Embedded System Design and Synthesis

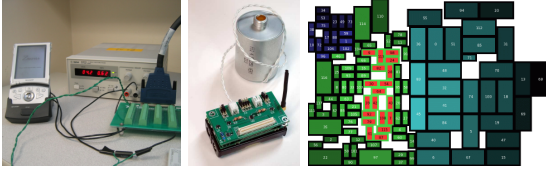Robert Dick

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Summary of course
Future research directions and collaboration
Project presentations
Project report

What is embedded system research?

- Hardware and software
- Design and automation
- Multiobjective (power, performance, reliability, etc.)
- Rich with applications and theory

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What topics are central?

- Algorithm design
- Software systems and software engineering
- Analog and digital hardware design
- Low-power design
- Synthesis
- Scheduling
- Distributed systems
- Real-time systems
- and many more

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What techniques are used?

- Optimization
- Complexity analysis
- Simulation
- Compression
- Prediction
- Architectural and circuit design
- Compiler design
- Operating system design
- and many more

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What applications are important?

- Personal communication
- Multimedia
- Transportation
- Sensor networks
- Home automation
- Medicine
- Military
- and many more

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Multiprocessor system-on-chip synthesis

Working on complete flow from verifiable specification to HW/SW system

Must consider temperature, performance, reliability, and power

The Ph.D. students to finish this should start a company when they graduate

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Thermal analysis and temperature-aware design of integrated circuits

Fast thermal modeling and analysis techniques

Determining which thermal problems are most critical in real industrial integrated circuits and solving them

E.g., via reliability and on-line thermal management

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Optimizing computer systems subject to user satisfaction

Design embedded systems that understand and adapt to the needs of their users

Start with explicit commands from users

Move to automatic, implicit understanding of user needs

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Sensor network synthesis: opening the use of wireless sensor networks to application experts

Design compact, verifiable specification languages tailored to sensor network application domains

Automatically compile/synthesize to sensor network hardware and applications

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Thermal modeling, management, and optimization for high-performance integrated circuit testing

Thermal modeling, sequential test generation, and test scheduling to prevent chips from burning up during test

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Hardware-software techniques to eliminate off-chip voltage regulation circuitry from embedded systems

Build a hardware–software system to prove that deregulation works

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Industry liaisons

- · AMD
- · Cadence
- · Intel
- · Mentor Graphics
- · Texas Instruments
- · HP
- · Freescale
- · LSI Logic
- · IBM
- · NEC Labs America

Collaboration

If you are interested in working on these topics, or other topics in embedded systems, CAD, or VLSI, I may be able to help

Three options for collaboration

- · Can collaborate from Tsinghua
- · Can participate in Tsinghua–Northwestern exchange program
  - · Come work with us for a year, then return to your group at Tsinghua and continue collaboration throughout your Ph.D.
  - · Working on allowing students in the program to receive a Northwestern Master's degree without cost
- · If you are about to graduate with a Bachelor's or Master's degree, may be able to join us for a Ph.D.
- · If you are about to finish your Ph.D. degree, may be able to spend a year as a visiting scholar

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Project presentation

5–10 minutes per person
- Motivation
- Problem definition
- Proposed solution
- Method of evaluating solution

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Project report

- · Due 6 September by email
- · Can give to me in person on 5 September

- Motivation
- Related work
- Problem definition
- Proposed solution
- Method of evaluating solution
- Evaluation results