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Analog Signal and Digital Signal Processing in Telecommunication System

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Abstract

This study discusses signal in telecommunication system. The term digital signal is a term from a technology that converts an analog signal into digital data so that the signal can be processed more easily and quickly. The term digital itself is a system that only recognizes two conditions. The two conditions are usually represented by the numbers zero and one, on and off, or others. The smallest unit of digital signal is the bit. The method of carrying out operations on a signal is called signal processing or flag handling. Models and sorts of signals in telecommunication frameworks moreover have a signal demonstrate which is meant by communication framework maybe an arrangement of forms for trading certain information or data utilizing signaling help.

Introduction

There are several reasons why digital signals are used. The first reason is because the signal processing using a digital programmed system has flexibility in processing. In digital systems, changing a process only requires changing the program. Meanwhile, if using an analog system, changing the process means changing the settings of the hardware to get the expected results.

Apart from the problems mentioned above, accuracy and accuracy are also important in processing a signal. Signal processing using a digital signal system has better control and accuracy when compared to processing using an analog system. Tolerance factors found in analog signal systems often cause difficulties in controlling process accuracy. One of the requirements needed to determine the accuracy of a digital signal system includes the determination of the accuracy of the analog to digital (A / D) converter. Digital signals can be stored on magnetic media without experiencing attenuation or distortion of the corresponding signal data. Thus the signal can be moved and processed easily without reducing data quality too much. Digital signal processing methods also allow the implementation of more sophisticated signal processing algorithms.

Understanding the Signal

According to Harms et.al (2010) signal is comes from the English word signal which means sign or signal. But more specifically, what is meant by signal is a physical quantity that varies with time, position, or other independent variables or several independent variables at once. Mathematically, the signal can be expressed in terms of a function of one or more independent variables, for example:

x (n) = cos (2p (0.3) n)

s (t) = 3t2 + 10t

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s (x, y) = 3x + 2xy + 10y2

It's just that, the existence of a functional relationship as above, is not always known or sometimes too complicated to formulate. In this last case - which is often referred to as a random signal - usually the signal is expressed in terms of statistical functions.

Signal Classification

There are many kinds of signals, for example electrical signals, mechanical signals, acoustic signals, and many others. Signal classification is carried out according to several criteria, including: (1) Channel and Dimensions (2) Periodicity (3) Randomness (4) Odd and Even (5) Energy and Power (6) Value and Time (Rajendran et.al, 2018)

Understanding Systems and Signal Processing

The system is a device (hardware or software) that performs certain operations on a signal (Gazi, 2018). These operations can be elementary operations or complex operations. The process of carrying out operations on a signal is called signal processing or signal processing.

Based on the processed signal, signal processing can be divided into two types, namely analog signal processing and digital signal processing. Analog signal processing has analog signal input and analog signal output, while digital signal processing has digital signal input and digital signal output. It's just that, because most of the signals in nature are analog signals, to process analog signals in a digital system, an analog to digital converter (Analog to Digital Converter, abbreviated as ADC) must be inserted, and if necessary a digital to analog converter (Digital to Analog Converter, abbreviated as DAC).

Comparison of Analog Signal Processing with Digital Signal Processing

In general, Digital Signal Processing is better than Analog Signal Processing, for several reasons: (1) A digital programmable system, that is to say using software, has the flexibility to reconfigure signal processing operations by changing the program. Meanwhile, reconfiguring an analog system usually demands a hardware redesign followed by testing and proving to see if the system is operating properly. (2) Digital system components, in general, have higher accuracy than analog system components. High accuracy components in analog systems are usually expensive. (3) Digital signals are easily stored on magnetic media (tape or disk) without experiencing a decrease or loss of signal authenticity, compared to analog signals. (4) Digital signal processing methods also allow the implementation of sophisticated signal processing algorithms. Usually this is difficult for mathematical operations of signals in precise analog form. (5) Digital systems do not require impedance matching. (6) Digital systems can operate at very low frequencies. (7) Digital systems can do delay (delay) and compression (compressing) easily. (8) The digital system is not sensitive to noise (noise). (9) Digital systems can work with a dynamic range of more than 70 dB, which is the maximum limit for analog systems. (10) Digital systems usually do not require periodic adjustments (Shenoi, 2006).

