KI DATA TOOLING
The Data Kit for Automotive AI

# A-Eye: Driving with the Eyes of AI for Corner Case Generation

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## Use-Case in Data Tooling

Targeted enrichment of training data with safety-critical driving situations, also known as corner cases, using a self-designed test rig that allows driving in a network's output. For this purpose the driving simulator CARLA [1] was equipped with two control units (screens, steering wheels, pedals) so that two drivers could control the same vehicle.

*Figure 1: Test rig including steering wheels, pedals, seats and screens, where two human drivers can control the ego-vehicle.*

## Approach

- Integration of a driving instructor who recognizes discrepancies between human and machine perception (Figure 1)
- Implementation of the logic for corner case triggering (Figure 2)
- Conducting two driving campaigns, the first for data collection and the second for testing purposes

## Training

- Use of the real-time semantic segmentation network Fast-SCNN [2]
- 1st driving campaign: training for model was stopped early to increase the frequency of perception errors
- 2nd driving campaign: 3 models were fully trained on the following datasets **(same number of images)**: *natural distribution, pedestrian and corner case enriched*

## Experiments

Scene recording with the help of two test subjects in a specially constructed test rig, where one subject (safety driver) gets to see the "real" virtual image and the other (semantic driver) receives the output of the semantic

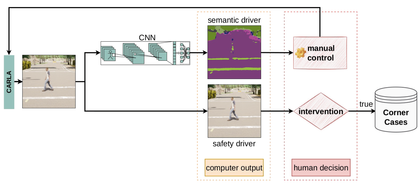


*Figure 2: Flowchart of the A-Eye method to trigger corner cases.*

segmentation network in real-time. The safety driver takes the role of the driving instructor and intervenes in dangerous driving situations caused by misjudgments of the AI.

## Results

Tested on test data (see Figure 3) and during free-driving on all three trained models, where the drivers didn't know on which model they were driving (Table 1).

| dataset | Driven distance d [km] | Driven time t [s] | Number corner cases [-] | $d_{CC}$ [km/CC] | $t_{CC}$ [min/CC] |
|---|---|---|---|---|---|
| **naturally distributed** | 121.32 | 411 | 13 | 7.73 | 25.93 |
| **pedestrian enriched** | 163.09 | 500 | 21 | 7.52 | 23.25 |
| **corner case enriched** | 153.38 | 528 | 11 | **13.84** | **47.47** |

*Table 1: Corner case occurence during the second driving campaign.*

We notice that driving on a model trained with corner cases was less error-prone, resulting in almost 2x longer damage-free drives compared to models trained without corner cases.

## Contribution

We show that targeted data enrichment with corner cases created with limited perception leads to improved pedestrian detection in critical driving situations.

## References:

[1] Alexey Dosovitskiy et al., CARLA: An Open Urban Driving Simulator. In: Proceedings of the 1st Annual Conference on Robot Learning. 2017, pp. 1-16.
[2] Rudra P. K. Poudel, Stephan Liwicki, and Roberto Cipolla. Fast-SCNN: Fast Semantic Segmentation Network. In 30th British Machine Vision Conference 2019, BMVC 2019, Cardiff, UK, September 9-12, 2019. BMVA Press, 2019, p. 289.

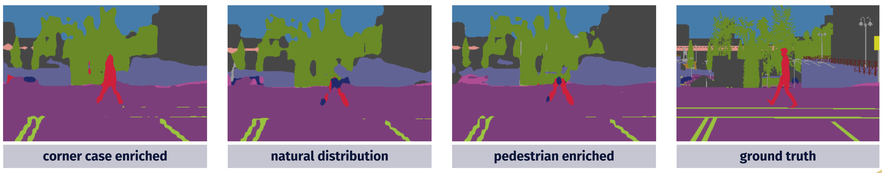


*Figure 3: Evaluation on corner case test data shows that the model using corner case data in training recognizes pedestrians better than the model trained with the natural distributed dataset or the dataset which contains more pedestrians.*

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## Partners

## External partners

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