Universität Hamburg
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MIN Faculty
Department of Informatics

Fusion++
Volumetric Object-Level SLAM

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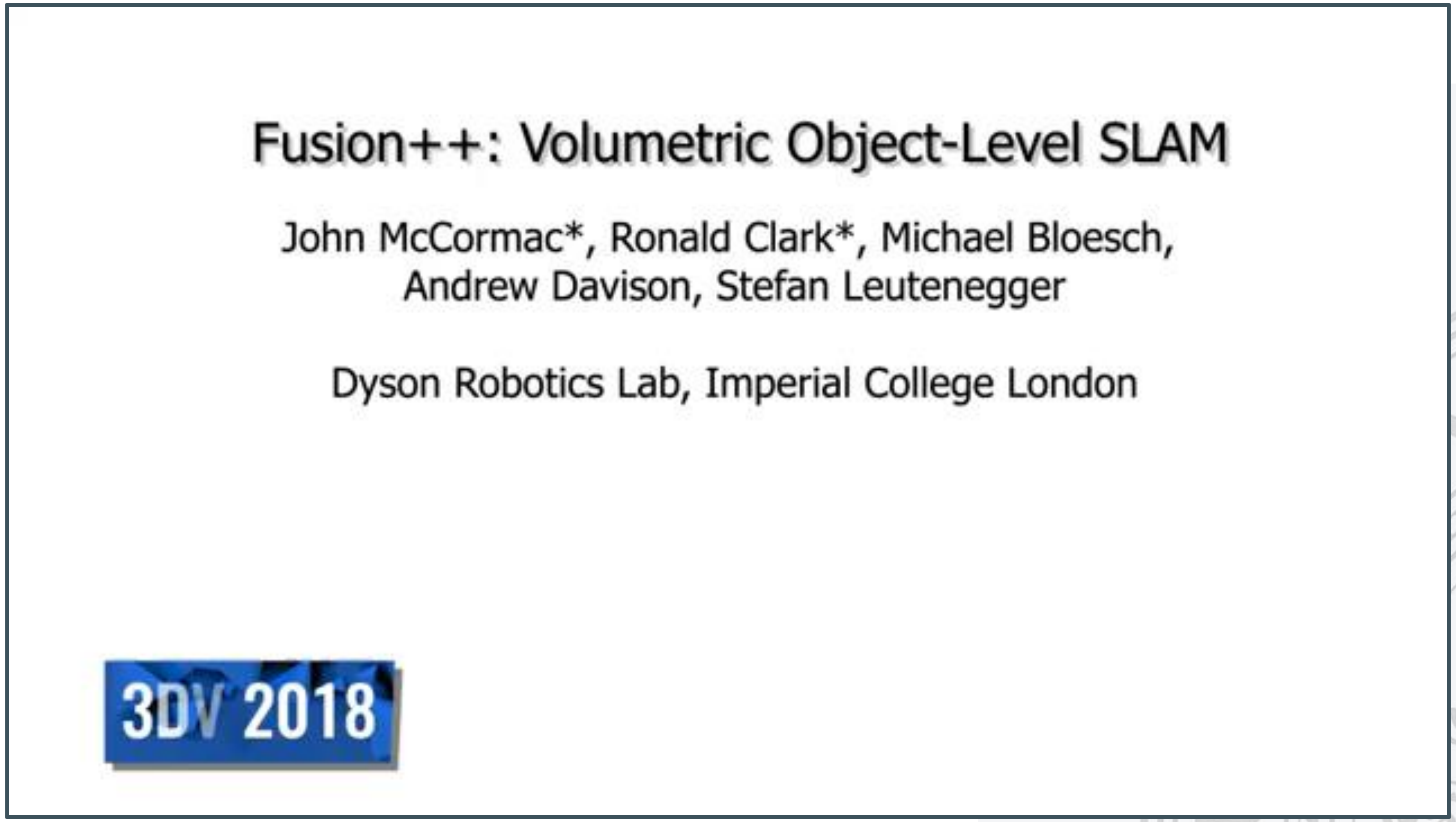
Technical Aspects of Multimodal Systems

