CO2029 - Digital Signal Processing

Fall 2019

anhpham (at) hcmut (dot) edu (dot) vn

Course Introduction

- General Information
  - CO2029 – Digital Signal Processing

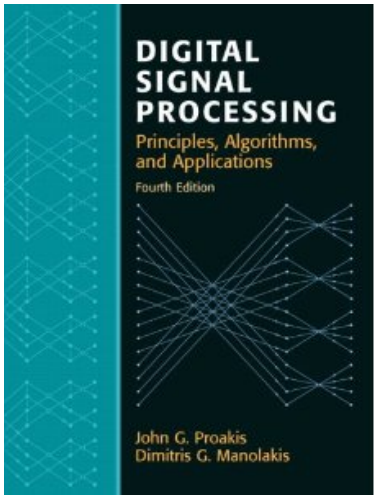
- Instructor
  - **Pham Hoang Anh, Ph.D**
  - Department of Computer Engineering,
  - Faculty of Computer Science and Engineering, HCMC University Of Technology

  - Email: anhpham@hcmut.edu.vn
  - Phone: (84)(8) 38647256 (Ext. 5843) - Mobile: 0967.333.820
  - Homepage: to be updated.

Course Introduction

- Objectives
  - Provide radical concept and knowledge in field of digital signal processing.
  - Establish a background in digital signal processing theory.

- Textbook
  - Digital Signal Processing: Principles, Algorithms, and Applications (4th Edition), John G. Proakis, Dimitris G. Manolakis, Prentice Hall.



- Grading
  - Labs: 30% (Attendance + Report)
  - Mid-term Exam: 20% (45-60 mins)
  - Final Exam: 50% (75-90 mins)

Course Policies

- Do not expect that everything said during the lecture will be documented in the lecture notes.
- Expect that everything "said" during a lecture or tutorials will be known by all students. So, if you do not attend, then please frequently update or "at least" ask !
- Your responsibility is to frequently check the course website (BKeL) regularly for any announcements or materials

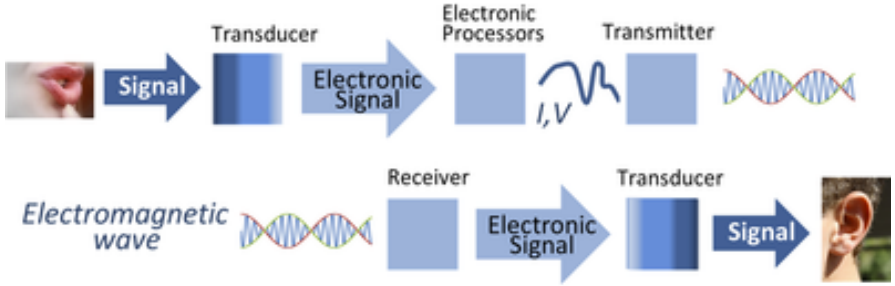
Course Outline

- Introduction to Digital Signal Processing
- Signal and System in Time Domain
- Z-Transform
- Signal and System in Frequency Domain
- The Discrete-Fourier Transform

