Digital Signal Processing (DSP)

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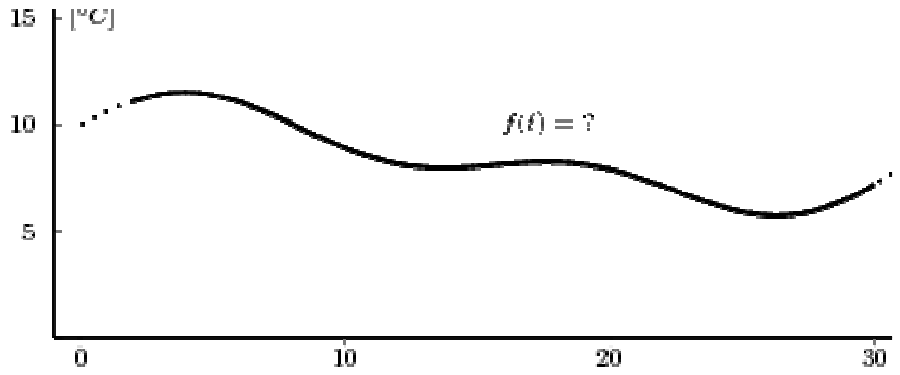
Course materials: https://naghsh.iut.ac.ir

Introduction

Introduction

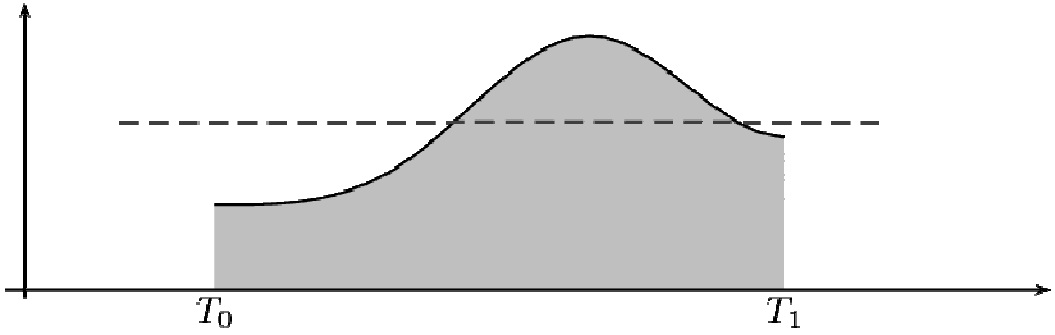
- Signal: a function of one or several variables carrying information, x(t)
- Speech signal, image signal, biomedical, etc.



