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# A Review on **Color** Image Fusion Techniques

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***Image fusion can be defined as the process of extracting the appropriate information from a set of images and then combining them intelligently to form a single composite image with extended information content in order to overcome the limitation of the type and resolution of the hardware sensors capturing images . Image fusion technology can be applied to many areas dealing with images such as medical image analysis, remote sensing, military surveillance, etc. This paper discusses about the problems in color image fusion and PCA(principal Component Analysis SWT(stationary wavelet transform ,DWT(Discrete Wavelet transform) based image fusion techniques along with the process flow diagram and .***

***Keywords:Image Fusion ,Principal Component Analysis , Discrete Wavelet Transform ,StationaryWavelet Transform.***

**INTRODUCTION**

Figure below demonstrates the general image fusion process. This figure illustrates the fusion process for two source images, but the process can be implemented for combining multiple source images .

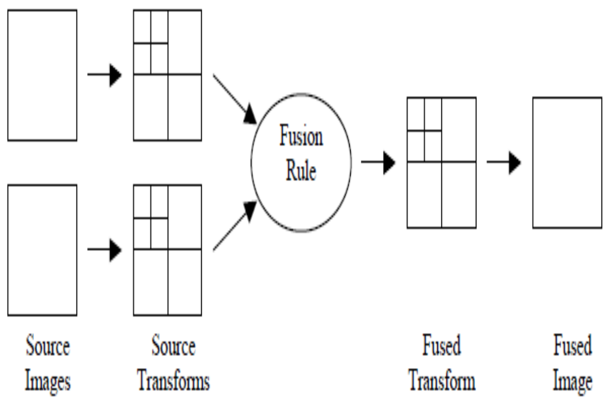



Fig. 1 General image fusion processes

In general, the spatial domain of image data needs to be transformed to the frequency domain of data because the frequency form of data provides more flexibility and functionality than the spatial data for image processing . The frequency domain of data can be obtained using a decomposition scheme such as Discrete Fourier transform, Wavelet transform, etc. Wavelet transform is known to be better than Fourier transform . This image fusion system will use a Haar wavelet to decompose source images and compose fused transform. In a brief explanation of image fusion process, source images are decomposed to source transforms and the fused transform is produced with source transforms based on fusion rule. The simplest fusion rule is choosing the one with larger magnitude; the fused image is composed through the fused transform.

***Evolution of Image Fusion Research***

The evolution of the research work into the field of image fusion can be broadly put into the following three stages:

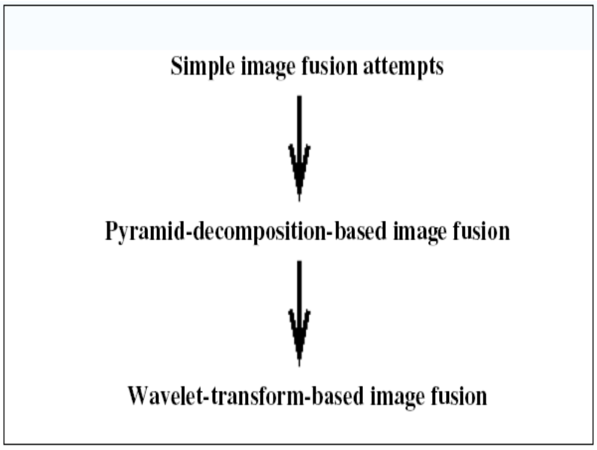
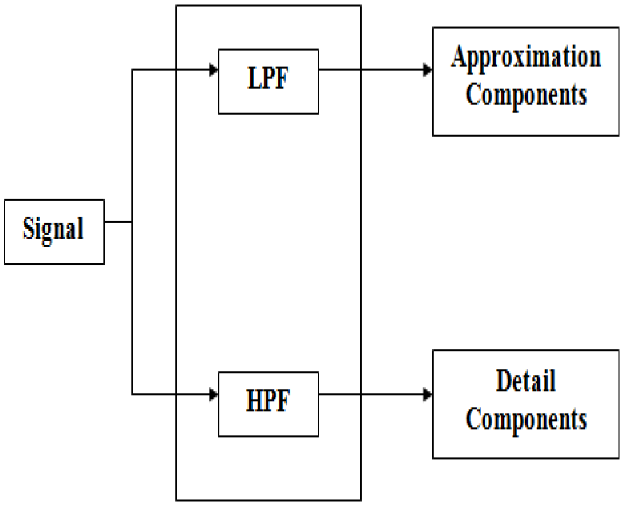


Fig. 2 Evolution of Image Fusion Research

***First DWT***, In DWT the signal is passed through a low pass filter and a high pass filter so as to get both high and low frequency parts of the signal. High frequency part contains edge components wherein low frequency part contains information components. The same process is repeated for the low frequency part so as to get second level low and high frequency components. This process is continued until the signal has been entirely decomposed or stopped before by the application at hand. For compression and watermarking applications, generally no more than five decomposition steps are computed. Furthermore, from the DWT coefficients, the original signal can be reconstructed. The reconstruction process (synthesis) is called the inverse DWT (IDWT).




