Overview of Monocular Depth Estimation with Applicability in Intelligent Transportation

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Outline

1. Main challenges – automated driving
2. Depth estimation for automated driving.
3. Technical Innovation of surveyed methods.
4. Object Level Results
5. Conclusions and remarks
6. Q&A

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Automated Driving Systems, Autonomous Vehicles

What are the main challenges?

https://nypost.com/2025/09/04/us-news/airborne-car-rockets-over-4-lanes-of-highway-in-insane-video-of-smoky-wreck/

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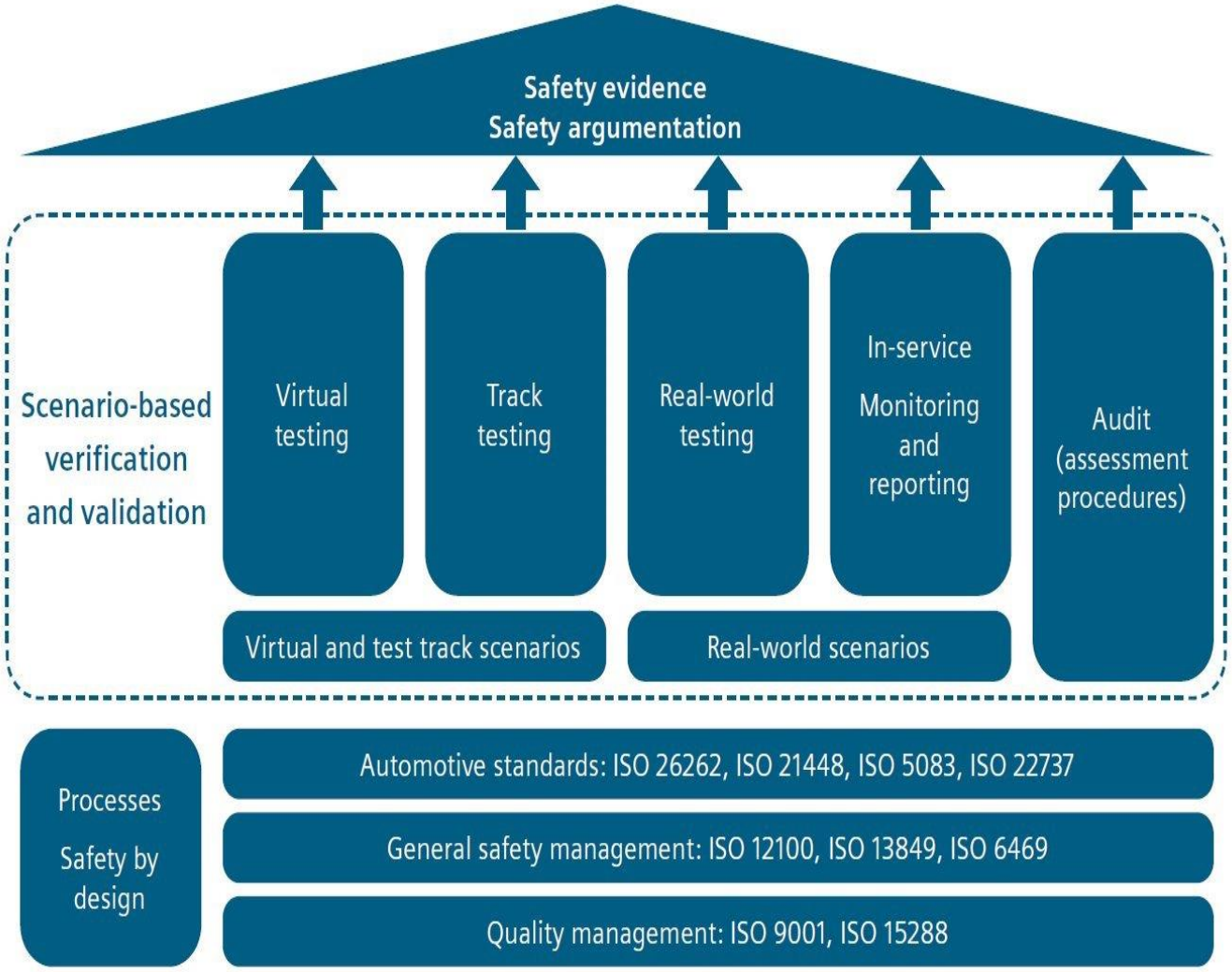
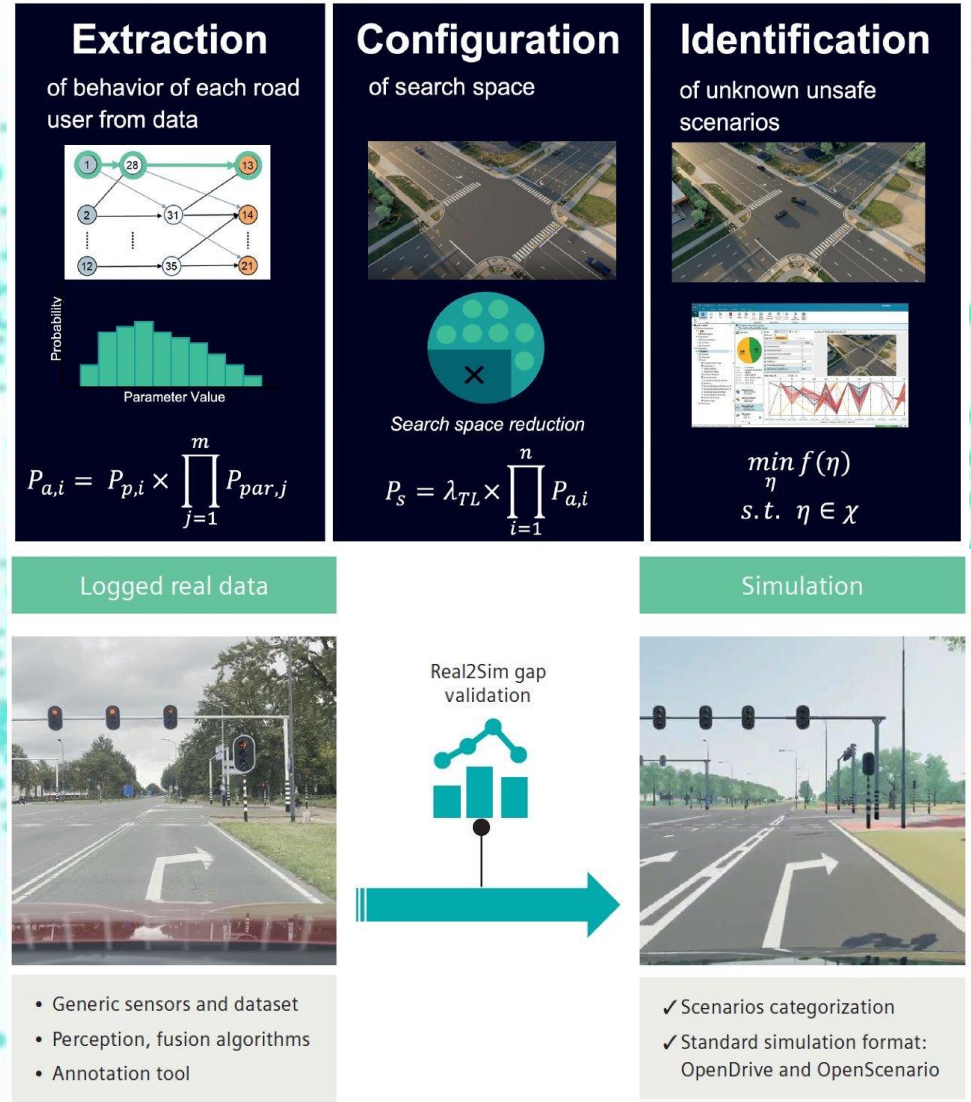
Siemens Autonomy Toolchain – Virtual Validation & Verification of ADAS & AVs