http://www.sp4comm.org/webversion/livre.html

Introduction

- Categories: x(t)/ x[n]
  - Discrete-time
  - Continuous-time



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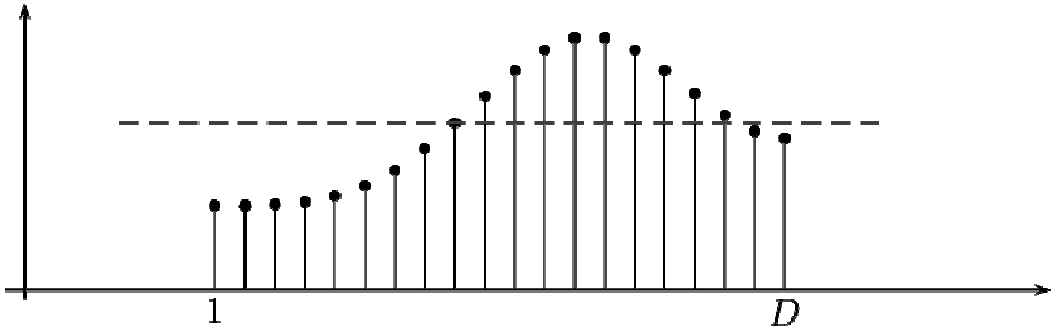
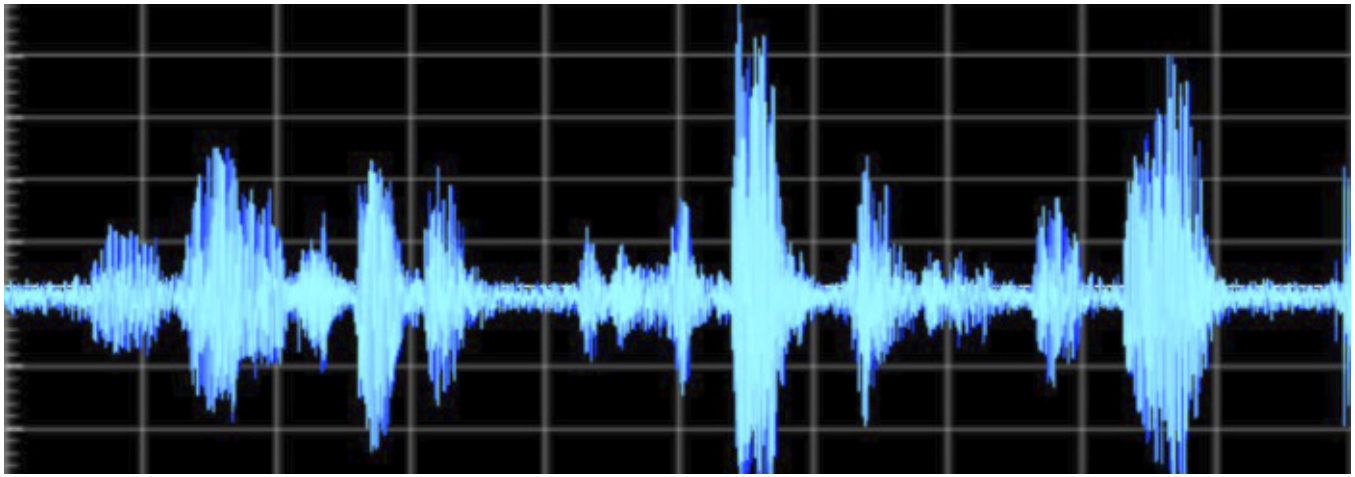


Introduction

- Digital vs. analog: xq[n]/x(t)
  - Discrete-time & quantized value
  - Values belong to a set with finite elements
  - xq in S; S={-1,-.8,-.6,-.4,-.2,0,.2,.4,.6,.8,1}
- Multi-channel: x(t)=(x1(t), x2(t),…, xN(t))
  - Array signal processing
- Multi-dimensional: x(t1,t2,…,tN)
  - Image signal

Introduction

- Speech signal: sound waves
  - x(t): 1-D (continuous-time) signal
  - Speech processing: sampling/quantization



http://www.csee.umbc.edu/2011/11/talk-rutledge-on-multichannel-amplitude-compression-for-speech-processing-1118

