© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 08 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

REVIEW ON POWER SYSTEM HARMONICS ESTIMATION USING SIGNAL PROCESSING

[1]Amit Kumar , [2]Sweety Sharma
[1] Research Scholar, Department of Electrical Engneering, IIET, Kinana jind, ID:- amitkhatri652@gmail.com
[2] Sweety Sharma Assistant Professor IIET, Kinana Jind, ID:- sweetys.1000@yahoo.co.in

ABSTRACT: **Signal processing** is an enabling technology that encompasses the fundamental theory, applications, algorithms, and implementations of processing or transferring information contained in many different physical, symbolic, or abstract formats broadly designated as signals.[1] It uses mathematical, statistical, computational, heuristic, and linguistic representations, formalisms, and techniques for representation, modeling, analysis, synthesis, discovery, recovery, sensing, acquisition, extraction, learning, security, or forensics.[1] According to Alan V. Oppenheim and Ronald W. Schafer, the principles of signal processing can be found in the classical numerical analysis techniques of the 17th century. Oppenheim and Schafer further state that the "digitalization" or digital refinement of these techniques can be found in the digital control systems of the 1940s and 1950s.[2]

[1] Introduction

Signal processing is an enabling technology that encompasses the fundamental theory, applications, algorithms, and implementations of processing or transferring information contained in many different physical, symbolic, or abstract formats broadly designated as signals.[1]

Categories

Analog signal processing

Analog signal processing is for signals that have not been digitized, as in legacy radio, telephone, radar, and television systems. This involves linear electronic circuits as well as non-linear ones. The former are, for instance, passive filters, active filters, additive mixers, integrators and delay lines. Non-linear circuits include commanders, multiplications (frequency mixers and voltage-controlled amplifiers), voltage-controlled filters, voltage-controlled oscillators and phase-locked loops.

Continuous-time signal processing

Continuous-time signal processing is for signals that vary with the change of continuous domain(without considering some individual interrupted points).

The methods of signal processing include time domain, frequency domain, and complex frequency domain. This technology mainly discusses the modeling of linear time-invariant continuous system, integral of the system's zero-state response, setting up system function and the continuous time filtering of deterministic signals

Discrete-time signal processing

Discrete-time signal processing is for sampled signals, defined only at discrete points in time, and as such are quantized in time, but not in magnitude.

Analog discrete-time signal processing is a technology based on electronic devices such as sample and hold circuits, analog time-division multiplexers, analog delay lines and analog

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 08 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

feedback shift registers. This technology was a predecessor of digital signal processing (see below), and is still used in advanced processing of gigahertz signals.

Digital signal processing

Digital signal processing is the processing of digitized discrete-time sampled signals. Processing is done by general-purpose computers or by digital circuits such as ASICs, field-programmable gate arrays or specialized digital signal processors (DSP chips). Typical arithmetical operations include fixed-point and floating-point, real-valued and complex-valued, multiplication and addition. Other typical operations supported by the hardware are circular buffers and look-up tables. Examples of algorithms are the Fast Fourier transform (FFT), finite impulse response (FIR) filter, Infinite impulse response (IIR) filter, and adaptive filters such as the Wiener and Kalman filters.

Nonlinear signal processing

Nonlinear signal processing involves the analysis and processing of signals produced from nonlinear systems and can be in the time, frequency, or spatio-temporal domains.[5] Nonlinear systems can produce highly complex behaviors including bifurcations, chaos, harmonics, and sub harmonics which cannot be produced or analyzed using linear methods.

[2] Literature Review

Umar Naseem Khan in 2006 written by "Signal Processing Techniques used in Power Quality Monitoring"

This paper gives a general review of different signal processing techniques which are widely used for the power quality monitoring. The majority of power quality problems can be characterized through measurements of voltage and current. To distinguish the type of disturbances, monitoring systems require the processing of signals, which concern the extraction of features and information from measured digital signals. In fact, the use of signal processing techniques can influence the way that voltage and current signals are measured and analyzed in power system field. Different signal processing techniques has been discussed in this paper. In terms of calculation RMS techniques is simple, fast, and much sensitive in sags, swells, and interruptions in the signals.

