Wavelet Theory and its application in Digital Image Processing

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Abstract

The poster presented here aims to show the representation of Wavelet Theory and demonstrates its various applications pertaining to Image Processing. The Poster covers the following points :- Wavelet Theory, and its representation

- **Image Enhancement**, and how wavelet is useful for it.
- **Image Compression**, and its usage of wavelet theory
- **Image Denoising**, and its usage of wavelet theory

Introduction

Wavelet theory involves representing general functions in terms of simpler building blocks at different scales and positions. The fundamental idea behind the wavelet transform is analyze according to scale. The wavelet transform was first introduced in the context of a mathematical transform by Grossman and Morlet in 1984

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Image Enhancement

Image enhancement is one of the measure issues in high-quality pictures from digital cameras and in high definition television (HDTV).

- The main purpose of image enhancement is to obtain finer details of an image and to highlight useful information. The images appear darker or with low contrast under poor illumination conditions. Such low-contrast images need to be enhanced. Image enhancement is basically improving the interpretability or perception of information in images for human viewers, and providing better input for other automated image processing techniques
- Image enhancement methods can broadly be divided into two categories: 1. spatial domain methods, and 2. frequency domain methods In spatial domain methods, we directly deal with the image pixels. The pixel values are manipulated to achieve the desired enhancement. In frequency domain methods, the image is first transferred into the frequency domain.
- Wavelet analysis has proven to be a powerful image processing tool in recent years. When images are to be viewed or processed at multiple resolutions, the wavelet transform is the mathematical tool of choice. In addition to being an efficient, highly intuitive framework for the representation and storage of multiresolution images, the WT provides powerful insight into an image's spatial and frequency characteristics.

Figure 1. Enhanced image

Image Compression

- The objective of image compression is to minimize the size of an image by exploiting redundancy within the data without degrading the quality of the image.
- Image compression is the main application of the wavelet transform in image processing. Wavelet compression algorithms provide better compression and quality than the traditionally used JPEG algorithm
- The original image is transformed in eight-by-eight blocks, then via inverse transform in eightby-eight blocks to reconstruct the image and the error image (the difference between the original and reconstructed image).Then came a new image compression scheme with a pruning proposal based on discrete wavelet transform. It provides sufficient high-compression ratios with no appreciable degradation of image quality

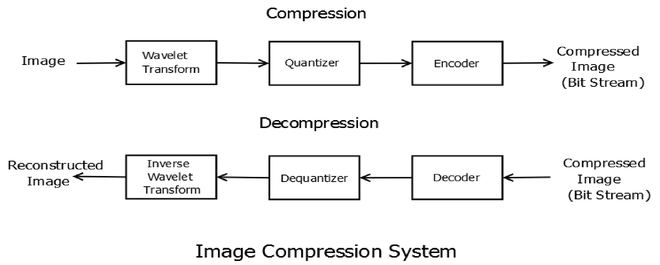

Figure 2. Enhanced image

Image Denoising

- Image denoising (as expected an image corrupted by noise) is a classical problem in the field of signal or image processing systems. Additive random noise can easily be removed using simple threshold methods.
- Denoising of natural images using wavelet techniques is very effective because of its ability to capture the energy of a signal in a few energy transform values.
- The wavelet denoising technique thresholds the wavelet coefficients arising from the wavelet transform. A wavelet transform helps a large number of small coefficients and a small number of large coefficients.

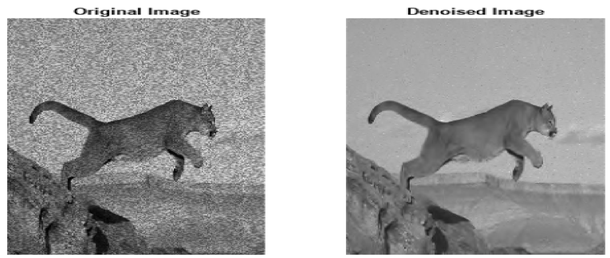

Figure 3. Denoised image

Conclusion

- In this poster, we reviewed wavelet theory, an important mathematical tool for signal and image processing, with an emphasis on its application to image processing. Representative work was identified in image compression, image denoising, and image enhancement, analysis, and classification. Compared to other tools, such as the Fourier transform, wavelet transforms often provide a better spatial domain localization property, critical to many image applications.
- In this poster, we reviewed wavelet theory, an important mathematical tool for signal and image processing, with an emphasis on its application to image processing. Representative work was identified in image compression, image denoising, and image enhancement, analysis, and classification. Compared to other tools, such as the Fourier transform, wavelet transforms often provide a better spatial domain localization property, critical to many image applications. The application of wavelets in image processing is only a decade old. Wavelets have demonstrated their importance in almost all areas of signal processing and image processing. In many areas, techniques based on wavelet transforms represent the best of the available solutions.

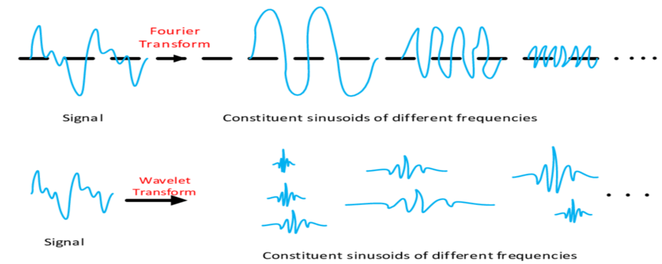

Figure 4. fourier vs wavelet

Future Scope

- In the coming years, we expect to see more (and more successful) wavelet-based techniques in the field of image processing. We expect image restoration incorporating wavelets, wavelet transforms, and other statistical techniques to achieve greater success.
- Theoretical research inspired by wavelets has led to new techniques, such as quaternion wavelets and quaternion transforms that are more promising in certain situations.
- Explorations of these new frontiers are likely to bring us more successful applications in image denoising, image enhancement, image restoration, etc.

References

[1] Dipali D Buchade and LK Chouthmol.
Image resolution enhancement by using wavelet transform.
IMAGE, 4(06), 2017.

[2] Aparna Vyas and Joonki Paik.
Review of the application of wavelet theory to image processing.
IEIE Transactions on Smart Processing and Computing, 5(6):403–417, 2016.

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