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Wavelets development for data reliability[1]

Fadia Shah[24], Jianping Li[2], Yasir Shah[3], Faiza Shah[3]

Abstract. The big data is around us everywhere. How much quality oriented this big data is and how much useful it is, this is not certain. Terabytes of data does not mean that the entire data is important to keep secure. Useful information determination is carried out by using Wavelets tool which is consists of mathematical functions. The wavelets processing via approximation and coefficient data reconstruction insight theme is mentioned. The Wavelet Compression algorithm is proposed which is simple in processing but generates efficient results.

Key words. Wavelet transformation, big data, pattern recognition, image compression.

1. Introduction

From last few decades the exponential growth in data made the importance of data an important area in the study of not only computer science, but it made a bridge between many branches of sciences including Medical, Finance, Business, Commerce, Industry, Technology, Education, Research and Development. From existing data, by applying smart and intelligent tools and techniques to predict new conclusions for corrective actions against them, the importance of data is increased much more times as before. Unfortunately, from a huge pool of data, there is very less useful form of information which can be processed to carry out specific operation. There is variety of companies that process data by the help of technical staff called data scientists [1–4]. That is why in future, there will be data factories. For ever

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[2]School of Computer Science and Engineering, University of Science and Technology, Chengdu, China

[3]Department of Management Science, Central University of Finance and Economics, Beijing, China

[4]Corresponding author; e-mail: fadiashah13@yahoo.com

organization this data is very useful. The Data is only collective facts and characters and gathering of words to form meanings. The very initial form of data is the "raw data". Where only words are collected sometimes give meanings but sometimes meaningless until and unless collaborated with any other word. This raw data is further structured to form information. For data companies, some proportion of data is important and losing some data may have no severe effects but the entire information is very much important every time to maintain the quality. Loosing information means losing precious asset [5–7]. Every day more and more bytes are being increased and most of them are considered useful. Data has a direct relationship between human beings. It means more the humans more the data. It means more the human beings, more the data is increased annually, or daily or hourly. There are different types of organizations which process different types of data. Such data may or mostly is not related to the other one. In coming few years, there will be data crucial jobs.

2. Methodology

2.1. Development in wavelets

The developments in wavelets analysis tool has gone through many phases, it was initialized with Haar's work in early 20th century. Later Dennis Gabor proposed Gabor atoms in 1964 which were nearly considered wavelets. Zweig proposed wavelet transformation in 1975, which was termed as cochlear transform. It was found by analysis of sound waves and the response the ear generates after receiving them. Pierre, Groupillaud, Grossmann and Morlet's formulation work, now famous as Continuous Wavelets Theory (CWT) [8] arose in 1982. Jan-Olov Stromberg extended the work to Discrete Wavelet Theory (DWT) [7] in 1983 which works in discrete domain; somewhat complex than DWT. This was further dig down to its level where Daubeechies Orthogonal Wavelet raised new directions in Wavelets in 1988. The signal analysis from here could be analyzed in a number of limited components called multiresolution framework. It was a new phase proposed by Mallat in 1989. Here Akansu's Binomial quadrature mirror filter (QMF) which is Orthogonal perfect reconstruction development took place in 1990. Nathalie Delprat's time-frequency implementation of CWT was proposed in 1991. Newland's harmonic wavelet transform in 1993 and many others continue work on Wavelet functions. It is still in progress to give new directions to Wavelets as a remarkable analysis tool.

2.2. Wavelet analysis

A lot of big data is collected and warehoused every time. Relational database and intelligent schemes are adopted to make this data available for fast, easy access for future use. The wavelet applications using cloud technologies and big data. Wavelet de-noising, online image monitoring, and watermarking algorithm for big data, the function approximation ability and image processing in big data is considered. Wavelet analysis methods in cloud computing and big data are discussed.

We can obtain the family of wavelet functions by scaling and translating Mother Wavelet function. This can be written as

$$\Psi_{s,\tau} = \frac{1}{\sqrt{s}}\Psi\left(\frac{t-\tau}{s}\right).$$

3. Results

3.1. Wavelets unveils

Wavelets is a tool that mathematically function based analysis and reconstruction using partial coefficients of data in different forms. Wavelets is a reliable and quality oriented tool that has a number of utility features for applications. It contains scaling functions, low-pass and high-pass filters or real-coefficient filters. The coefficients and approximations yield majority of technical data from the noisy data, in the form of signals or image. The pixel is smallest unit for image and frame is the smallest unit for voice or video data. Available data is never pure data, when it is collected. The properties of Wavelet functions are listed in Table 1.

Table 1. Wavelet functions

Wavelet function	Haar	Daubechies	Biorthogonal	Coiflets	Symlets	Morlet	Mexian-hat
Abbreviation	haar	db	bior	coif	sym	morl	mexh
Orthogonality	yes	yes	no	yes	yes	no	no
Compact support	yes	yes	yes	yes	yes	no	no
Continues transformation	yes	yes	yes	yes	yes	yes	yes
Symmetry	yes	similar	no	similar	similar	yes	yes

Additionally the noise is added that is usually not increasing the value of data, rather, it increases the size of data and is responsible for statistical error. Just for example, the multiresolution is helpful for signal frequency and time distribution analysis, is an important quality that is possible by Wavelets.

