Real-Time & Embedded Systems

Uwe R. Zimmer - The Australian National University

Real-Time & Embedded Systems 2019

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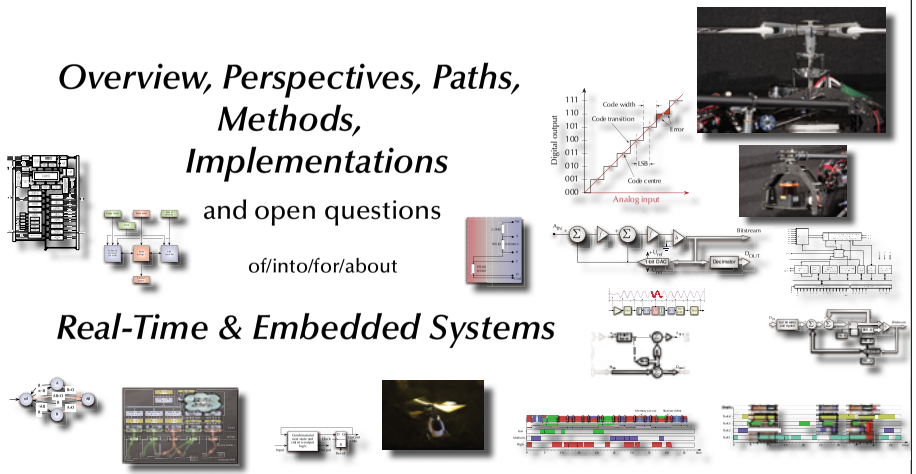
what is offered here?

Overview, Perspectives, Paths, Methods, Implementations

and open questions

of/into/for/about

Real-Time & Embedded Systems



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who could be interested in this?

anybody who …

… would like to see **immediate real-world involvement** *in his/her work.*

… would like to learn how to create
predictable and fault-tolerant, complex systems.

… would like to know more about the usage of >95% of all processors.

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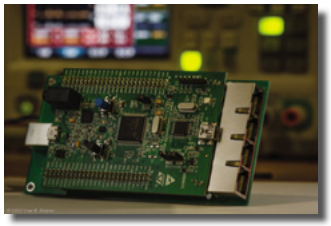
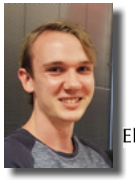
who are these people? – introduction

This course will be given by

Uwe R. Zimmer

Tutoring and labs by





Calum Snowdon &
Michael Bennett

Electronics design by

Mark Turner

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how will this all be done?

☞ Lectures:
- 2x 1.5h lectures per week … all the nice stuff
  Monday, 15:00 (Engineering Theatre) and Thursday 09:00 (Forestry Theatre)

☞ Laboratories:
- 2 hours per week … all the rough stuff
  time slots: on our web-site – all in CSIT laboratories
  -enrolment: https://cs.anu.edu.au/streams/

☞ Resources:
- Introduced in the lectures and collected on the course page:
  https://cs.anu.edu.au/courses/comp4330/ … as well as schedules,
  slides, sources, link to forums, etc. pp. … keep an eye on this page!

☞ Assessment:
- Exam at the end of the course (70%) plus one assignments (30%)
  – both are tested in oral exams (unless enrolment numbers require otherwise).

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Textbooks (sort of …)

[Burns2009]
Alan Burns and Andy Wellings
Real-Time Systems and Programming Languages
Addison Wesley, fourth edition, 2009

[Burns2007]
Alan Burns & Andy Wellings
Concurrent and Real-Time Programming in Ada
Cambridge University Press, 2007

[McCormick11]
McCormick, J. W., Singhoff, F., & Hugues, J.
Building Parallel, Embedded, and Real-Time Applications with Ada.
Cambridge University Press, 2011.

… plus specific references for each topic (all on the course site).

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
   - 1.1. Staking out the field
   - 1.2. Features (and non-features) of a real-time system
   - 1.3. Components of a real-time system
   - 1.4. Real-time languages
     - Ada
     - Esterel
     - Pearl
     - VHDL
     - Timed CSP
     - Real-time JAVA
     - POSIX
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
   - 2.1. Physical values
   - 2.2. Introduction to sensors
   - 2.3. Frequently employed sensors
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
   - 3.1. Analogue signal chain in a digital system
   - 3.2. Analog-Digital converters
   - 3.3. Interface devices
   - 3.4. µ-controllers
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
   - 4.1. What is time? / What is embodiment?
   - 4.2. Time: notion, delays, time-out
   - 4.3. Interfacing with time
   - 4.4. Specifying timing requirements
   - 4.5. Satisfying timing requirements
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
   - 5.1. Interrupts, signals, exceptions
   - 5.2. Atomic Actions
   - 5.3. Asynchronous transfer of control
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
   - 6.1. Variable-based synchronization
   - 6.2. Message-based synchronization
7. *Scheduling*
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
   - 7.1. Basic real-time scheduling
   - 7.2. Real-world extensions
   - 7.3. Language support
8. *Resource control*
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
3. *Interfaces*
4. *Time & Embodiment*
5. *Asynchronism*
6. *Synchronisation*
7. *Scheduling*
8. *Resource control*
   - 8.1. Resource synchronization primitives
   - 8.2. Resource reclaiming schemes
   - 8.3. Real-time resource control
9. *Reliability & Fault-tolerance*

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Topics

1. *Introduction & Real-time languages*
2. *Physical coupling*
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9. *Reliability & Fault-tolerance*

9.1. Terminology

9.2. Faults

9.3. Redundancy

9.4. Reduce & Formalise

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