introduction to signal and system

Eason

November 26, 2019

Contents

1 preface

While students studying signals and systems should certainly have a solid foundation in disciplines based on the laws of physics, they must also have a solid foundation in disciplines based on the laws of physics, they must also have a firm grounding in the use of computers for the analysis of phenomena and the implementation of systems and algorithms. As a consequence, engineering curricula now reflect a blend of subjects, some involving continuous-time models and others focusing on the use of computers and discrete representations. For these reasons, signals and systems courses that bring discrete-time and continuous-time concepts together in a unified way play an increasingly important role in the education of engineering students and in their preparation for current and future developments in their chosen fields.

It has pedagogical advantage by taking both the continuous-time and discrete-time in mind.

Chapter 1 introduces block diagram representations of interconnections of systems and discusses several basic system properties such as causality, linearity and time-invariance.

The concepts of signals and systems arise in a wide variety of fields, and the ideas and techniques associated with these concepts play an important role in such diverse areas of science and technology such communications, aeronautics and astronautics, circuit design, acoustics, seismology, biomedical engineering, energy generation and distribution systems, chemical process control, and speech processing. Because of its importance, it worth to take time to digest each single idea and concept appearing in such course. Also, it will be greatly helpful for the newbie to have an open course to help them dive into the world of signals and systems. I tried my best to give the best explanation of the concept in this course and comprehensive details are given during my creation of videos and posts. It takes time to produce one piece of work so that sometimes I think it was a grind. However, for the sake of beautiful result, I pretty enjoy the process of doing such creation.

The signals, which are functions of one or more independent variables, contains information about the behavior or nature of some phenomenon, whereas the systems respond to particular signals by producing other signals or some desired behavior.

Examples:

1. Voltages and currents as a function of time in an electrical circuit are examples of signals. and a circuit is itself an example of a system, which in this case responds to applied voltages and currents.
2. As another example, when an automobile driver depresses the accelerator pedal, the automobile responds by increasing the speed of the vehicle.
3. A computer program for the automated diagnosis of electrocardiograms can be viewed as a system which has as its input a digitized electrocardiogram and which produces estimates of parameters such as heart rate as outputs.
4. A camera is a system that receives light from different sources and reflected from objects and produces a photograph.
5. A robot arm is a system whose movements are the response to control inputs.

The purpose of signals ans systems:

1. characterizing the system in detail to understand how it will respond to various inputs.
2. design systems to process signals in particular ways. such enhancement and restoration of certain signals, extraction of specific pieces of information from signals.
3. modify or control the characteristics of a given system.

2 15:39 Basics of signals and systems

This section is from Signals-and-Systems.ppt by Gloria Menegaz. The textbook is : *Signal Processing and Linear Systems* by B.P. Lathi, CRC Press.

3 definition of signals and systems

Fist give the definition of singal then system.

3.1 definition of signals

A signal is defined as any physical quantity that varies with time, space, or any other independent variable or variables. Mathematically, we describe a signal as a function of one or more independent variables. Signals convey information.

A continuous-time signal is a quantity of interest that depends on an independent variable, where we usually think of the independent variable as time. In the real world, physical quantities take on real numerical values, though it turns out that sometimes it is mathematically convenient to consider *complex-valued functions of t*. However, the default is real-valued $x(t)$, and indeed the type of sketch exhibited about is valid only for real-valued signals.

Remarks:

1. A continuous-time signal is not necessarily a continuous function as defined in calculus. They are two different definition.
2. The independent variable need not to be time, it could has other meaning. But considering it as time does not affect we study the concepts of signals and systems.

A discrete-time signal is a sequence of values of interest, where the integer index can be thought of as a time index, and the values in the sequence represent some physical quantity of interest. Because many discrete-time signals arise as equally-spaced samples of a continuous-time signal, it is often more convenient to think of the index as the "sample number".

3.2 examples of signals

3.2.1 ECG signal

3.2.2 Speech signal

3.2.3 Image

3.3 definition of systems

Systems process signals to produce a modified or transformed version of the original signal. For the information and communication technology, this series of videos and posts help engineers analyze and design the signals and systems they meet in daily life.

In general, two types of tools related with continuous-time signals and discrete-time signals will be covered. For example, for the continuous-time signals we have Fourier Transform and Laplace transform whereas for the discrete-time signals we have discrete time Fourier Transforms and Z-transform. Living in a digitized world, I use discrete-time signals related tools more often than the continuous-time counterpart. Now, it seems that the continuous-time signals only exists before analog-digital converter (ADC). However, to analyze a signal, the continuous-time related tools provide a more mathematical and theoretical way. So during the learning and teaching signals and systems, I will cover both continuous-time and discrete-time topics and give as many details about both realms as I can. Fortunately, we have sampling theory and ADC, we can easily move from continuous-time world to discrete-time world . Most of the conclusions we draw from the continuous-time world will apply in the discrete-time world with no or only a little modification.

