

Digital Signal Processing

Chap 1. Introduction

Chang-Su Kim

Course Outline

- Pre-requisites
 - Engineering Mathematics
 - Signals and Systems
- Course Homepage
 - Homepage: <http://mcl.korea.ac.kr>
- Questions
 - Ask questions any time, but preferably during the lectures
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Course Outline

- Assessment Methods
 - Assignments: 15%
 - Attendance & Quizzes: 15%
 - Mid-term Exam: 30%
 - Final Exam: 40%
- Textbook
 - A. V. Oppenheim and R. W. Schaffer, *Discrete-Time Signal Processing*, 3rd edition, Pearson, 2010.
- Reference
 - Sanjit K. Mitra, *Digital Signal Processing: A Computer-Based Approach*, McGraw Hill, 2006.

Course Outline

Week	Topics	Events
1	Chap 1. Introduction	
2	Chap 2. Discrete-Time Signals and Systems	
3	Chap 2. Discrete-Time Signals and Systems	
4	Chap 2. Discrete-Time Signals and Systems	
5	Chap 3. Z-Transform	
6	Chap 3. Z-Transform	
7	Chap 3. Z-Transform	
8	NA	Mid exam (29 OCT 2018)
9	Chap 4. Sampling of Continuous-Time Signals	
10	Chap 5. Transform Analysis of LTI Systems	
11	Chap 5. Transform Analysis of LTI Systems	
12	Chap 6. Structures for Discrete-Time Systems	
13	Chap 7. Filter Design Techniques	
14	Chap 8. DFT	
15	Chap 9. Computation of DFT	
16	NA	Final exam (17 DEC 2018)

DSP Systems (~2005)



iPod **mini**

A thousand songs.
Five cool colors.



DSP Systems (2006)



DSP Systems (2007)



DSP Systems (2008)



SLRCLUB Presents



Nikon D90



DSP Systems (2009)



DSP Systems (2013)



iPhone 5



Samsung GALAXY S4



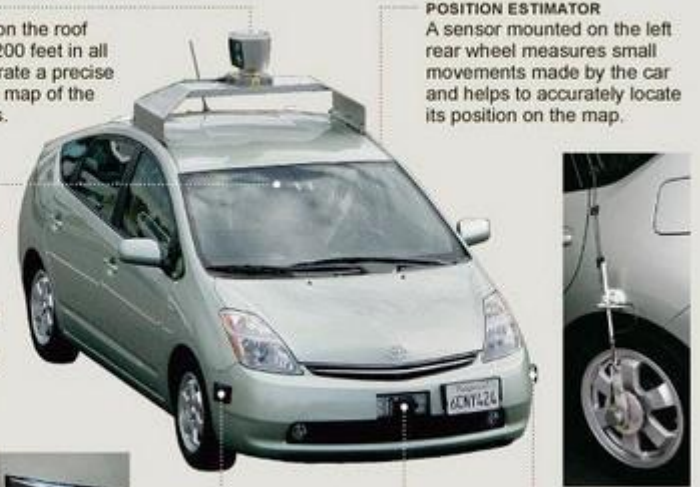
Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

LIDAR
A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.

POSITION ESTIMATOR
A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.

VIDEO CAMERA
A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.



RADAR
Four standard automotive radar sensors, three in front and one in the rear, help determine the positions of distant objects.