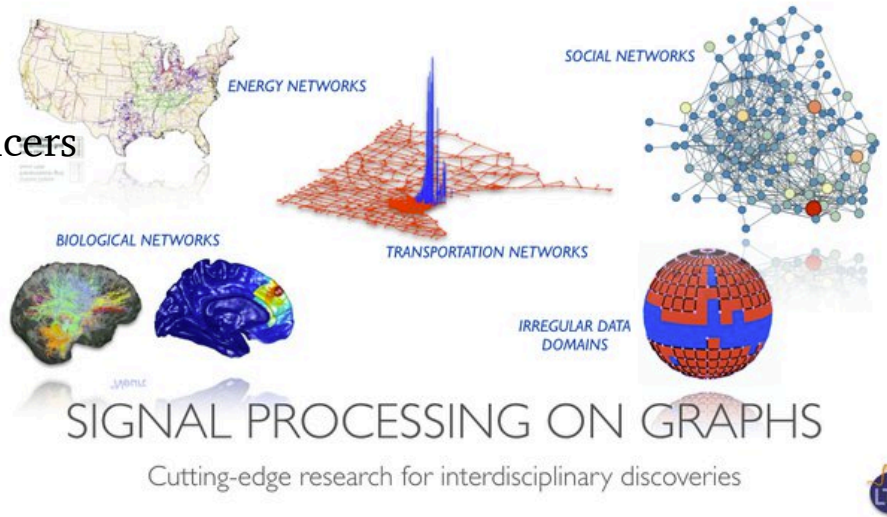
Scilab

- www.scilab.org

Signal Processing



- Humans are the most advanced signal processors
  - speech and pattern recognition, speech synthesis,…
- Encounter many types of signals in various applications
  - Electrical signals: voltage, current, magnetic and electric fields.
  - Mechanical signals: velocity, force, displacement.
  - Acoustic signals: sound, vibration,…
  - Other signals: pressure, temperature,…
- **Most real-world signals are analog**
  - They are continuous in time and amplitude
  - Convert to voltage or currents using sensors and transducers
- Analog circuits process these signals using
  - Resistors, Capacitors, Inductors, Amplifiers
- Analog signal processing examples
  - Audio processing in FM radios
  - Video processing in traditional TV sets

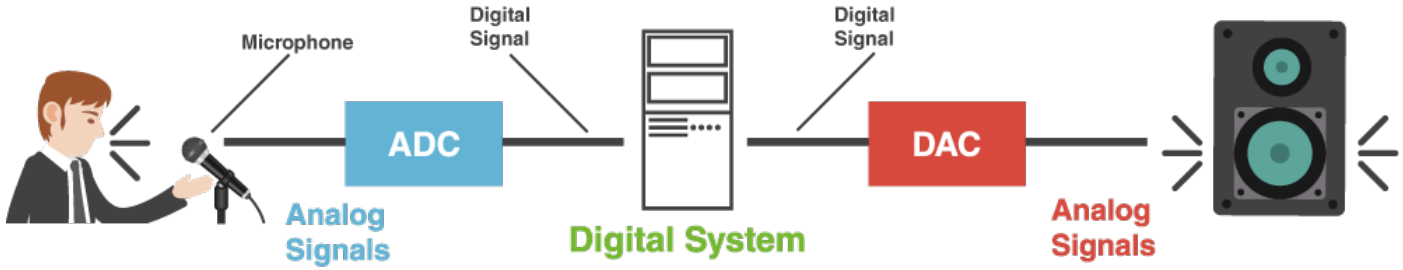


Analog Signal Processing

- Accuracy limitations
  - Component tolerances, undesired nonlinearities
- Limited repeatability due to
  - Tolerances, Temperature, Vibration
- Sensitivity to electrical noise
- Limited dynamic range for voltage and currents
- Inflexibility to changes
- Difficulty of implementing certain operations
  - Nonlinear operations, Time-varying operations
- Difficulty of storing information

What is Digital Signal Processing?

- Convert naturally occurring analog signals to digital form.
- Represent analog data as an approximated digital version or vice-versa to represent digital data as an approximate representation of an analog signal.



Digital Signal Processing

- **Pros**
  - Remove unwanted noise
  - Encode/Encrypt the data for secure transmission
  - Detect and correct data
  - Process, store, transmit, and reproduce data more easily
  - Dynamic range can be controlled using floating point numbers
  - Flexibility can be achieved with software implementations
  - Price/performance and reduced time-to-market

