Digital Signal Processing

Lecture 1 - Introduction

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Lecturer Information

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Course Resources

- A. V. Oppenheim, R. W. Schafer, ‘‘Discrete-Time Signal Processing’’, Prentice Hall Signal Processing Series, ISBN: 013083443-2

- J. G. Proakis, D. G. Manolakis, “Digital Signal Processing, Principles, Algorithms and Applications”, Prentice-Hall International, ISBN: 0131873741

- S. Ertürk, “Sayısal İşaret İşleme”, Birsen Yayınevi, ISBN:9755113096

Schedule

1) Introduction to digital signal processing; Signals
2) Discrete-time signals; Basic discrete-time signals
3) Discrete-time systems and convolution
4) Linear constant difference equality systems
5) Frequency analysis of discrete-time signals & systems
6) Discrete-time Fourier transform; Properties
7) Discrete Fourier series; Discrete Fourier transform
8) Fast Fourier transform; Sample decimation in time and freq.
9) Discrete-time processing of continuous-time signals
10) Z transform analysis of systems and signals
11) Zero-pole locations and frequency response
12) Discrete-time FIR filter design
13) Discrete-time IIR filter design

Signals & Systems

Signals & Systems

- *Signal: Pattern of variations of a physical quantity that carries information and that can be manipulated, stored or transmitted by physical processes*

- *System: Something that can manipulate, store or transmit signals*

Signals & Systems

- *Signal: A function of one or more variables that conveys information on the nature of a physical phenomenon*

- *System: An entity that manipulates one or more signals to accomplish a function, thereby yielding new signals*

Signals & Systems

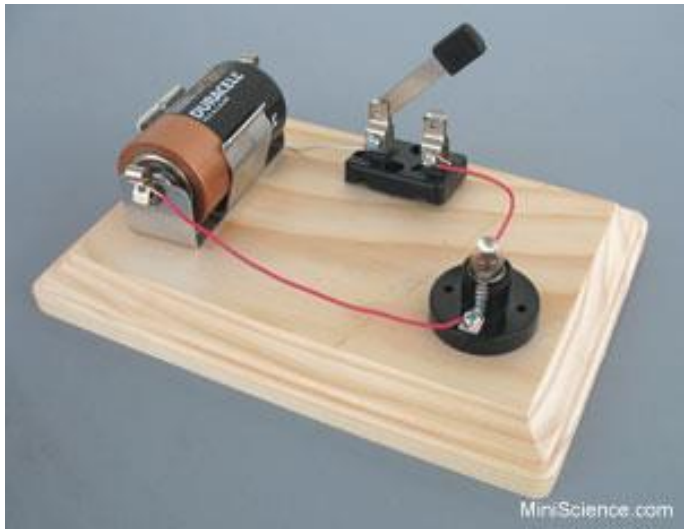
- *Signal: Function of one or more independent variable, contains information about the behavior or nature of some phenomenon*

- *System: Responds to a signal particular signal by producing other signals or some desired behavior*

Signals & Systems

- *Voltages and currents as a function of time in an electrical circuit => Signals*

- *Circuit => System*



Signals & Systems

- *The pressure on the accelerator pedal of an automobile => Signal*
- *Automobile => System*
- *Increasing the speed of the vehicle => System response*