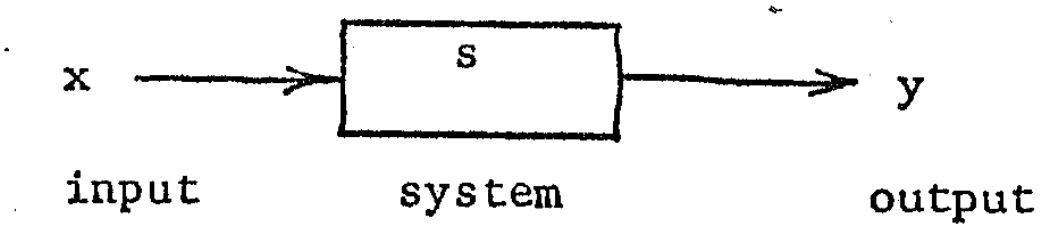
Introduction

- Image signal: ccd
  - x[n1,n2]: 2-D (discrete-time) signal

http://www.ece.rice.edu/~wakin/images/

Introduction

- Systems
  - Input/output



  - Analog, digital, discrete-time
  - Linear/non-linear

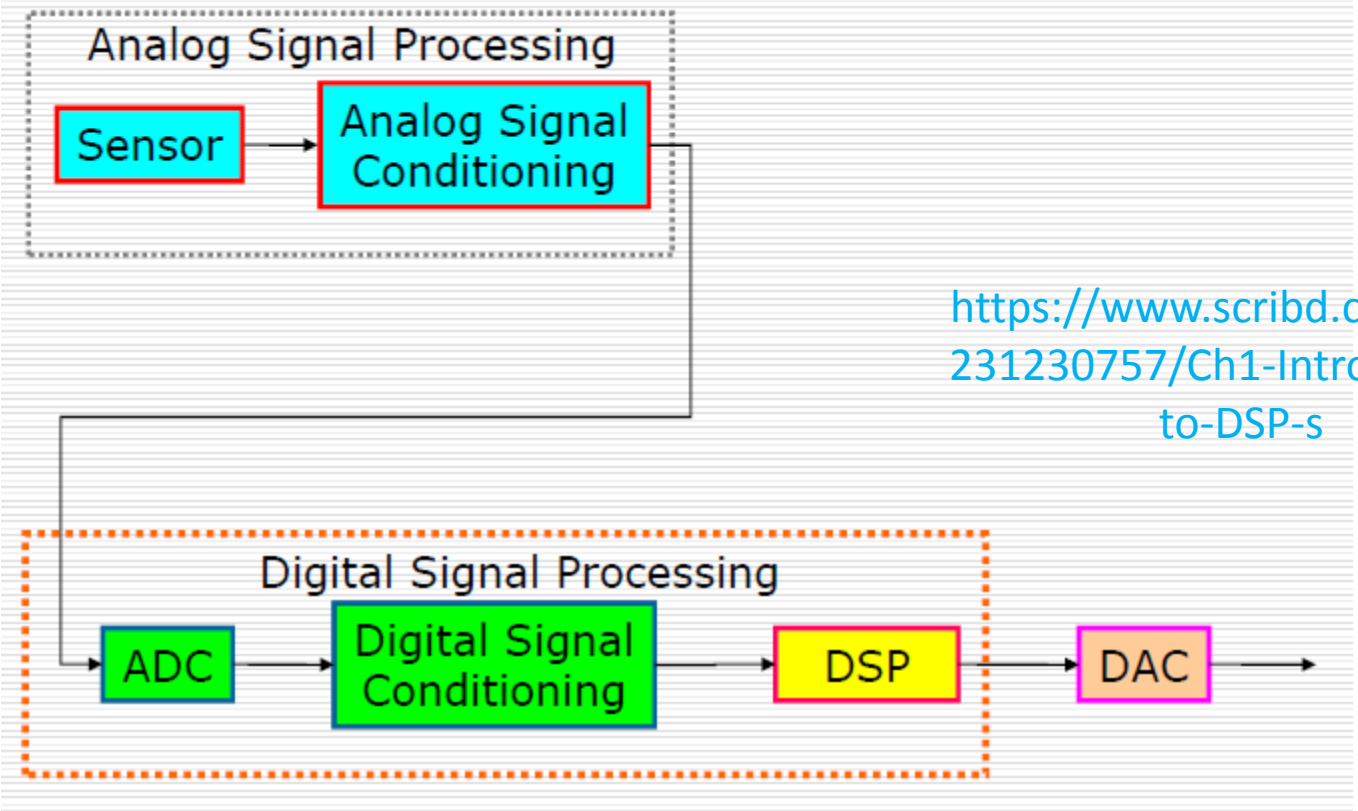
Introduction

- Processing of analog signals
  - General trend: digital processors
  - DSP: discrete-time processing of analog signals via Digital hardware (software)

  - Key components:
    - ADC: analog to digital convertor
    - DAC: digital to analog convertor

