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computer science 12

Bachelor/Master Thesis

Advancing an Evaluation Framework for Self-Suspending Tasks

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Real-time systems often contain self-suspending tasks—tasks that intentionally pause execution, for example, to wait for I/O or shared resources. These suspensions introduce new challenges for schedulability analysis, making their correct evaluation essential for ensuring system reliability. Figure 1 shows a self-suspending task with two execution segments and one self-suspension segment in-between.

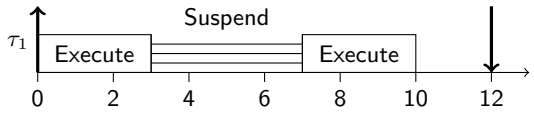

Figure 1: Example of a self-suspending task τ_1.

A Python-based evaluation framework [6] (with GUI depicted in Figure 2) for self-suspending tasks, which supports multiple models (segmented, dynamic, and hybrid) [2], has been developed by our group. The functionality of the framework is threefold: First, it can be used to generate self-suspending task sets, using existing synthesis approaches. Second, it provides schedulability tests from 18 different papers that can be applied to the generated task sets or external task sets, which are loaded into the framework. Third, it illustrates the performance of schedulability tests by plotting acceptance ratio, i.e., the amount of task sets that are deemed schedulable by the test divided by the total amount of task sets, over the total utilization of task sets.

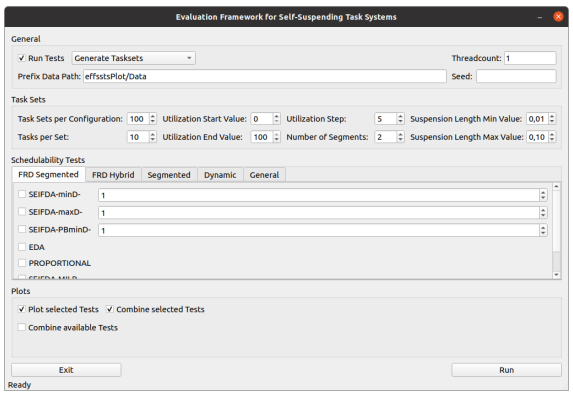

Figure 2: Graphical User Interface of the Evaluation Framework.

While the evaluation framework is already established as a useful resource for the evaluation in the research community, there are several **possible improvements** to keep the framework up to date and to enhance its capability and usability:

- *User Interface:* Add a command line interface (CLI) or terminal-based user interface (TUI) to improve the usability.
- *Integration of New Analysis Techniques:*
  - A test for Fixed-Priority (FP) with arbitrary deadlines and arrival curves [5]
  - A test for Earliest-Deadline-First (EDF) with constrained deadlines [1]
  - A test for EDF-Like scheduling [4]
  - Support for the sporadic task model in the UPPAAL-based test [7] (current integration only supports periodic tasks)
- *Framework extensions:*
  - Include release jitter into the task model
  - Use the Dirichlet-Rescale (DRS) [3] Algorithm for task generation

In this thesis, the student advances the evaluation framework for self-suspending task sets by targeting **some** of the potential improvements mentioned above. The precise scope of the thesis will be decided in communication with the student. 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: Are flexible and depend on the scope of the thesis. Reasonable (but not required!) skills are:

- Knowledge in real-time systems.
- Interest in the analysis of self-suspending tasks.
- Experience with GUI, CLI or TUI programming in Python3.

Acquired Skills after the thesis:

- Knowledge about self-suspending tasks.
- Experience with open-source publication of code.

References

[1] Aromolo et al. "Response-Time Analysis for Self-Suspending Tasks Under EDF Scheduling". In: *ECRTS*. https://drops.dagstuhl.de/entities/document/10.4230/LIPIcs.ECRTS.2022.13. 2022.

[2] J. Chen et al. "Many suspensions, many problems: a review of self-suspending tasks in real-time systems". In: (2019). https://link.springer.com/article/10.1007/s11241-018-9316-9.

[3] D. Griffin et al. "Generating Utilization Vectors for the Systematic Evaluation of Schedulability Tests". In: *RTSS*. https://ieeexplore.ieee.org/document/9355491. 2020.

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[4] M. Günzel et al. "EDF-Like Scheduling for Self-Suspending Real-Time Tasks". In: *RTSS*. https://ieeexplore.ieee.org/abstract/document/9984793. 2022.

[5] M. Günzel et al. "Suspension-Aware Fixed-Priority Schedulability Test with Arbitrary Deadlines and Arrival Curves". In: *RTSS*. https://ieeexplore.ieee.org/document/8715111. 2021.

[6] TU Dortmund LS12. *Evaluation Framework for Self-Suspending Task Systems*. https://github.com/tu-dortmund-ls12-rt/SSSEvaluation. 2021.

[7] B. Yalcinkaya et al. "An Exact Schedulability Test for Non-Preemptive Self-Suspending Real-Time Tasks". In: *DATE*. https://ieeexplore.ieee.org/document/8715111. 2019.