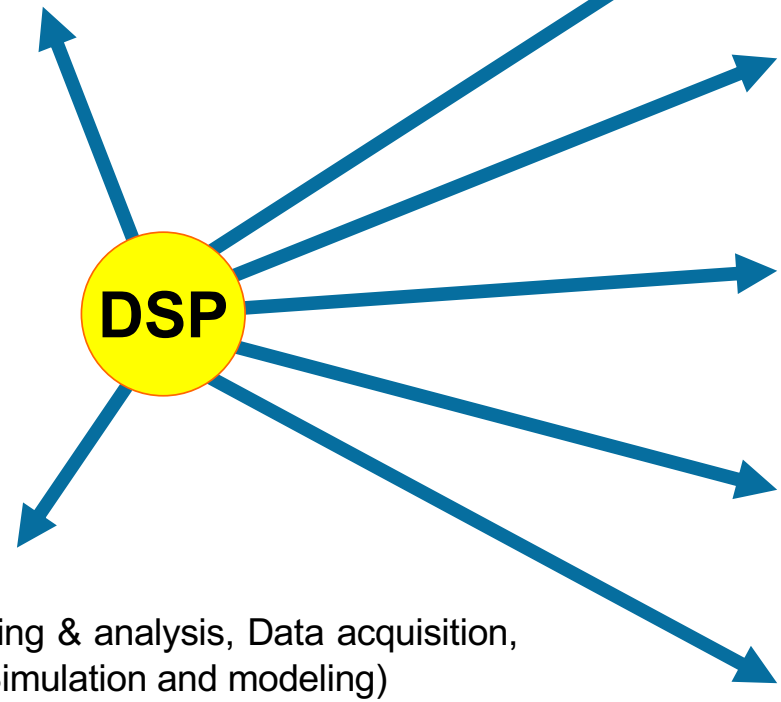
- **Cons**
  - Sampling causes loss of information
  - A/D and D/A requires mixed-signal hardware
  - Limited speed of processors
  - Quantization and round-off errors

Digital Signal Processing

- Analog input – Analog output
  - Digital recording of music
- Analog input – Digital output
  - Touch tone phone dialing
- Digital input – Analog output
  - Text to speech
- Digital input – Digital output
  - Compression of a file on computer

DSP Applications

Industrial
(Oil and mineral prospecting, Process monitoring & control, Nondestructive testing, CAD and design tools)



Space
(Space photograph enhancement, Data compression, Intelligent sensory analysis by remote space probes)

Medical
(Diagnostic imaging (CT, MRI, ultrasound, and others), Electrocardiogram analysis, Medical image storage/retrieval)

Commercial
(Image and sound compression for multimedia presentation, Movie special effects, Video conference calling)

Telephone
(Voice and data compression, Echo reduction, Signal multiplexing, Filtering)

Military
(Radar, Sonar, Ordnance guidance, Secure communication)

Scientific
(Earthquake recording & analysis, Data acquisition, Spectral analysis, Simulation and modeling)

DSP is Everywhere

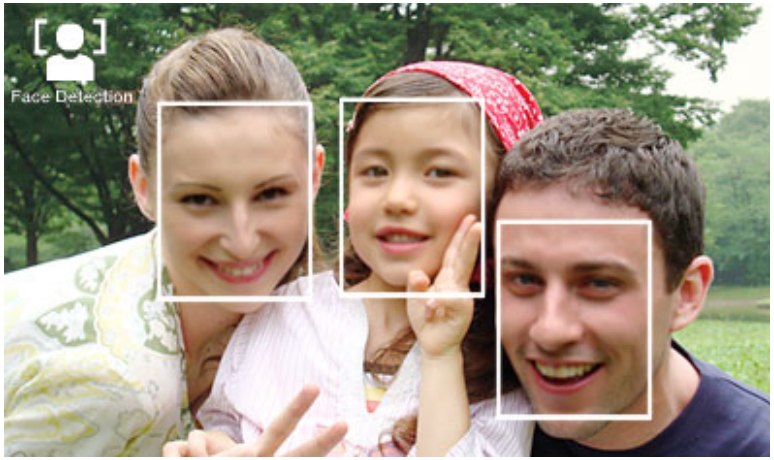
- Sound applications
  - Compression
  - Special effects
  - Synthesis
  - Recognition
  - Echo cancellation

