The Role of Programming Languages in the Curriculum for Teaching Embedded and Real-Time Systems

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Overview

- Issues to consider when attempting to produce a curriculum for embedded systems
- Experiences at York

Issues

- Curriculum is broad but not shallow
- Systems is hard to teach at undergraduate level
  - Hard to be coherent
  - Hard to attract students
- Postgraduate courses (MSc)
- Some refocusing of undergraduate courses

Computer Science

- Moving more towards Engineering
- Has many (but not all) of the basic material needed for an embedded systems curriculum
- Can move students towards careers in embedded systems engineering

York CS Degree

- A lot of maths
- Analogue and digital electronics
- Usual OS material, device drivers etc
- Model-based view of design
- Students can choose an Embedded Systems strand to their degree

Embedded Systems Strand

- Development work in 2nd year
- Networking, comms etc in 2nd year
- Real-Time Systems in 3rd year
- Control theory in 3rd year
- Hardware/Software co-design in 4th year
- High Integrity Systems in 4th year

Real-Time Systems

- To give cohesion to the material, and student enjoyment, we give a programming centred course
- Computer languages provide a framework to discuss many embedded system concepts
- We use language abstractions, experimental languages and mainstream languages (eg Ada, C with POSIX, Java)

Key Concepts

- Concurrency
  - Various models
  - Form of analysis, eg model checking
  - Common idioms – control loops, sampling etc
- Fault tolerance
  - Various primitives
  - Fault models etc
  - Atomic actions etc

Key Concepts

- Scheduling
  - Resource usage, including fault tolerance
  - Various forms of analysis, eg RTA
  - Distributed systems
- Low level programming
- Lab sessions
  - Student build and analyse embedded systems

Conclusions

- Programming and the study of languages is one way to bind a number of concepts together
- Advanced courses, MScs, are one way to approach the full embedded system curriculum – but ensuring students have a common set of pre-requisites is difficult