Signals and Systems

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Chapter 1

Signal Analysis

B.Tech ECE: Signals and Systems **II-I Semester**

Chapter 1: Signal Analysis

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Signals can be used to describe a wide range of natural phenomena. A signal is generally imagined as a pattern of variations of some quantity with respect to another independent quantity. In the following section we shall look into the definition of a signal as well as a system along with some examples

1.1 Introduction

Signal It is defined as a function of any independent variable. Generally speaking, a signal is a function of time which conveys some sort of information.
E.g;

- Speech or Voice signals
- Image signals
- etc

System It is a collection of objects which work together to perform a particular task
From a communications standpoint, systems are used to process signals.

1.2 Classification of Signals

If a signal is defined in terms of only one independent variable, it is called a one dimensional signal otherwise it is called a multi-dimensional signal.
in addition to dimensions,signals can be classified on the basis of various parameters:

On the basis of time t

Continuous Time Signals
A signal which is defined continuously for all values of time t is called a continuous time

signal. It is represented by $x(t)$ (in parentheses) and are also called analog signals.

Discrete Time Signals
A signal that is defined for only specific instances of time or at discrete values of time.It is represented by $x[n]$ (in brackets).It is generally obtained by sampling an analog signal.

These signals can be further classified as follows:

On the basis of periodicity

Periodic Signals :

Continuous Time Periodic Signals
a signal is said to be CT-periodic if it repeats after a certain time interval T_0
Mathematically, it is defined as the signal which satisfies :
$x(t) = x(t + T_0) \forall t \in R$

Discrete Time Periodic Signals
a signal is said to be DT-periodic if it repeats after a certain time interval N_0
Mathematically, it is defined as the signal which satisfies :
$x[n] = x[n + N_0] \forall n \in Z$

Aperiodic Signals :
A signal that does not satisfy the above conditions is called aperiodic signal. It may be viewed as a limiting case of a periodic signal in which period tends to Infinity.

Even and Odd signals

a signal $x(t)$ is said to be even if it satisfies :

$$x(t) = x(-t) \quad (CT)$$
$$x[n] = x[-n] \quad (DT)$$

a signal x(t) is said to be odd if it satisfies :

$$x(t) = -x(-t) \quad (CT)$$
$$x[n] = -x[-n] \quad (DT)$$

if it satisfies neither it is said to be neither even nor odd.

1.3 Next topic

Here is how to define things in the proper mathematical style. Let f_k be the $AND - OR$ function, defined by

$$f_k(x_1, x_2, \ldots, x_{2^k}) = \begin{cases} x_1 & \text{if } k = 0; \\ AND(f_{k-1}(x_1, \ldots, x_{2^{k-1}}), f_{k-1}(x_{2^{k-1}+1}, \ldots, x_{2^k})) & \text{if } k \text{ is even;} \\ OR(f_{k-1}(x_1, \ldots, x_{2^{k-1}}), f_{k-1}(x_{2^{k-1}+1}, \ldots, x_{2^k})) & \text{otherwise.} \end{cases}$$

Here is a citation, just for fun [CW87].

References

[CW87] D. Coppersmith and S. Winograd, "Matrix multiplication via arithmetic progressions," *Proceedings of the 19th ACM Symposium on Theory of Computing*, 1987, pp. 1–6.