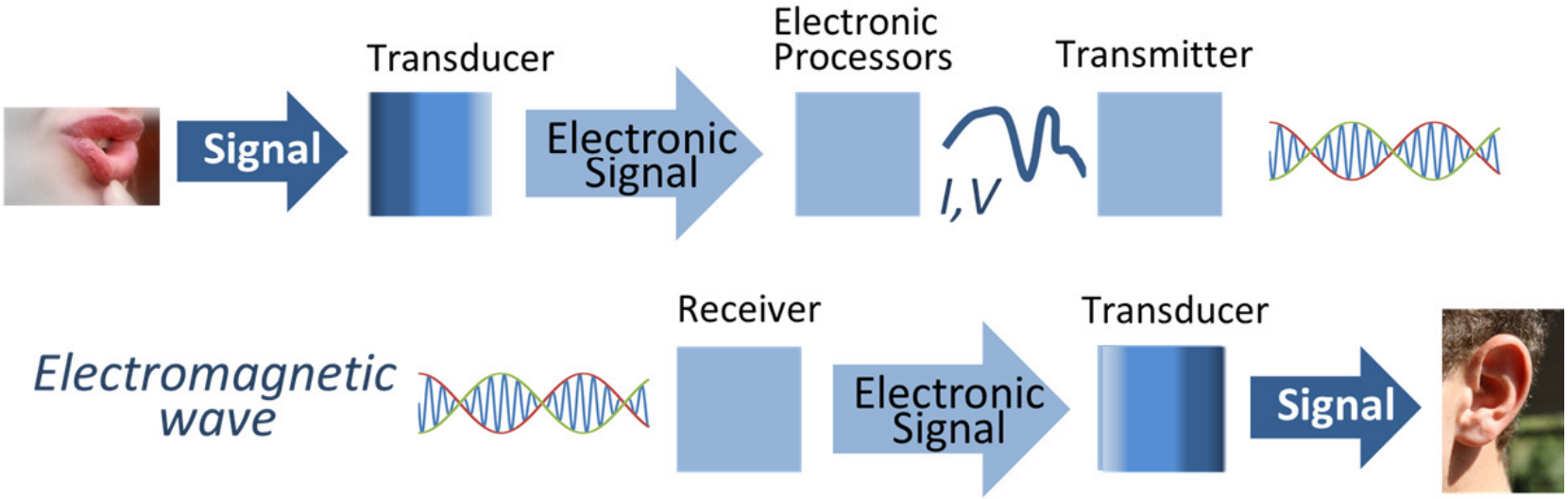
Introduction

- Processing of analog signals



https://www.scribd.com/doc/231230757/Ch1-Introduction-to-DSP-s

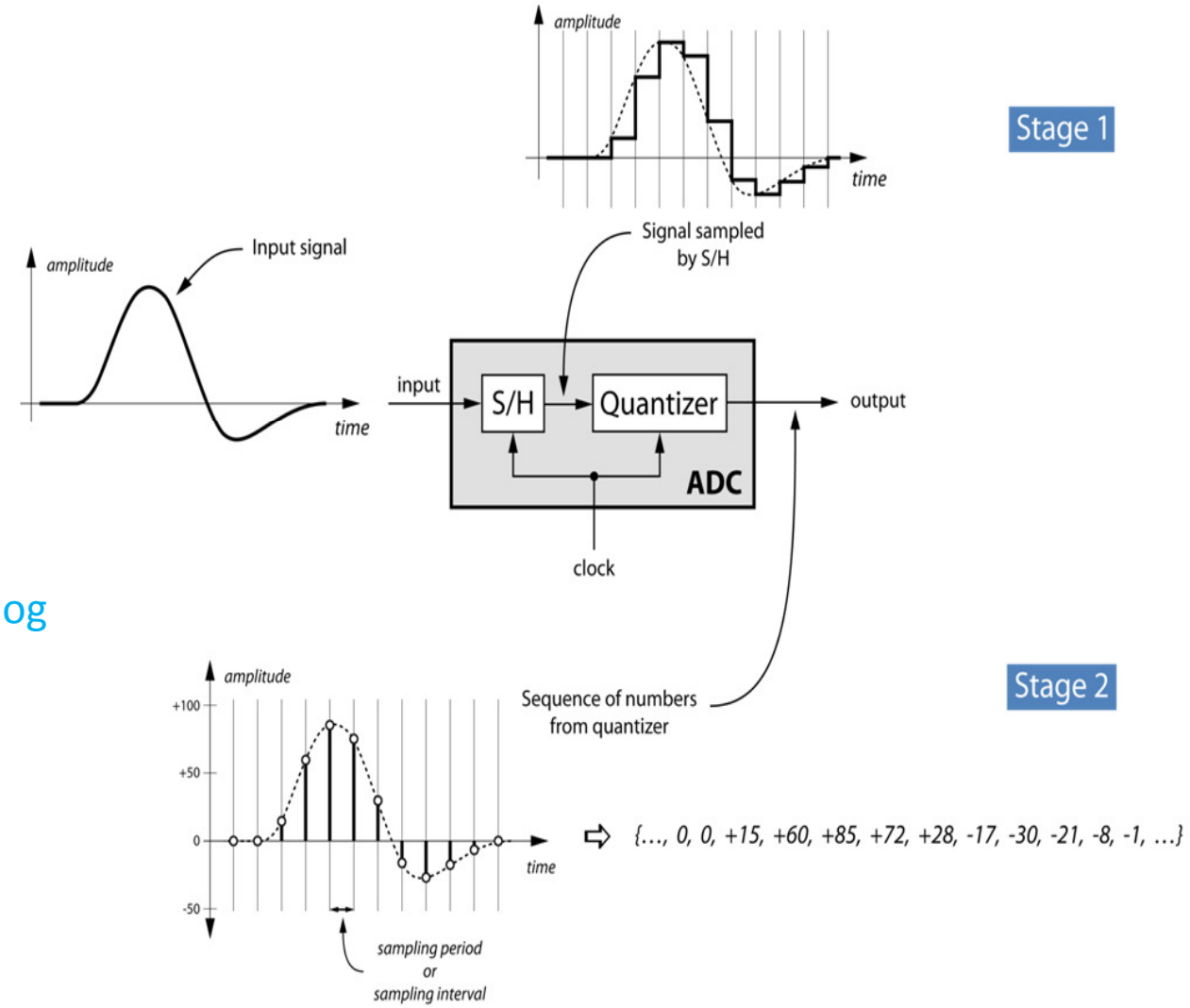
Introduction



http://en.wikipedia.org/wiki/Signal_%28electrical_engineering%29

Introduction

- ADC

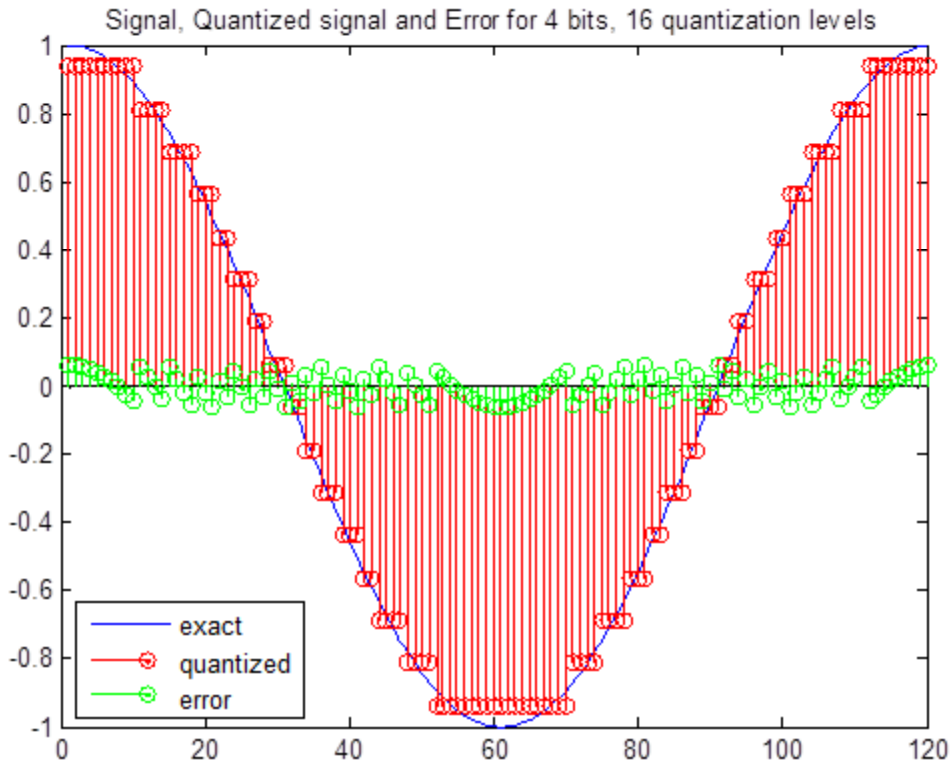


http://nutaq.com/en/blog/analog-digital-%E2%80%93-part-2-conversion-process

