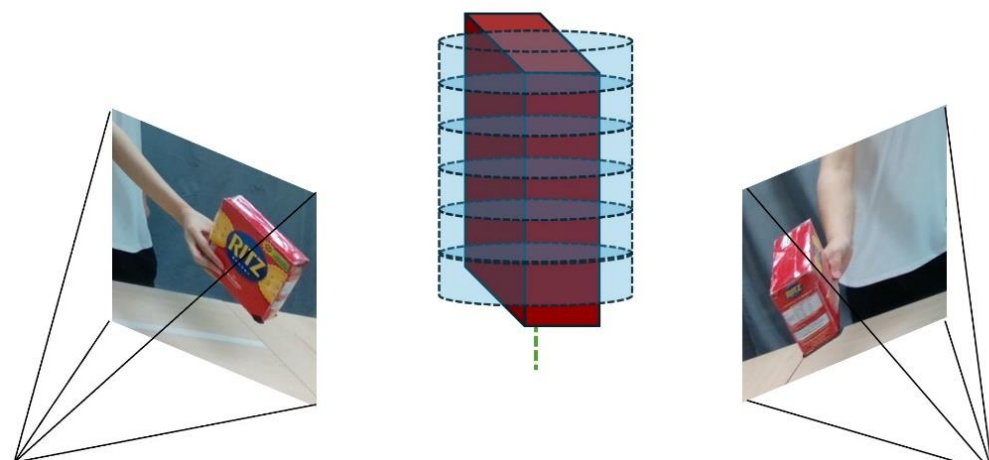
RGB

Depth



Fail to retrieve transparent object shape

Stereo reconstruction w/ cylindrical shape prior



Fail to generalise to non-container objects

Contributions

- Wide baseline stereo hand-object reconstruction
- No depth sensors
- No handcrafted shape priors
- Trained entirely on synthetic hand-object data
- Integrated into a human-to-robot handover pipeline

Objects for training/testing

Training with synthetic objects (ObMan)



Objects for testing hand-object reconstruction (DexYCB)