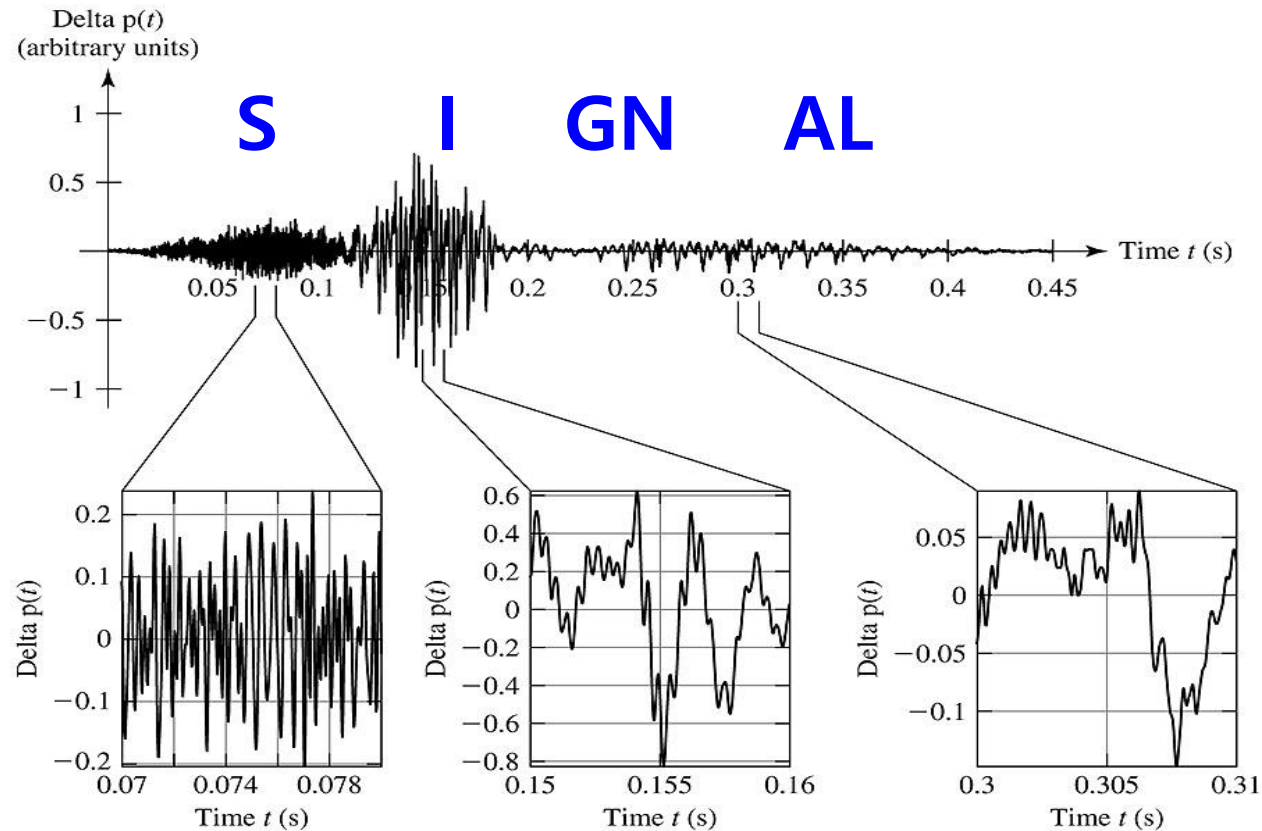


DSP Systems (2014)



Signals

- $s(t) = 1.05 t^2$
- $s(x, y) = 3x + 2xy + 10y^2$



Systems and Signal Processing

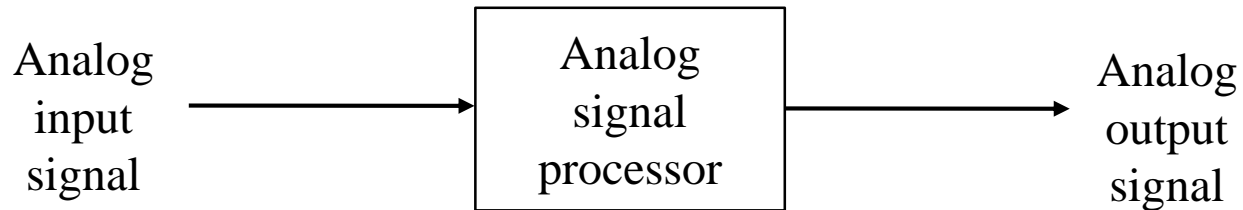
- A *system* performs an operation on a signal