Any signal contains its most important and informative part in its low-frequency component and that is the reason why low frequency components are very important. The high frequency content, on the other hand, imparts flavour or nuance. Consider the human voice. If high frequency components are removed from a song it would sound different, but one can still identify the saying. However, if low-frequency components are removed, one would be able to hear garbage only. In wavelet analysis two words are frequent i.e. approximations and details. The approximations are the high scale, low-frequency components of the signal. The details are the low-scale, high-frequency components. The first stage of the decomposition wherein signal is applied to low pass and high pass filters. If the original signal is of size 256x256 then size of each of the detail and approximation component would be 256x256. So the output contains twice the samples compare to input. So output of both of the filter is down sampled by 2 so that each of the output would have half the size of the original signal and hence the total size equals to that of the original signal. Figure shows the concept. The decomposition or analysis process with down sampling produces DWT coefficients.

***Second Multi Level DWT,*** The successive approximation components can be iteratively decomposed so that one signal can be divided into many components having lower resolution. This is said to be the wavelet decomposition tree and it is shown in figure.

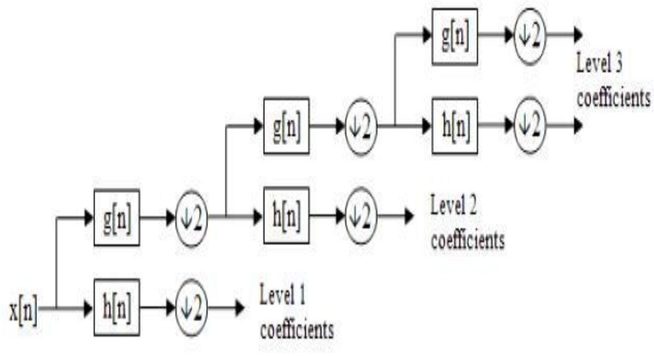



Fig.3 Multilevel Decomposition

For a two dimensional image F (x,y), the forward and reverse decomposition can be done by applying DWT and IDWT first on dimension x and then the same process can be performed for the other dimension y. This results in the representation of the image which is pyramidal in nature. This kind of 2D DWT decomposes the image into four parts namely, approximation component, Horizontal Detail component, Vertical Detail Components and Diagonal Detail
Components.

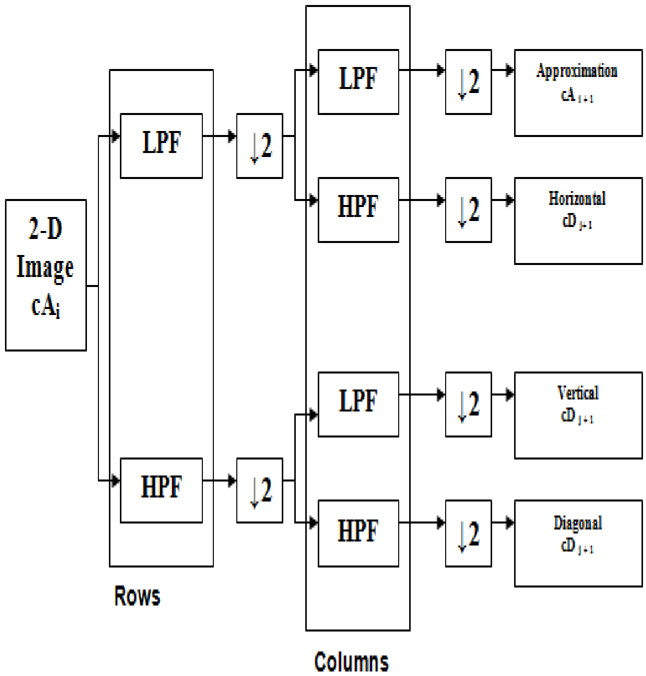



Fig. 4 Decomposition Detail

Since image is 2-D signal, we will mainly focus on the 2-D wavelet transforms. The following figures show the structures of 2-D DWT with 3 decomposition levels:

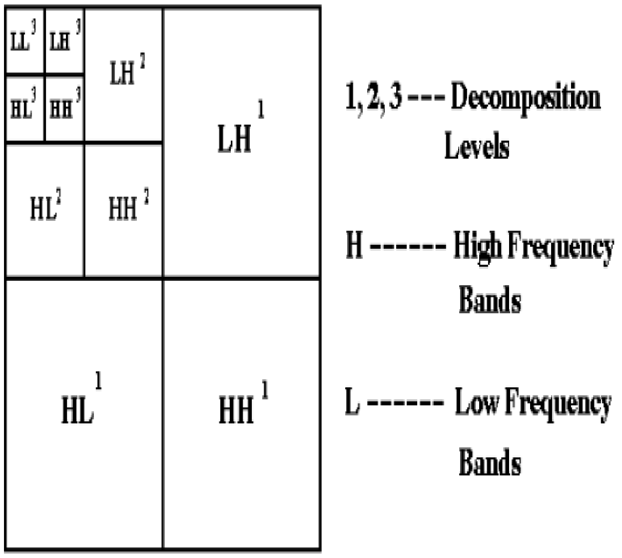



Fig. 5 Pyramid Hierarchy of 2-D DWT

After one level of decomposition, there will be four frequency bands, namely Low-Low (LL),Low-High (LH),High-Low (HL) and High-High (HH). The next level decomposition is just applied to the LL band of the current decomposition stage, which forms a recursive decomposition

***PCA***, It is a mathematical tool from applied linear algebra. It is a simple parametric method for extracting relevant information from confusing data sets. PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimensions The origin of PCA lie in multivariate data analysis, it has a wide range of other application PCA has been called, 'one of the most important results from applied linear algebra and perhaps its most common use is as the first step in trying to analyses large sets. In general, PCA uses a vector space transform to reduce the dimensionality of large data sets. Using mathematical projection, the original data set, which may have involved many variables, can often be interpreted in just a few variables.

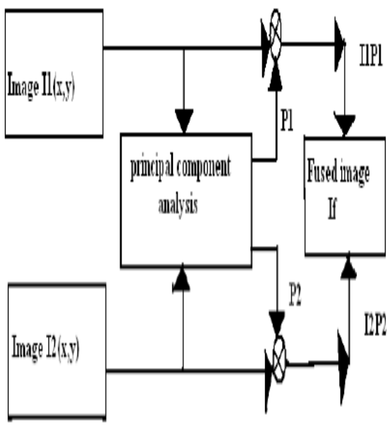



Fig. 6 Image fusion process using PCA.

***SWT,*** The Discrete wavelet Transform is not a time invariant transform. The way to restore the translation invariance is to average some slightly different DWT ,called un-decimated DWT ,to define the stationary wavelet transform(SWT).it does so by suppressing the down sampling step of the decimated algorithm and instead up-sampling the filters by inserting zeros between the filter coefficients. Algorithms in which the filter is upsampled are called "a trous'',,meaning "with holes". As with the decimated algorithm, the filters are applied first to the rows and then to the columns. In this case, however, although the four images produced(one approximation and three detail images) are the same size as the original image. The approximation images from the undecimated algorithm are therefore represented as level in a parallelepiped, with the spatial resolution becoming coarser at each higher level and the size remaining the same.

Stationary wavelet Transform (SWT)is similar to Discrete Wavelet transform(DWT) but the only process of down sampling is suppressed that means the SWT is translation invariant. The 2-D SWT decomposition scheme is

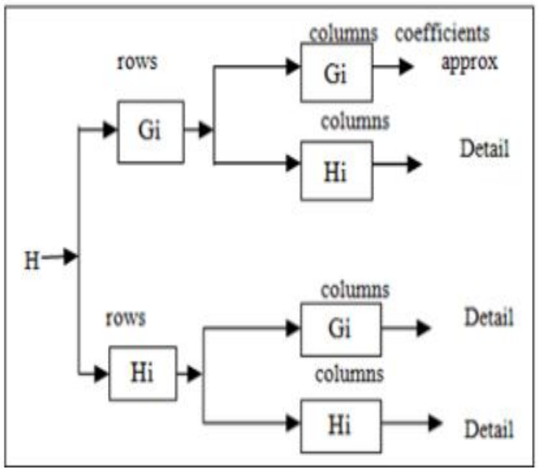



Fig.7 SWT Decomposition schemes

The 2-D Stationary wavelet Transform(SWT) is based on the idea of no decimation. It applies the discrete Wavelet Transform (DWT) and omit both down sampling in the forward and up-sampling in the inverse transform. More precisely, it applies the transform at each point of the image and saves the detail coefficient and uses the low frequency information at each level. The stationary wavelet Transform decomposition scheme is illustrated in

## I. PROBLEMS IN IMAGE FUSION

- There is problem related to spectral distortion of the images, which means that the variation of hue before and after the fusion process has appeared.
- There is problem of spatial characteristics and spectral information in the fused image.
- There is color distortion when the fusion is appeared in the color images.
- There are ambiguity and redundancy problems in medical images.
- There is human visualization and objective evaluation criteria related problems when the

fusion of two images occurred that I have studied in the literature survey.

- The Hue, Saturation and the Intensity of the color images effected due to fusion and due to noises.

## II. CONCLUSION

In this paper , we have analyzed 3 image fusion techniques namely DWT,PCA and SWT. On the basis of analysis done on the various image fusion techniques it has been concluded that each technique is meant for specific application and can be used in various combinations to get better results as compared to previous one's.

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