KI ABSICHERUNG
Safe AI for Automated Driving

Synthetic Dataset for Pedestrian Detection (synPeDS) - Overview

Bastian Knerr[1], Thomas Stauner[2], Frédérik Blank[3], Michael Fürst[4], Philipp Heidenreich[5]

Dataset

Use Case / Overview

This synthetic dataset (camera & LiDAR) is aimed at being used for training, testing and assurance of ML-based pedestrian detection algorithms. Its vast amount of ground truth and metadata enables in-depth data, sensitivity and correlation analyses.

Data Generation / Requirement Engineering-Process

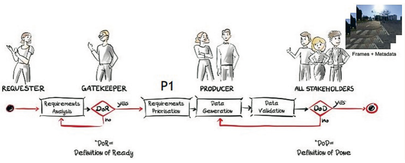

Figure 1: Schematic Data Generation and Acceptance Process

Different sets of requirements:

- RE for AI development
- RE for safety analysis
- RE on optical quality
- Tech RE from data production

Design Process and Content Highlights

The dataset was designed in an iterative, user- focused manner. The data requirement process was based within the P1 process in coordination with TP2. Fix scripts have been applied from AP1.2.

Tranche	Features included	Data Producer
1, 2	Preparatory measures for large scale data production (tranches not part of published dataset)	BIT-TS, Mackevision
3	Introduction of HDR images for variation in lighting situations (dark to very bright)	BIT-TS
	Further ramp-up for large scale production	BIT-TS
4	Frame-to-Frame variations	BIT-TS, Mackevision
	Meta Information on ASsetIDs	BIT-TS, Mackevision
	Bodypart segmentation	BIT-TS
	Introduction of procedural sun model	Mackevision
5	Integration of sensor noise (postprocessing)	BIT-TS
	Introduction of procedural clouds	Mackevision
	Ground truth for pose estimation	Mackevision
	Meta information on occlusion	Mackevision
6	Environmental effects: wetness, sun glare	Mackevision
	Out-of-Distribution Assets	Mackevision
	Data for different camera sensor parameters	Mackevision
7	Data generation with camera and LiDAR sensor models using physically based rendering with OSPray	BIT-TS
	Data for different LiDAR sensor parameters	BIT-TS
	Environmental effects: fog, vignetting	Mackevision
	Meta information on AnimationID	Mackevision
8	Introduction of night scenes, incl. artificial light	Mackevision
9	Inclusion of specific user requests for data generation (e.g. contrast, material measures)	Mackevision

Table 1: Iterative content build-up of synthetic dataset and highlighted content

Focus on Training vs. Assurance Data

Dataset designed to include data with focus on:

- Training: high variance and frame2frame variations to increase learning speed and efficiency of DNN
- Assurance: challenging test scenarios, out-of-distribution datasets and out-of-ODD assets to identify insufficiencies in DNN generalization

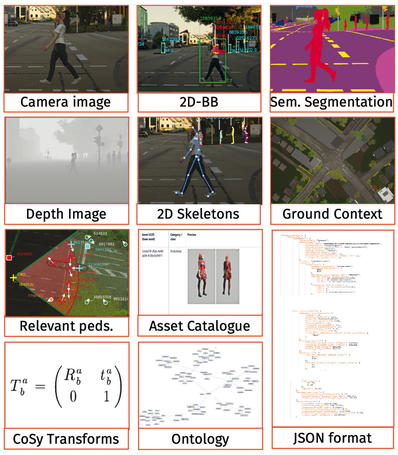

Fig. 2: Ground Truth and Meta Information (2D), Source: Mackevision

Ground Truth and Meta Information

Ground truth includes pixel-accurate information. Additionally, rich meta information w.r.t. the project's ontology is provided and supports correlation analysis.

Comparison of Dataset (Performance Analysis)

Cross-domain generalization performance results evaluated with mIoU on real-world datasets and on synthetic datasets.

Trained Model	Evaluated Dataset (mIoU)								
	Real World						Synthetic		
	A2D2	*BDD100k*	*CS*	*IDD*	*KITTI*	*MV*	*SynPeDS*	*GTAV*	*SYNS*
SynPeDS	45.76	44.73	55.94	43.87	53.93	55.15	-	40.72	60.00
GTAV	34.69	42.56	39.07	45.17	54.67	48.30	50.41	-	48.83
SYNS	22.67	25.00	59.33	29.59	43.70	35.03	50.25	28.71	-

Table 2: Results of performance analysis

Cross-domain generalization performance of class person results – as aim of pedestrian detection is focus for safety aspects.

Trained Model	Evaluated Dataset (Person mIoU)								
	Real World						Synthetic		
	A2D2	*BDD100k*	*CS*	*IDD*	*KITTI*	*MV*	*SynPeDS*	*GTAV*	*SYNS*
SynPeDS	42.88	35.98	73.31	58.65	25.40	53.03	-	16.91	72.33
GTAV	47.26	47.04	53.71	76.67	39.78	60.69	76.15	-	66.57
SYNS	15.04	21.47	73.41	43.52	15.40	20.60	69.24	4.29	-

Table 3: Results of performance analysis with person mIoU

For more information contact:
Thomas.stauner@bmw.de
Bastian.knerr@qualityminds.de

Based on contribution from following APs & partners: AP2.1, AP2.2, AP2.5, P1, AP2.4, AP4.1, AP1.2

Image sources:
Fig. 1: QualityMinds
Fig. 2: Mackevision

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