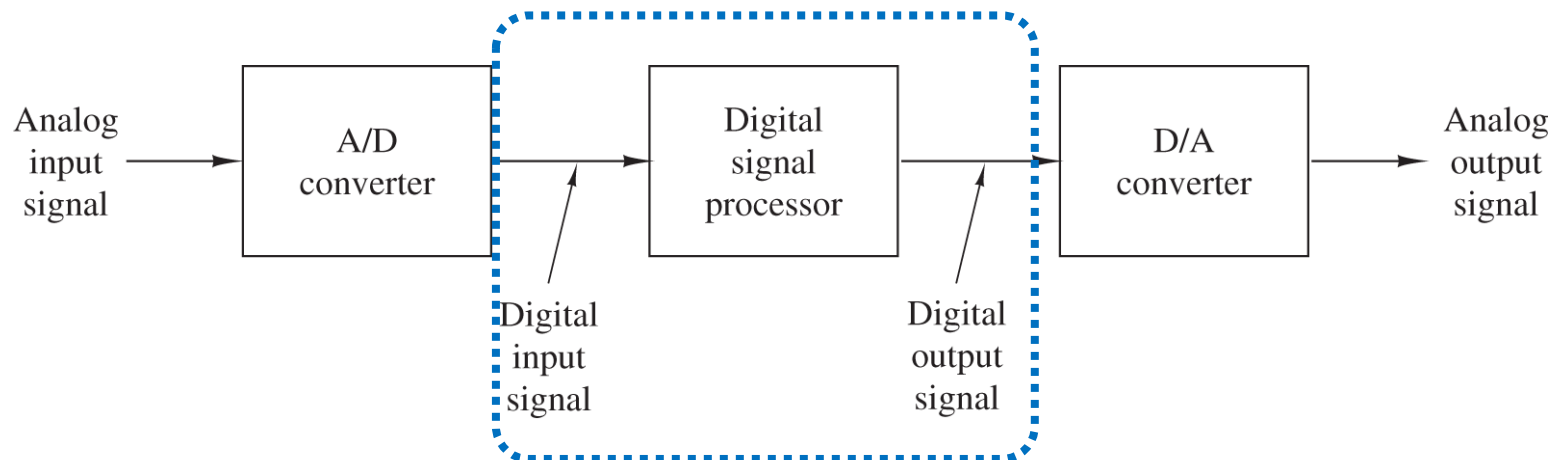
- Such operations are referred to as *Signal Processing*

Analog Signal Processing vs. Digital Signal Processing

- Analog signal processing



- Digital signal processing



Advantages of DSP over Analog Signal Processing

- Flexibility
- Accuracy
 - 16-bit, 32-bit, 64-bit digital computing
 - Extremely difficult to make accurate analog circuit components
- Easy storage and duplication
- Cost
 - Digital computing gets cheaper



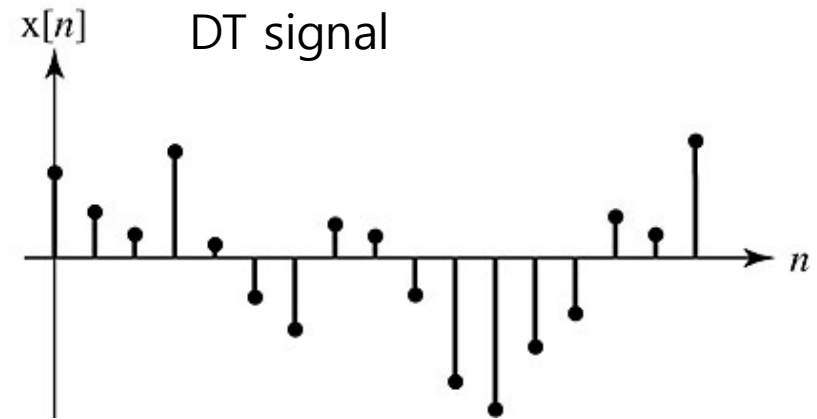
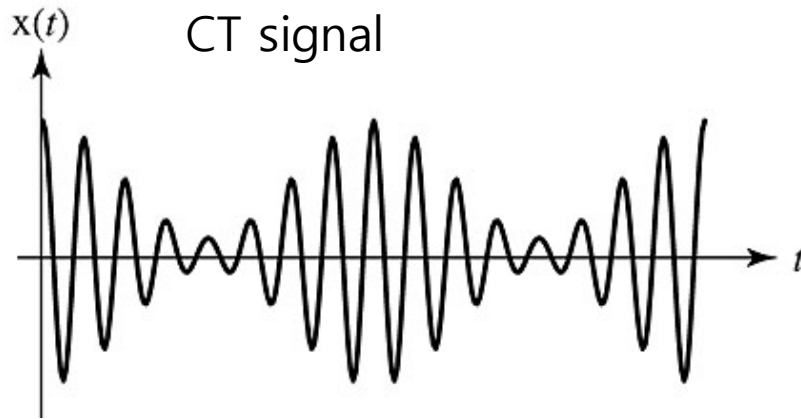
A color picture is a **three-channel, two-dimensional** signal