Silk Smita1, Sharmila Biswas2, Sandeep Singh Solanki in 11, November 2014 written by Audio Signal Separation and Classification: A Review Paper

Music signals are not solely characterized because of other mixed audio signals. Mixed audio signals contain music signals mixed with speech signals, voice and even background noise.Thus, mixed signals need to classify separately. Researchers have developed many algorithms to solve this problem keeping in mind with their characteristic features of music signals: by timbre, harmony, pitch, loudness etc. The algorithm ICA (Independent component analysis) uses basis of Blind source separation, HSS(Harmonic structure stability), "SOSM" APPROACH (Second Order Statistical Measures Approach), Sinusoidal Parameters based audio classification using FDMSM etc. are some of the mixed signal classification algorithms. This paper highlights all these existing methods and their experimental results. Signal separation is a difficult problem and no reliable methods are available for the general case. The detailed research on all the works done on separation of audio signals has led us to the conclusion that Harmonic Structure characteristic is the effective with respect to others as it preserves the audio quality. Moreover, most of the instrument sounds are harmonic in nature. Harmonic structure of music signal is stable. Harmonic structures of the music signals performed by different instruments are different. So, we can easily classify and separate different signals. However, this algorithm doesn't work for non-harmonic instruments, such as some drums. Some rhythm tracking algorithms can be used instead to separate drum sounds. Pre-processing techniques like sinusoidal parameter approach and SOSM approach have also led us to the conclusion that selection of feature is an important step in the research field especially in music. That is why, the need to select the most efficient and accurate feature is essential for audio classification. Classifiers like SVM are proven to be the best classifiers as they more accurate than other although it may get trade off by the elapsed time.

3, MARCH 2002 written by Peter Asbeck, *Fellow, IEEE*, Ian Galton, *Member, IEEE*, Digital Signal Processing—Up to Microwave Frequencies

Digital logic integrated circuits are advancing toward ever higher speeds of operation. Clock frequencies already exceed 1 GHz in some Si CMOS-based consumer products, and even higher speeds are attainable in specialized technologies, such as those based on GaAs, InP, and SiGe bipolar and field-effect transistors. Digital approaches may be used to carry out a variety of functions important in microwave systems, including signal generation, filtering, and frequency conversion. The digital implementation provides a variety of potential benefits, including lack of sensitivity to aging and component inaccuracies, flexibility, and programmability. The dynamic range and degree of nonlinearity can be specified by design. Signal storage and memory functions are easily accomplished. Single-chip integration of digital and microwave systems are also facilitated. The application of digital techniques in domains previously considered to be analog is an important ongoing technology thrust, which may be expected to accelerate. Critical interfaces between the digit and analog domains are provided by analog-to-digital converters, digital-to-analog converters, and fractional- frequency synthesizers. This paper reviews the prospects of digital techniques for microwave systems, and briefly describes the state-of-technology and future possibilities.

Sasikumar Gurumurthy #1, Vudi Sai Mahit #2, Rittwika Ghosh #3 in 2009 Analysis and simulation of brain signal data by EEG signal processing technique using MATLAB

EEG is brain signal processing technique that allows gaining the understanding of the complex inner mechanisms of the brain and abnormal brain waves have shown to be associated with particular brain disorders. The analysis of brain waves plays an important role in diagnosis of different brain disorders. MATLAB provides an interactive graphic user interface (GUI) allowing users to flexibly and interactively process their high-density EEG dataset and other brain signal data different techniques such as independent component analysis (ICA) and/or time/frequency analysis (TFA), as well as standard averaging methods. We will be showing different brain signals by comparing, analysing and simulating datasets which is already loaded in the MATLAB software to process the EEG signals.

[3] Research & Methodology

Harmonic voltages and currents in an electric power system are a result of non-linear electric loads.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 08 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

Harmonic frequencies in the power grid are a frequent cause of power quality problems. Harmonics in power systems result in increased heating in the equipment and conductors, misfiring in variable speed drives, and torque pulsations in motors. Reduction of harmonics is considered desirable.

Harmonic mean is one of several kinds of average, and in particular one of the Pythagorean means. Typically, it is appropriate for situations when the average of rates is desired.

