SIGNAL

A signal is a function that conveys information about a phenomenon. In electronics and telecommunications, it refers to any time varying voltage, current or electromagnetic wave that carries information.In a communication system, a transmitter encodes a message to create a signal, which is carried to a receiver by the communications channel.

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In a broader sense , Signal is an action of conveying information via various means. It is a part of evolution. In modern age signals are used for many purposes and it is an essential part of humankind.

A signal can be defined as a function of time. The common signals which are mathematically generated are
•constant (or static or DC) signal
• the unit step signal
• the unit ramp signal
• a rectangular pulse signal
• a sinusoidal signal

In the real world, Signals are not determined by mathematical formulas as signals are used for transmission of information over a medium and thus it varies according to the data. Signals are used for FM/AM radio, Cable TV signal, Audio signal ,Video signal , Telephone network , Digital electronics etc.

Characteristics Of Signal

The Characteristics of a signal defines the signal and gives information about the nature of the signal. The Characteristics of a signal are:

Amplitude : The amplitude of a wave refers to the maximum amount of displacement of a particle on the medium from its rest position.

Frequency : Frequency is the rate of Oscillation of a signal’s waveform in a second. The unit of Frequency is hertz (Hz).

Time Period : The time period of a signal is the time in which the wave completes its one full cycle. The unit of the time period is Second. The time period is denoted by ‘T’ and it is the inverse of frequency. I.e. T=1/F

Phase : In electronic signaling, phase is a definition of the position of a point in time (instant) on a waveform cycle.

Size of a signal : The size of a signal is a number that shows the strength or largeness of that signal. According to the size of the signal, there are two parameters.

1. Signal Energy , 2. Signal Power

Classifications of Signals

Signals can be classified into different categories based on their nature and properties :

1. Based on variation in Amplitude :

Analog Signal : An **analog signal** is any continuous signal for which the time-varying feature (variable) of the signal is a representation of some other time-varying quantity, i.e., *analogous* to another time-varying signal. For example, in an analog audio signal, the instantaneous voltage of the signal varies continuously with the pressure of the sound waves.

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Digital Signal : A **digital signal** is a signal that is being used to represent data as a sequence of discrete values; at any given time it can only take on one of a finite number of values. A special case is a *logic signal* or a *binary signal*, which varies between a low and a high signal level. Because discretization, relatively small changes to the analog signal levels do not leave the discrete envelope, and as a result are ignored by signal state sensing circuitry. As a result, digital signals have noise immunity

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2. Based of Time

Continuous- Time Signal: Continuous-time signal is the “function of a continuous-time variable that has an infinite set of numbers in its sequence”. The continuous-time signal can be represented and defined at any instant of the time in its sequence.

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Discrete-Time Signal : Discrete-time signal is the “function of a discrete-time variable that has a countable or finite set of numbers in its sequence”. The discrete-time signal can be represented and defined at certain instants of time in its sequence.

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3. Based on Periodicity

Periodic Signal : A signal is a periodic signal if it completes a pattern within a measurable time frame, called a period and repeats that pattern over identical subsequent periods. The completion of a full pattern is called a cycle. A period is defined as the amount of time required to complete one full cycle.

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Aperiodic Signal : A signal that does not repeat itself after a specific interval of time is called an aperiodic signal. aperiodic function can be considered similar to a periodic function with an infinite period.

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4. Energy and Power Signal

Energy Signal : A signal is said to be an energy signal if it has a finite amount of energy associated with it. This finite energy, when averaged over an infinite amount of time, will result in zero power.

Power Signal : A signal is said to be a power signal if it has a finite amount of power associated with it. This finite power when accumulated over an infinite amount of time, will result in infinite energy.

5. Deterministic and Non-Deterministic signal

Deterministic signal : A signal is said to be deterministic if there is no uncertainty with respect to its value at any instant of time. Or, signals which can be defined exactly by a mathematical formula are known as deterministic signals.

Non-Deterministic signal : A signal is said to be non-deterministic if there is uncertainty with respect to its value at some instant of time. Non-deterministic signals are random in nature hence they are called random signals. Random signals cannot be described by a mathematical equation. They are modelled in probabilistic terms.

Importance of Signals

Application of Signals and Signal Processing

1. Telecommunication : The Telecommunication network is based on signals.Cellular networks , Internet , WiFi , Bluetooth , NFC operated on signals of different types which varies on frequency and amplitude which affects the rate of data transmission and range.
2. Healthcare, Pharmacy and medicine: Analysis of the ECG, EEG are just some examples of medicine using signal processing. Further, a lot of non-invasive techniques for health monitoring are being developed which involve signal processing strategies on Ultra Wide Band signals.
3. Meteorology: Analysis of a vast extent of collected data involves signal processing methods as well, and hence these help to perform accurate weather prediction.
4. Radars, Sonar , military equipment and surveillance systems involve signal processing.
5. Seismology: scientists use spectral analysis to determine periodicity and anomalies in the recorded data. It gives them a better insight into the nature of earthquakes and what follows before and after an earthquake. Recently, after the 2011 Tohoku earthquake, it has been revealed that slow quakes which are basically like noise in the grand scheme of things as recorded by a seismograph are being used to predict big earthquakes near subduction zones. This involves a lot of efficient and clever signal processing techniques.