KI ABSICHERUNG
Safe AI for Automated Driving

Applying Image Analysis, Combinatorial and Search-based Testing for DNN-Verification

Christoph Gladisch, Falko Matern, Frédérik Blank, Martin Herrmann, Simon Heming

Performance limiting factor

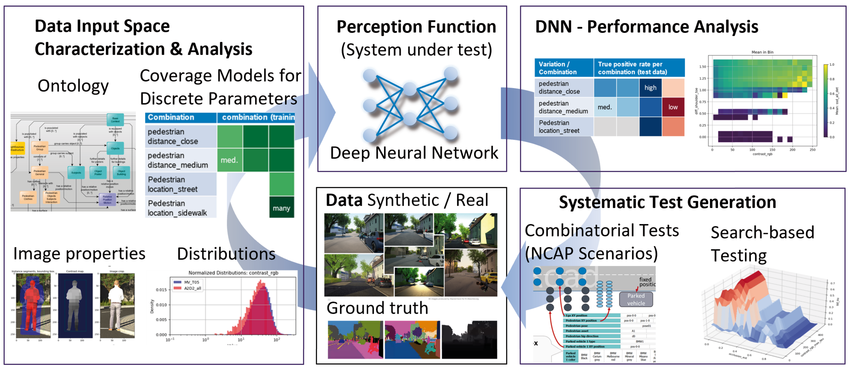

Figure 1: A schema of a verification loop to test a perception function consisting of image analysis and testing approaches like combinatorial and search-based testing

Introduction / Motivation

Rigorous and systematic testing of AI requires new approaches focusing on data. We extract information such as semantic ontology parameters, image appearance and the DNNs predictions. This information is aggregated to apply a collection of testing and analysis techniques, which subsequently provide feedback for the generation of new test data.

We propose a verification loop including:

- **Input characterization** with image analysis and coverage models
- Detailed analysis of **DNN performance** regarding semantic dimensions
- **Search-based and combinatorial testing** techniques for efficient testing
- Structured **image generation** techniques to generate new test samples

Search-based Testing

SBT learns a hypothesis, where the DNN performs good and bad. It then uses the hypothesis to select new data (missing tests, E4.4.1a). (Fig. 2)

Image and Performance Analysis

In-depth analysis of detections per semantic bin allows to identify conditions with insufficient DNN performance. (Fig. 3)

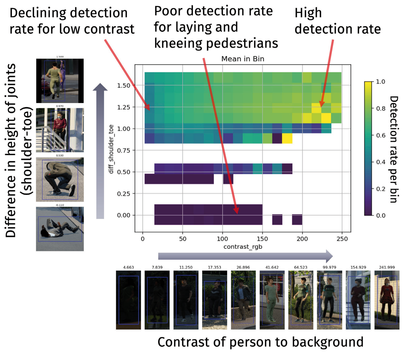

Figure 3: Analysis of detection performance in relation to human interpretable parameters

Conclusion

We implemented a verification loop to systematically test a perception function. It revealed critical cases regarding pedestrian pose, occlusion and contrast. These parameters lead to new critical test cases.

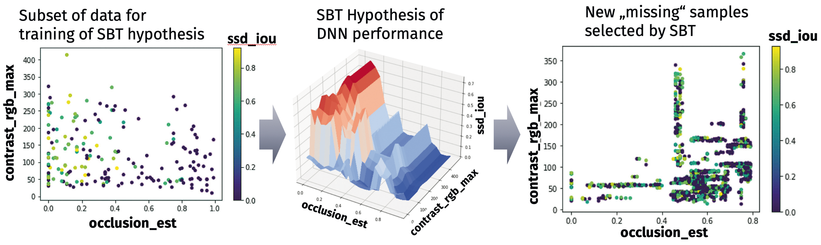

Figure 2: Application of search-based testing with parameters contrast and occlusion

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For more information contact:
Christoph.Gladisch@de.bosch.com
Falko.Matern@de.bosch.com

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Combinatorial Testing
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