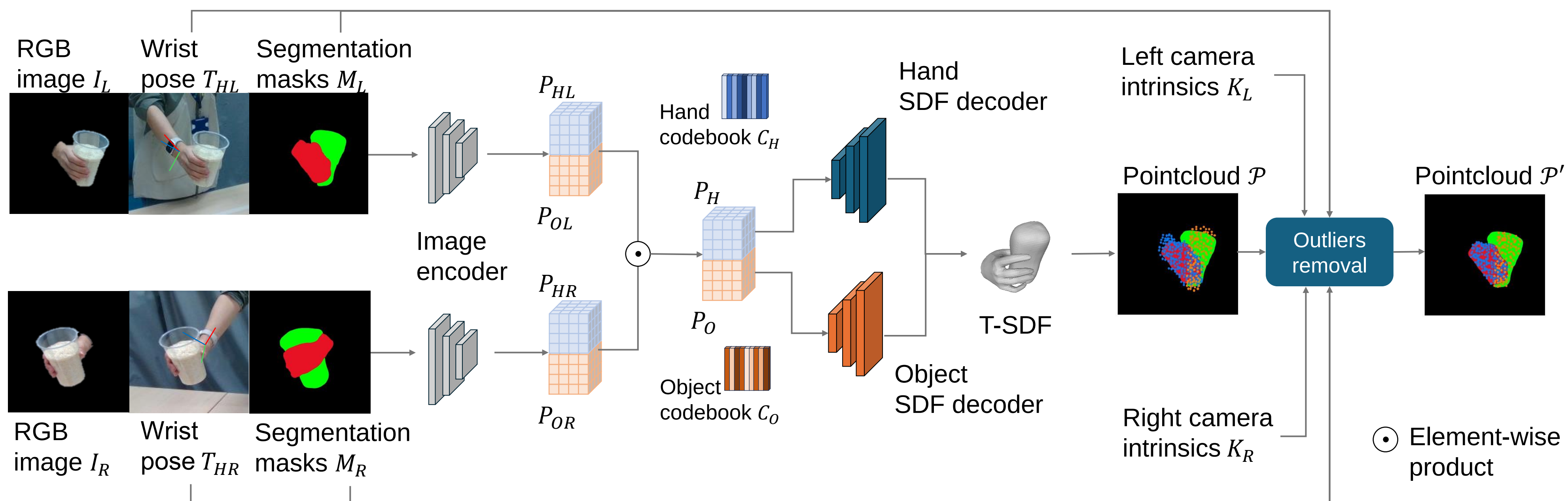


Objects for handovers

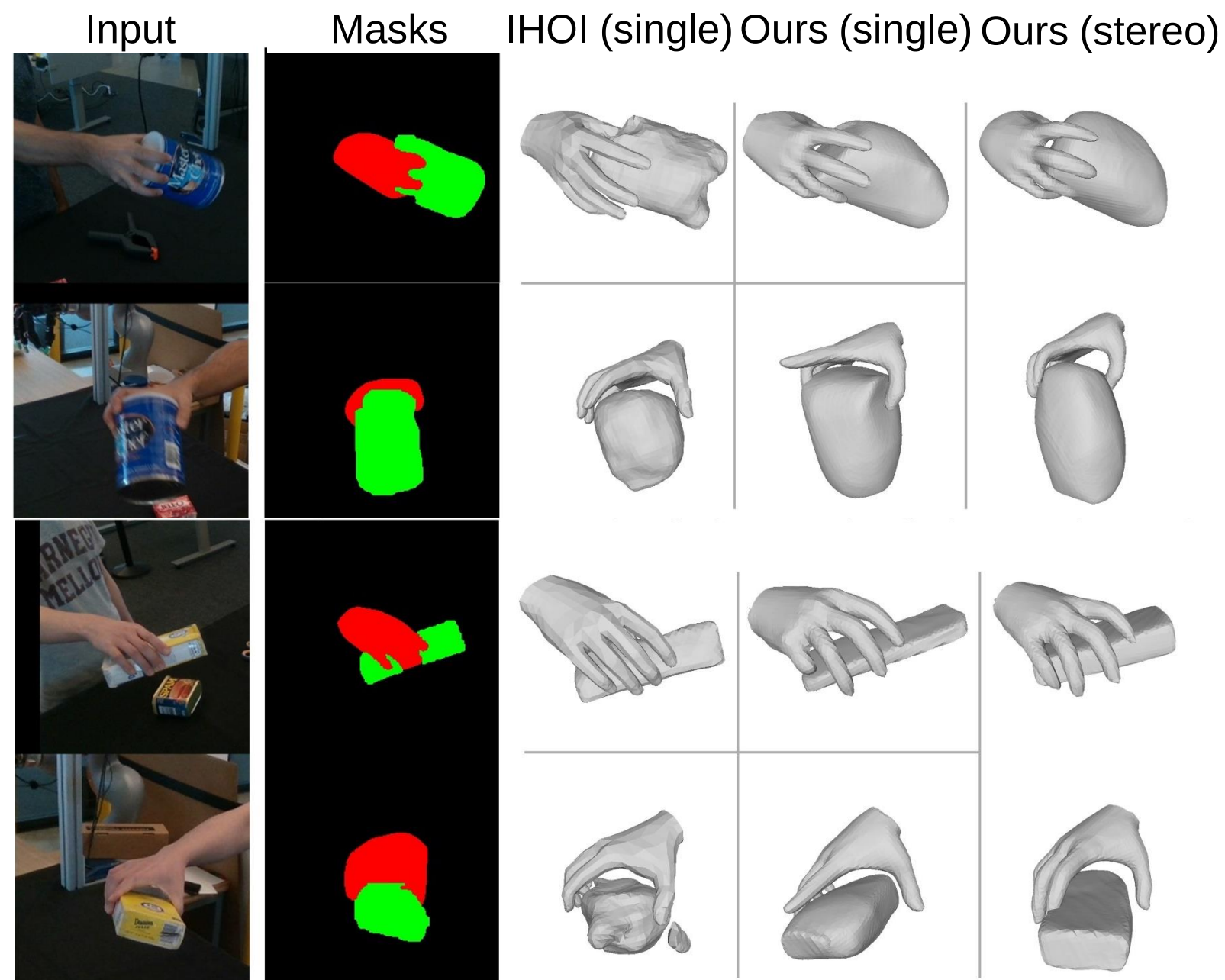


Stereo hand-object reconstruction

- Predict hand and object shapes as a probability distribution over learned codebooks of discrete shape embeddings
- Combine shape predictions from both views as a single coherent reconstruction
- Remove outliers using segmentation masks by reprojecting predicted pointcloud to the image space