DSP is Everywhere

- Image and Video Applications
  - DVD
  - JPEG
  - Movie special effects
  - Video conferencing
  - …

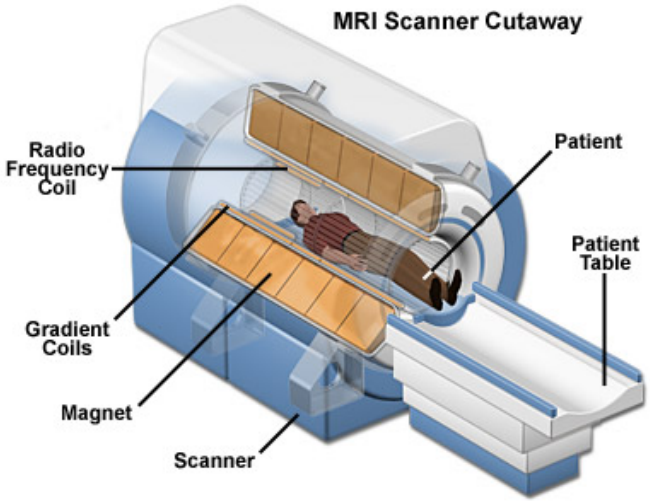
DSP is Everywhere

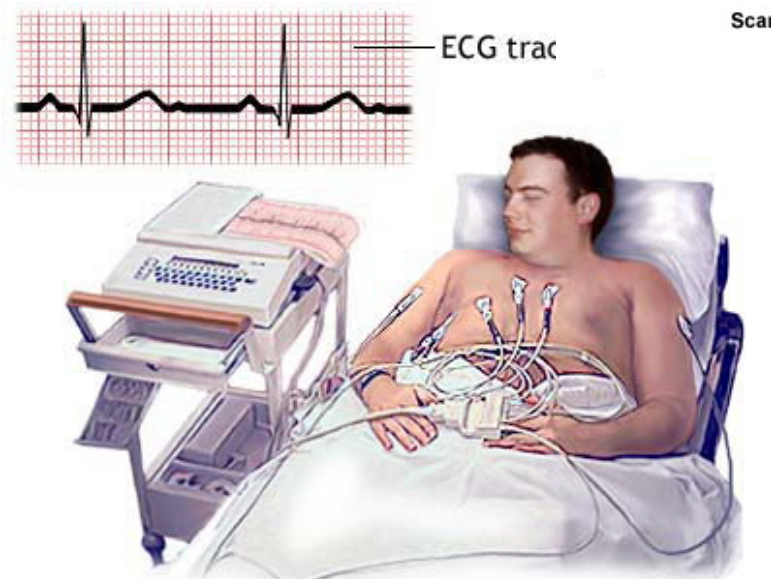
- Communication
  - Modulation
  - Coding
  - Detection
  - Equalization
  - Echo cancellation
  - Cell Phones
  - Dial-up modem
  - DSL modem
  - Satellite Receiver
  - …

