

Embedded computing for scientific and industrial imaging applications

Lecture 1 - Goal of course, overview, requirements.

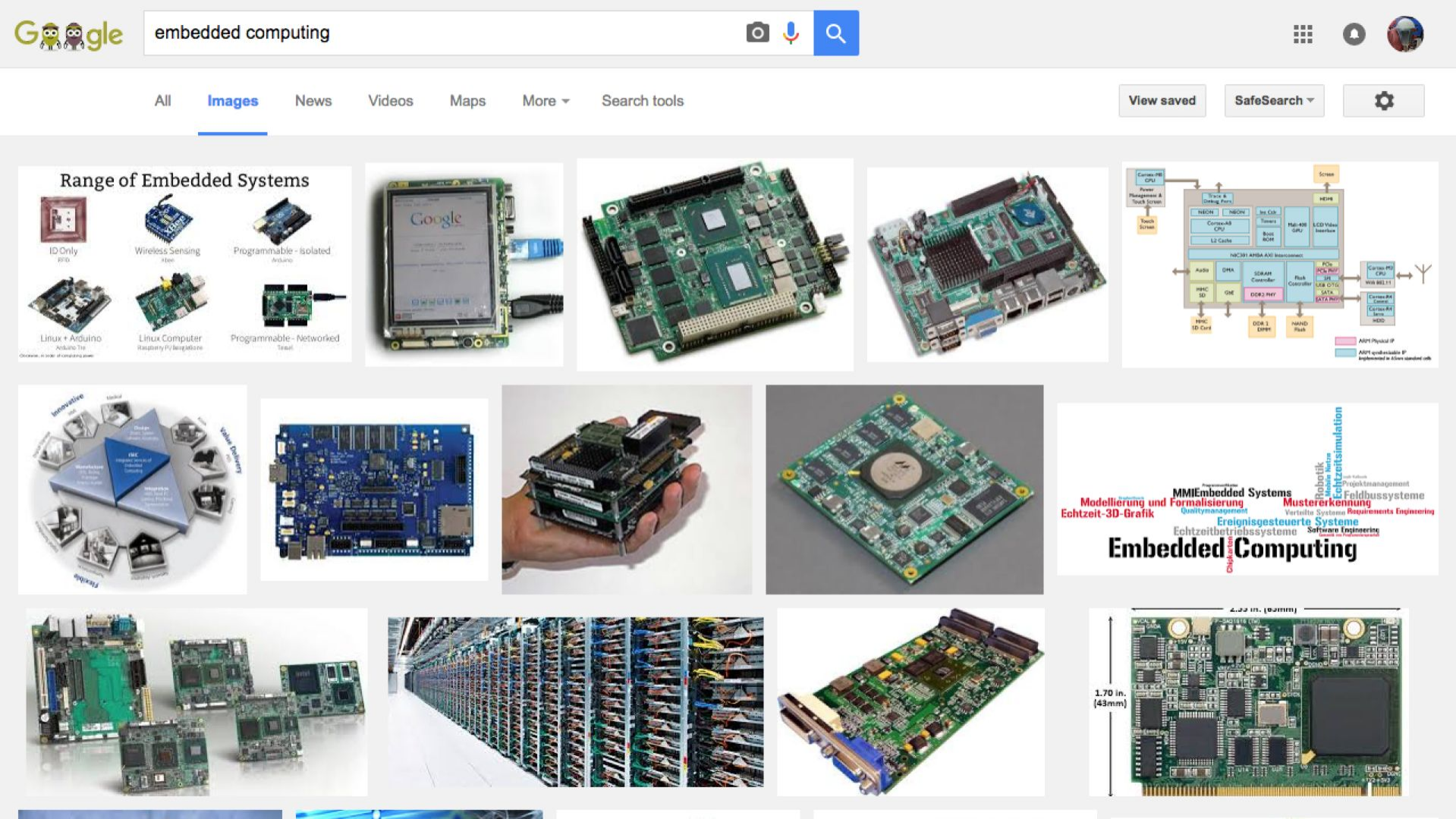
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Assignments and grading

- See [course webpage](#) for schedule and assignments.
- 3 homework assignments and a final project
- These will be turned in by pushing to a GitHub repository.

Embedded computing?



Embedded system?

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Wallpapers



Examples



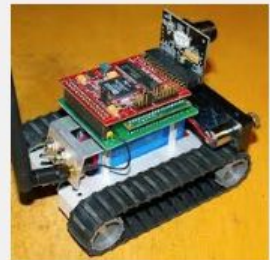
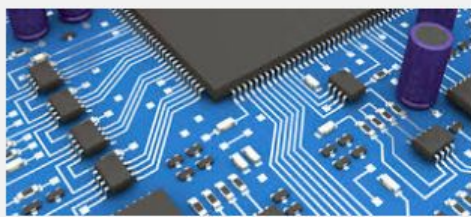
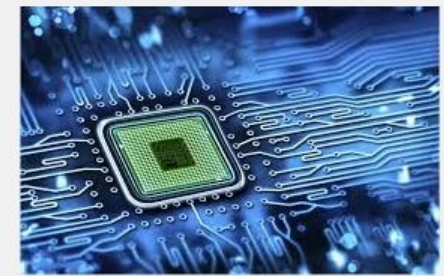
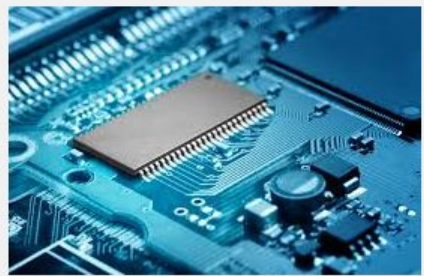
Logo



