Embedded Systems: An Application-Centered Approach

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Your teacher's background

- Embedded systems researcher with 100 publications in the area.
- Have reviewed a huge number of papers on the topic, served as technical program committee co-chair for a top embedded systems conference.
- Co-founded wearable electronics company with product coming to market in near future.
- Learned the hard way that customer discovery is important in research, and essential in business.

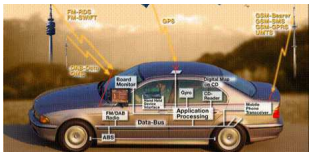
Embedded system definition

Embedded system: A computer within a host device, when the host device itself is not generally considered to be a computer.

Embedded systems examples


Medical devices


Sensor networks


Automobiles


Smartphones

Embedded system market size

- Dominates general-purpose computing market in volume.
- Similar in monetary size to general-purpose computing market.
- Growing at 15% per year, 10% for general-purpose computing.

Example: cars

40% of value in embedded electronics, from zero a few decades ago.

Hot embedded topics

- Internet of things
- Mobile computing
- Wearable electronics
- Cyber-physical systems
- Distributed wireless communication systems
- Intelligent infrastructure/transportation
- Smart buildings
- Embedded system security

Embedded system requirements

- Hard real-time
- Wireless
- Reliable
- First time correct
- Rapidly implemented
- Low price
- High-performance
- Low power

More on these later.

What you can do in the course project.

- Develop better embedded system design or analysis ideas.
- Automate aspects of embedded system design process that are currently done manually.
- Find a way to solve a new real-world problem with an embedded system.

Course goals I

- Define, design, and prototype an embedded system.
- Build broad knowledge of the field.
- **Understand how to select and define a problem that others want solved.**
  Customer discovery interviews. Literature surveys. Market research.
- **Have a general understanding of embedded system uses and design process.**
  Covered in lecture, practical reading material, and study for project.

Course goals II

- **Have a general understanding of current embedded system research topics.**
  Covered in lecture, research papers, and study for project.
- **Have a deep understanding of one particular research problem.**
  Primarily covered through self-study of research and technical documents while working on project.
- Be prepared for research on, and development of, embedded systems.
- Be capable of writing technical papers, presenting, and selling your work.

Today's goals

1. Start picking project topics and forming teams.
2. Know how to get access to course resources.
   - Website.
   - CTools.
   - References.
   - Piazza.
3. Understand work and grading policies.

Class prerequisites

Knowledge of **some** of the following topics.

- Computer architecture.
  - Distributed systems.
  - Cache effects.
  - Power consumption impact of architectural decisions.
- Networking.
- Systems programming.
  - Project-oriented course with substantial programming component.
- Algorithm design and analysis.
  - Computational complexity analysis.
  - Efficient algorithm design.

Pick project team members carefully.

Course structure I

Lectures

- Initially background material, survey papers, classical (old) research papers.
- Then recent research papers.
- Near the end of the course, project presentations will be given.

Office hours

- Immediately after lecture and by appointment.
- I will need to have in-depth discussions with teams as projects progress.
- 2417-E EECS.

Course structure II

Lab sessions

- Initially, descriptions of past projects to provide examples.
- Coverage of practical implementation problems.
- Help on specific project problems.
- Near the end of the course, project demos will be given.

Course structure III

Project reports (25% weight), demos/design (50% weight), and presentations (25% weight)

- 7 Jan: Topics of interest.
- 9 Jan: Team formation.
- 12 Jan: Written project proposals with clear plan for checkpoint 1 and checkpoint 2.
- 14 Jan and 16 Jan: Project proposal presentations to get feedback from classmates and instructor.
- 20 Feb: Checkpoint 1 report.
- 27 Feb and 2 Mar: Checkpoint 1 presentation and demo.
- 25 Mar: Checkpoint 2 report.
- 27 Mar and 30 Mar: Checkpoint 2 presentation and demo.
- 17 Apr and 20 Apr: Final presentation and demo.
- 21 Apr: Final report.

Grade weighting scheme

Product–market search: 30% weight

Interviews every week.

Projects: 30% weight

Design/research quality.

Presentations: 25% weight

Clarity, story telling, brevity, and delivery.

Exam and quizes: 15% weight

- Will have many short quizes on reading and lecture material.
- Unpredictable timing.
- Lowest quiz grade will be dropped.
- Exam is for breadth. Projects are for depth.

What to do before Friday

1. Follow the CTools link to Piazza and use Piazza to find a teammate.
2. Narrow down your topic of interest to an embedded system idea and describe it in 3-4 sentences.
3. Be prepared to state your idea in Friday's lecture.
4. Get and read Chapter 5 (and ideally also 1-4) in Naeem Zafar's book.
5. (Optional) Do a few interviews of people who might value what you are trying to provide and take detailed notes. This stops being optional after Friday.