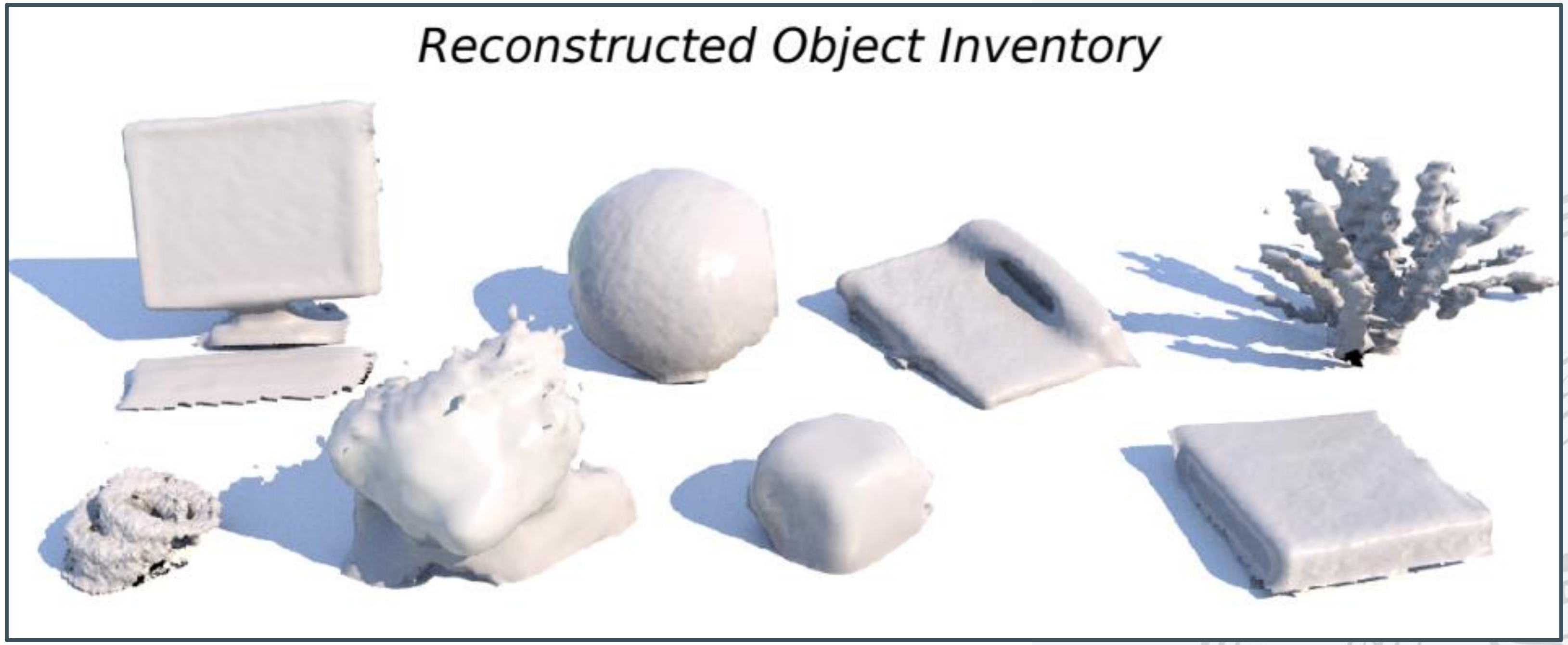
25.06.2020

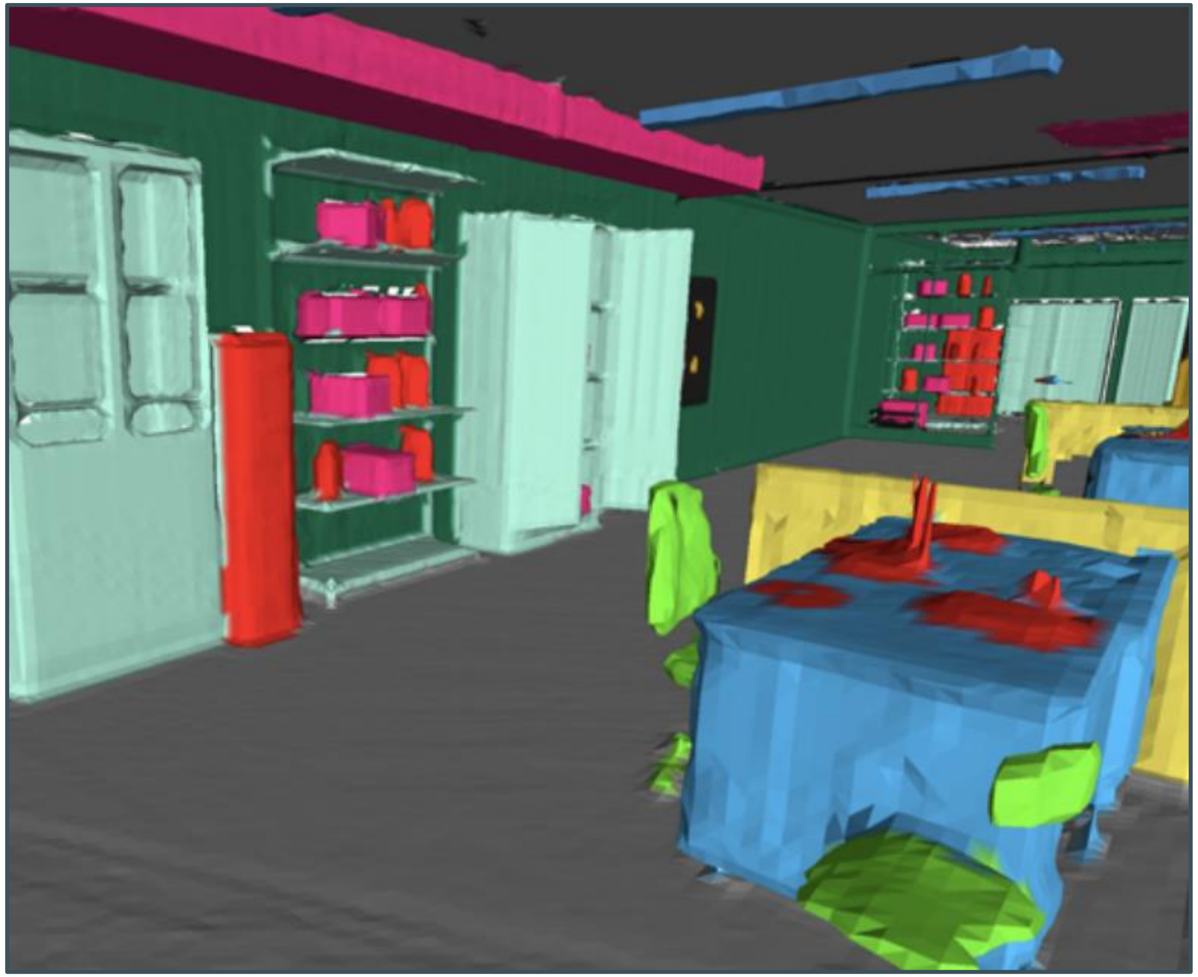
Intro



https://www.youtube.com/watch?v=2luKNC03x4k

Fusion++





Kimera

Fusion++

Kimera:

One dense mesh

Pixel to object label

Navigation, Obstacle avoidance

Fusion ++:

Seperate object instances

Object-centric map

Communication, Interaction

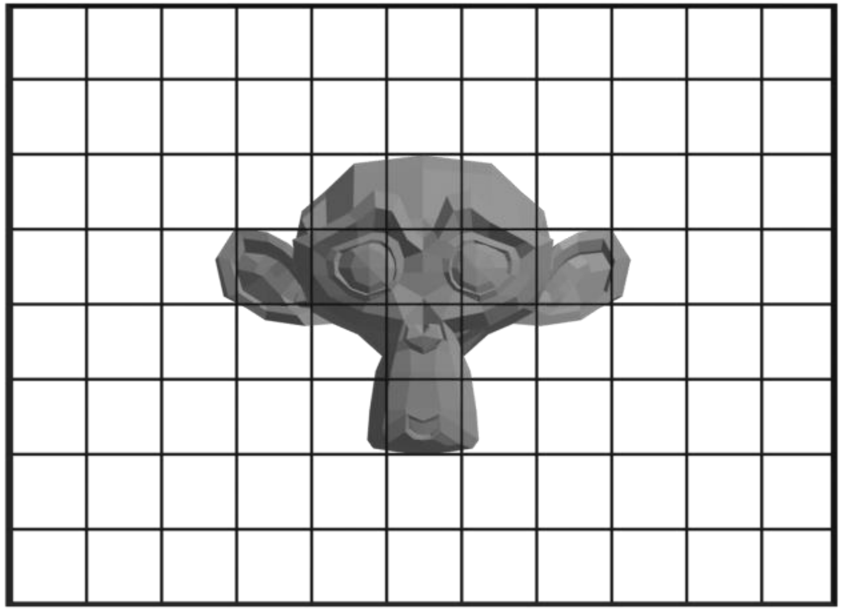
TSDF

Raycasting

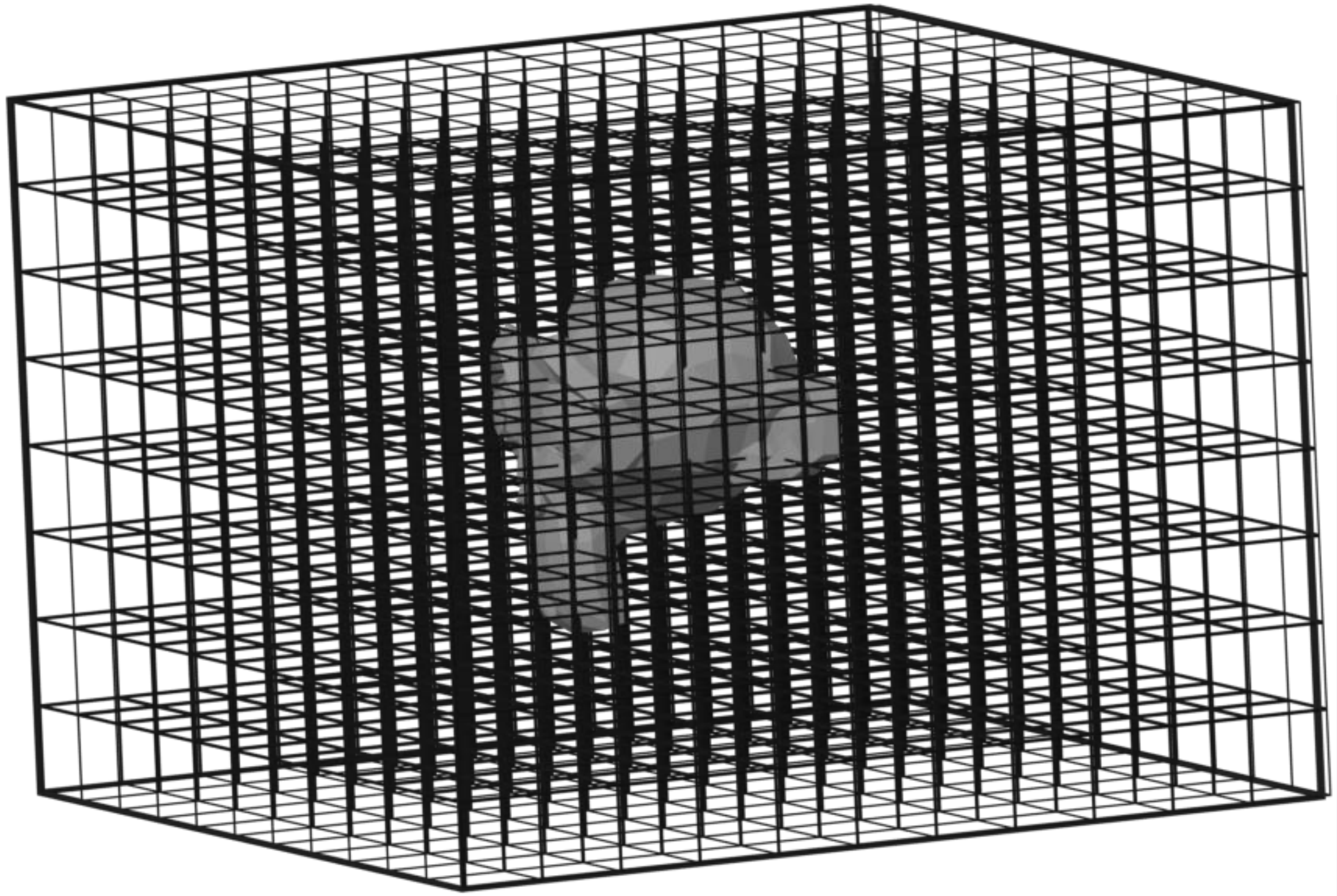
Object detection

TSDF

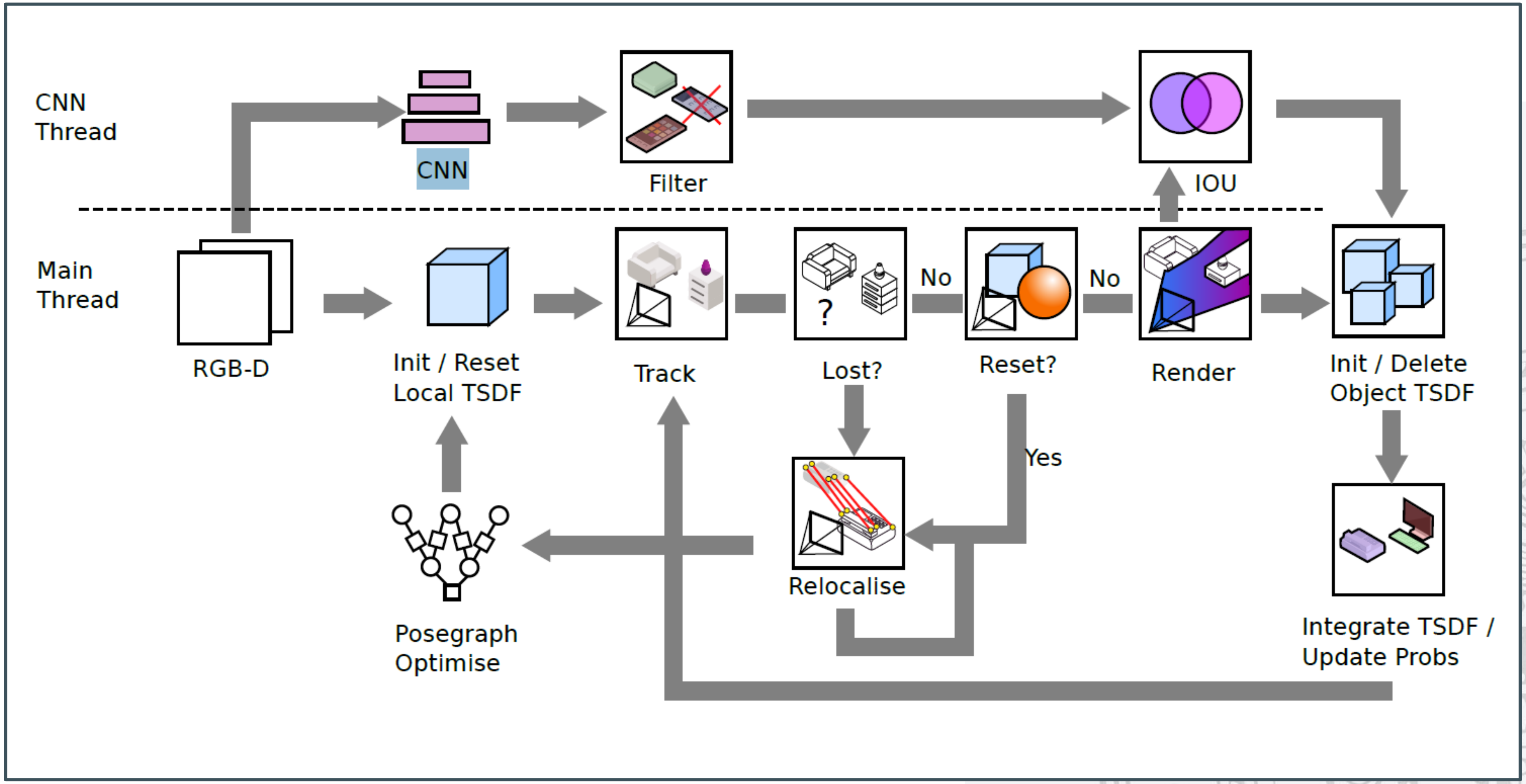
Truncated signed distance function:



TSDF



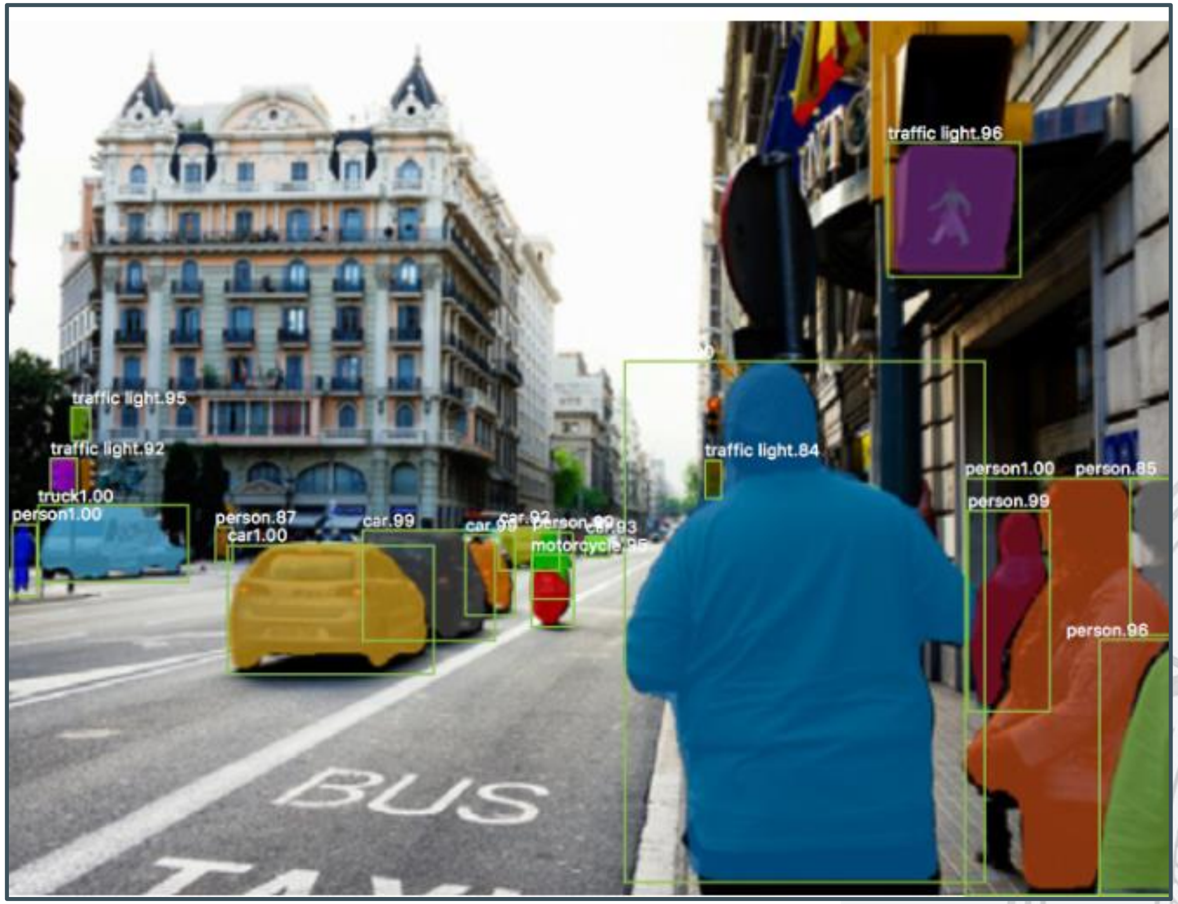
Method


CNN
Thread
CNN
Filter
IOU
Main
Thread
RGB-D
Init / Reset
Local TSDF
Track
Lost?
No
Reset?
No
Render
Init / Delete
Object TSDF
?
Yes
Relocalise
Posegraph
Optimise
Integrate TSDF /
Update Probs

Method

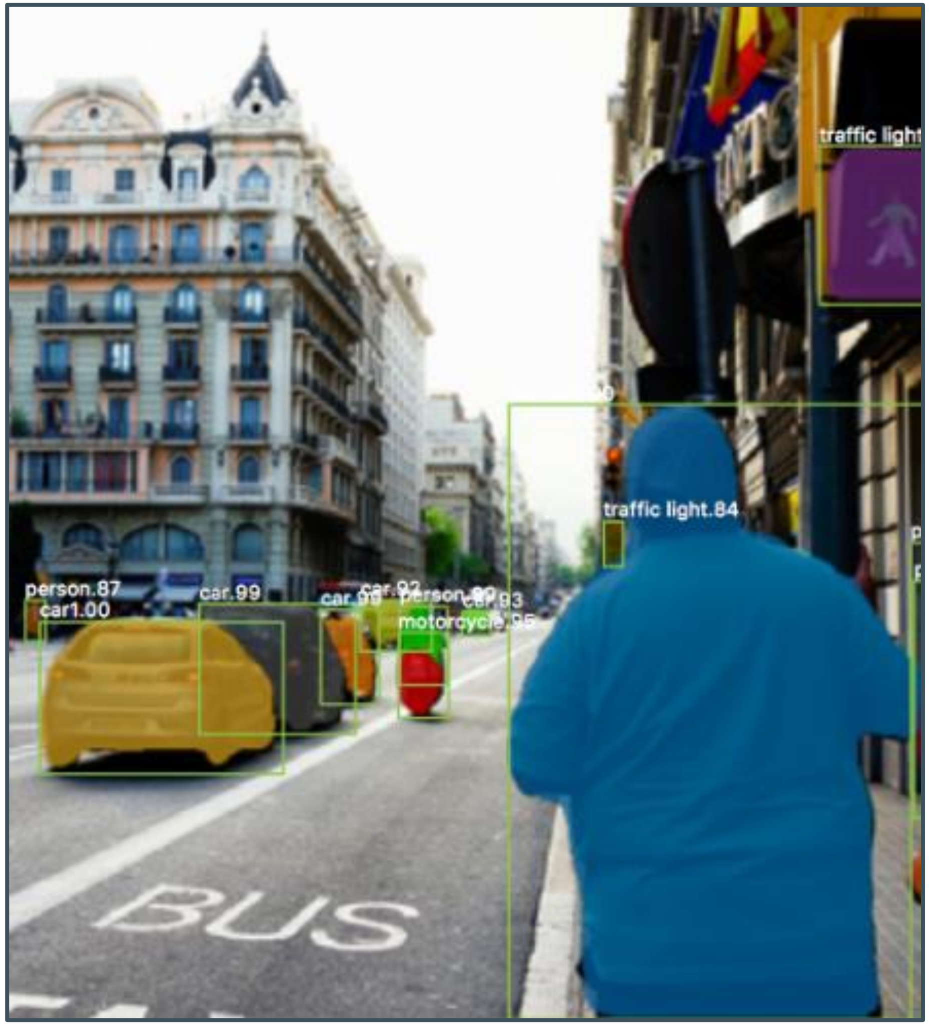
1. Mask-RCNN on a seperate thread
2. Track background
3. Localize camera
4. Initialize new objects
5. Integrate into / update existing objects