The harmonic mean can be expressed as the reciprocal of the arithmetic mean of the reciprocals. As a simple example, the harmonic mean of 1, 2, and 4 is

$$\frac{3}{\frac{1}{1}+\frac{1}{2}+\frac{1}{4}} = \frac{1}{\frac{1}{3}(\frac{1}{1}+\frac{1}{2}+\frac{1}{4})} = \frac{12}{7}.$$

The harmonic mean *H* of the positive real numbers $x_1, x_2, x_3 \ldots\ldots, x_n$ is defined to be

$$H = \frac{n}{\frac{1}{x_1}+\frac{1}{x_2}+\cdots+\frac{1}{x_n}} = \frac{n}{\sum\limits_{i=1}^{n}\frac{1}{x_i}} = \frac{}{\sum\limits_{i=1}^{n}}$$

From the third formula in the above equation, it is more apparent that the harmonic mean is related to the arithmetic and geometric means. It is the reciprocal dual of thearithmetic mean for positive inputs:

$$1/H(1/x_1 \ldots 1/x_n) = A(x_1 \ldots x_n)$$

The harmonic mean is a Schur-concave function, and dominated by the minimum of its arguments, in the sense that for any positive set of arguments,

$$\min(x_1 \ldots x_n) \le H(x_1 \ldots x_n) \le n \min(x_1 \ldots x_n)$$

Thus, the harmonic mean cannot be made arbitrarily large by changing some values to bigger ones.

Current harmonics

In a normal alternating current power system, the current varies sinusoidally at a specific frequency, usually 50 or 60 hertz. When a linear electrical load is connected to the system, it draws a sinusoidal current at the same frequency as the voltage (though usually not in phase with the voltage).

Current harmonics are caused by non-linear loads. When a non-linear load, such as a rectifier, is connected to the system, it draws a current that is not necessarily sinusoidal. The current waveform can become quite complex, depending on the type of load and its interaction with other components of the system. Regardless of how complex the current waveform becomes, as described through Fourier series analysis, it is possible to decompose it into a series of simple sinusoids, which start at the power system fundamental frequency and occur at integer multiples of the fundamental frequency.

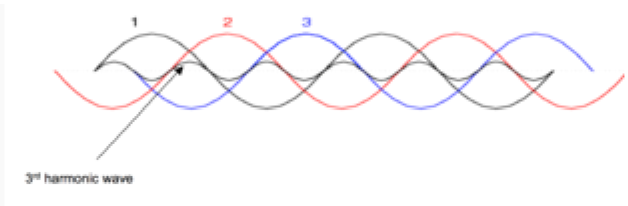
Further examples of non-linear loads include common office equipment such as computers and printers, Fluorescent lighting, battery chargers and also variable-speed drives.

Third-order harmonics

In power systems, Harmonics are multiples of the fundamental wavelength. Thus, the third order harmonic is the third multiple of the fundamental

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 07 Issue: 08 | October – December 2016
Paper is available at www.jrps.in | Email : info@jrps.in

wavelength. This type of harmonics is generated in non-linear loads. Examples of nonlinear loads include transistors, electrical motors, and the non-ideal transformer. Nonlinear loads create disturbances in the fundamental harmonic, which produce all types of harmonics. However, in this section we focus on the 3rd order harmonic due to its certain special characteristics in the context of powers systems.[1]



3rd Order Harmonic Addition

Our power is supplied by a three phase system, where each phase is 120 degrees apart. This is done for two reasons: Firstly it is because generators/motors that use three phases are more efficient due to the constant torque the phases supply, and secondly it is because after power is supplied to a load, the three phases can theoretically be added onto a neutral wire and cancel each other out. This saves the utility from creating return wiring to the power plant. However, if the 3 phases contain 3rd order harmonics, the currents will not fully add to zero. As seen in the figure, the 3rd harmonic will add constructively with the 3rd harmonics within the other phases. This leads to an oscillating current in the neutral wire, which can be dangerous since it is designed to carry minimal current.[1] To avoid 3rd harmonics adding togetherDelta connections are used, and the current is cycled around the connection instead of combining into the neutral of a wye connection.

