Digital Signal Processing

Course Introduction

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Outline of DSP Course

- Introduction to digital signal processing
- Discrete time signals and sequences
- Standard discrete time signals
- Classification of discrete time signals, system properties.
- Convolution
- Correlation
- Frequency domain representation
- Discrete Fourier Transform
- Fast Fourier Transform
- Introduction to Z transform
- Realization of digital filter

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References

Main Reference:

“Digital Signal Processing: An Introduction with MATLAB and Applications”, by Hussain, Zahir M., Sadik, Amin Z., O’Shea, Peter, Springer, 2011

Extra References:

“Digital Signal Processing: Principles, Algorithms, and Applications”, by John G. Proakis, and Dimitris G. Manolakis.

“The Scientist and Engineer’s Guide to Digital Signal Processing”, by Steven W. Smith, second edition

Digital Signal Processing

Lecture (1): Introduction to digital signal processing

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DSP Introduction and its basic elements

Digital Signal Processing (DSP) is a branch of signal processing that emerged from the rapid development of VLSI technology that made feasible real-time digital computation. DSP involves time and amplitude quantization of signals and relies on the theory of discrete-time signals and systems. It emerged as a field in the 1960s. Early applications of off-line DSP include seismic data analysis, voice processing research.

Generic structure:

In its most general form, a DSP system will consist of three main components, as illustrated in Figure (1).

- The analog-to-digital (A/D) converter transforms the analog signal xa(t) at the system input into a digital signal xd [n]. An A/D converter can be thought of as consisting of a sampler (creating a discrete time signal), followed by a quantizer (creating discrete levels).
- The digital system performs the desired operations on the digital signal xd[n] and produces a corresponding output yd [n] also in digital form.
- The digital-to-analog (D/A) converter transforms the digital output yd[n] into an analog signal ya(t) suitable for interfacing with the outside world.
- In some applications, the A/D or D/A converters may not be required; we extend the meaning of DSP systems to include such cases.