Mask-RCNN



HE, Kaiming, et al. Mask r-cnn. In: *Proceedings of the IEEE international conference on computer vision*. 2017. S. 2961-2969.

Mask-RCNN



Mask-RCNN:

- Extension of FASTER-RCNN
- Output exclusive binary masks
- Bottleneck

TSDF Instances

Overlay binary mask into depth map to get a point cloud

Take 10-90 percentile. Create a cube from that edge length.

Sample that cube at 64 steps per edge.

Squirrel 89

Take the [10-90] percentile

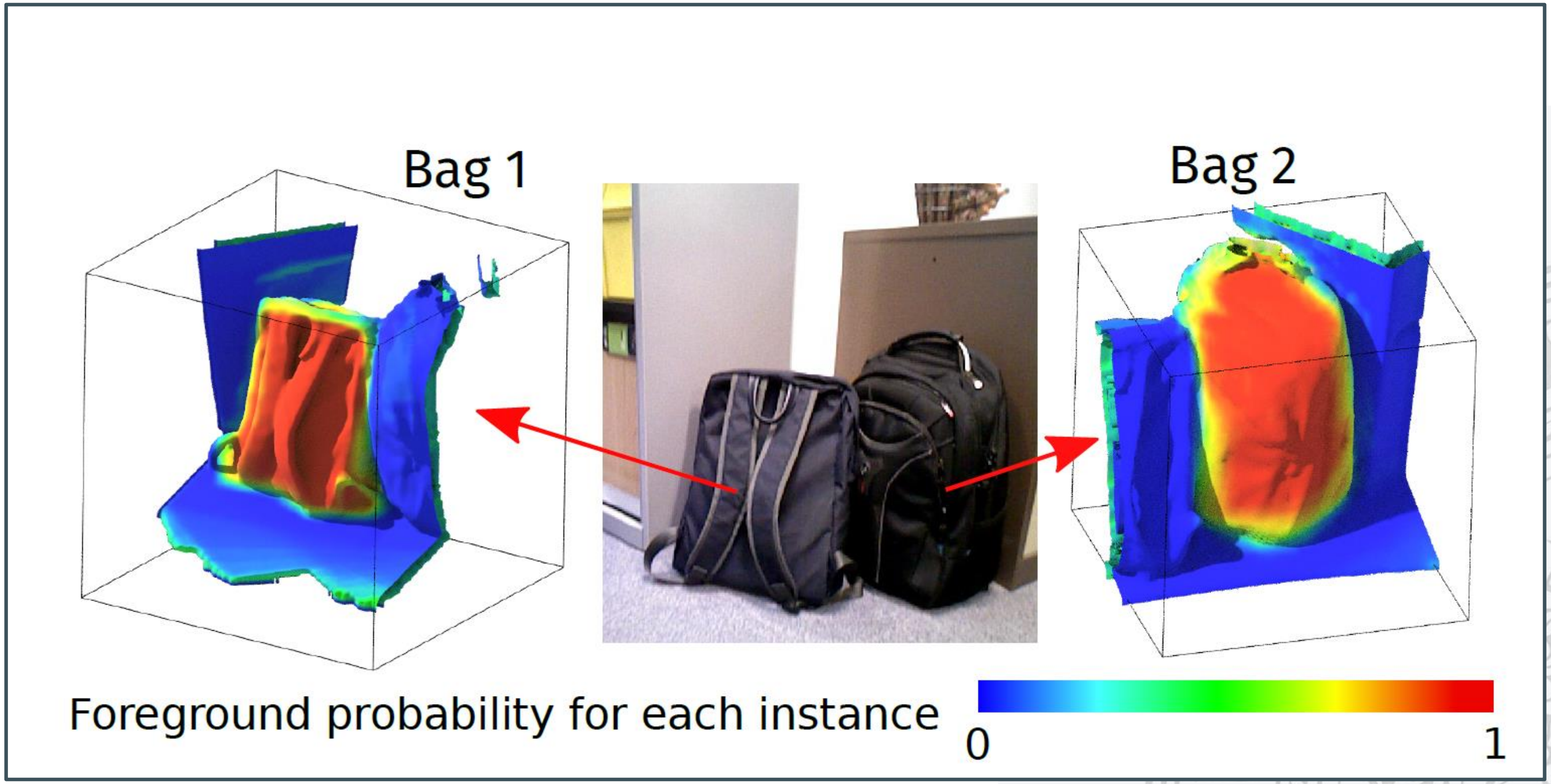
[30-245]