Introduction

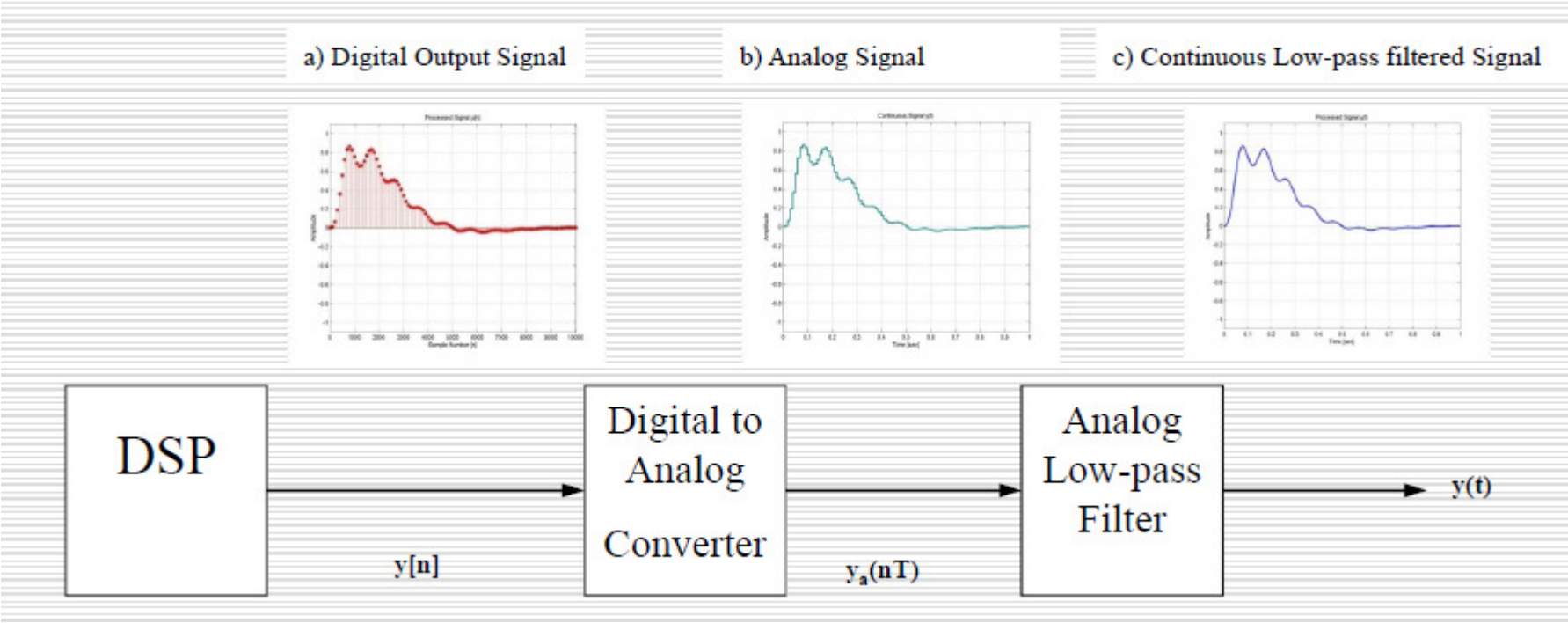
- An illustrative example

http://www.cheers4all.com/2012/07/analog-to-digital-convertor-matlab-code/



Introduction

- DAC



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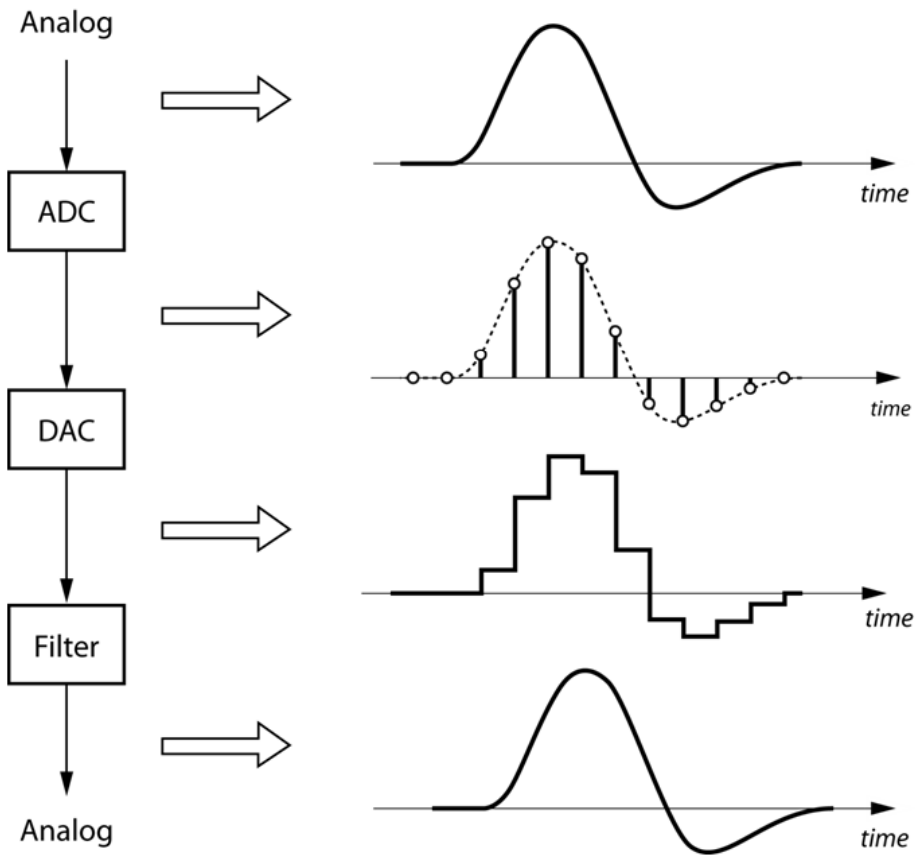
Introduction

- ADC/DAC

http://nutaq.com/en/blog/analog-digital-%E2%80%93-part-2-conversion-process



Introduction

