technische universität dortmund

computer science 12

Master Thesis

Evaluation Framework for End-to-End Analysis

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Real-time systems require a formal guarantee of timing-constraints. In typical industrial systems, usually several tasks communicate to achieve a certain functionality. As an example, Figure 1 shows a simplified data dependency graph for an autonomous driving application. For such highly distributed systems, usually the *end-to-end latency* is examined. That is, considering some external activity (i.e., a change in the environment) occurs, then:

> How long does it take until the external activity is fully processed by the system?

In the literature, there are several analytical results that can be applied to analyze the end-to-end latency of cause-effect chains, e.g., [2, 3, 4]. However, it is often difficult to perform a comparison between end-to-end analyses because they are available in different repositories, use different programming languages, rely on different task generators, etc. An evaluation framework, similar to the one for self-suspending task systems [5], should be pursued.

In this thesis,[1] the student implements an evaluation framework for end-to-end analysis. First, the student gets familiar with the analysis landscape of end-to-end analysis for cause-effect chains. Afterwards, a framework should be designed that allows easy integration of analyses and benchmarks. The student collects available results from the literature and includes them in the framework. Students should note that, the involved source code prepared in this thesis will be publicly released and should be fully documented to comply the rationale of open-source software development.

Required Skills:

- Knowledge about Real-Time Systems.
- Interest in analysis of distributed systems.
- Comfortable in a suitable programming language, preferred Python.

[1]Other suggestions and related topics are also welcome. Please do not hesitate to make an appointment.

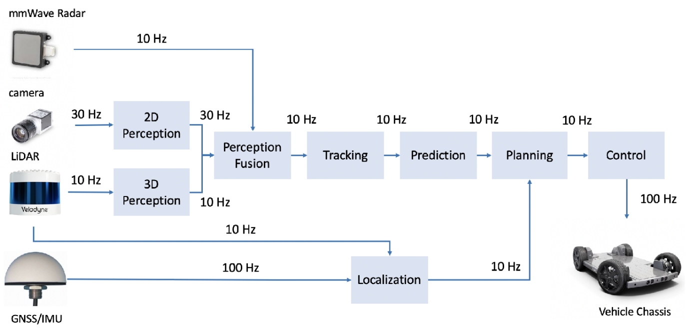

Figure 1: An autonomous driving application as presented in the RTSS industry challenge 2021 [1].

Acquired Skills after the thesis:

- Knowledge about end-to-end timing analysis of cause-effect chains.
- Experience with open-source publication of code.

References:

[1] Industry Challenge of 42nd IEEE Real-Time Systems Symposium (RTSS). 2021. (PDF)

[2] Abhijit Davare, Qi Zhu, Marco Di Natale, Claudio Pinello, Sri Kanajan, and Alberto L. Sangiovanni-Vincentelli. 2007. Period Optimization for Hard Real-time Distributed Automotive Systems. In Design Automation Conference, DAC. 278–283. https://doi.org/10.1145/1278480.1278553

[3] Matthias Becker, Dakshina Dasari, Saad Mubeen, Moris Behnam, and Thomas Nolte. 2016. Synthesizing Job-Level Dependencies for Automotive Multi-rate Effect Chains. In International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA). 159–169. https://doi.org/10.1109/RTCSA.2016.41

[4] Mario Günzel, Niklas Ueter, Kuan-Hsun Chen, and Jian-Jia Chen. 2023. Timing Analysis of Cause-Effect Chains with Heterogeneous Communication Mechanisms. In RTNS. ACM, 224–234. https://dl.acm.org/doi/abs/10.1145/3575757.3593640

[5] LS12 DEAS Group. Evaluation Framework for Self-Suspending Task Systems. (Github repository).