Foreground probability

Surface integration is performed over the entire volume

Overlay masks from different frames as foreground probability

Foreground probability



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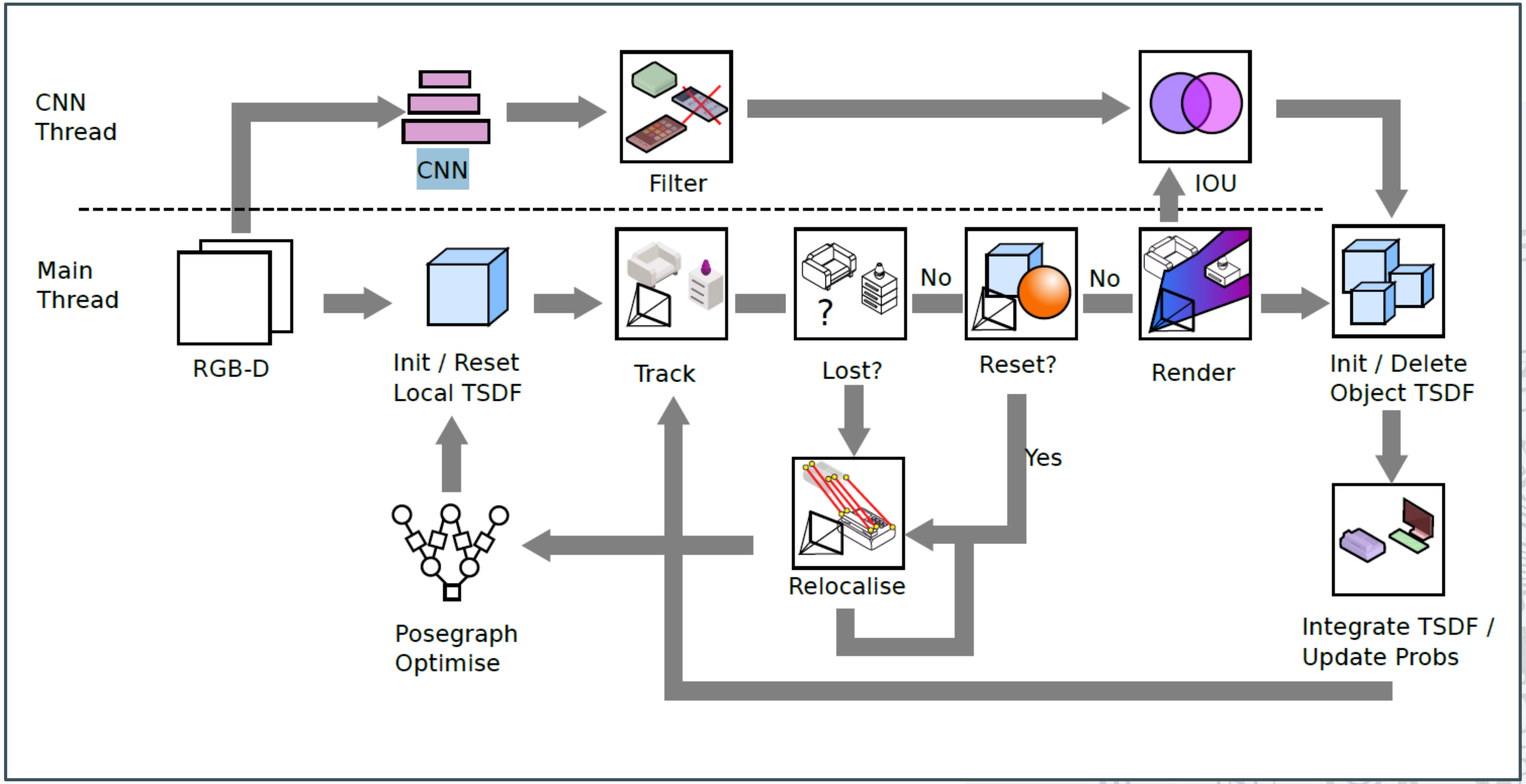
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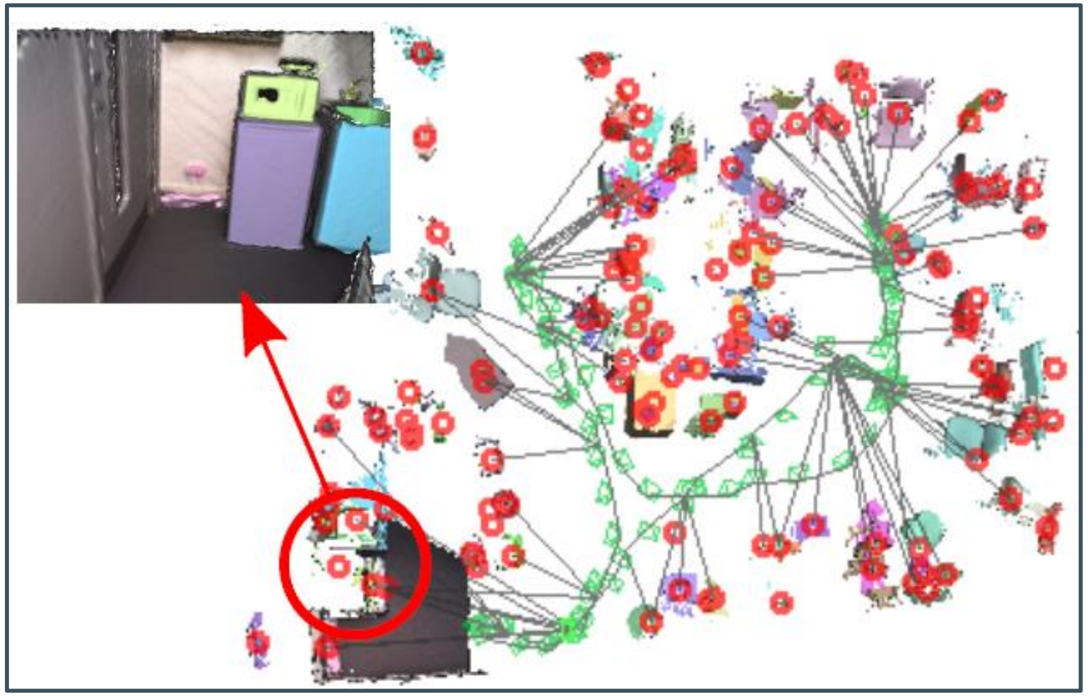
How do we position our objects?