Design



Projects



Embedded system

- Any computer that is a component in a larger system and that relies on its own microprocessor - *Wayne Wolf, Princeton University,*
[What_is_embedded_computing](#)
- An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system.often with real-time computing constraints. - https://en.wikipedia.org/wiki/Embedded_system

Embedded system

- Low power consumption, small size, rugged operating ranges, and low per-unit cost. limited processing resources,
- Modern embedded systems are often based on microcontrollers (i.e. CPUs with integrated memory or peripheral interfaces)
- dedicated to specific tasks, reduce the size and cost of the product and increase the reliability and performance.
- range from portable devices to large stationary installations (smart phones, vehicles, medical devices such as MRI, CT and US)
- Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

Example - AP (Application processor)

- Memory, Display system/controller
- Multimedia en/decoding codec
- 2D/3D accelerator engine,
- ISP(Image Signal Processor),
- Camera, Audio, Modem,
- High & low speed Serial/Parallel connectivity interface

⇒ SOC(System-On-Chip)

ref : <https://news.samsung.com/kr/482>

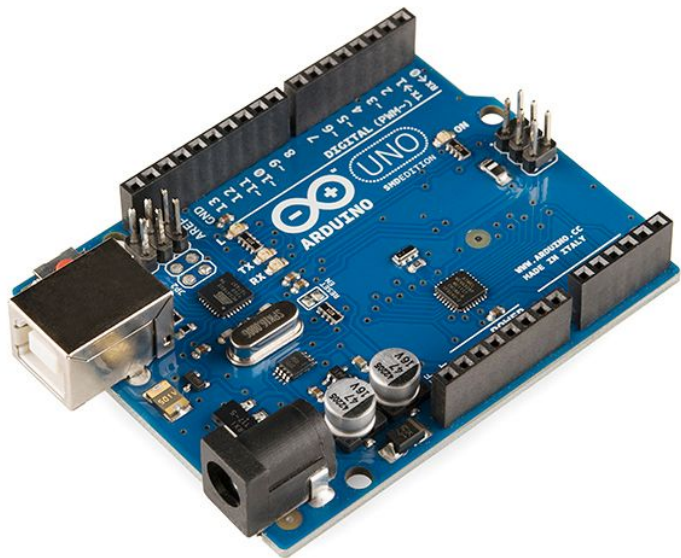


Diagnostic ultrasound imaging system

- Ultrasound system
 - Computing unit - ASIC, FPGA, DSP
 - Storage - RAMs and ROMs
 - User Interface - Ultrasound transducer
- Industrial embedded computer
 - Computing unit - CPU, GPU
 - Storage - RAMs, ROMs, HDD and SSD
 - Communication - ethernet, WIFI, USB
 - User Interface - Key panel, Keyboard and trackball



Examples



Raspberry Pi

- <https://www.raspberrypi.org/>
- Credit card-sized single-board computers
- Promoting the teaching of basic computer science in schools and developing countries
- Pi 1 released in Feb 2012.
Pi 3 released in Feb 2016.
- Raspbian, Ubuntu, Windows 10 IOT
- Python and Scratch
- 8 million in 2016
- <https://github.com/raspberrypi>



Arduino

- <https://www.arduino.cc/>
- open-source electronics platform based on easy-to-use hardware and software.
- 700,000 official boards in 2013.
- <https://github.com/arduino>
- C / C++



Goal of this course

Essential skills for embedded computing

- Essential to know if you eventually want to work on embedded systems.
- Extremely useful for any embedded computing project, even on a laptop.

Strategy

- Concentrate on basics, simple motivating examples.
- Focusing hands-on experience.
- Learn what's out there to help select what's best for your needs.

Focus and Topics

Efficiently using your computing units

- Basic computer architecture
- Languages issues, e.g. compiled vs. interpreted, object oriented, etc.
- Specific languages: C
- Parallel computing with OpenMP

Efficient programming and good software practices

- Version control system : **Git** and **GitHub**
- **C** with visual studio
- Debuggers, code development and testing

Class materials

- All class materials are on GitHub repository.
 - Recommend having a GitHub account.
- You can clone the repository or download from webpage
 - <https://github.com/CSE6000/Fall2016>

Prerequisites

Some programming experience in some language,
e.g., Python, Matlab, C/C++, Java. Swift, C#

You should be comfortable:

- editing a file containing a program and executing it,
- using basic structures like loops, if-then-else, input-output
- writing subroutines or functions in some language

You are not expected to know C

Some basic knowledge of linear algebra - vector or matrices addition, multiplication, solving a linear system

Some comfort level for learning new software and willingness to dive into lots of new things

Requirements and recommendations

- Requirements

- [Git](#)
- Any C compiler
- [GitHub](#) account

- Recommendations

- Microsoft Windows 10
- [MS Visual Studio 2015 Community](#)
- [Git](#) for Windows

Note : Linux is often required for embedded computing, but learning linux is not part of this class