Signals & Systems

- *Light from different sources and light reflected from objects => Signals*

- *Camera => System*

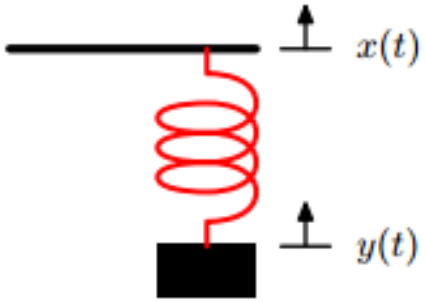
- *Photograph => System response*

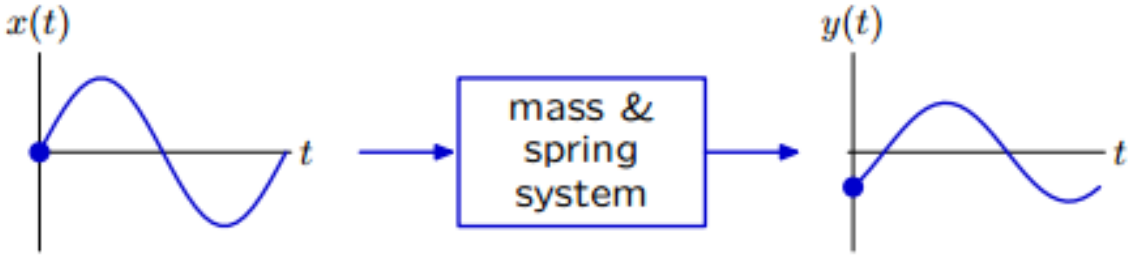
Signals & Systems

- *Control inputs => Signals*
- *Robot arm => System*
- *Arm movement => System response*