3.2. Wavelet transformation applications

Wavelets tool is not only a mathematical set of functions, nor is it limited to approximations and coefficients. Technically it is a logical problem solving derivations that has scaling functions and wave lets breakdown. But this is a tool that helps results drawing in many sensitive information based real life applications which was one never thought to be possible. Some of them have been explored and further are under observation. The successful few are mentioned as follows:

3.2.1. Data and image compression. Before JPEG 2000, the compression was Discrete Cosine Transformation (DCT) consisting of 8 by 8 blocks, using different quantization tables. Though for compression and transformation results were quality based but the image reconstruction does not produced the same results. There found the difference in colors and the quality was badly suffered. So, for JPEG 2000, Wavelets compression was applied and it had the best results for image reconstruction. This algorithm was proposed in 1991. In JPEG 2000 two different wavelet transform functions are used; biorthogonal, Daubechies for lossless compression and Daubechies wavelets for lossy compression. The Daubechies wavelet is an irreversible transform because it has quantization noise that depends on the precision of the decoder. The Daubechies is reversible because the coefficients are integers. At low compression ratio, the performance of JPEG and JPEG 2000 is almost the same. At high compression ratio, the performance is much better than the JPEG because it has no block effect. JPEG 2000 requires much computation time than JPEG on the similar compression rates. The results also (DCT CR = 53.43 and RMSE = 10.96, for Wavelet CR = 51.38 and RMSE = 9.694) declare Wavelets being more efficient than DCT in terms of quality.

3.2.2. Edge and corner detection. Wavelets is a reliable tool to find edge detection for specific image region. Specifically the whole is segmented into number of small components. There are many ROI and edge detection algorithms which generate good results and fulfill the definition of edge detection requirements. Every segment has a meaning and may have some importance. The pixels dimension is compared with its neighboring pixel and if similar, it is made a part of that region. Further, the segmented image is considered according to the importance of the segments. The less useful segments are discarded and the important segments are considered for further processing. Such schemes are a vital research area in Medical Big Data, Compression, systems that work on load balancing schemes.

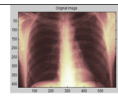
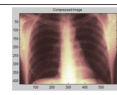
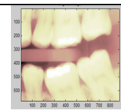
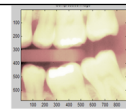
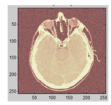
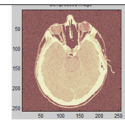
3.2.3. Pattern recognition. Wavelets tool is ideal for pattern identification and recognition. The repeating sequence makes a pattern which if repeatedly appear, it causes certain effect on the application where it is applied. Wavelets transformation reduces the computation cost. It depends on computing the features of data. It reduces the size of image that utilizes limited bandwidth and can be stored in a less space. Such schemes are useful if the image is not altered and the information is not changed.

Table 2 shows the image quality of the original image and compressed images after applying Wavelets compression of Biorthogonal Wavelet function 3.3, it is compressed up to level 5.The energy 100 % preservation means the images are reliable. SNR is Signal to Noise Ratio and CR is Compression Ratio. These two measurements are used for image quality statistical analysis.

4. Conclusion

Information reliability is very important for proper decision making. Huge collective bits of data do not mean that this all is necessary information. The effective information is sometimes hidden under chunks of non- effective data. Wavelets is a tool that is reliable to find the accurate information which is needed for accurate decision making. This information collection may be further useful for predicting further assumptions. Simple and meaningful algorithms are when applied with Wavelets mathematical functions at multiresolution schemes, the results are quality oriented because new era is the Information Communication era.

Table 2. The Wavelet Biorthogonal family 3.3 is implemented till level 5 to three different images that can be seen with the statistics calculation of Zeros, Signal to Noise Ratio and Compression Rate

Image	Original Image	Compressed Image	Zeros	SNR	CR
Img1			47.7%	38.7	1090
Img2			43.2%	35.7	1943
Img3			47.2%	44.58	403

References

[1] H. Hangan, G. A. Kopp, A. Vernet, R. Martinuzzi: *A wavelet pattern recognition technique for identifying flow structures in cylinder generated wakes.* Journal of Wind Engineering and Industrial Aerodynamics *89* (2001), Nos. 11–12, 1001-1015.

[2] M. Kociolek, A. Materka, M. Strzelecki, P. Szczypinski: *Discrete wavelet transform-derived features for digital image texture analysis.* Interational Conference on Signals and Electronic Systems, 18–21 September 2001, Lodz, Poland, Proceedings (2001), 163–168.

[3] K. Kaur, S. Malhotra: *Image compression using HAAR wavelet transform and discrete cosine transform.* International Journal of Computer Applications *125* (2015), No. 11, 28–31.

[4] A. Salatian, F. Adepoju, L. Oborkhale: *Using wavelets to improve quality of service for telemedicine.* International Journal of Advanced Science and Technology *27* (2011), 27–34.

[5] Y. Q. Sun, L. Xi: *A new parallel segmentation algorithm for medical image.* International Journal of Signal Processing, Image Processing and Pattern Recognition *8* (2015), No. 2, 139–146.

[6] I. Daubechies: *The use of enzymatic interesterification for the modification of oils.* Capital City Press, Montpelier, Vermont (1992).

[7] C. K. Chui: *An introduction to wavelets.* Academic Press (1992).

[8] S. Mallat: *A wavelet tour of signal processing.* Academic Press, San Diego (1998).

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