$$\mathbf{S}(x, y) = \begin{bmatrix} r(x, y) \\ g(x, y) \\ b(x, y) \end{bmatrix}$$



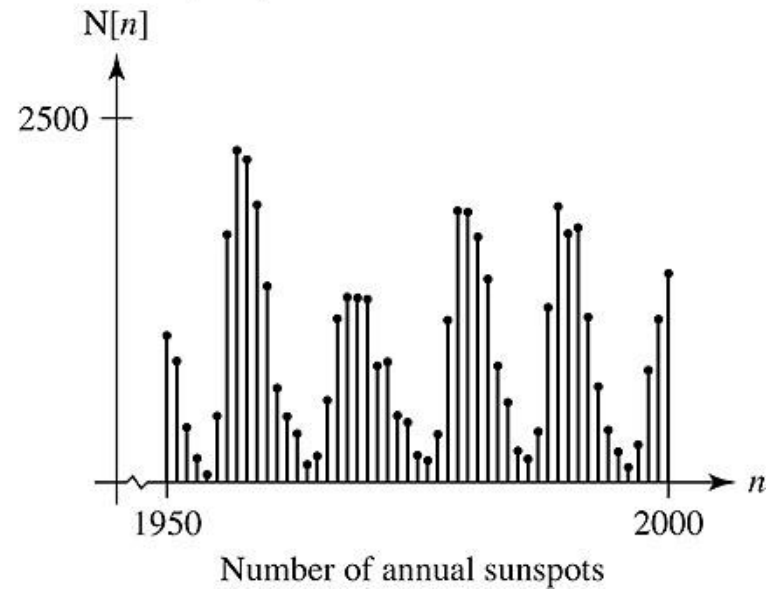
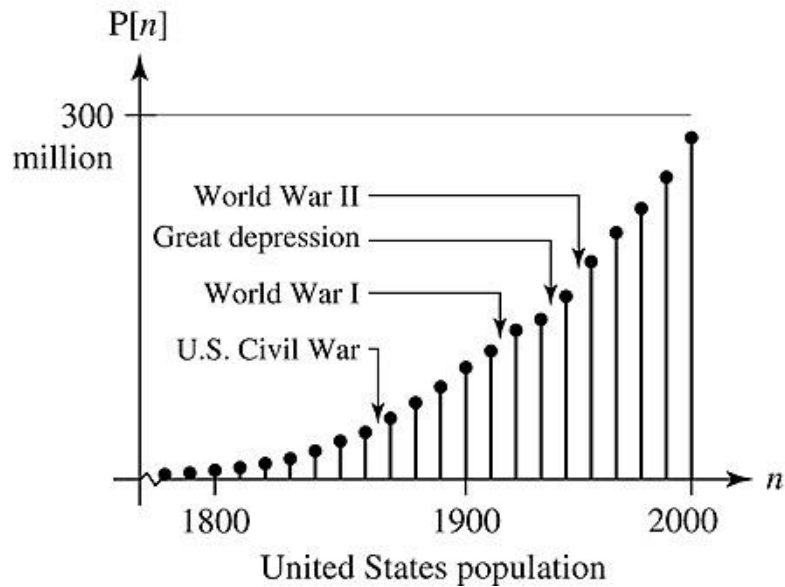
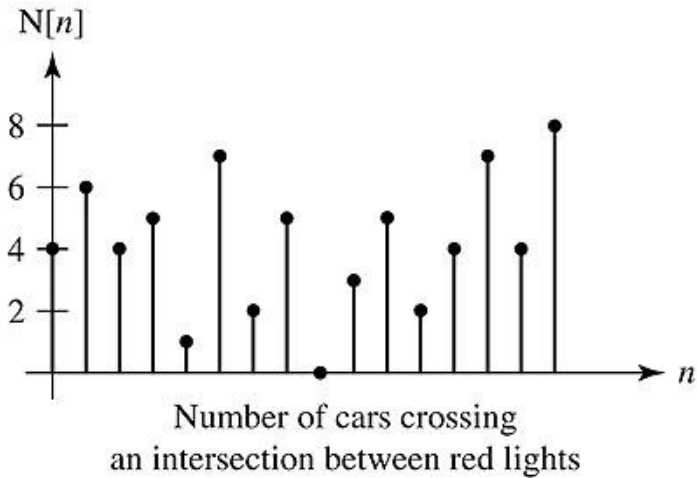
- In this work, we focus on single-channel, one-dimensional signals
- The single variable is called time