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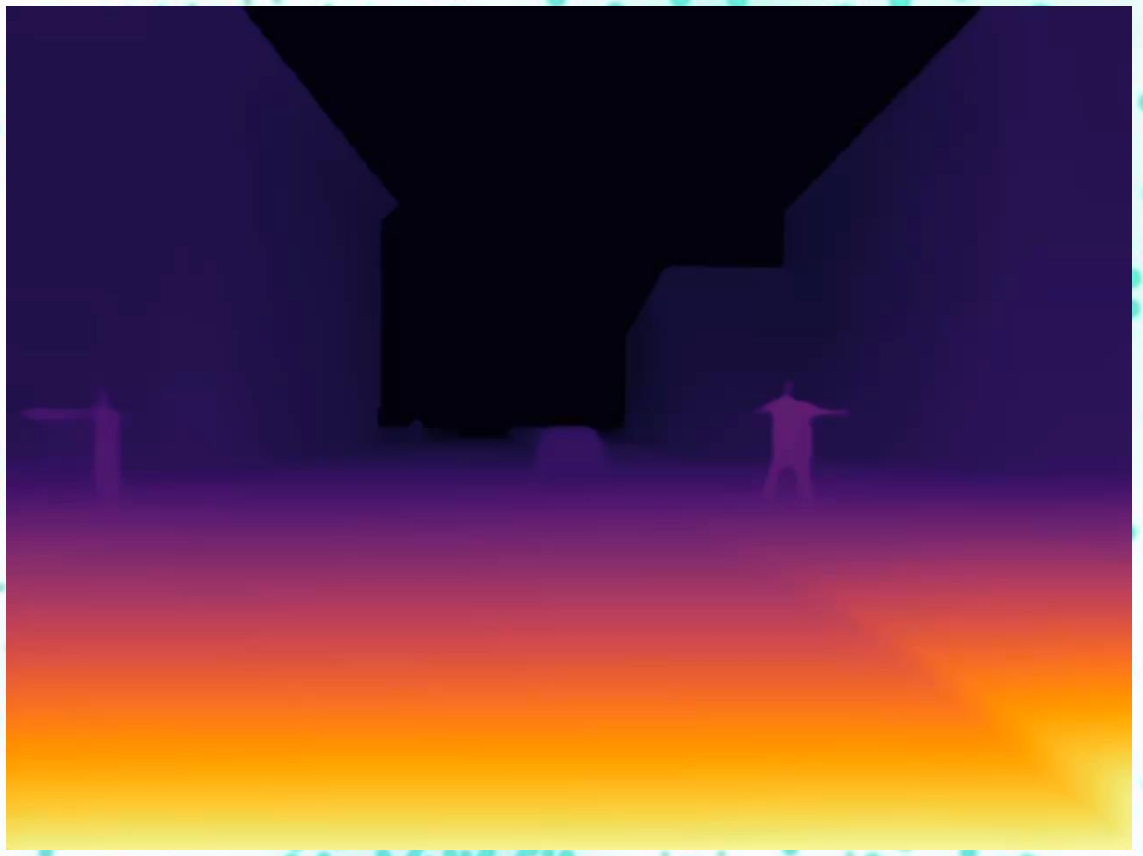
Depth Estimation for Automated Driving

2D Object detection

Metric Depth Estimation



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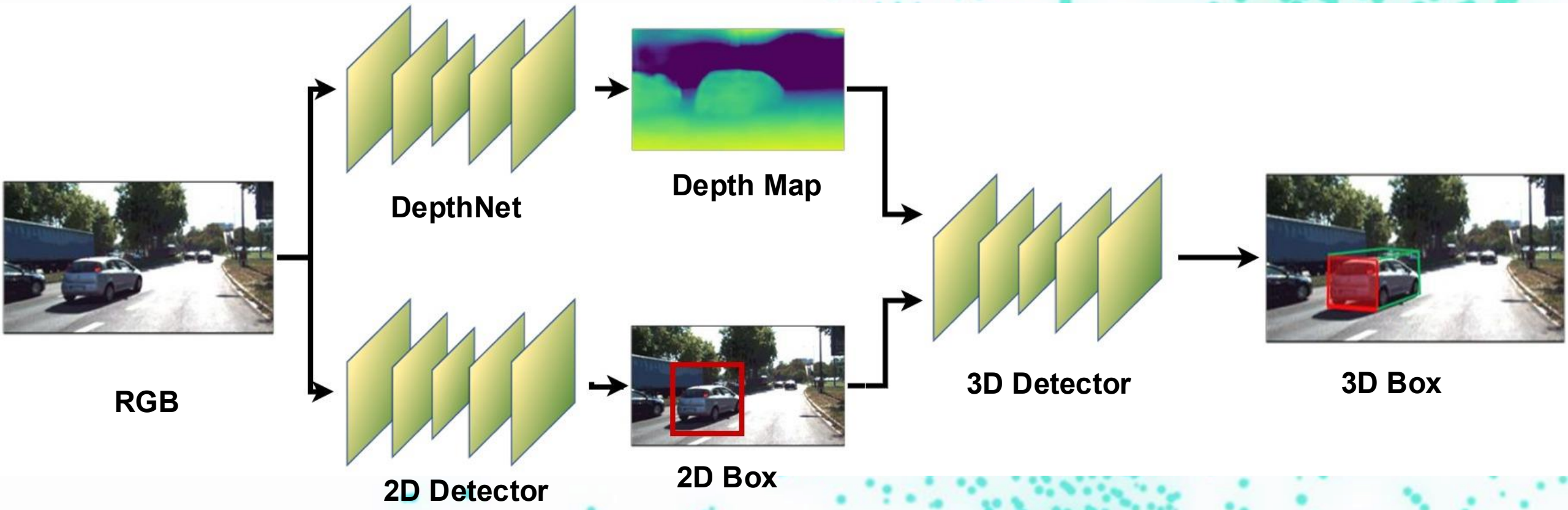
Depth Estimation in Automated Driving – Depth Guided 3D Object Detection