Signals & Systems Example

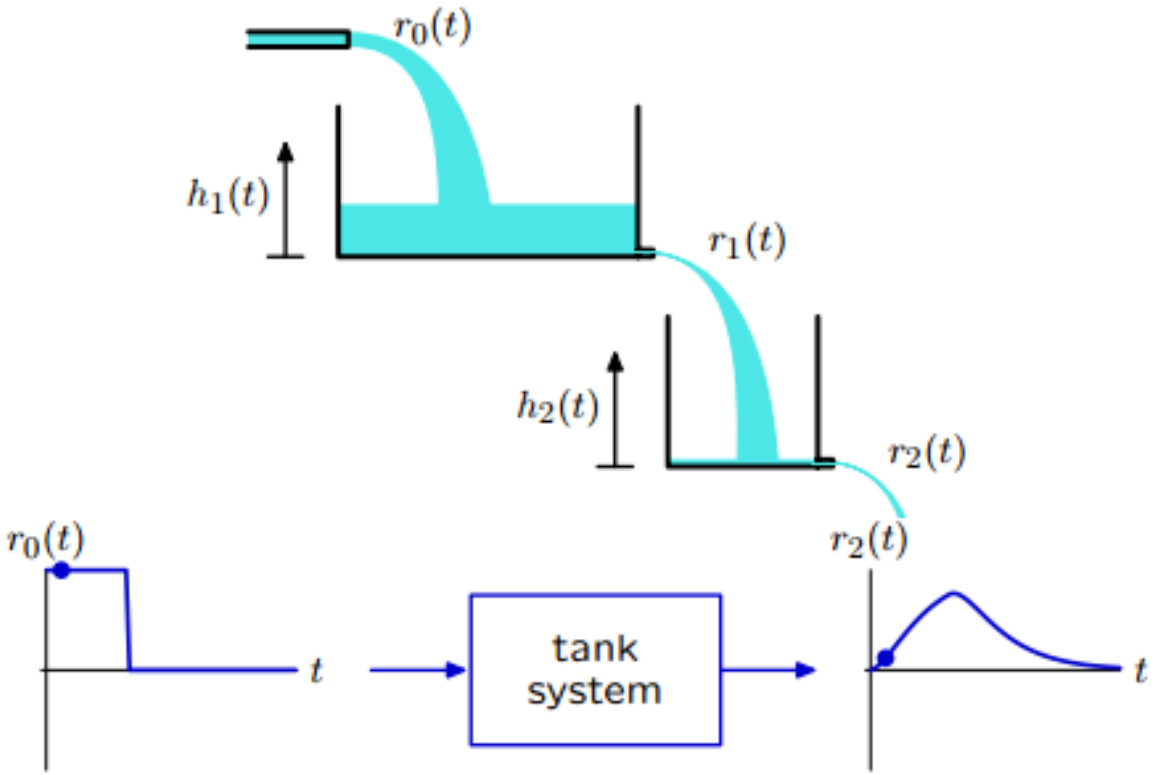
- *Mass and Spring*





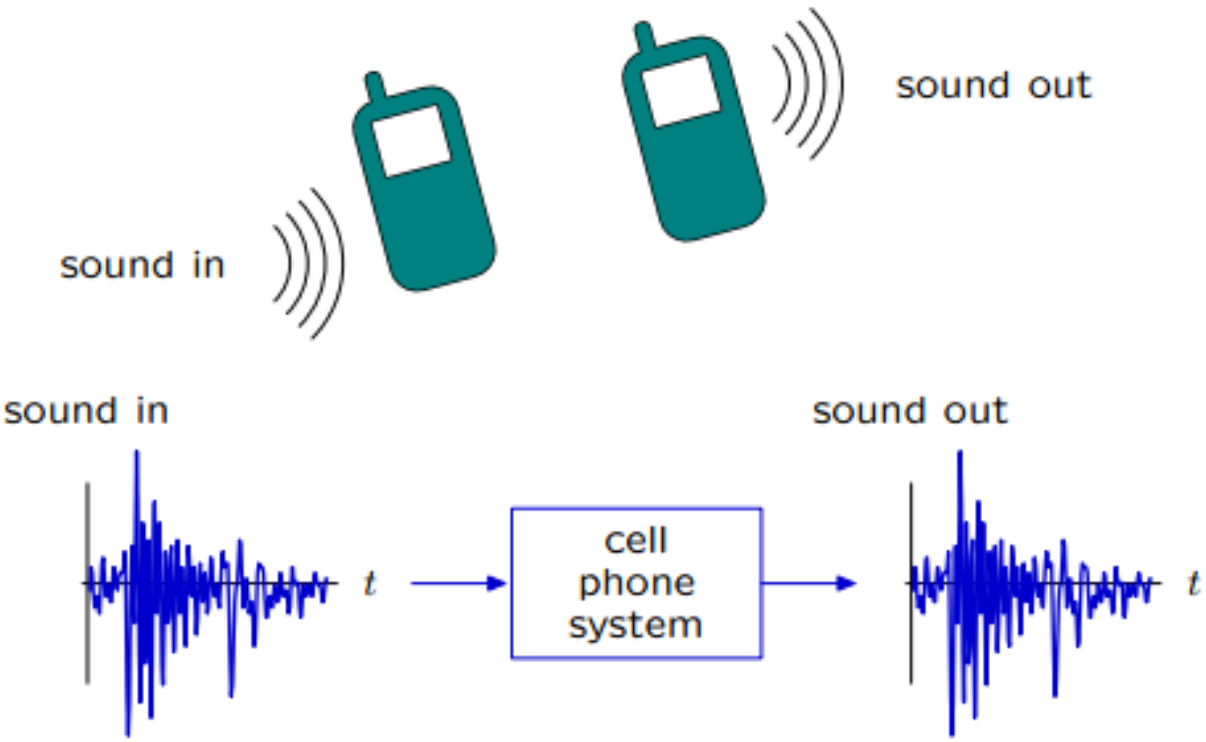
Signals & Systems Example

- *Tanks*



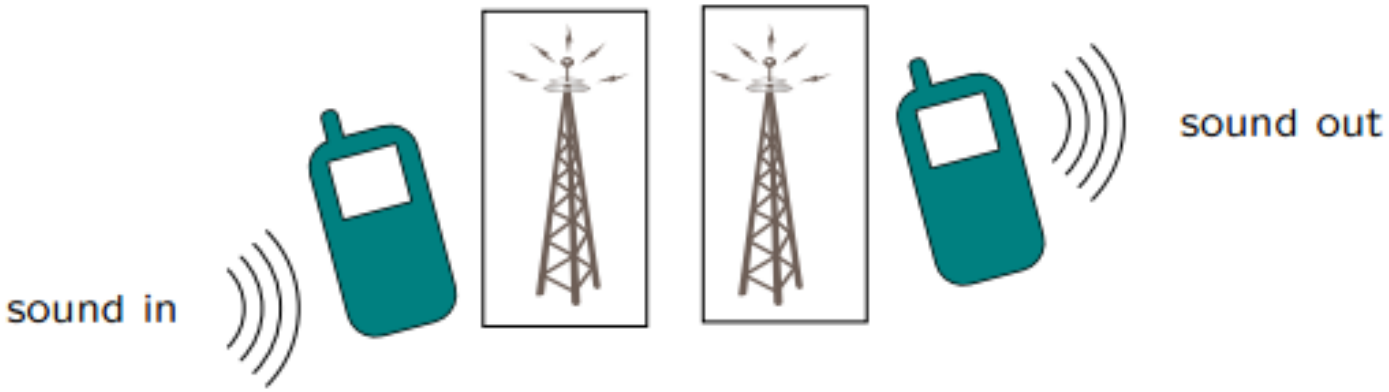
Signals & Systems Example

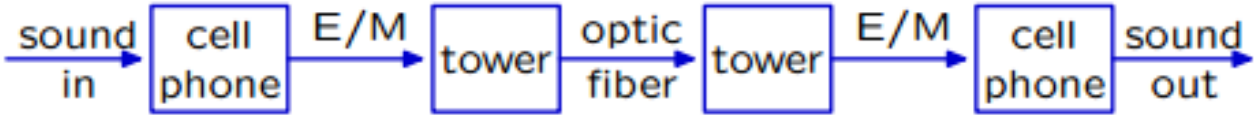
- *Cell Phone System*

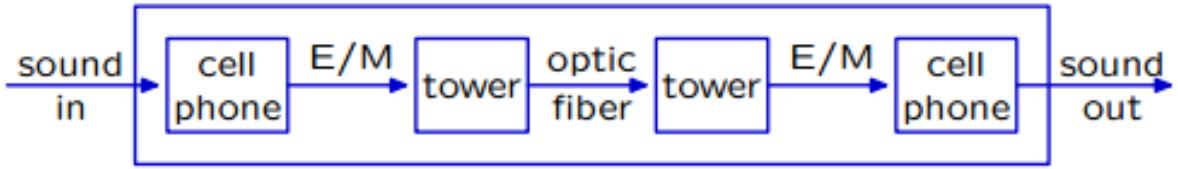


Signals & Systems Example

- *Cell Phone System: Modularity*







Used in the fields of :

- *Acoustics*
- *Aeronautics*
- *Biomedical Engineering*
- *Chemical Process Control*
- *Circuit Design*
- *Communications*
- *Control*
- *Electromagnetics*
- *Energy*
- *Military*
- *Image Processing*
- *Remote Sensing*
- *…*

Continuous-Time / Discrete-Time

- The information in a signal is contained in a pattern of variations of some form
- Signals are represented mathematically as functions of one or more independent variables
- For example, a speech signal can be represented by acoustic pressure as a function of time
- As another example, a picture can be represented by brightness as a function of two spatial variables