- Digital system:
  - Mathematical arithmetic in discrete-time domain (algorithm) & saving results
- Implementation: Hardware/software
- Real-time: speed issue
- Off-line: memory issue

Introduction

- Advantages of digital processing
  - Stability/immunity against noise
  - Off-line processing/data saving
  - Flexibility
    - Software controlled
    - Multi-task on DSP, connections, etc.

Introduction

- Disadvantages of digital processing
  - Complexity/cost of ADC/DAC
  - Sampling/input bandwidth
  - Quantization error/noise
  - Memory

Introduction

- Notes
  - Selection of sampling frequency
  - Selection of the number of quantization levels

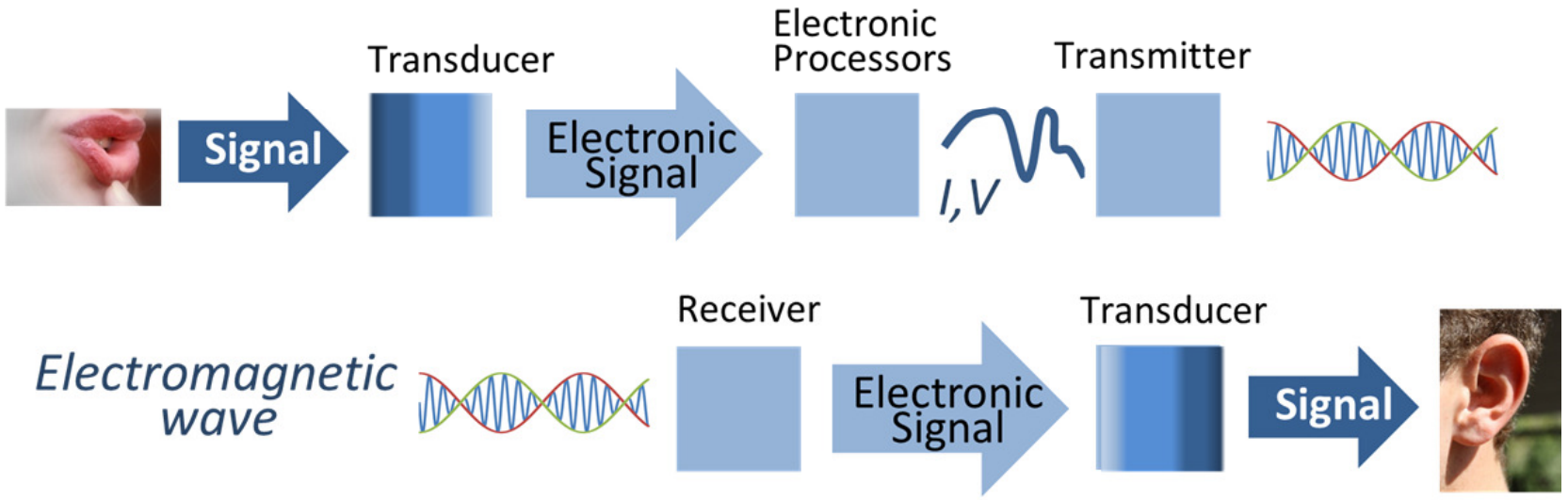
- Two parts for studying these systems:
  - **Discrete-time signal processing**
  - Selections of fs/v