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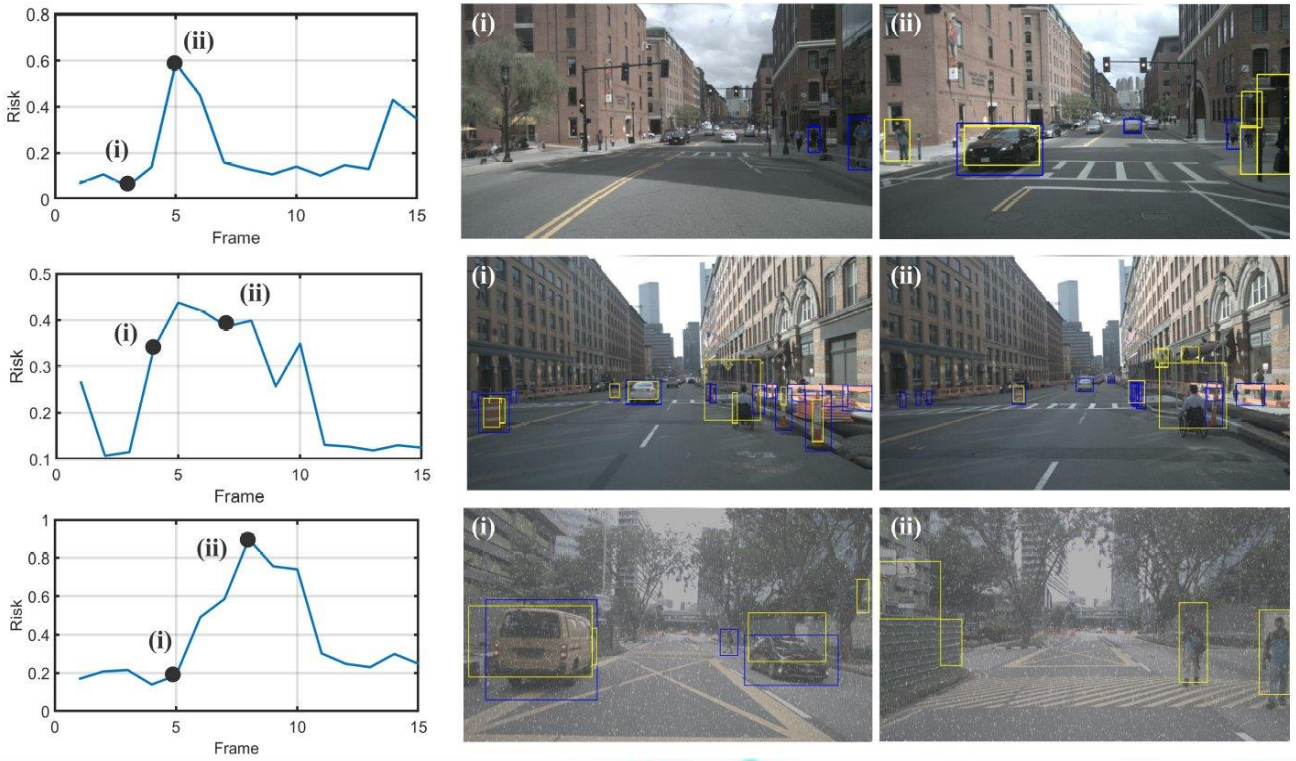
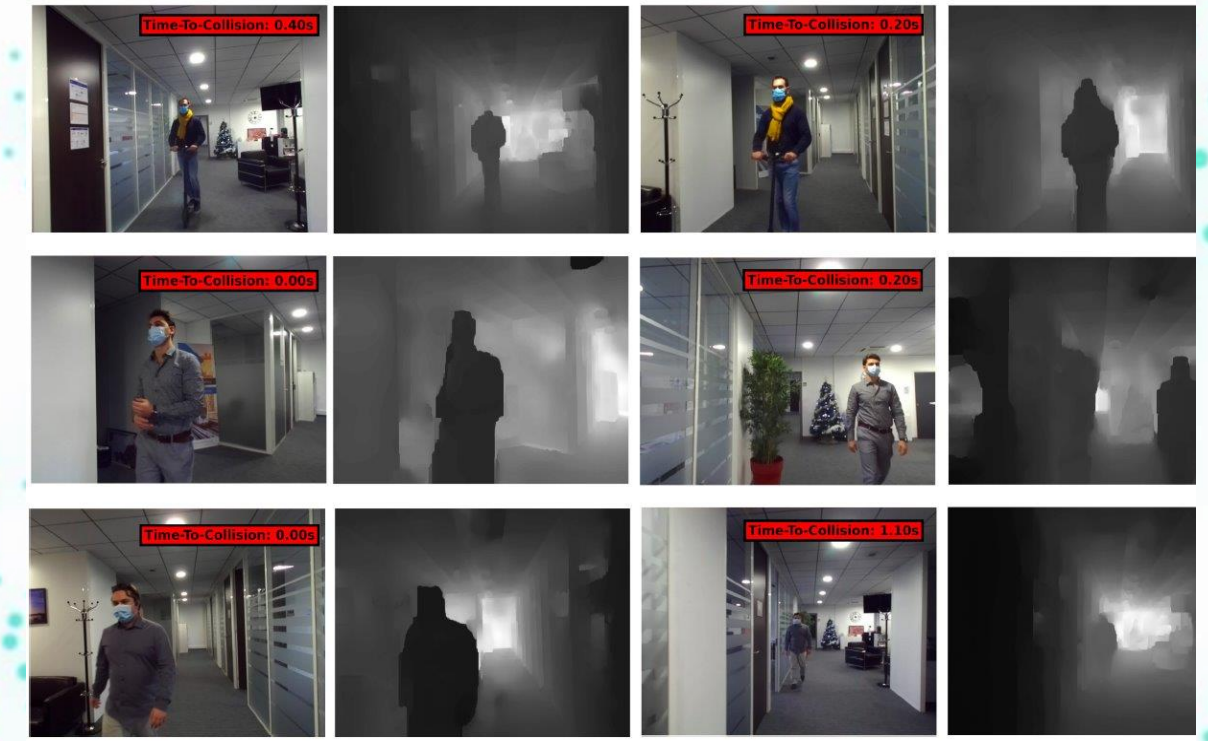
Depth Estimation in Automated Driving – Risk Assessment



FuzzRisk: Online Collision Risk Estimation for Autonomous Vehicles based on Depth-Aware Object Detection via Fuzzy Inference



