EECS 507: Introduction to Embedded Systems Research From Idea to Publication and/or Company and Specifications

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Outline

Breadth I

- Reading and writing research papers.
- Costs, constraints, and optimization.
- Specification languages and models. Allocation, assignment, and scheduling.
- The role of the memory hierarchy in embedded systems.
- Embedded (real-time) operating systems.
- Sensors and actuators.
- Cyberphysical systems.
- Low power sensing (guest lecture)
- Energy- and temperature-aware design and embedded power supplies.
- Wireless communication and its impact on power consumption.
- Reliability-aware design and formal methods.

Breadth II

- Testing.
- Security.
- Applications: smartphones.
- Applications: wireless sensor networks.
- Applications: wearables.
- Applications: autonomous vehicles.
- Applications: vision.

Depth I

- The IoT problem.
- Overview of machine learning in the IoT.
- Efficient embedded machine learning algorithms in the IoT.
- Devices and circuits for machine learning.
- IoT reliability.
- LPWAN communication.
- IoT security and privacy.
- Vision in the IoT.
- Data compression in the context of energy efficiency and machine learning.

Outline

Finding research papers

- Google Scholar, considering publication date and citations.
- Recommendations by researchers in the area.
- Top conferences and journals in the area.
- Find surveys and follow the citations.
- Find great papers and follow citations in reverse order.
- In some cases, consider patents.

Embedded systems conferences and journals I

- Embedded Systems Week conferences.
- Cyber-Physical Systems Week conferences.
- Design Automation Conference.
- Design, Automation, and Test in Europe Conference.
- International Conference on Architectural Support for Programming Languages and Operating Systems.
- Conference on Embedded Networked Sensor Systems.
- IEEE Transactions on Mobile Computing.
- IEEE Transactions on Very Large Scale Integration Systems.

Embedded systems conferences and journals II

- IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems.
- IEEE Design and Test of Computers.
- ACM Transactions on Embedded Computing Systems.

Not exhaustive.

Reading research papers

Read in detail. If you must skim once, reread in detail.

When you encounter a concept you aren't yet aware of, note it and move on.

If the paper starts to become incomprehensible, return to missing concepts and follow citations or search for definitions.

This is hard and slow; it speeds up when you better understand a field.

Check equations and algorithms carefully; most people miss them.

Read experimental setup carefully and skeptically.

Interpret results with an open mind, ignoring the authors' claims.

Study the ideas that remained unclear at the end of the paper.

Search for the most interesting and important ideas and findings; don't copy-paste the abstract.

Paper summaries: Why?

Force you to think while reading.

- Most research paper authors don't write outright lies.
- They frequently misinterpret their results.
- They frequently miss connections with other work.
- They very frequently don't see the implications of their work.
- They usually bias their descriptions toward "success".

Remember what ideas were in each paper

- Imagine you will be working on a project for over a year, then writing a paper.
- You read 20–100 papers.
- Remembering which ideas were in which paper is difficult without terse notes.

Paper summaries: How?

What are the most important ideas and implications?

Don't trust the author's interpretation.

Don't copy the abstract.

Caveat: Survey papers are very difficult. Sometimes a good summary of a survey paper overlaps the abstract.

Focus on a few very important points; generally 0.5–1 page is best.

From idea to publication

While not novel

- Develop idea.
- Do literature survey to find best closely related work.

Develop method of evaluating idea. Abandon if it cannot be evaluated.

While not highly rigorous

Evaluate with increasing detail, comparing with best closely related work.

Write the abstract and claims. Abandon if not important.

Identify appropriate conference or journal.

- Ask experts in the area.
- See where excellent related papers were published.
- Consider impact factors and acceptance rates.
- See whether similar ideas were published there recently.

Write paper.

Anticipatory writing

- Know your audience.
- Don't waste their time.
- Don't spin.
- Make novelty clear.
- Give credit when it is due.
- Be careful, but blunt when comparing.
- More novel ideas are harder to publish...
- ...but they are eventually heavily cited and win awards.

Understanding the reviewer

Off record.

From idea to company

Develop an idea that many people value deeply.

