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Super Resolution Image Reconstruction through Wavelet Based Technique

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Abstract: Several noisy and blurred low-resolution images enhanced through a computational procedure referred to as super resolution reconstruction helps in reconstructing high-resolution images. Image deconvolution closely links to super resolution reconstruction, but low-resolution images remain unregistered. The approximation of their relative relations and translations should form part of the super reconstruction process. The wavelet-based techniques offer high accuracy in numerical differentiation and a flexible implementation of physical boundary conditions. Wavelets are a grand candidate for multi resolution and adaptive schemes that fosters large computational savings. This paper explores the utilization of wavelets linked multi resolution techniques in reconstruction procedure of high-resolution image to enhance the visual quality and accuracy of the reconstructed image.

I. Introduction

Digital images are on the rise due to the constant growth of computer power, rapid internet use and reduction in cost of storage (Piao, Shin and Park 1446). As a result, effective and fast techniques to organize and search image in large image database environments is a crucial aspect. Images require effective clustering. Indexing images bases on raw image data and indexing images based on coefficients in the transform domain such as total energy of wavelet coefficient promote effective clustering of images (Tang and Li 164). According to Srinivasan and Sathyanarayana, interests in wavelets grew historically from the concept that they are efficient tools for numerical solutions of PDEs (106). The most significant and desired aspect of applications of image processing is a good image quality. An imaging system captures a natural or true scene with finite resolution levels, as opposed to a natural or true scene with infinite resolution levels. Software and hardware help to augment the image system resolution (Bannore 16). The preferred option is the hardware enhancement of an imaging system to attain higher resolution (Bannore 16). However, it is not always practical to attain high resolution through hardware improvement because of practical reasons. In such an event, it is rational to use an intelligent software solution to form higher resolution. One such software solution is super-resolution image reconstruction through wavelet-based method (Bannore 16).

II. Super resolution Image Reconstruction

Super resolution (SR) reconstruction refers to a branch of image fusion for bandwidth extrapolation beyond limitations of, conventional electronic, image systems (Stathaki 1). On the other hand, super solution is a function procedure for reconstructing a high-resolution (HR) image from different (LR) low-resolution images covering similar region in the world. Super resolution is the construction of a high-resolution image from noisy and blurred low-resolution images (Stathaki 1). Low-resolution images hold new data regarding the scene. The objective of super resolution is to combine the information from the scene, and the image to offer a high-resolution image. Super resolution extends classical single frame image restoration techniques through simultaneous use of information from multiple observed images to obtain resolutions that are higher than that of the original information (Liyakathunisa and Abanthashayana 106).

Super resolution is a significant method in different applications. High-resolution image provides more details to the viewer than low-resolution. Super resolution implies that the pixel density within an image is high (Liyakathunisa and Abanthashayana 107). Such images depend on the device of image resolution acquisition employed. A resolution improvement perspective using signal process resolution method referred to as super

resolution image reconstruction prevents degradation of the image quality (Liyakathunisa and Abanthashayana 107). The present technology to attain high-resolution images depends on sensor manufacturing technology. This technology tries to augment the pixels number per unit area through putting to remission the interpixel distance and the pixel size. The decrease in the amount of light and increase of shot noise affects the quality of the image. As a result, there is a need to improve the resolution of the taken images through a software approach. This calls for high-resolution image reconstruction. The procedure of high resolution entails sampling the image to increase pixel density and processing low-resolution images that help in enriching the data. Most super resolution algorithms generate the issue as a signal reconstruction problem. The algorithms differ through lining up of the sequence image and reconstruction of high-resolution image (Leonardis and Pinz 295).

The problem of high-resolution image reconstruction entails reconstructing a high-resolution image from under sample degraded, multiple, noisy and shifted frames where each frame is dissimilar from others by some sub pixel shifts. Damlamian and Jaffard assert that the earliest study of high-resolution reconstruction received motivation from the need to enhance resolution of images (2). The capturing devices hold some limitations that prevent image perfection. The super resolution image reconstruction has the aptitude to triumph over the inherent resolution limitations of the system of image (Wong 512). The Super resolution image reconstruction offers a high-resolution image to promote image processing applications performance. For instance, providing high-resolution images in medical imaging append the accuracy of diagnosis and in astronomical imaging, high-resolution images provide accurate images. With the increased web use by human beings, high-resolution image reconstruction is paramount. This is because it helps in saving transmission time, bandwidth and storage space. The use of existing methods for down sampling the image leads to loss of data (Wong 512). Super resolution images promote the ability of identification and detection of details in the image. They also enhance the operation of algorithms of pattern recognition besides performance of instinctive classification algorithms in computerized methods (Wong 512). Super resolution holds broad applications among them Iris recognition, video conferencing, face recognition, telemedicine, space research, medical imaging and satellite imaging. The super resolution image is in increased demand in diverse applications. As a result, an algorithm to reconstruct super resolution images that help in overcoming the shortcomings of the present methods is paramount.