Time- and Resource-Efficient Time-to-Collision Forecasting for Indoor Pedestrian Obstacles Avoidance

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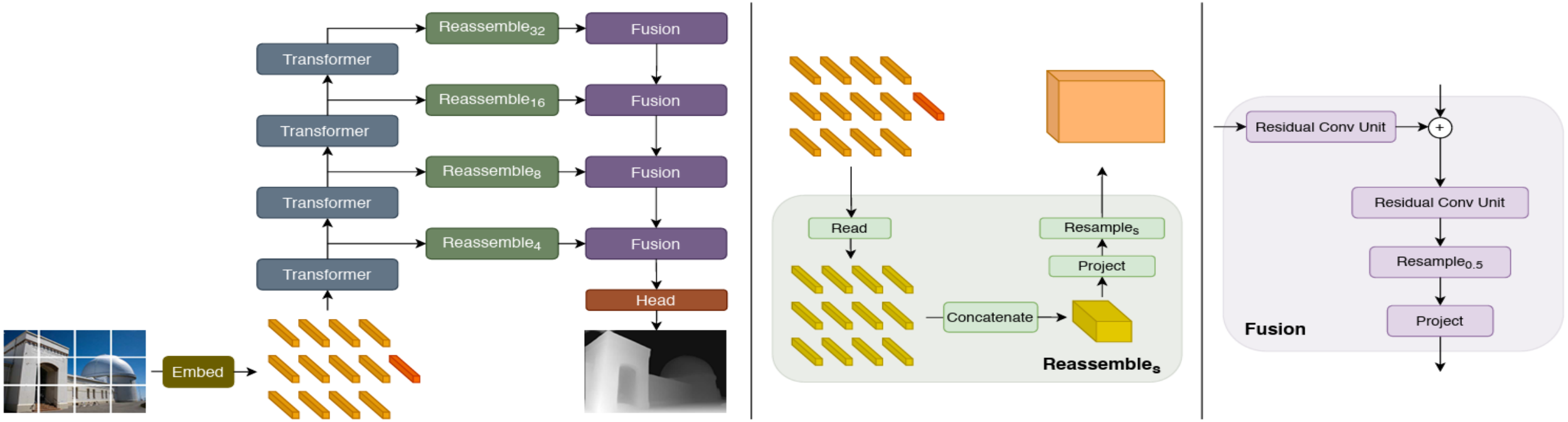
Overview of surveyed methods – MiDAS

Scale & Shift Invariant Loss

$$\mathcal{L}_{ssi}(\hat{d}_i, \widehat{d_i^*}) = \frac{1}{2M}\sum_{i=1}^{M}\left|\hat{d}_i - \widehat{d_i^*}\right|$$

$$\hat{d}_i = \frac{d_i - t(d^*)}{s(d^*)} \qquad \widehat{d_i^*} = \frac{d_i^* - t(d^*)}{s(d^*)}$$

$$t(d^*) = \text{median}(d^*) \qquad s(d^*) = \frac{1}{M}\sum_{i=1}^{M}\left|\widehat{d_i^*} - t(d^*)\right|$$



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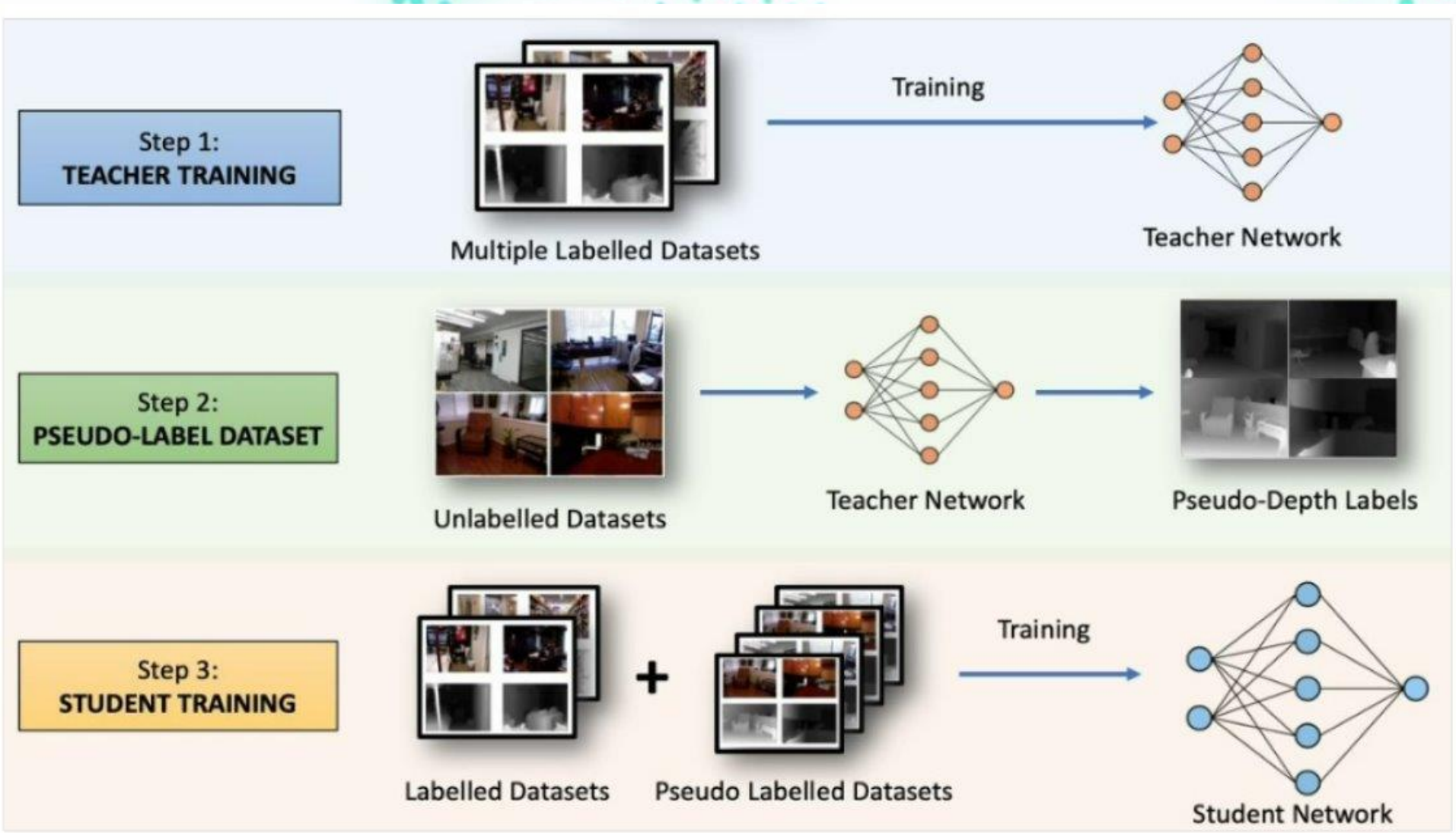
Overview of surveyed methods – DepthAnything



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Overview of surveyed methods – DepthAnything

CUT MIX AUGMENTATION

Cut Mix Augmentation increases the **SPATIAL DISTORTION** in the training images, making the Student Network learn more general and robust representations!