Models and Types of Signals in Telecommunication Systems

Signal Model

Defined by Isaksson et.al (2006) the communication system is a series of processes for exchanging certain data or information using signaling assistance. Data communication will also very closely discuss the concept and model of this signal. We can become more understanding about the concept of signals in data communication if we first learn about how the communication system can take place.(1) Analog signal model. Analog signal is a data signal in the form of waves that carry information continuously. Actually there are several kinds of components in it such as analog, frequency and amplitude. The three of them will be discussed into different descriptions in order to further clarify the model of the signal that is in data communication. (2) Digital Signal Model. In contrast to analog signals, digital signals

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carry data in the form of messages that can change suddenly and have a magnitude of 0 and 1. This is a common signal also found in communication technology today. The process can be very complex and take place simultaneously at the same time. (3) Signal Amplitude. Amplitude is a model of the signal that actually becomes part of the analog signal. This amplitude describes the high and low size of a wave that carries information in the signal. The difference in height and low in the size of the wave will determine the type of information carried in the signal. (4) Signal Frequency. As with amplitude, frequency is also a model of the existing signal from the analog signal model. If amplitude talks about the height and the low of the wave, then the frequency is the number of analog signal waves that exist for one second. The number of these waves will then have an effect on the level and type of information to be transmitted via analog signals. (5) Phase Signal. Phase is a model of the analog signal which emphasizes the angle of the analog signal. The phase will also determine how the communication process will take place and the type of information can be sent or differentiated by using different phase angles as well. It is one of the components of analog signal besides amplitude and frequency. (6) Data Sources. More broadly, the data communication model also involves data sources. It can be understood that existing data sources will send certain signals which will then be captured by the recipient of the message. Information may not be able to be sent if there is no data source from which the information originates. (7) Transmission Media. The transmission medium is one of the components in data communication as an intermediary. The existing signal is forwarded using this transmission medium, with the hope that it will be transmitted to the data recipient later. There are also many transmission media models depending on the ongoing data communication context. (8) Receiver of Data. Finally, regarding the data receiver model. All kinds of signals that have been sent earlier will lead to the data receiver. This will then be interpreted as new information which may also provide the integrity of the ongoing communication process.

Signal Type

GSM (Global System for Mobile Communication)

This is the first tier used by a cell phone. This technology is digital which utilizes microwaves and the transmission of signals that are divided by time. This signal can be accessed at frequencies between 800-1800 MHz with a speed of 9.6-14.4 kbps or if rounded to 1-1.5 Kbps. Because this signal has a very low speed, this type of technology cannot yet be used to access the internet, so it can only send text messages (SMS) and telephone calls (Hillebrand, 2002).

GPRS (Global Package Radio Service)

This is a development of the previous signal technology, namely GSM. This technology, which was introduced in Indonesia in 2001, is also known as 2.5 G. It has access speeds of 115-160 kbps / 10-20 Kbps. This technology can be used to send data such as pictures (MMS), sending e-mail, WAP, WWW. On smart phones, this type of technology is no longer used.

EDGE (Enchanced Data rates for GSM Revolution)

The EDGE signal has the E symbol on this smartphone, which is an evolution from GSM. Developed from GSM to increase data transmission speed, spectral efficiency, increase capacity and enable the use of new applications. This technology is also called 2.75 G with speeds capable of reaching 473 kbps, about 3 times faster than GPRS.

3G (Third Generation Technology)

Also called UMTS (Universal Mobile Telecommunication System) or WCDMA (Wideband Code-division Multiple Access). In addition to cell phones, this technology is also used in modem devices for wireless / portable internet connections. 3G is comparable to EVDO (Evolution Data Optimized) technology. Having a slightly higher speed compared to EDGE,

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this does not mean that 3G only has the same quality as EDGE. 3G has better quality than EDGE and is capable of video calling and streaming video and audio.

HSDPA (High Speed Download Packet Access)

Also known as 3.5 G has a speed of 7.2 to 14.4 Mbps. Also used as a technology for modems. The capability of HSDPA technology is not far from 3G, namely for streaming video, video chat, etc. The difference between HSDPA and 3G is that HSDPA has a clearer image compared to 3G.

4G (Fourth Generation) LTE (Long Term Evolution)

The technology that was recently released in Indonesia and received a warm response from the public. Many various smartphone vendors are now developing their brands with this technology. The downlink speed is able to reach 100 Mbps while the uplink is 50 Mbps. This is the advantage of 4G technology, users can download or upload large or HD files very quickly.