Voltage harmonic

Voltage harmonics are mostly caused by current harmonics. The voltage provided by the voltage source will be distorted by current harmonics due to source impedance. If the source impedance of the voltage source is small, current harmonics will cause only small voltage harmonics

[4] Propose work

Harmonics fundamental

Harmonics provides a mathematical analysis of distortions to a current or voltage waveform. Based on Fourier series, harmonics can describe any periodic wave as a summation of simple sinusoidal waves which are integer multiples of the fundamental frequency. Harmonics are steady-state distortions to current and voltage waves and repeat every cycle. They are different from transient distortions to power systems such as spikes, dips and impulses.

A semi analytical method will be developed to obtain energy consumption values of both virtual MIMO and SISO based sensor networks.

The energy and delay efficiencies of virtual MIMO-based sensor network will be compared to traditional SISO-based sensor network.

Main objective behind research is to represent that when extra energy overhead is given for MIMO training, the proposed virtual MIMO-based communication architecture may offer substantial energy savings in wireless sensor network. Simulation model of wireless sensor network using virtual MIMO can be presented.

Objective of research is to investigate that a semi-analytical method can be developed to obtain the energy consumption values of both virtual MIMO and SISO based sensor networks taking into account the effect of extra training overhead required in MIMO systems. Main Aim of research is to assure that the energy and delay efficiencies of the virtual MIMO-based sensor network compared to a traditional SISO-based sensor network will be computed using the techniques developed for different channel propagation conditions.

The purpose is to prove that even with extra energy overhead required for MIMO training, the proposed virtual MIMO-based communication architecture can offer substantial energy savings in a wireless sensor network provided that the system is designed judiciously. These will include careful consideration of transmission distance requirements, rate optimization as well as end-to-end delay constraints.

[5] Conclusion

Wireless sensor network has gained popularity world-wide consideration in recent years. Micro-Electro-Mechanical systems (MEMS) technology has supported the development of intelligent sensors.

Networks of interconnected wireless devices having built-in processing, storage and radio-frequency sensors and antennas that are considered embedded into physical environment to provide solutions of many points over large spaces is known as Wireless sensor network. Spatially distributed autonomous sensors are present in WSN to cooperatively monitor physical or environmental conditions, such as temperature, pressure, sound, vibration, motion or pollutants. MIMO known as multiple input multiple output is an antenna technology for wireless communications. In MIMO multiple antennas are used at both the transmitter and the receiver. To minimize errors and optimize data speed the antennas at each end of the communications circuit are combined. MIMO is a form of smart antenna technology, the others are Multiple input, Single output and Single input multiple output .In radio Multiple Input Multiple Output is the use of multiple antennas at both the transmitter and receiver to improve communication performance so it is one of many forms of smart antenna technology. Here the terms input and output means the radio channel will carry the signal, not to the devices having antennas.

Reference

1. Moura, J.M.F. (2009). "What is signal processing?, President's Message". IEEE Signal Processing Magazine. **26** (6). doi:10.1109/MSP.2009.934636.
2. Oppenheim, Alan V.; Schafer, Ronald W. (1975). Digital Signal Processing. Prentice Hall. p. 5. ISBN 0-13-214635-5.
3. Boashash, Boualem, ed. (2003). Time frequency signal analysis and processing a comprehensive reference (1 ed.). Amsterdam: Elsevier. ISBN 0-08-044335-4.
4. Stoica, Petre; Moses, Randolph (2005). Spectral Analysis of Signals (PDF). NJ: Prentice Hall.
5. Billings, S. A. (2013). Nonlinear System Identification: NARMAX Methods in the Time, Frequency, and Spatio-Temporal Domains. Wiley. ISBN 1119943590.
6. Da-Feng Xia, Sen-Lin Xu, and Feng Qi, "A proof of the arithmetic mean-geometric mean-harmonic mean inequalities", RGMIA Research Report Collection, vol. 2, no. 1, 1999, http://ajmaa.org/RGMIA/papers/v2n1/v2n1-10.pdf
7. *Statistical Analysis, Ya-lun Chou, Holt International, 1969, ISBN 0030730953
8. Mitchell, Douglas W., "More on spreads and non-arithmetic means," The

Mathematical Gazette 88, March 2004, 142-144.

9. Inequalities proposed in "Crux Mathematicorum", [1].
10. http://ecee.colorado.edu/~bart/book/effmass.htm