STEP 1: Take two pairs of images and their pseudo-labelled depth maps

STEP 2: Pasting a rectangular portion of Image A on top of Image B

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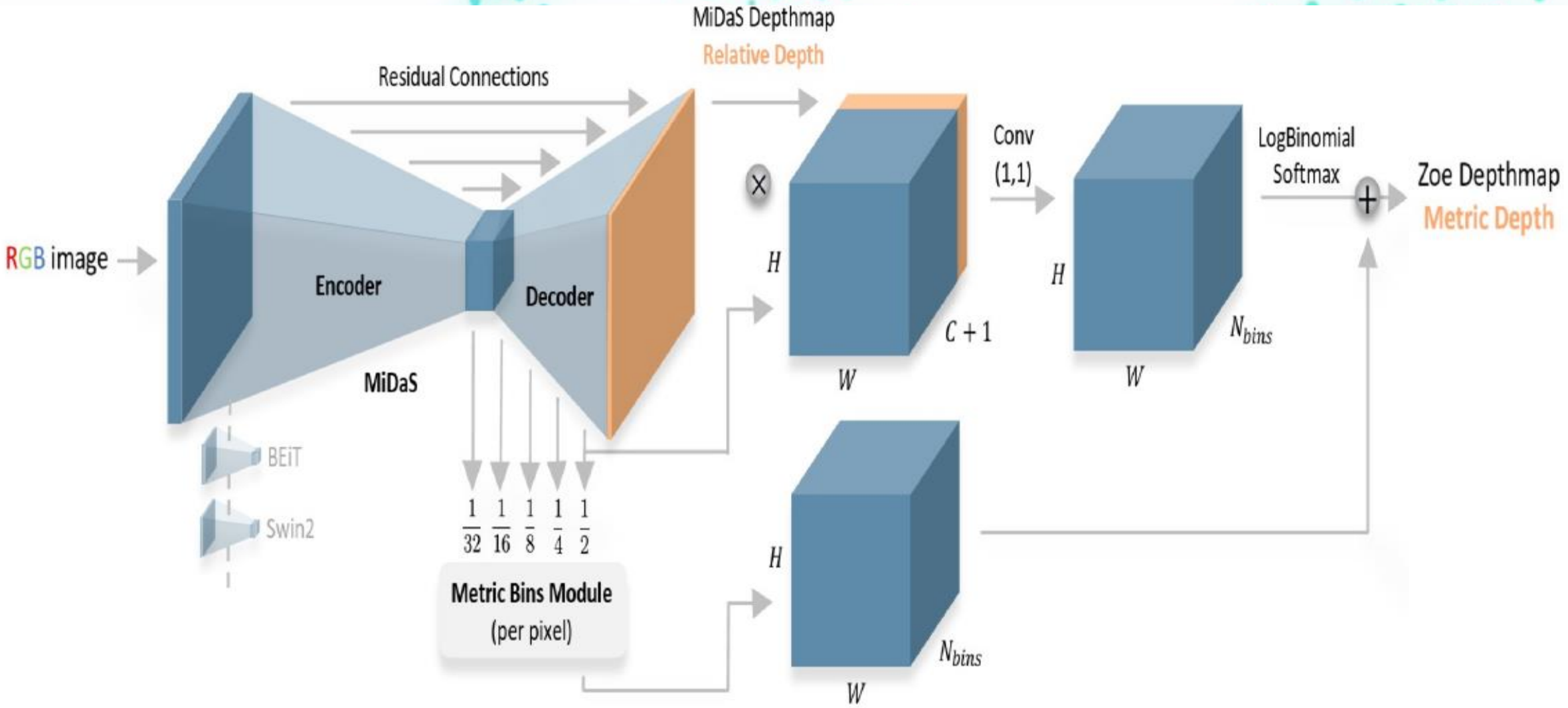
Overview of surveyed methods – ZoeDepth



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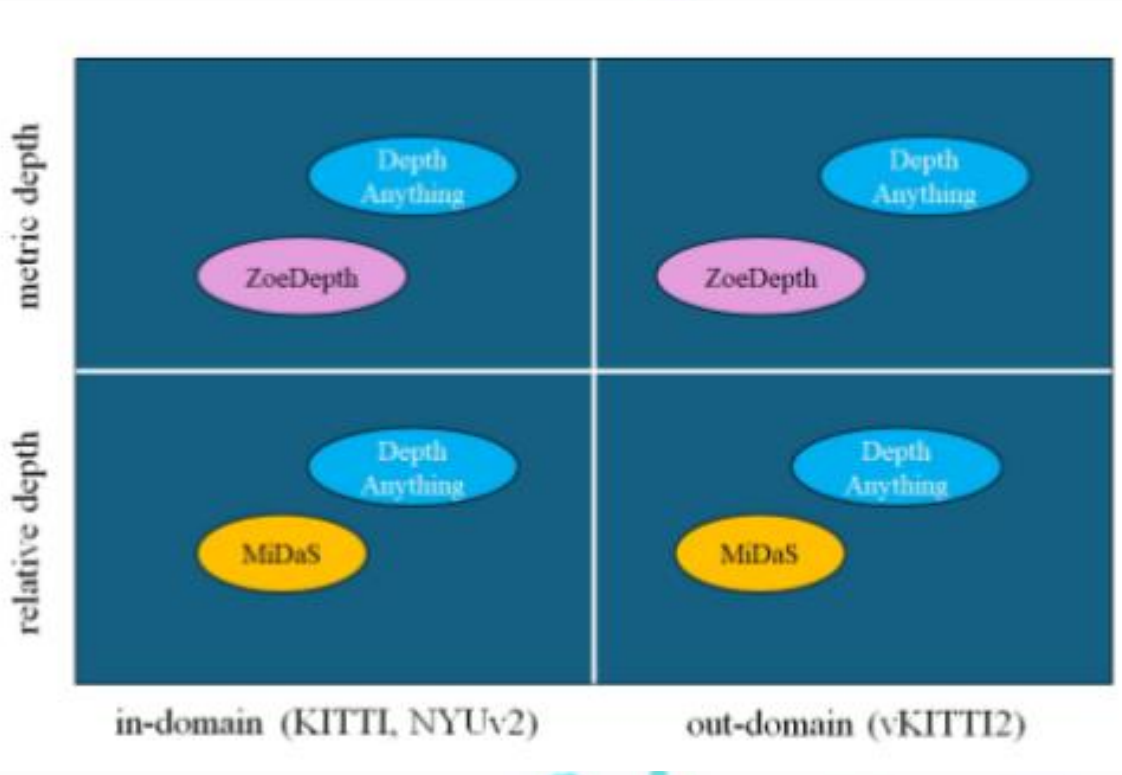
Assessment & KPIs



