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Multi-Scale DWT Approach for Image Fusion

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Abstract: ***Multisensor data fusion has become a discipline to which more and more general formal solutions to a number of application cases are demanded. Several situations in image processing simultaneously require high spatial and high spectral information in a single image. This is important in remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is data fusion. The principle of image fusion using wavelets is to merge the wavelet decompositions of the two original images using fusion methods applied to approximations coefficients and details coefficients. The low-frequency content is the most important part in the image. It is what gives the image its maximum energy or information. The high-frequency content, on the other hand, imparts flavor or nuance.***

Keywords: Discrete Wavelet Transform (DWT), MSE, PSNR, Wrapping Index, Bias Index

1. Introduction

Depending on the applications, fusion problems can occur in different situations, in which the types of information elements are not the same. Several images from the same sensor. This consists, for example, of several channels on the same satellite, or multi-echo images in MRI, or also of image sequences for scenes in motion. The data in those cases is relatively homogenous because it corresponds to similar physical measurements.

The most common case, in which the different physical principles of each sensor allow the user to have complementary perspectives of the scene. They can consist of ERS and SPOT images, MRI or ultrasound images, etc. The heterogeneity is then much greater, since the various sensors do not deal with the same aspects of the phenomenon. Each image gives a partial image with no information on the characteristics they are not meant to observe (for example, an anatomical MRI yields no functional information and the resolution of a PET scanis too low for a precise view of the anatomy).

In this situation, different types of information are extracted from an image using several sensors, operators, classifiers, etc., that rely on different characteristics of the data and attempt to extract different objects, often leading to very heterogeneous elements of information to fuse. The extracted information can involve the same object (fusion of contour detectors, for example) or different objects and the goal is then to find an overall interpretation of the scene and consistency between the objects.

2. Related Works

Piella, G; Centre for Math. & Computer Sci., CWI, Amsterdam, Netherlands-*"A region-based multiresolution image fusion algorithm*" proposes a multiresolution fusion algorithm which combines aspects of region and pixel-based fusion. We use multiresolution decompositions to represent the input images at different scales, and introduce multiresolution/multimodal segmentation to partition the image domain at these scales. [1]

John J. Lewis, Robert J. O'Callaghan, Stavri G. Nikolov, David R. Bull, Nishan Canagarajah- *"Pixel- and region-based image fusion with complex wavelets"* presents a number of pixel-based image fusion algorithms (using averaging, contrast pyramids, the discrete wavelet transform and the dual-tree complex wavelet transform (DT-CWT) to perform fusion) are reviewed and compared with a novel region-based image fusion method which facilitates increased flexibility with the definition of a variety of fusion rules. [2]

Zaveri, T.; Electron. & Commun. Eng. Dept., Nirma Univ., Ahmedabad, India ; Makwana, I. ; Zaveri, M.-*" A novel hybrid multispectral image fusion method using contour et transform"* is proposed which provides novel tradeoff solution between the spectral and spatial fidelity and preserves more detail spectral and spatial information. [3]

Manjusha Deshmukh & Udhav Bhosale-*"Image Fusion and Image Quality Assessment of Fused Images"* presents PCA based image fusion and also focuses on image fusion algorithm based on wavelet transform to improve resolution of the images. [4]

Jingmin Gao ; Zhenhui Liu ; Tao Ren– *"A New Image Fusion Scheme Based on Wavelet Transforms"* shows that the scheme can preserve all useful information from primitive images and the clarity and the contrast of the fused image are improved. The presented scheme is verified to be effective for the image fusion.[5]

Paresh Rawat, Sapna Gangrade, Pankaj Vyas-*"Implementation of Hybrid Image Fusion Technique Using Wavelet Based Fusion Rules"* adopted a novel approach to decompose the original images into high and low frequency parts to the smallest pixel and then fuse both the parts separately using same fusion rules to get an accurate, high resolution image with preserved spectral characteristics. [6]

Ghantous, M. ; Ghosh, S. ; Bayoumi, M.(2008)-*"A gradient-based hybrid image fusion scheme using object extraction"* presents a new hybrid image fusion scheme that combines features of pixel and region based fusion, to be integrated in a surveillance system. [7]

Lijian Zhou –*"A Gradient-based Multi-focus Image Fusion Method Using Multiwavelets Transform"* presents an approach of multi-focus pixel level image fusion, which is based on multi-wavelets transform and a gradient image representation. [8]

1. Shutao Li Corresponding, Bin Yang-*"Multifocus image fusion by combining curvelet and wavelet transform"*, propose a multifocus image fusion algorithm based on combination of wavelet and curvelet transform. [9]

