EE 102B: Signal Processing and Linear Systems II

Why study DSP?

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Arthur C. Clarke on Technology

Clarke's third law:

Any sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke, *Profiles of the Future*

Digital signal processing is indeed a magical technology, and its power to transform other technologies continues to increase.

My job is to get you to see the magic in it.

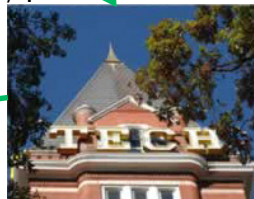
DSP has taken me to these great places.

UNL
1962 - 63

MIT 1963 - 1968

Bell Telephone Laboratories
1968 - 1974

Stanford
2007 -

HP Labs 2004 - 2012

Georgia Tech
1974 - 2004

DSP has been good for me. So what?

- Unfortunately, you can't have a career like mine.
  - All the industrial research labs are gone or are turning away from research.
  - Much of what were research topics is now in undergraduate courses and industry standards.
- So why should *you* study DSP?
  - DSP is at the heart of much of technology today. It's more important than ever.
  - We're only beginning to see what the combination of DSP theory and computational hardware and software can do!
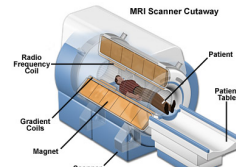
What do all these have in common?

Internet teleconference

Cameras

MRI Scanner
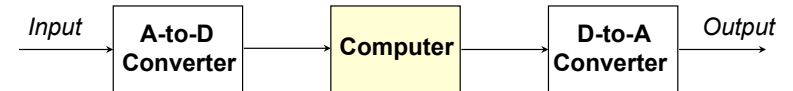
DSP enables them all and much more!

hearing aids

Imaging for scientific research

Hard disk drives

cell phones

What is DSP Technology?

The representation of signals in digital form and the manipulation of the digital representation by digital computation.

Input → **A-to-D Converter** → **Computer** → **D-to-A Converter** → *Output*

– sampling and quantization

– linear shift-invariant discrete-systems

– analysis/synthesis based on the frequency spectrum

– parametric modeling of signals and systems

– hardware and software implementation

Compelling Advantages

Input → **A-to-D Converter** → **DSP Chip** → **D-to-A Converter** → *Output*

- Permanence and robustness of signal representations

- Advanced IC technology works well for digital systems, although DSP computations can consume lots of power.

- Digital systems have virtually infinite flexibility

  * Multi-functionality, multi-input/multi-output

- As a result, DSP is everywhere in modern technology.

Needs and Opportunities for DSP

- Scientific instruments yet to be invented
- Next generation telecollaboration systems
- Sensors everywhere
- Systems for monitoring and control of generation, distribution and conservation of energy
- Imaging and mapping of buried infrastructure
- Entertainment , 3D and whatever
- Refined medical diagnostic instruments
- Robotic systems with human capabilities
- Speech-to-speech language translation
- Direct human-brain-digital-machine connections
- . . . .

  In all these areas, DSP is not the only thing, but it will be the key enabler.

NAE Grand Challenges

 Make solar energy economical

 Provide energy from fusion

 Develop carbon sequestration methods

 Manage the nitrogen cycle

 Provide access to clean water

 Restore and improve urban infrastructure

 Advance health informatics

 Engineer better medicines

 Reverse-engineer the brain

 Prevent nuclear terror

 Secure cyberspace

 Enhance virtual reality

 Advance personalized learning

 Engineer the tools of scientific discovery

Your favorite challenge

A Prediction

In the future, digital signal processing will be a critical enabler of almost every man-made object or system. Therefore, it is essential for every engineer to understand what digital signal processing *is* and what it can *do*.