$$REL_{obj} = \frac{1}{N}\sum_{i=1}^{N} |obj_i - obj_i^*| / obj_i^*$$

$$MAE_{obj} = \frac{1}{N}\sum_{i=1}^{N} |obj_i - obj_i^*|$$

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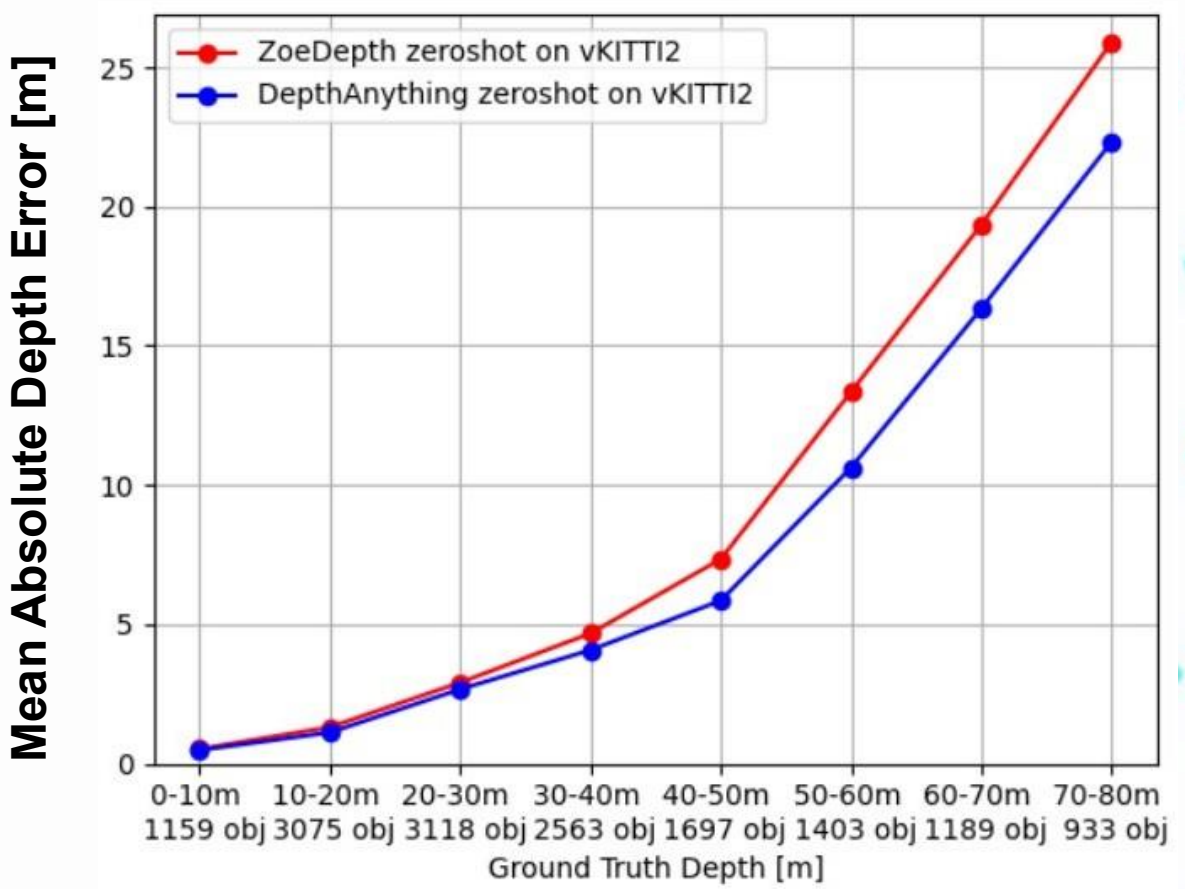
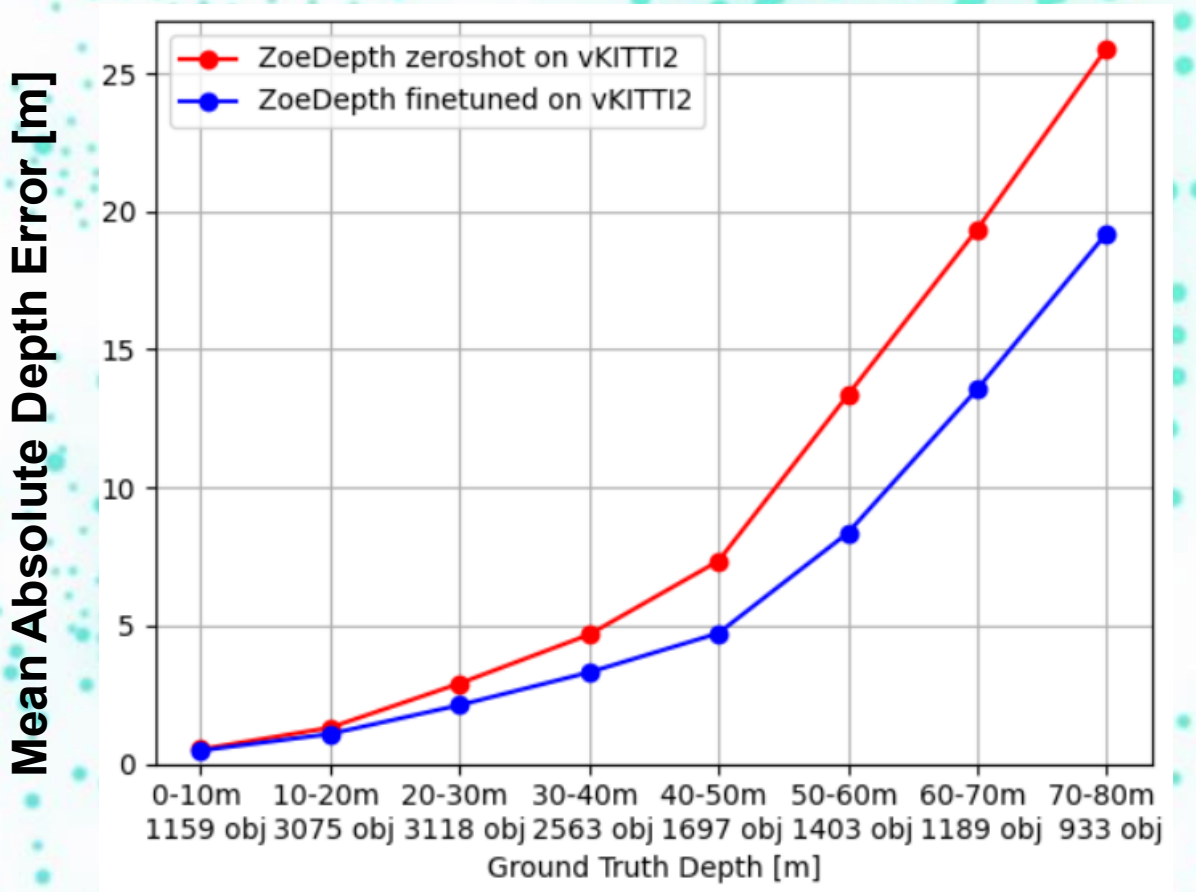
Results – Object Level