Vladimir Petrović Orasys MV, Year (2007) –*"Multi Level Image Fusion"* presents a fusion framework based on the idea that subjectively relevant fusion could be achieved if information at higher levels of abstraction such as image edges and image segment boundaries are used to guide the basic signal-level fusion process. [10]

3. Algorithm

The wavelets-based approach is appropriate for performing fusion tasks for the following reasons:

- It is a multi-scale (multi-resolution) approach well suited to manage the di4erent image resolutions.
- The discrete wavelets transform (DWT) allows the image decomposition in di4erent kinds of coefficients preserving the image information.
- Such coefficients coming from di4erent images can be appropriately combined to obtain new coefficients, so that the information in the original images is collected appropriately.
- Once the coefficients are merged, the final fused image is achieved through the inverse discrete wavelets transform (IDWT), where the information in the merged coefficients is also preserved.
- The key step in image fusion based on wavelets is that of coefficient combination, namely, the process of merge the coefficients in an appropriate way in order to obtain the best quality in the fused image.

4. Results and discussion

To see the qualitatively as well as quantitatively performance of the proposed algorithm, some experiments are conducted on several medical images. The multi-scale decomposition approach is used in the proposed algorithm because it gives smoother images and increases the efficiency of the fusion method and quality in the Image**.** The effectiveness of this approach has been justified using different medical images. The results are compared qualitatively (visually) as well as quantitatively using quality measures. The figures 1 and 2 show the different images which consists of original images and fused images.

Figure 1: First Image

Figure 2: Second Image

Figure 3: fused Image

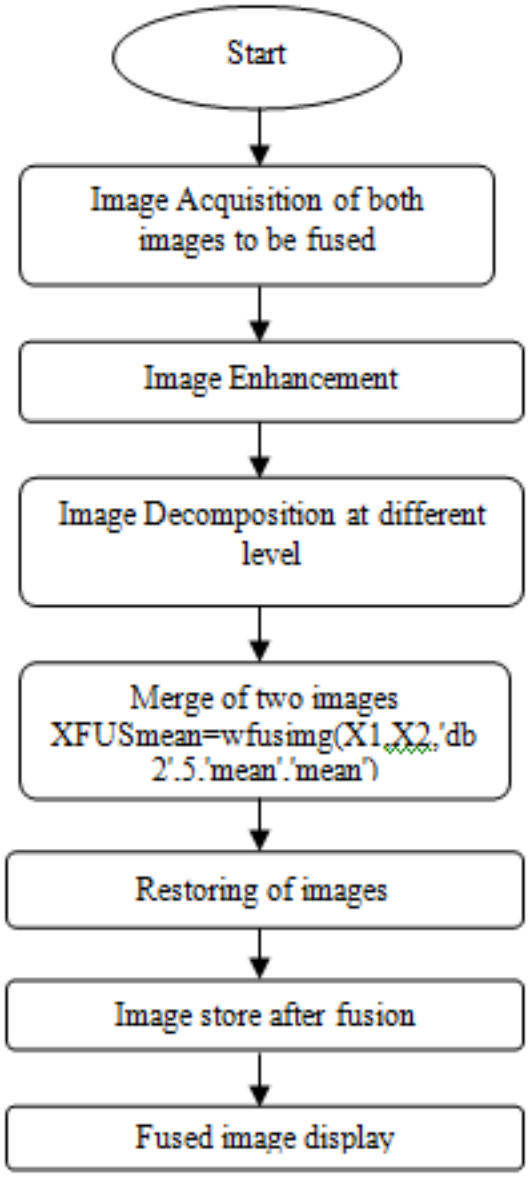

Figure 4: First Image

Figure 5: Second Image

Figure 6: Fused Image

Figure	Parameters				
	Mean value	Standard Deviation	Information Entropy	Bias Index	Warping degree
5.8	201.80	17.20	-0.00	2543.60	6.19
5.9	200.00	43.00	-0.00	2003.97	4.92
5.10	199.60	27.60	-0.00	-------	--------

Figure	Parameters				
	Mean value	Standard Deviation	Information Entropy	Bias Index	Warping degree
4	156.28	96.72	-0.00	8375.35	12.34
5	161.43	88.57	0.00	6626.70	11.08
6	157.97	106.77	0.03	-------	--------

The values of quality metrics of image fusion algorithms are shown in Table 1 and 2. The three quality metrics are used to evaluate the performance for image fusion algorithms: Entropy, Standard deviation and Quality index

5. Conclusion

Multi-sensor image fusion seeks to combine information from different images to obtain more inferences than can be derived from a single sensor. It is widely recognized as an efficient tool for improving overall performance in image based application. The spectral quality of the images is preserved better than using the other approaches. The reason that we can find more spatial detail from the fused composite images is that many mixed pixels in the original composite image are decomposed into many different categories in a fused image with the improvement of the spatial resolution.

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