Continuous-Time vs Discrete-Time Signals



- DT signals often arise
 - by selecting values of an analog signal at discrete-time instants
 - by accumulating a variable over a period of time

Examples of Discrete-Time Signals



Continuous-Valued vs Discrete-Valued Signals

- A discrete-time signal having a set of discrete values is called a **digital signal**
- Digitization =
 sampling (time) + quantization (value)

Analog-to-Digital Conversion

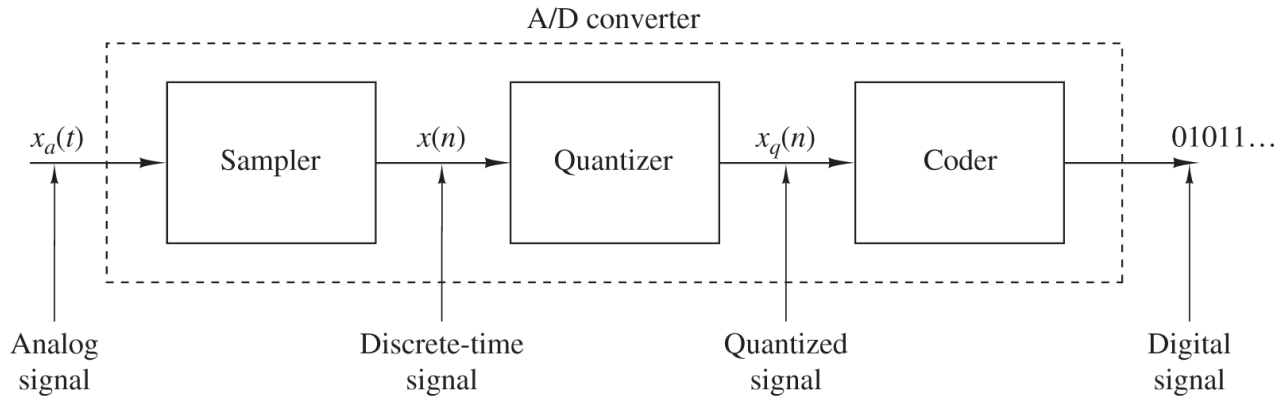


Figure 1.4.1 Basic parts of an analog-to-digital (A/D) converter.