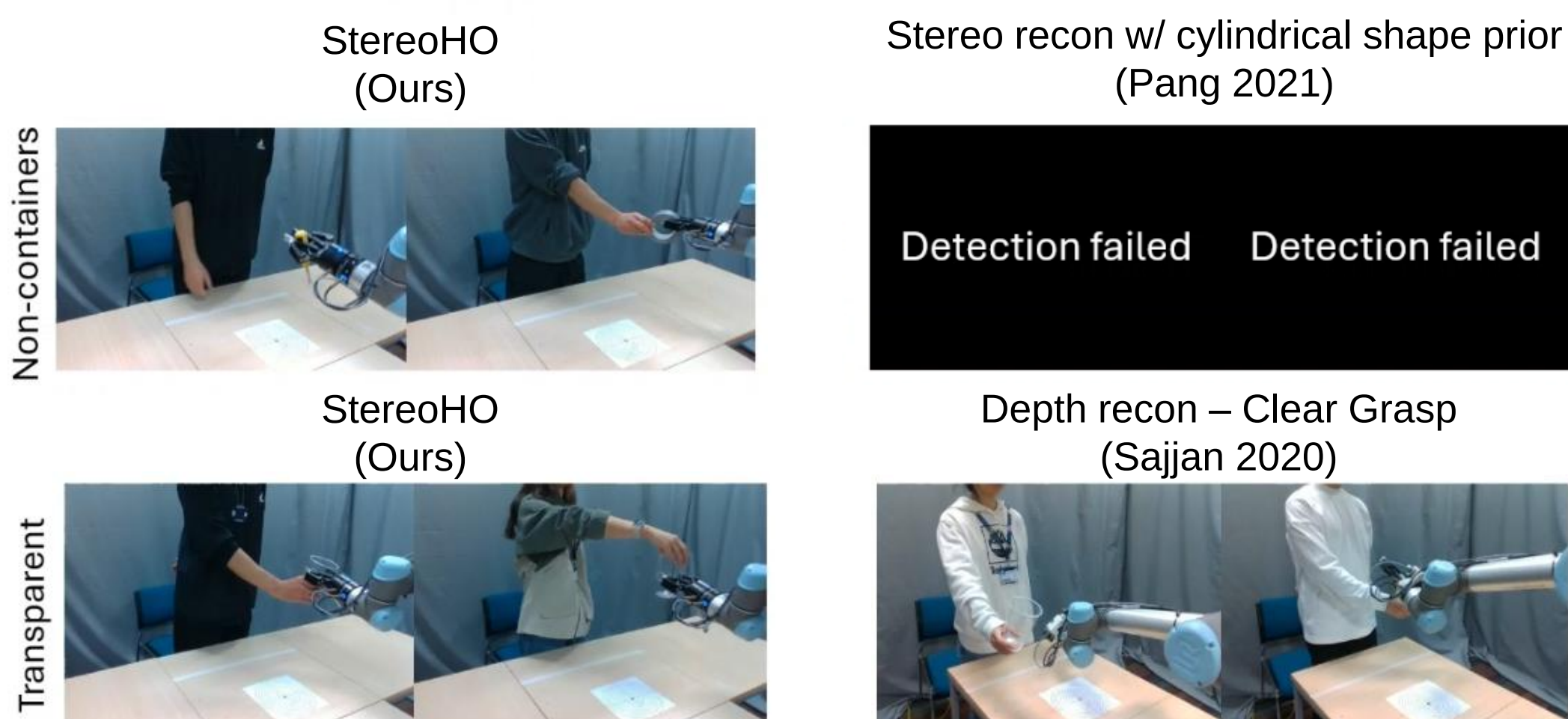


Single-view vs. stereo reconstruction



Handover of household objects and containers

- Previous stereo method cannot detect non-container objects
- Depth-based method fails on transparent objects



References

- [1] Hasson et al., Learning joint reconstruction of hands and manipulated objects. In *CVPR*, 2019
- [2] Chao et al., DexYCB: A benchmark for capturing hand grasping of objects. In *CVPR*, 2021
- [3] Ye et al., What's in your hands? 3D reconstruction of generic objects in hands. In *CVPR*, 2022
- [4] Pang et al., Towards safe human-to-robot handovers of unknown containers. In *RO-MAN*, 2021
- [5] Sajjan et al., Clear grasp: 3D shape estimation of transparent objects for manipulation. In *ICRA*, 2022

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