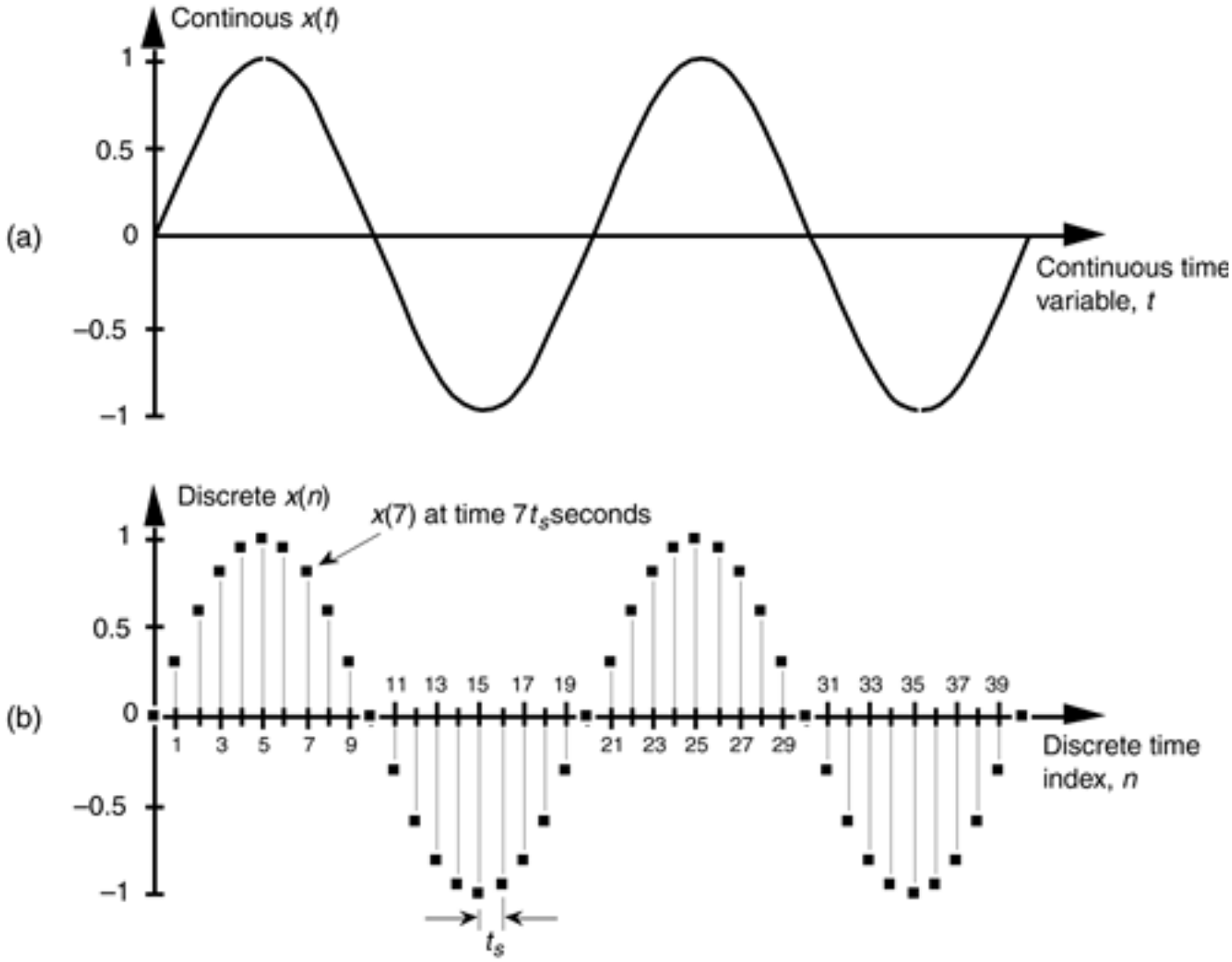
Continuous-Time / Discrete-Time

- Continuous-Time Signals: The independent variable is continuous. Hence, these signals are defined for a continuum of values of the independent variable

- Discrete-Time Signals: The independent variable takes on only a discrete set of values. Hence, these signals signals are defined only at discrete times.

- Discrete-time signals are also often derived from continuous-time signals by *sampling* at at uniform rate

Continuous-Time / Discrete-Time



Continuous-Time / Discrete-Time

- Continuous-time signal examples:
  - Mass and spring
  - Tanks and water
  - Speech signal
  - Atmospheric pressure as a function of altitude

Continuous-Time / Discrete-Time

- Discrete-time signal examples:
  - Bank accounts
  - Weekly stock prices
  - Daily average temperatures
  - Monthly unemployement ratios
  - Image signal

Digital Signals & Systems

- Digital signals are those signals for which both the independent variable (time) and amplitude are discrete

- Digital systems is a system for which both input and the output are digital signals

- Digital signal processing (DSP) deals with the transformation of signals that are discrete in both time and amplitude