Sampling

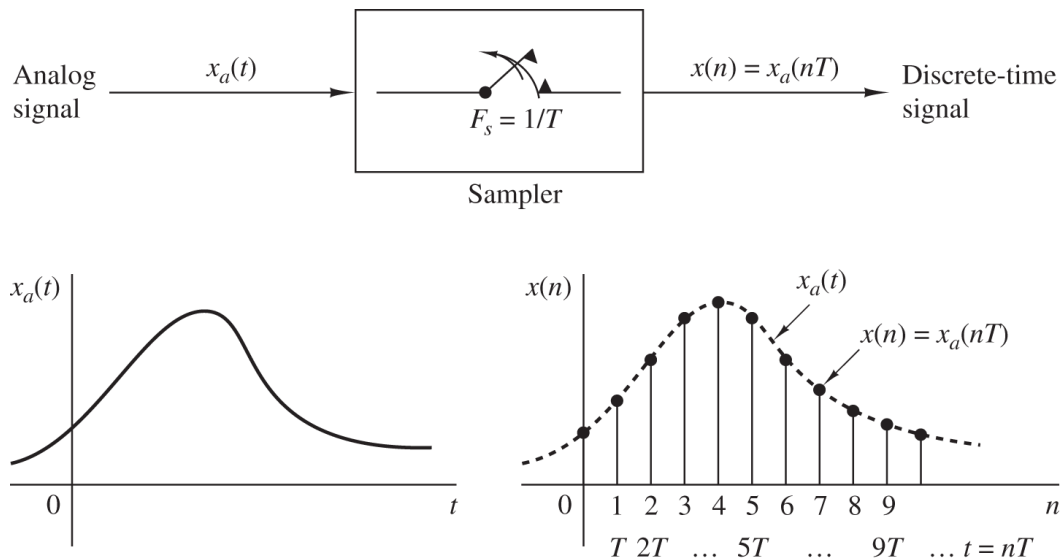
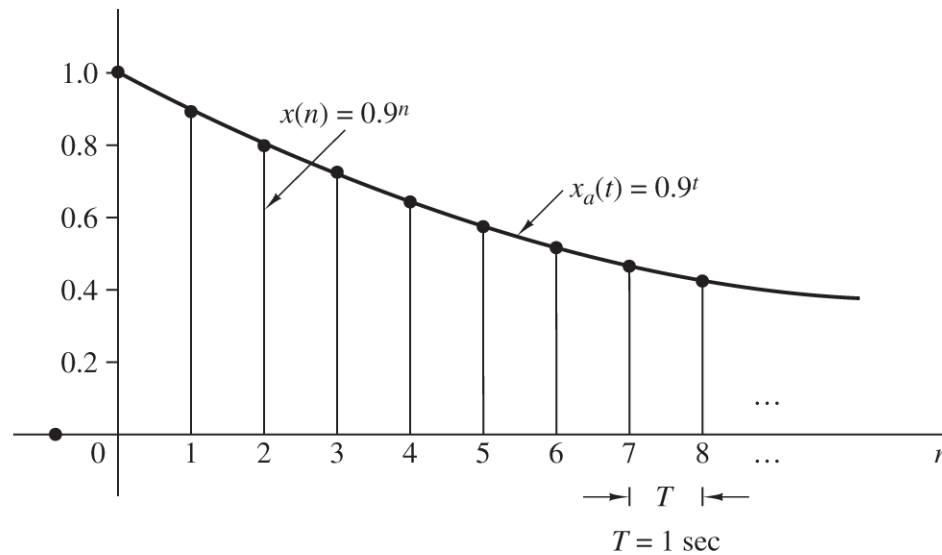


Figure 1.4.3 Periodic sampling of an analog signal.

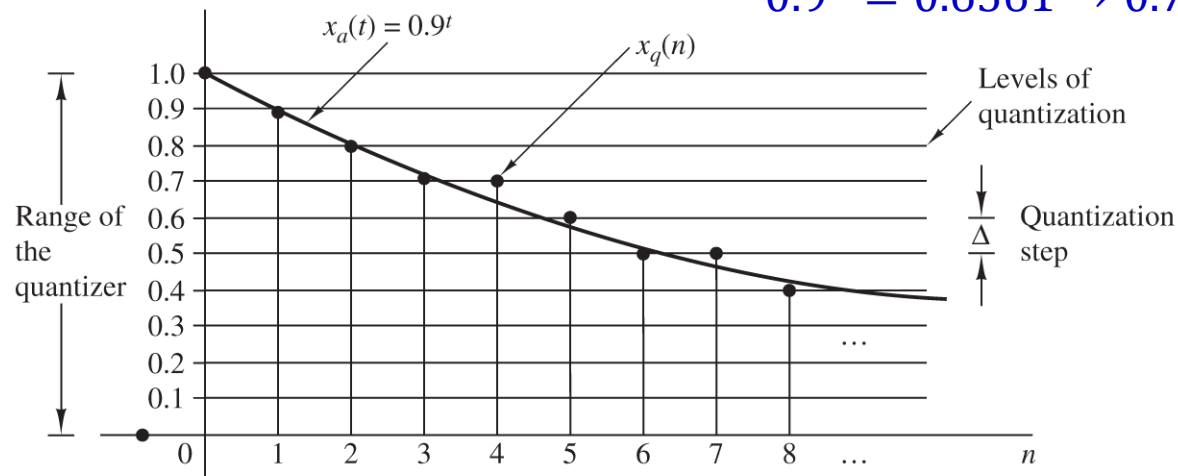
Analog-to-Digital Conversion

Quantization



(a)