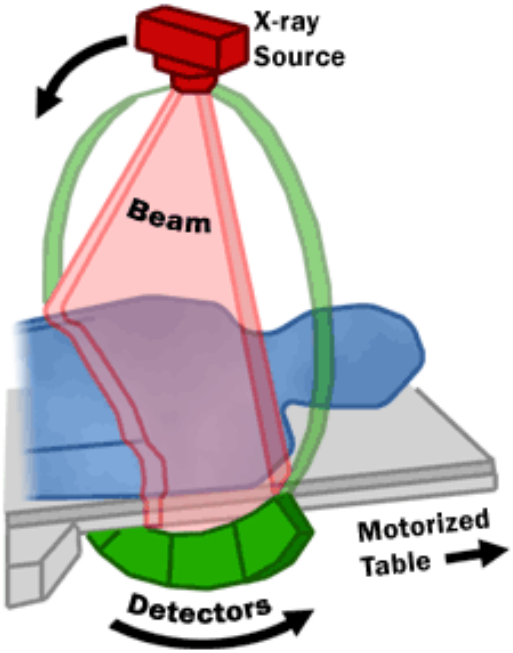


DSP is Everywhere

- Medical
  - Magnetic Resonance
  - Tomography
  - Electrocardiogram
  - …

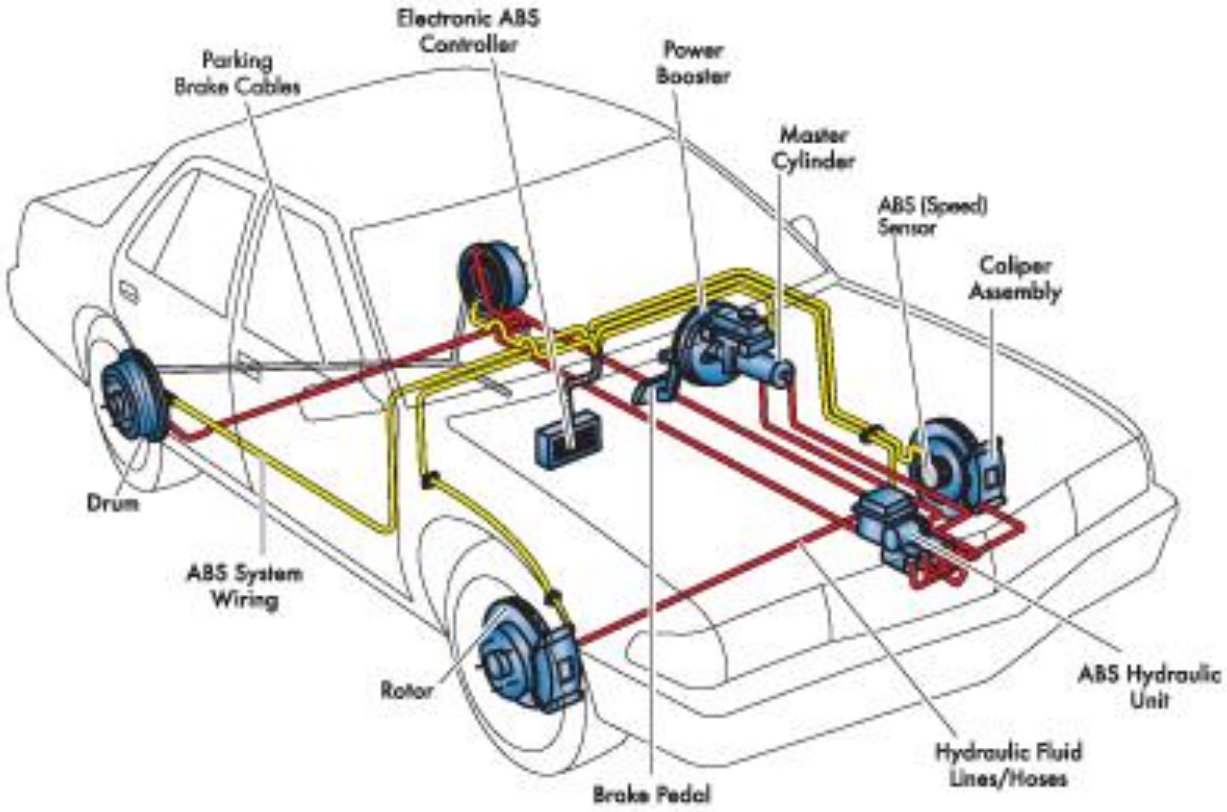