Introduction

- Applications
  - Filtering: signal enhancement
  - Detection/recognition
  - Coding/compression
  - Simulations of various phenomena
    - Communication channel

Introduction

- Example: speech enhancement



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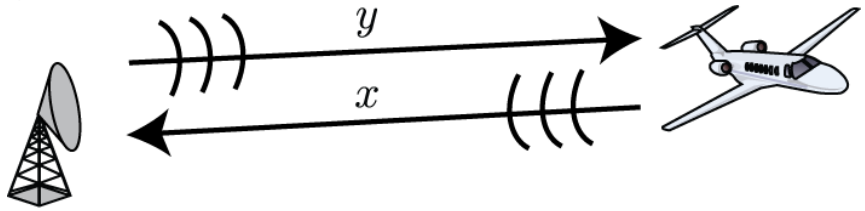
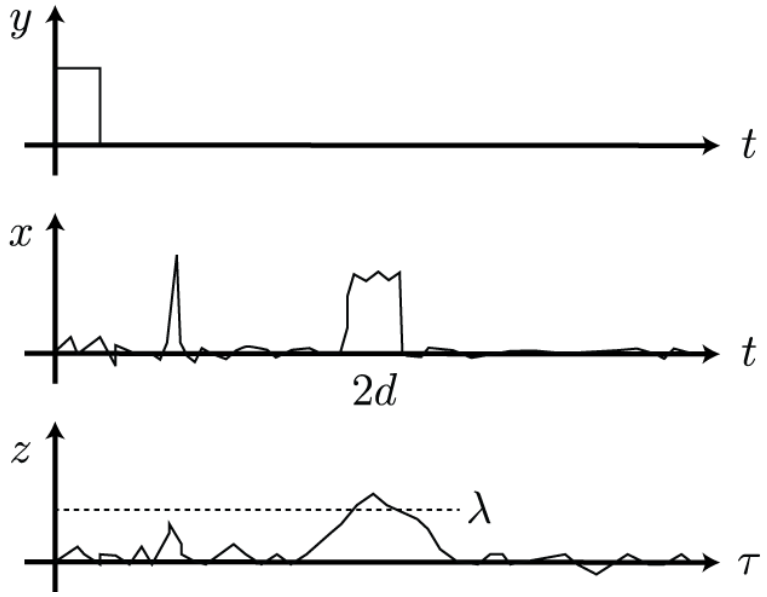
Introduction

- Example: the radar system



http://cnx.org/contents/9bb5c1f1-040c-4924-bd00-6863a0555554@5/Matched_Filter



Introduction

- Example: edge detection (image processing)

http://en.wikipedia.org/wiki/Edge_detection

Introduction

- References
  - A. V. Oppenheim, et al. “Discrete-time signal processing”, 3rd edition, Prentice-Hall, 2009.
  - S. Haykin, et al. “Signals and systems”, 2nd edition, Wiley, 2003.
  - Others

Introduction

- Course syllabus
  - Introduction
  - Discrete-time signals/systems
  - Sampling/DTSP
  - Multi-rate systems
  - DFT/FFT
  - Z-transform
  - Filter design

Introduction

- Grading policy
  - Homeworks: 10%
  - Midterm: 30%
  - Final: 50%
  - Project: 10%