$$0.9^4 = 0.6561 \rightarrow 0.7$$



(b)

Figure 1.4.7 Illustration of quantization.

Digital-to-Analog Conversion

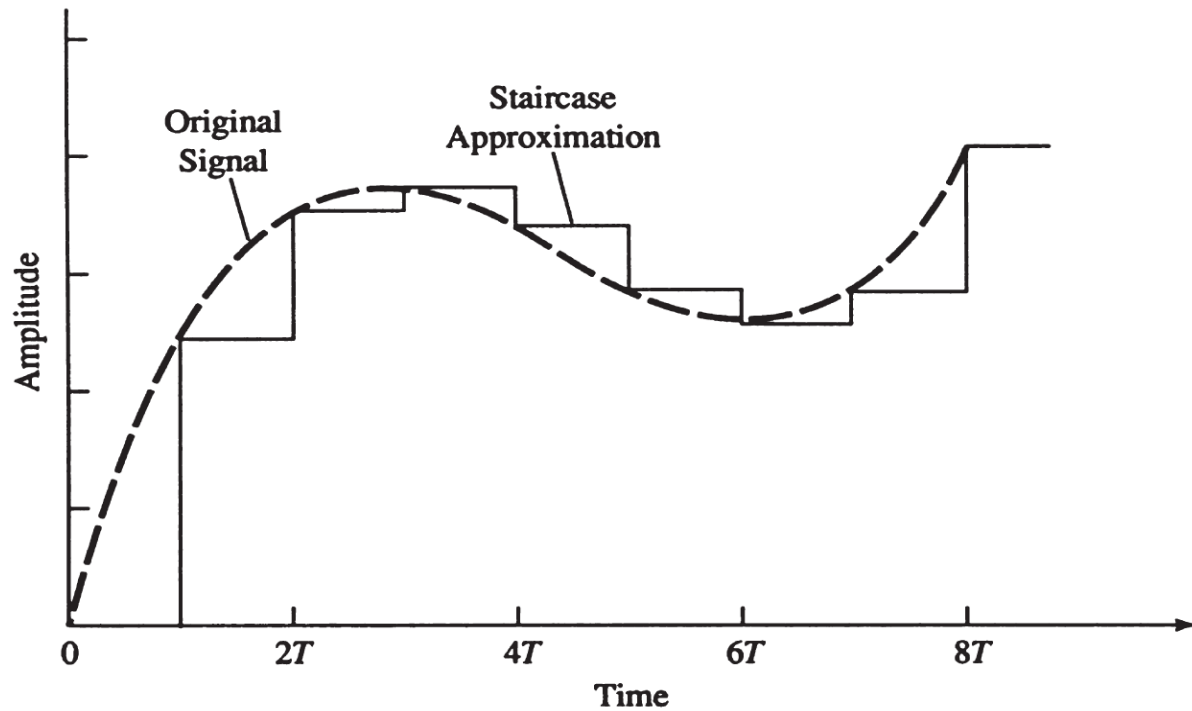


Figure 1.4.2 Zero-order hold digital-to-analog (D/A) conversion.

Examples

DSP LEADS TO ...

Dehazing

입력영상



결과영상



Deraining

Video Deraining and Desnowing

데모영상

Denoising and Enhancement



Object Tracking



IMAGE PROCESSING AND COMPUTER VISION

Computer Vision

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2. The New England Journal of Medicine	329	495
3. Science	311	431
4. The Lancet	248	381
5. Cell	223	343
...
65. IEEE Conference on Computer Vision and Pattern Recognition, CVPR	118	167

Opportunities