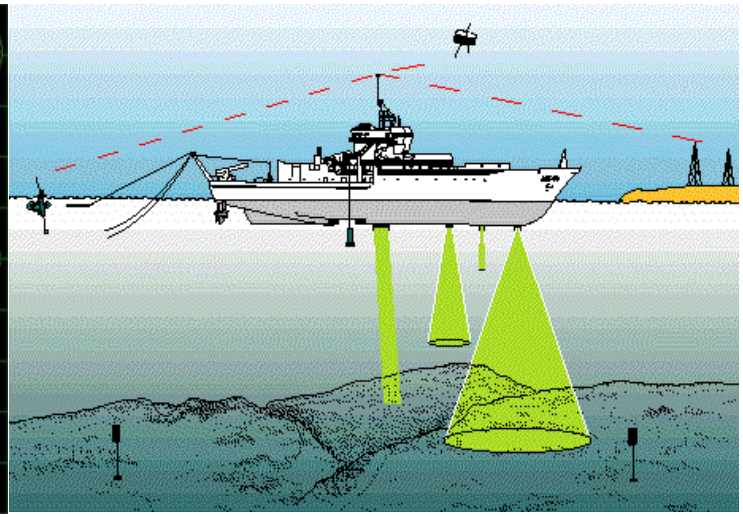
DSP is Everywhere

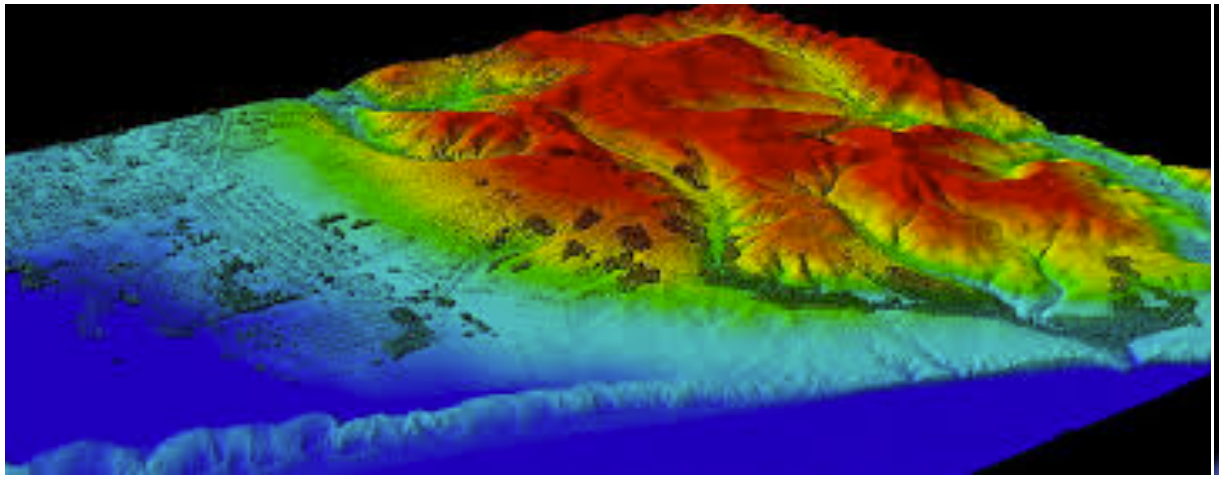
- Automotive
  - ABS
  - GPS
  - Active Noise Cancellation
  - Cruise Control
  - Parking
  - …

