inf456 - Real-Time Systems

<table>
<thead>
<tr>
<th>Module name</th>
<th>Real-Time Systems</th>
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<tr>
<td>Module code</td>
<td>inf456</td>
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<tr>
<td>ECTS credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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Used in degree programmes
- Master's Programme Computing Science > Mastermodule
- Master's Programme Embedded Systems and Microrobotics > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems > Systems Engineering

Contact person
- module responsibility
  - Ernst-Rüdiger Olderog
  - Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden
  - Ernst-Rüdiger Olderog

Prerequisites

Skills to be acquired in this module
Introduction to formal methods of the specification and verification of time sensitive systems and their combinations.

Professional competence
The students:
- Learn about different models of time and real-time properties
- Specify and verify real-time systems
- Model real-time systems using Timed Automata and PLC-Automata
- Apply the model checker UPPAAL for the verification of real-time properties
- Specify real-time systems using the Duration Calculus
- Learn about decidability and undecidability results for real-time systems

Methodological competence
The students:
- Recognize logic and automata as adequate forms for describing real-time systems

Social competence
The students:
- Work together in small groups to solve problems
- Present their solutions to groups of other students

Self-competence
The students:
- Learn persistence in pursuing difficult tasks
- Learn precision in specifying problems
Examples of time-critical systems are railway control systems, robots, or even gas burners. It is essential for these systems to comply with certain timing conditions. For example, the control of a railway crossing must close the gates not later than 4 seconds after the sensors have reported an approaching train. If the gates are open, they should stay that way for at least 15 seconds to allow for a safe crossing of vehicles.

Different specification methods have been developed to describe such timing conditions. The Duration Calculus developed by Zhou Chaochen in 1991 is one attractive method. It is a logic combined with a calculus, in which the duration of states can be described. The course will introduce the Duration Calculus and will explain its application by means of examples. As further specification method Timed Automata introduced by Alur & Dill in 1994 will be presented. After the specification of real-time system requirements the verification of programs implementing these requirements will follow. The specification methods of the Duration Calculus and Timed Automata are used to describe the real-time behaviour of these programs. The correctness is then proven on the basis of these behavioral descriptions.

Topics:

- discrete and continuous model of time
- logics and automata models for the specification of real-time systems (predicate logic, Duration Calculus, Timed CTL, Timed Automata, PLC-Automata)
- decidability and undecidability results for real-time systems
- model checker UPPAAL for Timed Automata
- formal specification of real-time systems using Duration Calculus as well as Timed Automata and PLC-Automata
- verification of concrete Timed Automata using the model checker UPPAAL,
- transformation of Duration Calculus for discrete time into regular languages
- implementability of real-time systems on PLC-like hardware

Recommended reading

Productive:


Recommended:


Links

- Languages of instruction: German, English
- Duration (semesters): 1 semester
- Module frequency: irregularly
- Module capacity: Unlimited
- Module level: AS (Akzentsetzung / Accentuation)
- Module type: Pflicht o. Wahlpflicht / compulsory or optional
- Learning/Teaching Type: V+Ü

Recommended reading


Recommended:

### Vorkenntnisse / Previous knowledge

Theoretical Computer Science I and II

<table>
<thead>
<tr>
<th>Examination</th>
<th>Examination periods</th>
<th>Type of examination</th>
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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Exercises and written or oral exam</td>
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<td>Lecture</td>
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<td>Exercises</td>
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<td>WinSem</td>
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**Total attendance time for module**: 56 h