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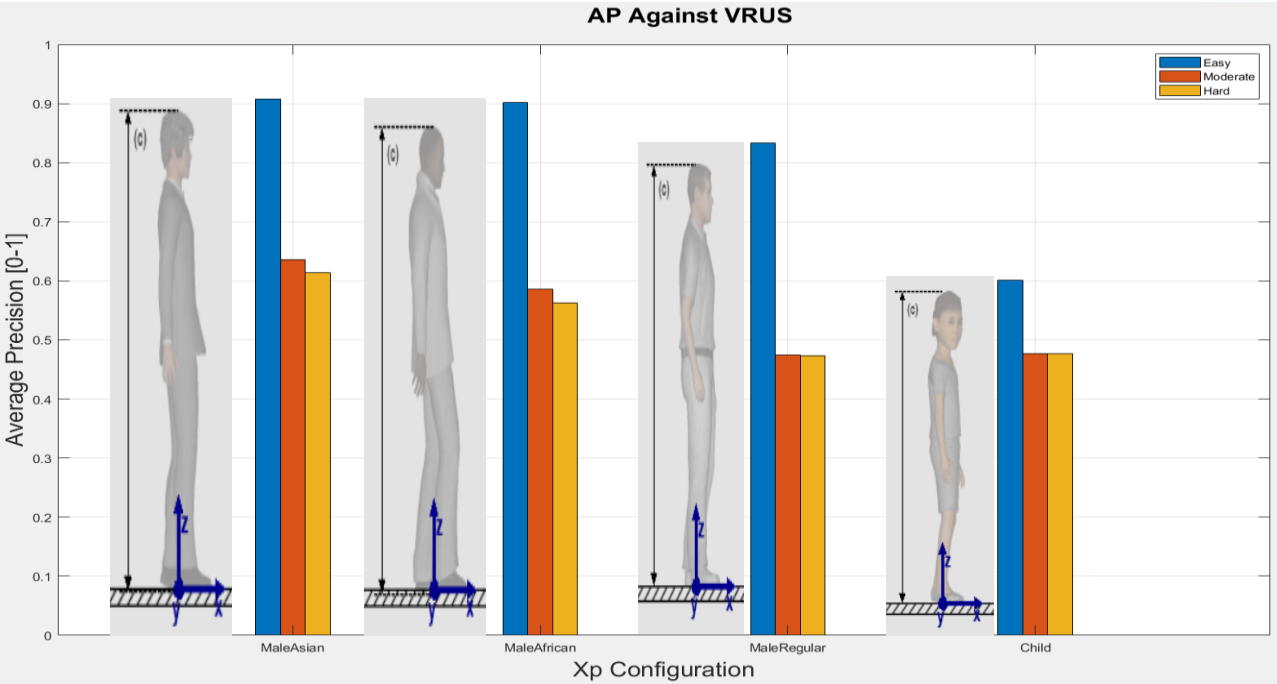
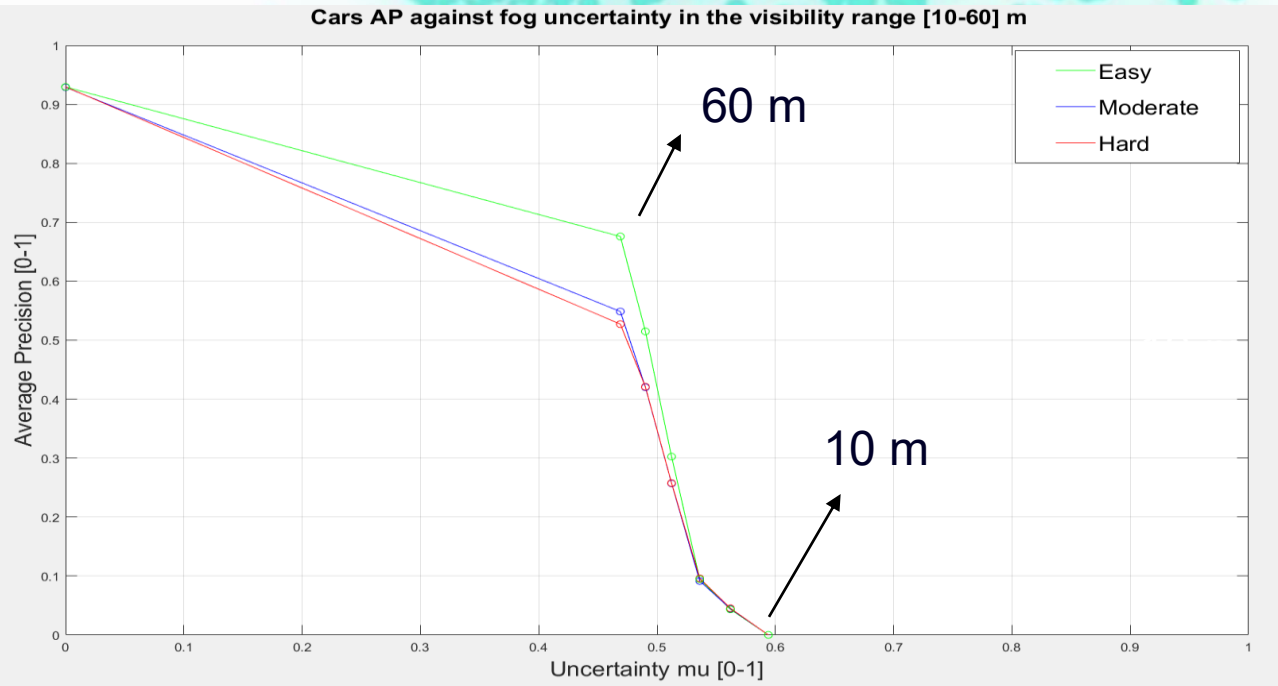
Conclusion & Remarks

Model	Encoder	KITTI Test	
		REL_{pixel}	REL_{Obj}
MiDAS v3.1	$BEiT_{L-512}$	0.12	0.25
DepthAnything	ViT-L	0.07	0.10





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Thank you for your attention!