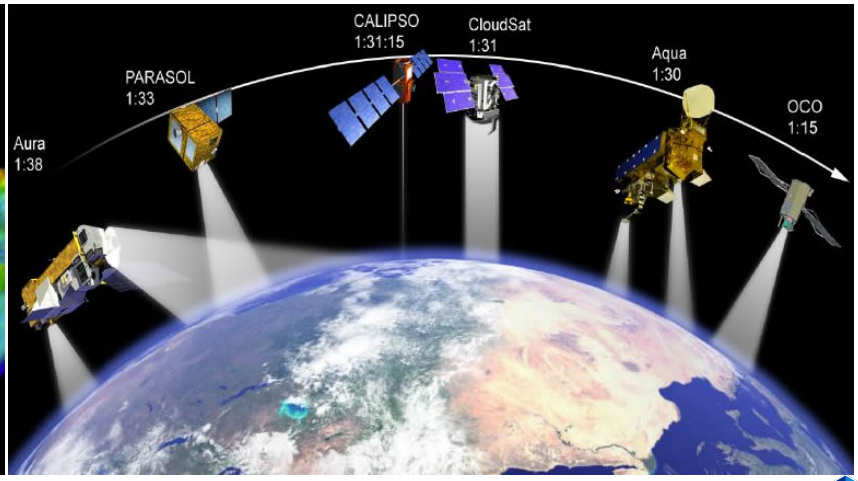


DSP is Everywhere

- Military
  - Radar
  - Sonar
  - Space photographs
  - Remote sensing
  - …

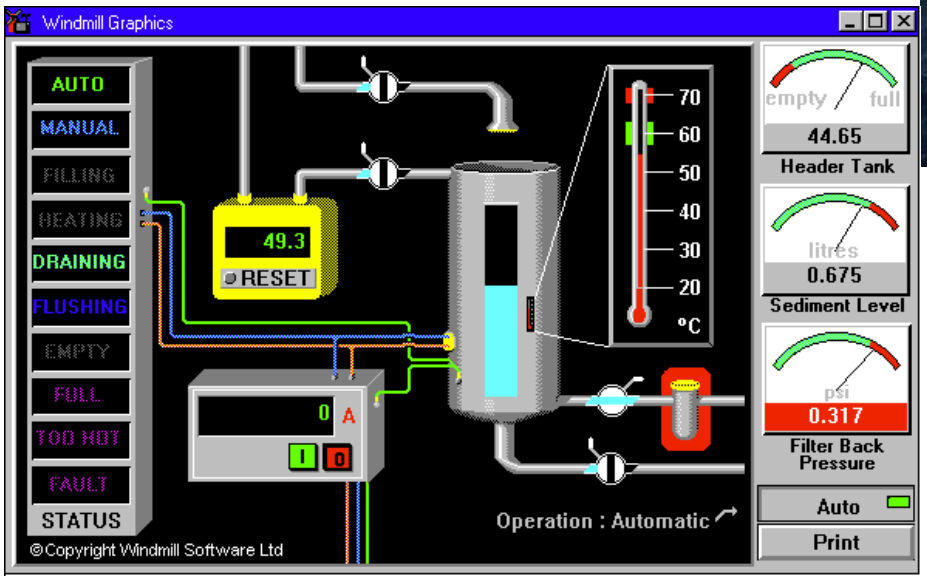






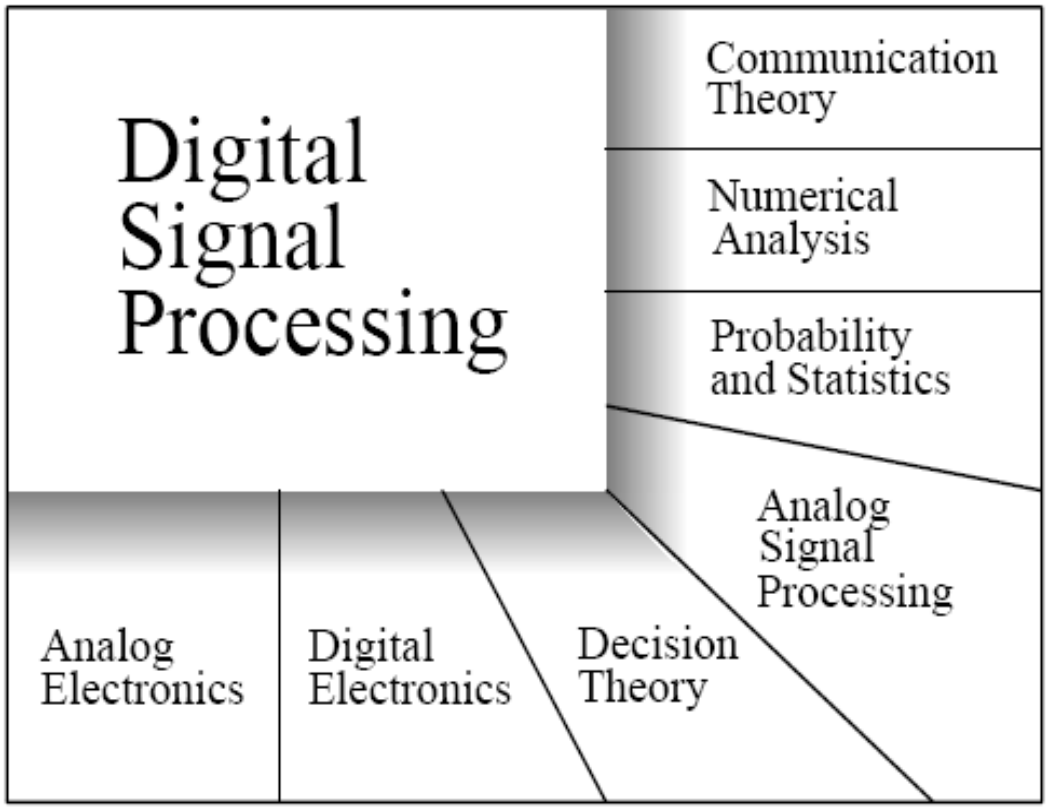
DSP is Everywhere

- Mechanical
  - Motor control
  - Process control
  - Oil and mineral prospecting
  - …



Characteristics of DSP Applications

- Mathematics
  - Multiplication, Addition
- Most of the signals encountered in science and engineering are analog in nature.



1st Exercise

- Review Video and Write a short report (2 pages A4) to present your understanding about digital signal processing.

- Report in Latex
  - Midtek
  - TexStudio

Project Brainstorming

- Vehicle Plate Number Recognition
  - Motorbike
  - Car, Truck
- Speech (Vietnamese) Recognition
  - Voice Control
  - Methods/Technique
  - Open-source Library
  - Online/Offline Recognition
  - Dependent vs. Independent Trainer
- Face Recognition
  - Methods/Technique
  - Open-source Lib.
- Background Modeling
  - Methods/Technique
  - Open-source Lib
- GS1 Standard
  - Documentation
  - RFID/Bar-Code for Product Tracking
- Distance Measurement from Stereo Camera
  - Methods/Technique