3.4 examples of systems

3.4.1 ECG system

3.4.2 Voice recording system

3.4.3 Camera Systems

4 summary of chapter 1

We developed a number of basic concepts related to continuous-time and discrete-time signals and systems. We have presented both an intuitive picture of what signals and systems are through several examples and a mathematical representation for signals and systems that we will use throughout the book. Specifically, we introduced graphical and mathematical representation of signals and used these representations in performing transformations of the independent variable. We also defined and examined several basic signals, both in continuous time and in discrete time. These included complex exponential signals, sinusoidal signals, and unit impulse and step functions. In addition, we investigated the concept of periodicity for continuous-time and discrete-time signals.

In developing some of the elementary ideas related to systems, we introduced block diagrams to facilitate our discussions concerning the interconnection of systems, and we defined a number of important properties of systems, including causality, stability, time-invariance, and linearity.

The primary focus in most of this book will be on the class of LTI systems, both in continuous time and discrete time. These systems play a particularly important role in system analysis and design, in part due to the fact that many systems encountered in nature can be successfully modeled as linear and time invariant. Furthermore, as we shall see in the following chapters, the properties of linearity and time invariance allows us to analyze in detail the behavior of LTI systems.

5 references

Other references are:

1. Signals and systems by Richard Baraniuk's lecture notes.2003_Richard_Baraniuk_Signals_and_
2. Digital Signal Processing by John G. Proakis, Dimitris K ManolakisDigital Signal Processing: Principles, Algorithms & Applications
3. Signal processing and linear systems, Schaun's outline of digital signal processing.
4. Foundations of Signal Processing.Foundations of Signal Processing and Fourier and Wavelet Signal Processing
   Together with Fourier and Wavelet Signal Processing (to be published by CUP), the two books aim to present the essential principles in signal processing along with mathematical tools and algorithms for signal representation. They comprehensively cover both classical Fourier techniques and newer basis constructions from filter banks and multiresolution analysiswavelets. Furthermore, they gives a synthetic view from basic mathematical principles, to construction of bases, all the way to concrete applications.
5. Signal processing for communications, by Palo Prandoni and Martin Vetterli. Signal Processing for Communications
   With a novel, less formal approach to the subject, the authors have written a book with the conviction that signal processing should be taught to be fun. The treatment is less focused on the mathematics and more on the conceptual and practical aspects but the book remains an engineering text, with the goal of helping students solve real-world problems. In this vein, the last chapter pulls together all the topics discussed throughout the book into an in-depth look at the development of an end-to-end communication system, namely, a modem for communicating digital information over an analog channel.
6. Lecture notes of ELE 301 by Paul W. Cuff . TheLecture 1 ELE 301: Signals and Systems process some basic of the signals and systems
7. Signal and system analysis by Jianping YaoELG3120 .
8. Notes for signals and Systems by Wilson J. RughNotes for Signals

and Systems . And in the siteSignals, Systems, and Control Demonstrations has some other demos about signals and systems.

9. Lee and Varaiya, Structure and Interpretation of Signals and Systems
   Signals convey information. Systems transform signals. This book introduces the mathematical models used to design and understand both. It is intended for students interested in developing a deep understanding of how to digitally create and manipulate signals to measure and control the physical world and to enhance human experience and communication. This book is based on several years of successful classroom use at the University of California, Berkeley. The material starts with an early introduction to applications, well before students have built up enough theory to fully analyze the applications. This motivates students to learn the theory and allows students to master signals and systems at the sophomore level. The material motivates signals and systems through sound and images. Calculus is the only prerequisite.
   And the PDF version of the book is here. There is also an accompanied laboratory manual using matlab.
10. Gurdal Arslan has several Courses about signals and systems.
11. ECE2610 Introduction to Signals and Systems
    Mathematical representation of signals and systems; spectrum representation; representation of signals by sample values; discrete-time filter characterization and response; the z-transform; continuous-time signals and linear, time-invariant systems; frequency response; continuous-time Fourier transform and application to signals and systems. Include lectures, demonstrations, and laboratory assignments.
12. Dr Wickert's website Dr. Wickert's Info Center has quite a lot resources for a engineering student.

6 architecture of each video

1. every video will contain several topics but the mathematical derivation will not be so all-inclusive. More details will given as posts in this site for whom may be interested. So you can grab the overall structure at first then reinforce the it with more bricks.
2. For each video, only several key points will be explained. I don't want the video make you feel boring or tired.
3. A piece of suggestion for the serious learner: watch the video twice or even more. Most often, even some concepts which are relatively simple at first look hide some deep relation with other concepts. The obscure relation will not be illustrated in the video if it does not affect the understanding of current object.