III. Wavelet Based Technique for Super Resolution Image Reconstruction

Wavelet transform is compacter and can offer directional data in the high-low, low-low, high-high and low-high bands (Mathew and Shibu 11). Wavelet transform hold distinctive data at diverse solutions making image fusion founded on wavelet transform capable of frequently offering better performance compared to image fusion based on multi scale techniques. Super resolution reconstruction algorithms explore the comparative sub-pixel motion data between numerous low-resolution images (Liyakathunisa and Abanthashayana 108). The algorithms also increase the spatial resolution through fusing them into a single frame. Zonal filters and blind deconvolution technique help in removing the noise and blur, besides increasing spatial resolution. With respect to blind image resolution, the images remain refurbished blind without the knowledge of the natural or correct image (Mathew and Shibu 11). The blind image refurbishment comes with major problems due to inadequate data. This calls for an overriding need to exploit extra information in super resolution hitch.

Algorithms founded on wavelets super resolution have the ability to achieve simultaneous reduction of noise via wavelets coefficient (Walker 16). Wavelet based for super resolution image reconstruction is a technique that uses low-resolution natural color image. The wavelet-based approach prevents image smoothing and removal of high frequency elements. This approach helps in seeking the directional relationship among pixels with an image. It allows for reconstruction of high resolution images from low-resolution image, through adding the detail data via prediction method (Mathew and Shibu 12). The wavelet approach decomposes the image and predicts the new worth of the pixel with respect to the image temperament. Most super resolution techniques use frequency area generation of super resolution hitch. The spatial area image gets transformation to frequency domain via wavelet transform (Mathew and Shibu 12). The most significant wavelets include Biorthogonal wavelet, Coiflets wavelet and daubenchies wavelet (Mathew and Shibu 12). For computations through wavelets based super resolution, the expert needs two images, which include the reconstructed image, and high-resolution image (Mathew and Shibu 12). In super resolution images, the inventive high-resolution, image reference does not count. As a result, there is a need for development of a blueprint for quality presentation measure for super resolution imaging.

Wavelet-based approach is essential in high image reconstruction as it transforms invertible differencing and smoothing operations without altering the number of pixels provided in the original image. The first level shows reduction and smoothing of the image to a lower resolution version of the actual image (Walker

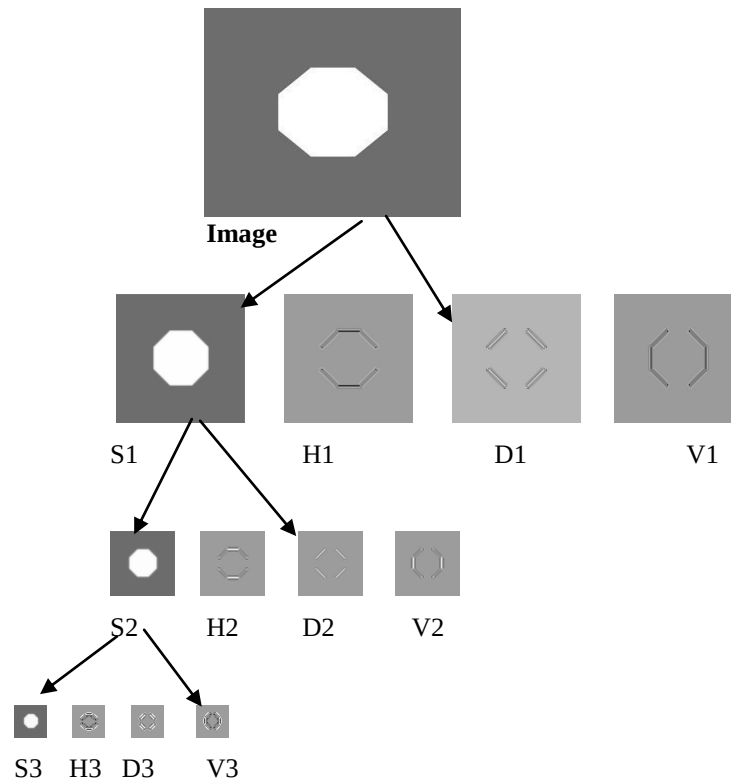
5). Three divergent local differencing performances also takes place in level 1 consequently offering edge detection of three different types which are diagonal component images, horizontal component and vertical component images. The pixels remain unaltered (Walker 5). In level 2, the wavelet transform repeat the differencing and averaging operations of level 1 smoothed sub image and the interactive procedure are constant.

With respect to the image frame alignment procedure, the flow-based perspective is the commonest option because of its flexibility. The complexity in correct estimation of common nonparametric image flow makes higher-resolution reconstruction to be less meaningful (Ji 3). As a result, some assumption regarding the underlying flow model requires enforcement. Such assumption makes the algorithm less general but on the other hand, more feasible (Ji 3). The frequently utilized flow models are the affine transform and the common projective transform. The renowned reconstruction process is the iterative back projection technique.