  - Demonstration
- Ad-hoc Communication using WIFI or Bluetooth
  - Methods/Technique
  - Configuration
  - Demonstration

Tentative Schedule (CC)

- Week #1: (21-Aug-2019)
  - Lecture
- Week #2: (28-Aug-2019)
  - Lecture
- Week #3: (04-Sep-2019)
  - Lecture
- Week #4: (11-Sep-2019)
  - Lecture
- Week #5: (18-Sep-2019)
  - Lecture
- Week #6: (25-Sep-2019)
  - Lecture
- Week #7: (02-Oct-2019)
  - Lecture
- Week #8: (09-Oct-2019)
  - Midterm
- 16-0ct-2019
  - Midterm Break
- 23-0ct-2019
  - Midterm Break
- Week #09: (30-Oct-2019)
  - Lecture
- Week #10: (06-Nov-2019)
  - Lecture

Tentative Schedule (L01)

- Week #1: (22-Aug-2017)
  - Introduction
- Week #2: (29-Aug-2017)
  - Lecture
- Week #3: (05-Sep-2017)
  - Lecture
- Week #4: (12-Sep-2017)
  - Lecture
- Week #5: (19-Sep-2017)
  - Lecture
- Week #6: (26-Sep-2017)
  - Lecture
- Week #7: (03-Oct-2017)
  - Lecture
- 10-0ct-2017
  - Midterm Break
- Week #8: (17-Oct-2017)
  - Midterm
- Week #09: (24-Oct-2017)
  - Lecture
- Week #10: (31-Oct-2017)
  - Lecture
- Week #11: (07-Nov-2017)
  - Lecture
- Week #12: (14-Nov-2017)
  - Lecture
- Week #13: (21-Nov-2017)
  - Lecture
- Week #14: (28-Nov-2017)
  - Lecture
- Week #15: (05-Dec-2017)
  - Review