Posegraph



Object-centric map:

Pose for each ask-RCNN frame

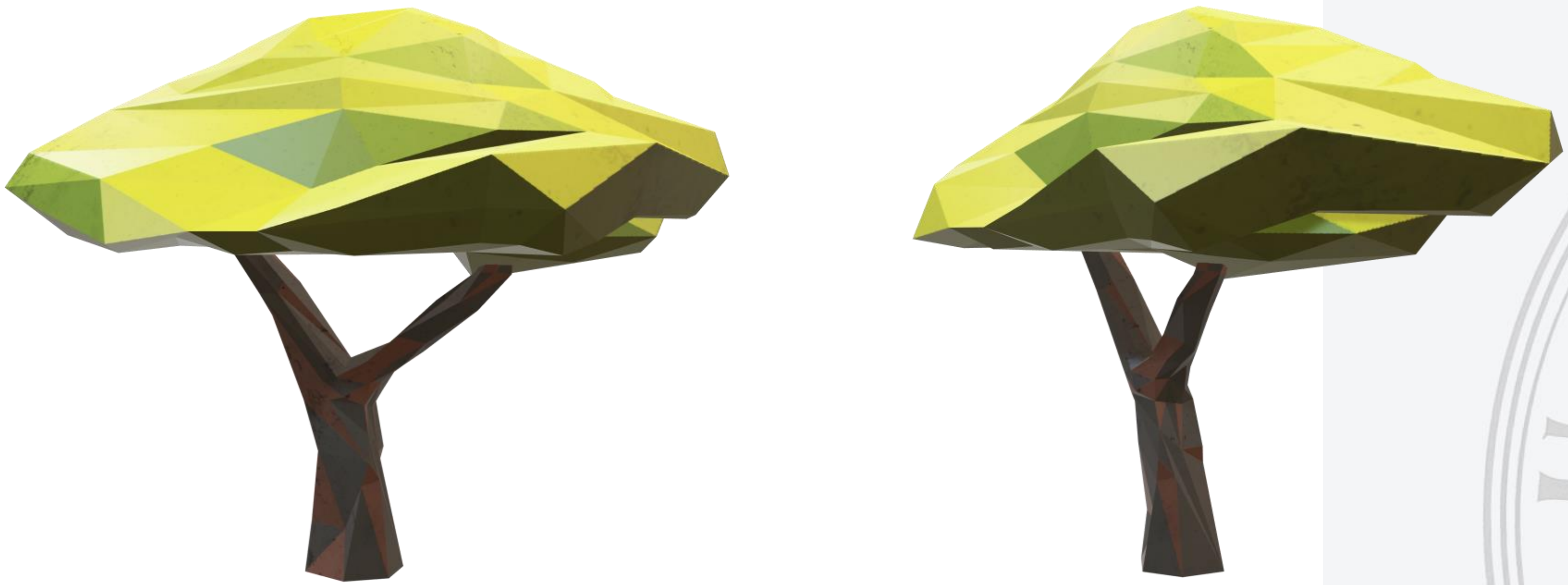
Red circle for each object instance

Loop closure after full loop

ICP-Tracking

Iterative closest point tracking:

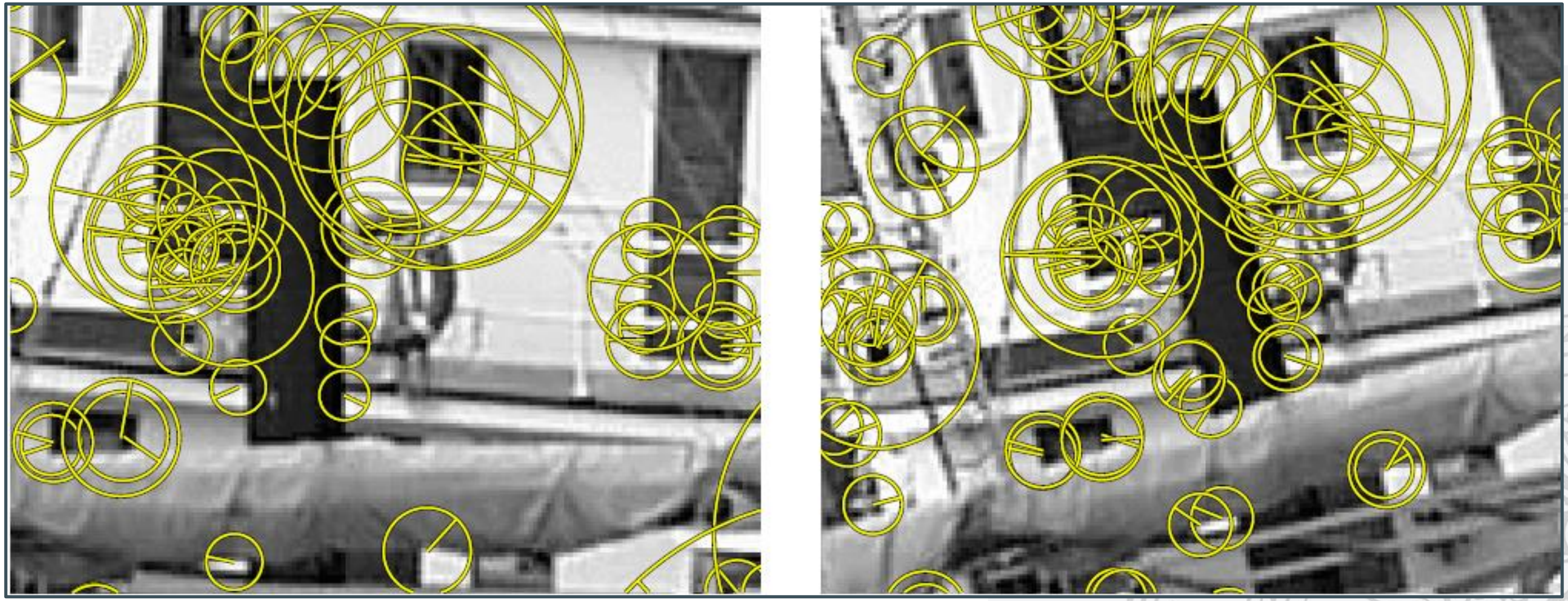
Match two point clouds



BRISK: Binary Robust Invariant Scalable Keypoints

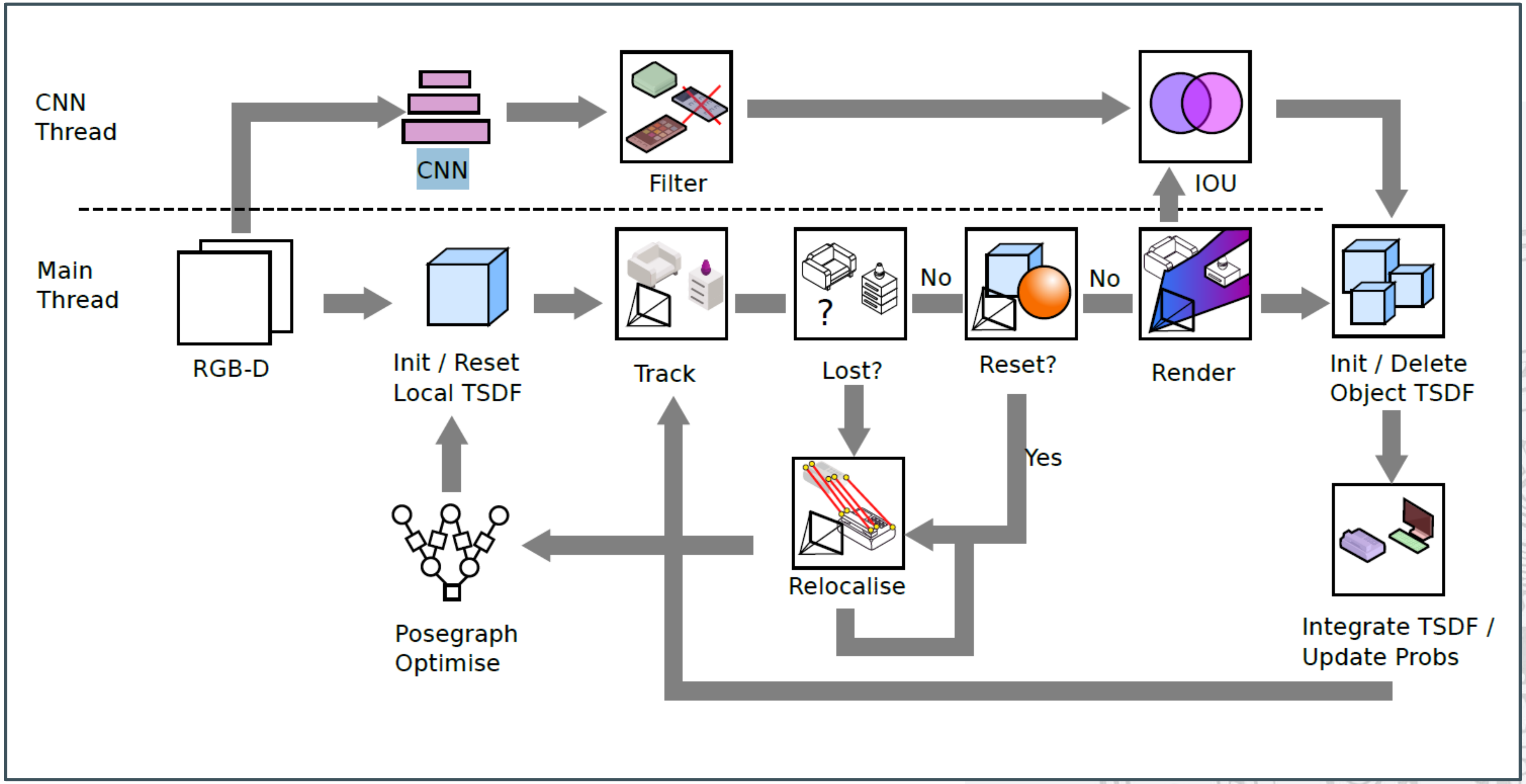
- Detect possible keypoints by 9-16
- Apply to every octave
- Pool nearest maxima
- Sample the location of the keypoint

BRISK



S. Leutenegger, M. Chli, and R. Siegwart. BRISK: Binaryrobust invariance scalable keypoints. In Proceedings of theInternational Conference on Computer Vision (ICCV), 2011.

Method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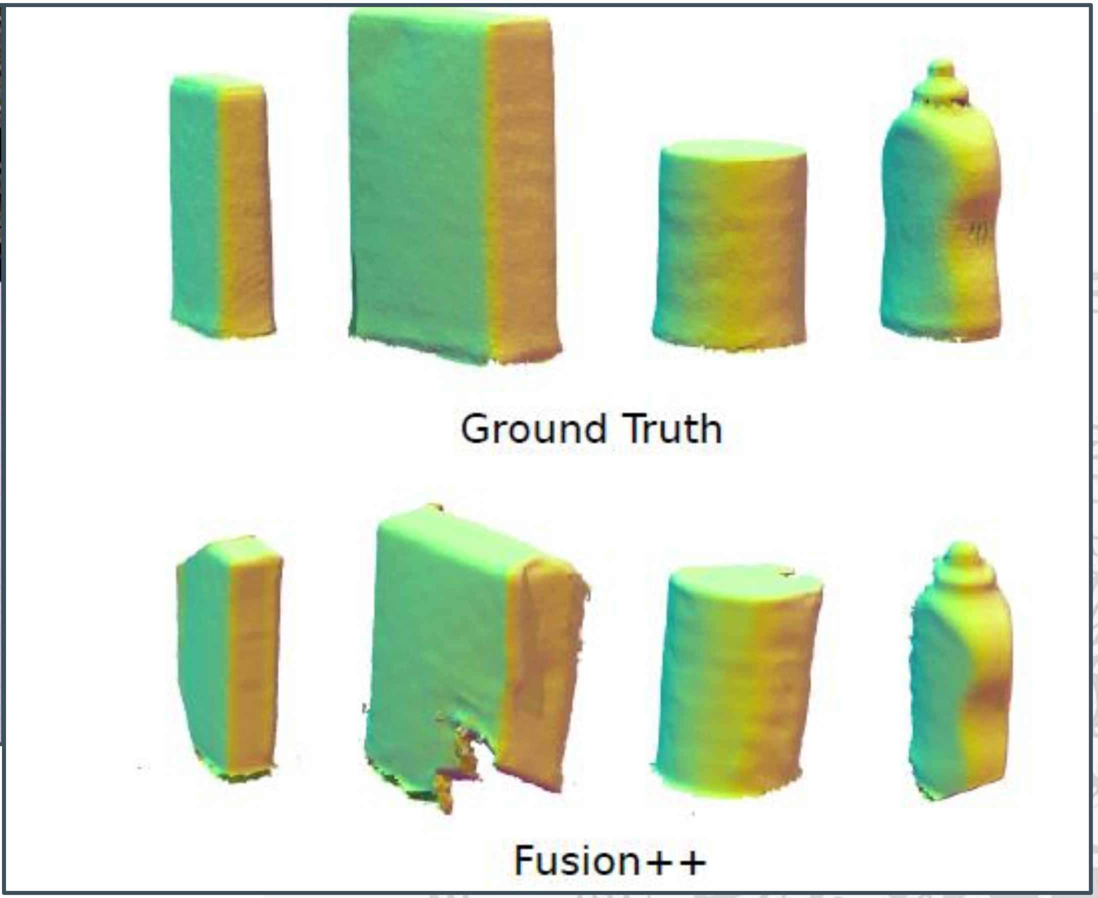
Comparison

YCB-Dataset Sequence 0001



Shortcomings

Sub-realtime performance

Static environment

Occlusion failures

Framerate dependency

Conclusion

Used techniques:

- Mask R-CNN
- TSDF
- ICP
- BRISK

This is one of the first approach to object-centric SLAM.

In terms of not strictly object-centric metrics, but general RGB-D SLAM metrics, it performs worse than state-of-the-art systems.

Thank you for your attention

References

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TSDF - Integration

RCNN