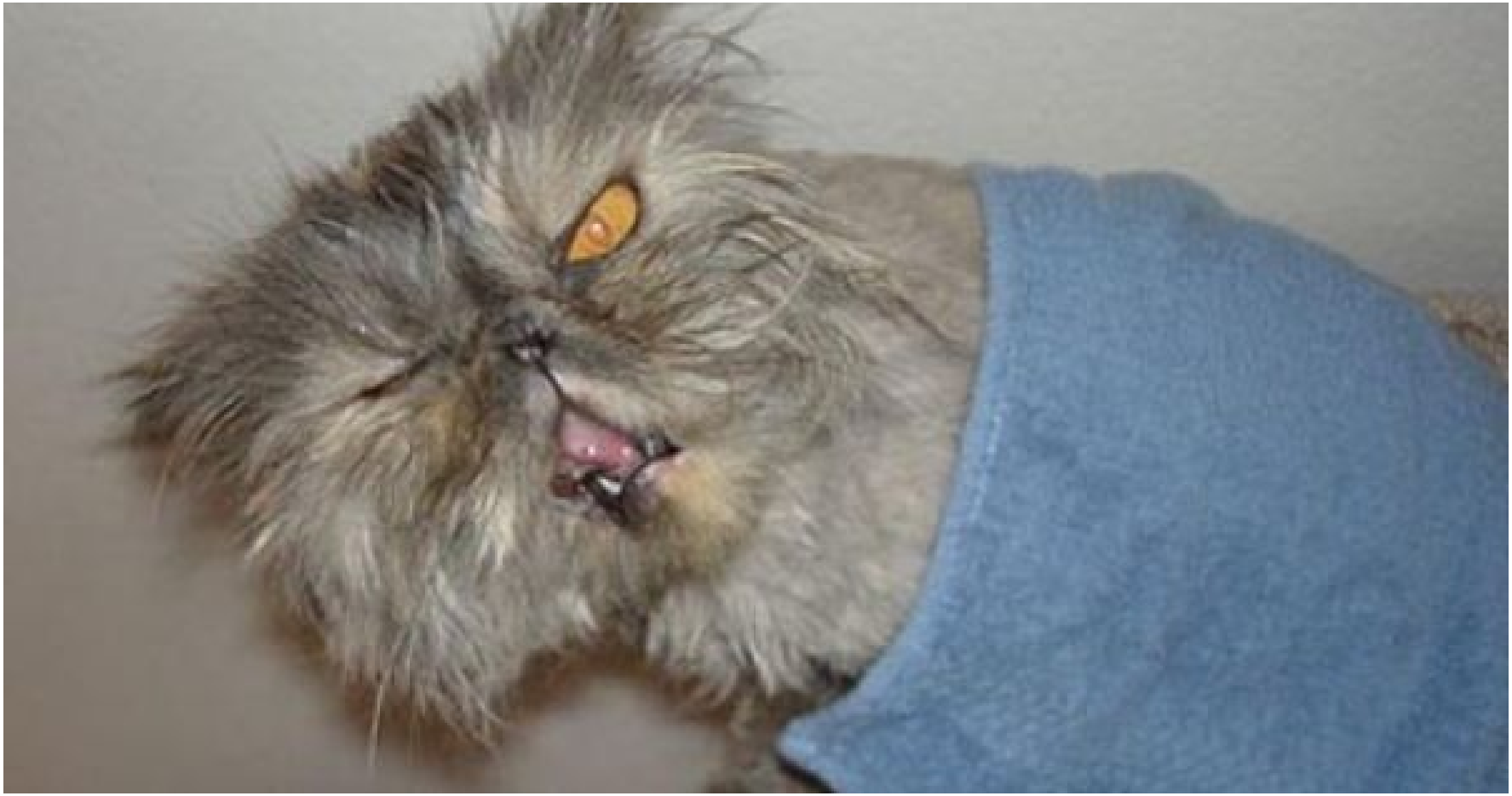
How? Talk to the potential customers first.

Start with the potential customers.

When you prototype, start with quick, low-resolution version.

How you see your idea

How your customers see your idea



How your customers see you

That's a great idea!

What they say: That's a great idea.

What they mean: I don't want to hurt your feelings you cute widdle engineer.

I would definitely use that!

There are almost no circumstances in which I would use that, let alone consider paying for or supporting it.

I have some ideas on how to make it better!

I'm pretending to be someone who would use it and leading you down a false path.

Follow your dreams, dude!

Squander your life, dude!

How to learn more

- Talking to Humans by Giff Constable.
- The Startup Owner's Manual by Steve Blank and Bob Dorf.
- Market Research on a Shoestring by Naeem Zafar.
- Steve Blank's online videos (steveblank.com).
- Contact me for more.

What you need to learn

How to design, sequence, and deliver questions to minimize bias, both yours and theirs.

How to talk with strangers.

This is highly unnatural, all the more so for most engineers.

Most must learn it.

You can learn it well enough to do a good job, even if it makes you uncomfortable.

Other topics

- Business plans.
- Self funding.
- Crowdfunding.
- Angel investors.
- VCs.
- Production.
- Marketing.
- Sales and distribution.
- Customer support.

Paper discussion mechanics

Papers all posted to website.

Everybody reads them and writes 0.5–1 page summaries (see template) covering the most important points.

Everybody critiques the summaries of other randomly assigned people.

A randomly assigned team presents each paper (slides and 20–30 minute presentation).

You can swap papers with others based on interest and background.

Outline

Deadlines TBD

Homework I

6 September

- Read A. Jantsch and I. Sander, "Models of computation and languages for embedded system design," *IEEE Proc.*, pp. 114–129, 2005.
- Write a 0.5–1 page ungraded summary.
- Take it seriously. Once chance for feedback without risk.
- I will post submission instructions on Piazza.

Homework II

6 September

- 0.5–1 page project description with 2–5 citations.
- Indicate the goal.
- Describe the best closely related prior work.
- Indicate what is novel about your idea or the data you will gather.
- Describe the solution(s) you will consider.
- Explain how the solution(s) will be evaluated.
- Upload PDF before class that day.
- Allows suggestions and team formation.
- Also watch Piazza. Will post examples.

Announcement: Optional project team formation meeting

5pm–7pm 6 September.

Come prepared to briefly pitch your project idea.

Room number TBA via Piazza.