THE CONCEPTS OF SIGNAL AND SYSTEM

Signal: A signal can be broadly defined as any quantity that varies as a function of time and/or space and has the ability to convey information.

• Signals are ubiquitous in science and engineering. Examples include:- Electrical signals: currents and voltages in AC circuits, radio communications signals, audio and video signals.- Mechanical signals: sound or pressure waves, vibrations in a structure, earthquakes.Biomedical signals: electro-encephalogram, lung and heart monitoring, X-ray and other typesof images- Finance: time variations of a stock value or a market index.
• By extension, any series of measurements of a physical quantity can be considered a signal (temperature Measurements for instance).

Signal characterization: The most convenient mathematical representation of a signal is via the concept of a function, say x(t).

In this notation:
- x represents the dependent variable (e.g., voltage, pressure, etc.)
- t the represents the independent variable (e.g., time, space, etc.).

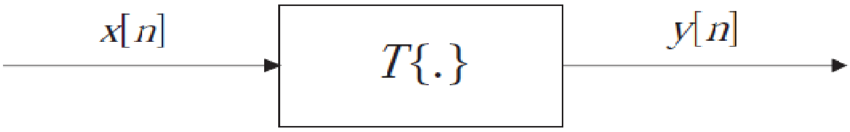
• Depending on the nature of the independent and dependent variables, different types of signals can be Identified:- Analog signal: t R→xa(t) R or C
When t denotes the time, we also refer to such a signal as a continuous-time signal.- Discrete signal: n □Z→x[n] R or C
• Distinctions can also be made at the model level, for example: whether x[n] is considered to be deterministic or random in nature.

Speech signal: A speech signal consists of variations in air pressure as a function of time, so that it basically represents a continuous-time signal x(t). It can be recorded via a microphone that translates the local pressure variations into a voltage signal. An example of such a signal is given in Figure 1.1(a), which represent the utterance of the vowel “a”. If one wants to process this signal with a computer, it needs to be discredited in time in order to accommodate the discrete-time processing capabilities of the computer .and also quantized, in order to accommodate the finite-precision representation in a computer These represent a continuous-time, discrete-time and digital signal respectively. As we know from the sampling theorem, the continuous-time signal can be reconstructed from its samples taken with a sampling rate at least twice the highest frequency component in the signal. Speech signals exhibit energy up to say, 10 kHz. However, most of the intelligibility is conveyed in a bandwidth less than 4 kHz. In digital telephony, speech signals are filtered (with an anti-aliasing filter which removes energy above 4 kHz), sampled at 8 kHz and represented with 256 discrete (non-uniformly spaced)

Digital Image: An example of two-dimensional signal is a grayscale image, where t 1 and t2 represent the horizontal and vertical coordinates, and $x(t1, t2)$ represents some measure of the intensity of the image at location $(t1, t2)$. This example can also be considered in discrete-time (or rather in discrete space in this case): digital images are made up of a discrete number of points (or *pixels*), and the intensity of a pixel can be denoted by $x[n1,n2]$. Figure 1.2 shows an example of digital image. The rightmost part of the Figure shows a zoom on this image that clearly shows the pixels. This is an 8-bit grayscale image, i.e. each pixel (each signal sample) is represented by an 8-bit number ranging from 0 (black) to 255 (white).

System: A physical entity that operates on a set of primary signals (the inputs) to produce a corresponding set of resultant signals (the outputs).

System characterization: A system can be represented mathematically as a transformation between two signal sets, as in $x[n]$ S1 $\rightarrow y[n] = T\{x[n]\}$ S2. This is illustrated in Figure



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