Analog VS. Digital

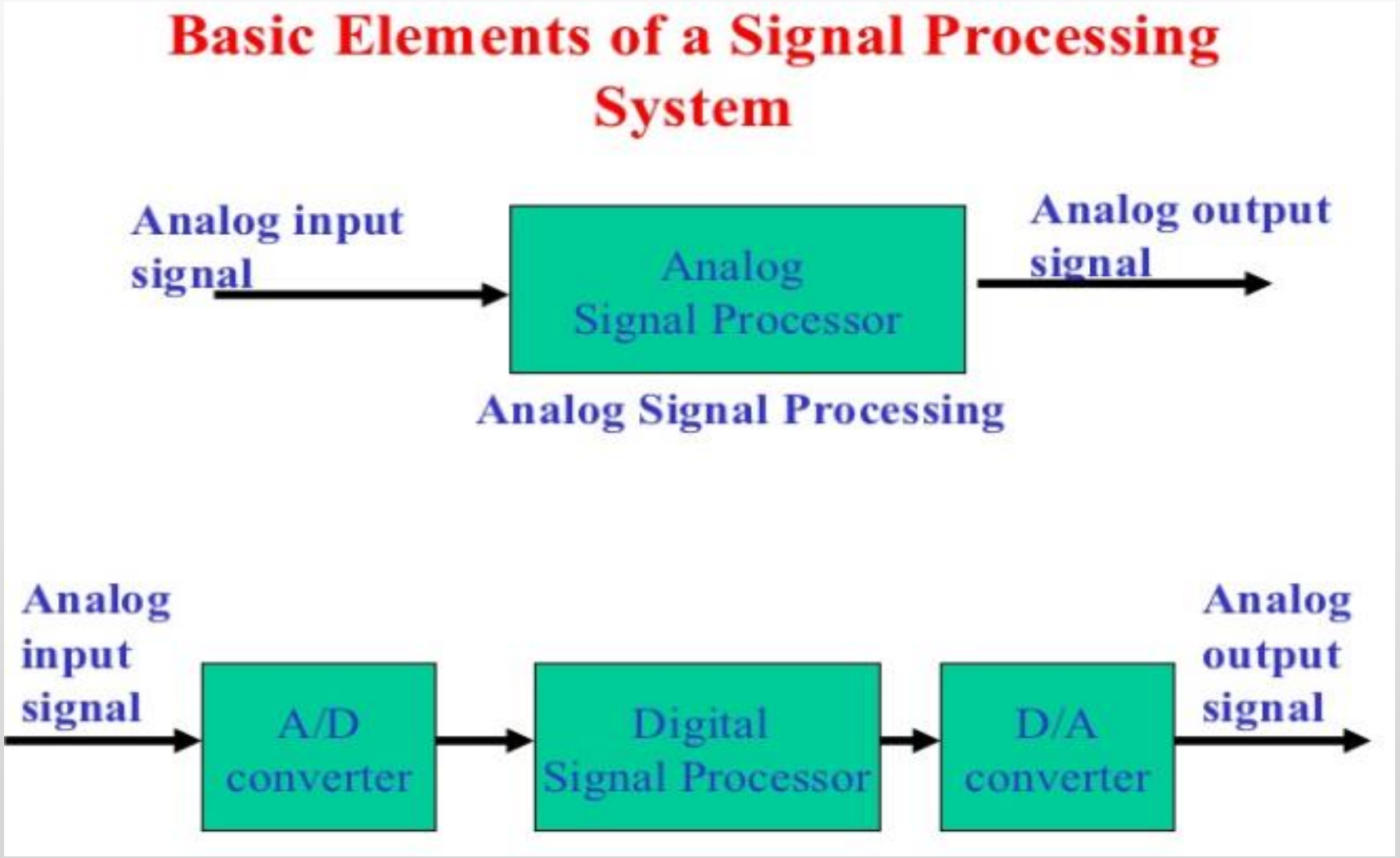


Figure (1): Elements of DSP


Analog input signal
A/D converter
Digital Signal Processor
D/A converter
Analog output signal

DSP vs ASP

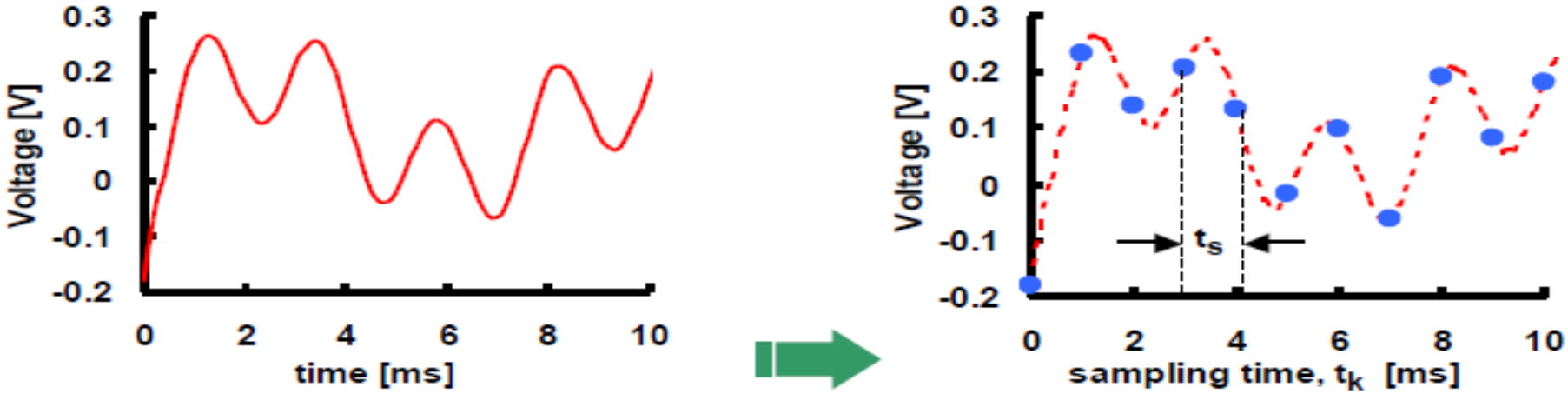
Analog

Continuous function V of *continuous* variable t (time, space etc) : V(t).

Sampled Signal

Digital

Discrete function V_k of *discrete* sampling variable t_k, with k = integer: $V_k = V(t_k)$.



Uniform (periodic) sampling.
Sampling frequency $f_s = 1/ t_s$

Advantages of digital over analog signal processing (ASP):

- flexibility via programmable DSP operations,
- storage of signals without loss of fidelity,
- off-line processing,
- lower sensitivity to hardware tolerances,
- rich media data processing capabilities,
- opportunities for encryption in communications,
- Multimode functionality and opportunities for software radio.

Disadvantages:

- Large bandwidth and CPU demands