KI WISSEN
Automotive AI Powered by Knowledge

3.3 A Concept to Support AI Models by Using Ontologies

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Objective

We propose a concept to support the decision making of the AI of automated vehicles by adding expert knowledge. If the AI system is strengthened with formalized knowledge using symbolic reasoning, the tracking of decision making is possible for many situations. Moreover, it is not necessary to learn all possible concepts and situations in a data-driven way [1].

Knowledge Sources

At international level, there are activities to advance the regulation on automated and autonomous driving, where guidelines and regulations are formulated. Requirements can be formulated like „The system shall be able to detect and identify lane markings“. Thus, we identify the German Technical Specification on Lane Markings from the Road and Transportation Research Association (FGSV) [2] as a possible knowledge source. This is a suitable candidate as it contains all kinds of information related to lane markings as naming, shape and dimension, type, and area and conditions of appearance.

Formalization into Ontology

We find that the knowledge can ideally be formalized as an ontology, because a hierarchical structure of the concepts can be created. Not only the concepts and relations can be created, but also axioms and rules can be defined to support decision making. First, a standalone ontology is created with proper relations between concepts. Afterwards, the concepts are properly integrated into the ASAM OpenXOntology (Fig. 1 and 2) [3]. For verification purposes, scenario specific concepts and simple rules are integrated into the modified ontology.

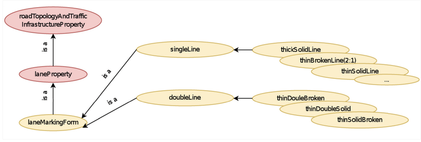

Figure 1: Modified structure of the lane marking form (©BASt | FOKUS)

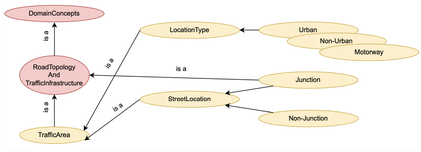

Figure 2: Modified structure of the traffic area concept (©BASt | FOKUS)

Demonstration on Use Case

We demonstrate that by using formalized normative knowledge the agent is able to correctly detect desired targets by reasoning over perceived data. The model takes real driving data, collected from on-board sensors and computational results of machine learning-based models, as inputs and maps these onto the A-Box via the ontology, which creates the knowledge base. We add a reasoner that executes pre-defined queries to answer the questions about the traffic scenarios (Fig. 3).

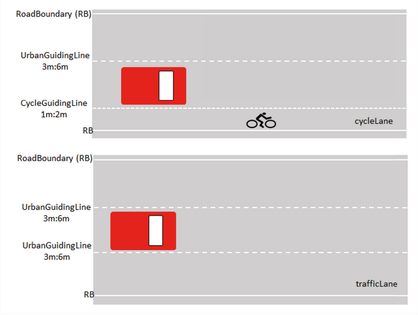

Figure 3: Ego Lanes left connected to the Urban Guiding Lines and right connected to the Cycle Guiding Line (top), and right connected to the Urban Guiding Line (bottom) (©BASt | FOKUS)

Conclusion

The formalization of the German Technical Specification on Lane Markings into an ontology is a feasible way to make AI decision making rule-compliant, transparent, and traceable. The structured representation of the Technical Specification on Lane Markings through ontology enables a method that is comprehensible and processable by both humans and machines. We develop and extend the ontology based on the ASAM OpenXOntology by incorporating scenario-specific concepts and rules. This approach significantly enhances situational awareness of ADS functions. Moreover, we demonstrated that combining symbolic reasoning with environmental context provides a reliable and traceable way to deepen the understanding of traffic situations.

References:

[1] M. Grabowski, Y. Wang: A Concept to Support AI Models by using Onologies – Presented on the Basis of German Technical Specifications for Lane Markings, 2023
[2] RMS-1 Richtlinien für die Markierung von Straßen. Teil 1: Abmessung und geometrische Anordnung von Markierungszeichen (Oktober 1993)
[3] https://www.asam.net/project-detail/asamopenxontology

Partners

External partners

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