IV. Results

High resolution reconstruction, multiple Lower resolution signals (y_k) with divergent E_k , can help in obtaining two complete sequences signals $a * x$ and $b * x$ from $[a * x] \#2, [a * x(\cdot+1)] \#2, [b * x] \#2, [b * x(\cdot+1)] \#2$. Without any assumption on the finite signal x , signal sequence can be reconstructed from two sequences, $x = \{x(i)\}$ defined as $x(z) = \sum X_i x(i)z^{-i}$. Such a transform maps between polynomial space and sequence space. The equation is solved by checking whether polynomial equation $(a(z)x(z))u(z) + (b(z)x(z))v(z) = x(z)$ can be solved from the two unknowns $u(z)$ and $v(z)$ through eliminating $x(z)$ from both sides of $(a(z)x(z))u(z) + (b(z)x(z))v(z) = x(z)$ (Ji 3). The following are some figures illustrating on the mechanism of Wavelet based technique.

Figure 1: example of a waveform transform

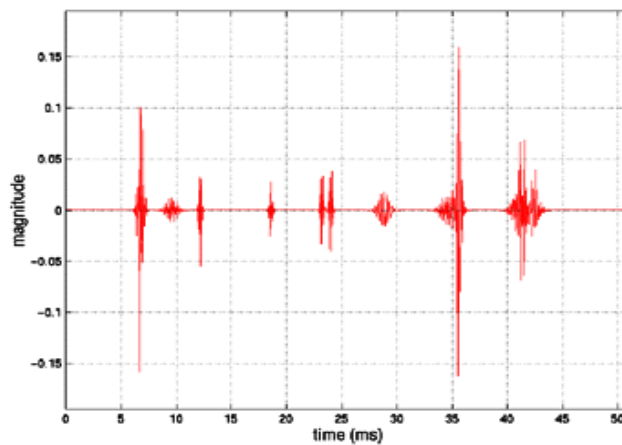


In the figure 1, S1 represents the subimage occurring after local averaging of image involving resolution of $\frac{1}{4}$. H1 represents the horizontal component subimage occurring after vertical and horizontal localized differencing and averaging respectively. D1 represents the diagonal component sub image occurring after vertical and horizontal localized differencing and localized averaging respectively.

V1 is the vertical component subimage resulting from localized horizontal differencing and localized vertical averaging of the image. Level 2 represents iteration of localized averaging and localized differencing to S1 subimage. Level 3 represents the iteration of subimage S2.

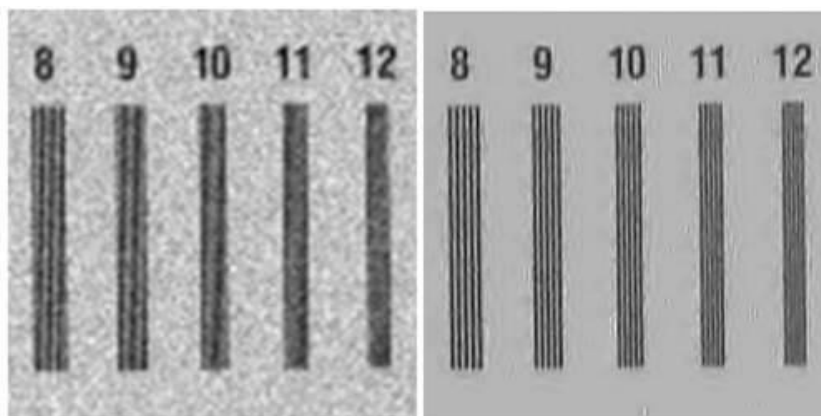
The figure 2 shows the application of wavelet based technique in realizing the defect in an extracted signature of a ball bearing

Figure 2 shows the application of wavelet based technique



The figure shows how the wavelet based technique helps in detecting unseen defects present in the in a ball bearing. The figure 3 shows on how the wavelet based technique could be used in deblurring cancer to make it be seen.

Figure 3 shows the wavelet based technique used in deblurring cancer



(Retrieved: <http://people.duke.edu/~sf59/>)

From number 8 to 12 shows the low quality images while number 8 to 12 shows the super reconstructed image through the wave-based technique.

Figure 4 shows a reconstructed image of a model



(Retrieved from: <http://people.duke.edu/~sf59/>)

V. Conclusions

The paper presents an algorithm for the hitch of super-resolution reconstruction. Wavelet based approach to high resolution construction identifies local aspects of low resolution and improve the resolution accordingly (Walker 16). The precision of the wavelet threshold relies on correct estimates of the local signal statistics in the wavelet area. The signal information should be estimated from the data of the captured image. The approach overcomes the hitch of blurring evident in interpolation methods. Wavelet transforms have profound effects on image processing. The procedure of forming edge sub images at numerous resolutions is analogous to a procedure performed through mammalian vision systems (Walker 16). The procedure through which a wavelet transform is constructed is similar to some significant techniques analyzing images. In fact, it is similar to the Laplacian pyramid technique of Adelson and Burt. Additionally, there is an analogy amid wavelet transforms and fractal theory. The objective of wavelet-transform programming is taking advantage of redundancy in the transformed image. Wavelet transform helps in attaining a good reconstruction after decompression.

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