Frequency Domain Signal

In physics, electronics, control systems engineering, and statistics, the frequency domain refers to the analysis of mathematical functions or signals with respect to frequency, not time. Put simply, time-domain graphs show how signals change over time, whereas frequency-domain graphs show how many signals are located within each frequency band in a frequency range. The frequency-domain representation can also include information about the phase shift that must be applied to each sinusoid in order to recombine the frequency components to recover the original time signal.

A given function or signal can be changed between the time and frequency domains by a pair of mathematical operators called transformations. An example is the Fourier Transform, which converts the function of time into the addition or integral of a sine wave at different frequencies, each representing a frequency component. The "spectrum" of a frequency component is a frequency domain representation of the signal. The inverse Fourier transform converts the frequency domain function back to a time domain function. A spectrum analyzer is a tool commonly used to visualize electronic signals in the frequency domain. Several specialized signal processing techniques use transformations that produce a combined time-frequency domain, with the instantaneous frequency being the primary link between the time domain and the frequency domain.

Magnitude and Phase

In using the Laplace, Z-, or Fourier transforms, the signal is described by a complex frequency function: the components of the signal at a given frequency are given by a complex number. The modulus of the number is the amplitude of the component, and the argument is the relative phase of the wave. For example, using the Fourier transform, sound waves, like human voices, can be broken down into different frequency tone components, each represented by a sine wave of a different amplitude and phase. The response of a system, as a function of frequency, can also be described as a complex function. In many applications, phase information is unimportant. By removing the phase information, it is possible to simplify the information in the frequency domain representation to produce the frequency spectrum or spectral density. A spectrum analyzer is a device that displays spectrum, while the time domain signal can be viewed on an oscilloscope.

$$E_\infty \triangleq \lim_{T\to\infty} \int_{-T}^{T} |x(t)|^2 dt = \int_{-\infty}^{+\infty} |x(t)|^2 dt, \qquad (1.6)$$

And in discrete time,

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$$E_\infty \triangleq \lim_{N\to\infty} \sum_{n=-N}^{+N} |x[n]|^2 = \sum_{n=-\infty}^{+N} |x[n]|^2 \quad (1.7)$$

For some signals, the integral of equation (1.6) or the sum in equation (1.7) cannot be centered on a single point if x (t) or x [n] equals a nonzero constant value at all times. The signal has unlimited energy, while the signal with E_∞ <∞ has limited energy.

By the same analogy, one can define a time averaged power over an infinite interval as

$$P_\infty \triangleq \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 dt \quad (1.8)$$

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$$P_\infty \triangleq \lim_{T\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{+N} |x[n]|^2 \quad (1.9)$$

Sequentially in continuous-time and discrete-time. With this definition, we can equate three important signal classes. The first of this class is a class of signals with limited total energy, namely signals at E_∞ <∞. Such a signal must have zero mean power, because in the case of continuous time, for example, we see from equation (1.8) that

$$P_\infty \triangleq \lim_{T\to\infty} \frac{E_\infty}{2T} = 0 \quad (1.10)$$

An example of a finite-energy signal is a signal having an energy of 1 at 0≤t≤1 and 0 otherwise. In this case, E_∞ = 1 and P_∞ = 0.

The second class of signals is those with a limited average power P_∞. From what we have just seen, if P_∞> 0, then, as needed E_∞ = ∞. This of course occurs when there is an average energy per unit time that is not zero, (i.e. non-zero power), so combining and adding it to an infinite time interval produces an unlimited amount of energy. For example, the constant signal x [n] = 4 has unlimited energy, but the average power P_∞ = 16. There are also signals that are P_∞ and E_∞ limited. A simple example is the signal x (t) = t.

Conclusion

From the discussion above we can conclude that understanding the signal is by a physical quantity that varies with time, position, or other independent variables or several independent variables at once. System and signaling process is a device (hardware or software) that performs certain operations on a signal. These operations can be elementary operations or complex operations. The process of carrying out operations on a signal is called signal processing or signal processing. Models and types of signals in telecommunication systems also have a signal model which is meant by communication system is a series of processes for exchanging certain data or information using signaling assistance. Data communication will also very closely discuss the concept and model of this signal. We can become more understanding about the concept of signals in data communication if we first learn about how the communication system can take place.

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