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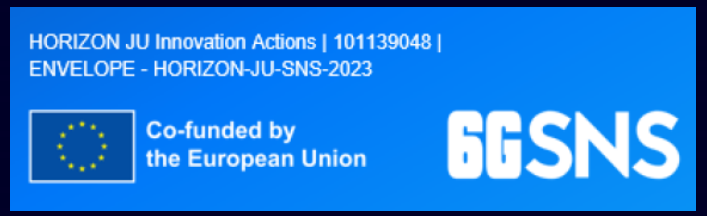

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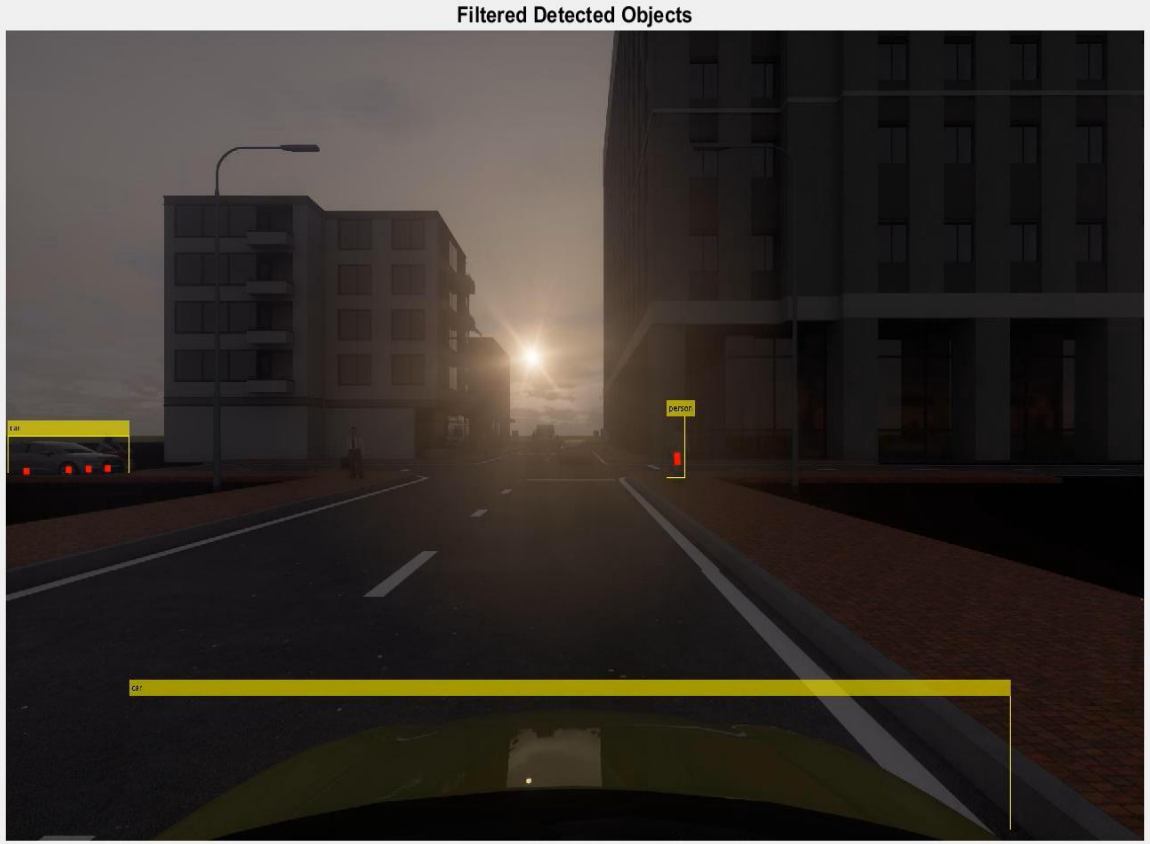
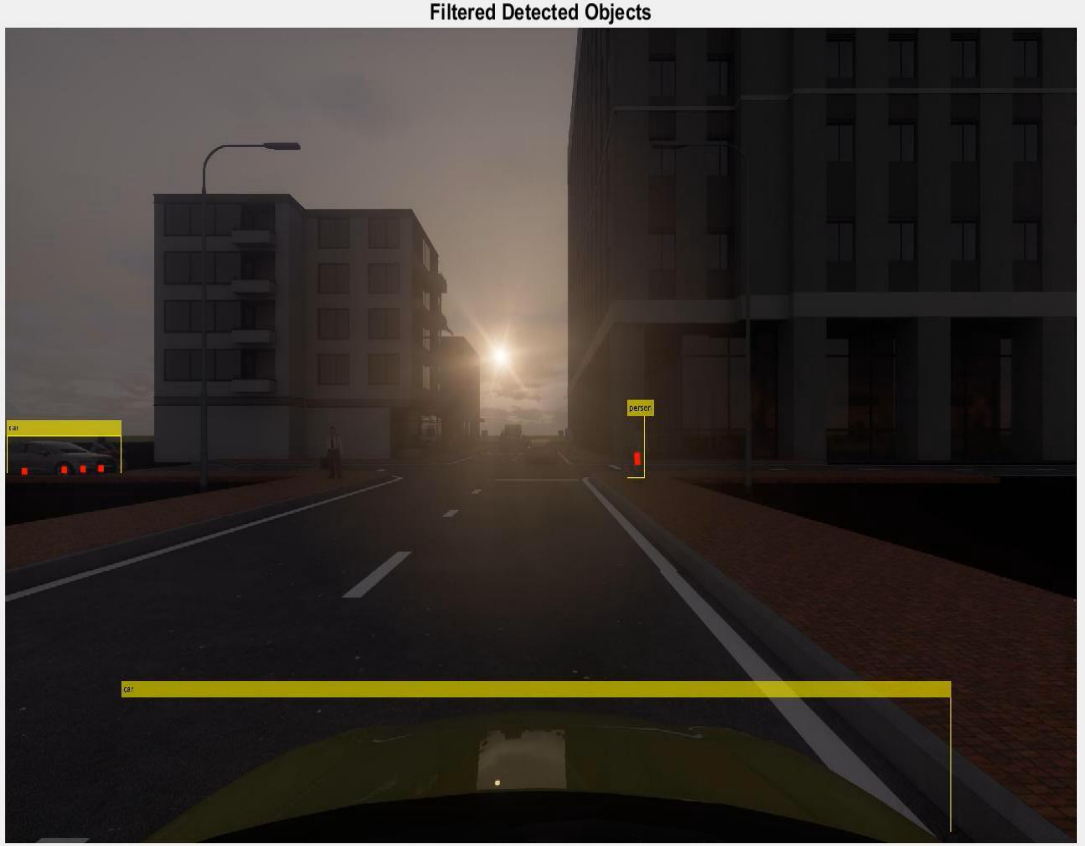
Radar-Camera Fusion Application

- Radar detections after fusion



- Radar detections after fusion
- Predicted object



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