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A DETAILED STUDY ON IMAGE FUSION TECHNIQUES

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ABSTRACT

In the digital era of image processing image fusion is most popular method to enhance the image quality with pixel density approaches. Basically image fusion is a process in which multiple inputs are intergrated to make a single image as an output that is fused image.. This paper mainly looks into the methods, technique and applications which helpful for the image fusion concept. Image fusion techniques are IHS, PCA, DWT, Laplacian pyramids, DCT, SF. There are various methods of image fusion for high resolution on real world images for better perception of human being machine perception or further image-processing tasks such as segmentation, feature extraction and object recognition All the techniques have their algorithms to extract the collective information from input images and make it better for human vision become more useful for additional vision processing. It also intends to review quality assessment metrics for image fusion algorithms.

Keywords*: Image fusion, fused image, PCA, DCT, IHS, SF, Discrete Wavelet Transform, Laplacianpyramid.*

I. INTRODUCTION

Image fusion is process of combining two input images or more than two input images into a single output image which contain the important features and better description of the scene than the one provided by any of the individual input images. Image fusion is helpful to combining the registered images from multiple outsources to produce a better quality of the images with high resolution. Image fusion gives the spatial or spectral information about the picture quality. The output fused image provides the more information without the introduction of distortion. Image fusion has many applications in different areas like medical imaging, microscopic imaging, satellite imaging for remote sensing, computer vision and robotics etc. There are various methods of image fusion and some techniques of image fusion such as IHS, PCA, DWT, Laplacian pyramids, Gradient Pyramids, DCT, and SF. One of the important pre-processing steps for the fusion process is image registration, i.e. coordinate transformation one image with respect to other image. The need of image fusion for high resolution on panchromatic and multispectral images or real world images for better vision. Several digital image fusion algorithms have been developed in a number of applications. Image fusion extracts the information

from several images of a given scene to obtain a final image which has more information for human visual perception and become more useful for additional vision processing..

II. HIERARICHAL CLASSIFICATION OF IMAGE FUSION

The Classification of image fusion has three levels which are further working on their individual fields which are various techniques under pixel level, classified feature area in feature level fusion, area of region in decision level fusion. All the levels are structured in the diagram of classification of image fusion

The hierarchical classification of Image fusion as shown in Fig 1 below.

Pixel level fusion is also known as signal level fusion, it is basically lowest level fusion which is at the base of all image fusions; we easily process the images in pixels with the first image information and have the capacity to hold more unique information. In the pixel level fusion, the similarity between unique images is significantly more precise which prompts its higher necessity of image coordinating metric [8,12, 13].

Feature level fusion process extracted features or the point, edge, surface and different qualities from the input images and make efficient output image.This type of fusion does not need any high level image matching features. The feature level preparing to provide the decision or choice making level fusion with backings. [8, 11 and 13].

Decision level fusion is also known as symbol level fusion which settles on ideal choice in view of the information data extracted from the pixel level fusion or the component level fusion, is the top level of image fusion preparing. The decision making is usually used in artificial intelligence and neural networks[13].The first principal of the choice or decision making level fusion is the target extraction and grouping of a few source images.

III. METHODS OF IMAGE FUSION

In this process fused image has relevant good information from each of the given images whose quality is superior to any of the input images. Image fusion method can be broadly classified into two groups which are as following:

Spatial domain: In spatial domain techniques, we directly deal with the pixels of image. The pixel values are basically manipulated to achieve desired result.The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spectral distortion becomes a negative factor while we go for further processing such as classification problem. There are various methods that have been developed to perform image fusion HIS, PCA, HFM.

Transform domain: In transform domain methods the image is first transferred in to frequency domain. It means that the Fourier Transform of the image is computed first. All the Fusion operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. Image Fusion applied in every field where images are ought to be analyzed [13]. Spatial distortion can be very

well handled by frequency domain approaches on image fusion.Multi scale transform based fusion methods are listed below

(A) Pyramid method(i) Gaussian pyramid (ii) Laplacian Pyramid (iii) Gradient pyramid (iv) Morphological pyramid (v) Ratio of low pass pyramid.

IV. RELATED WORK

Multiscale Approach to Pixel Level Image Fusion et al. [2] It shows the pixel level combination of images where resultant images shows the better combination of input images. The authors formulate the optimization and give review on proposed information theoretic approach on multiscale images. *Multisource Image Fusion based on Wavelet Transform et al. [3]* presents the image fusion concepts and shows the relationship between the image fusion and rules of fusion where the orthogonal and biorthogonal wavelet transform calculated the results of spatial frequency on panchromatic and multispectral images. Finally perform the wavelet decomposition on imag es then check for the coefficient detail of information under the tested images. *Hybrid Multiresolution Image Fusion et al. [10]* presents the spatial frequency on high frequency coefficients where haar and biorthogonal are used for efficient edges these edges gives the details of data. Through the wavelet coefficients it used the laplacian on low frequency levels. In this paper wavelet coefficients combine the low frequency and high frequency coefficients for better results where frequency is from spatial frequency approach for maximum selection fusion rule. A hybrid approach algorithm applied for individual image fusion methods. This paper uses the SIDWT approach for better results instead of DWT which has some blurred effects on images. Calculate the parameters like PSNR, RMSE, SSI, Average Gradient gives good output.

V. EXISTING METHODS OR TECHNIQUESOF IMAGE FUSION

(1) Intensity-Hue-Saturation transform based fusion (IHS): IHS fusion generally converts the RGB images to IHS space in which it worked on pan images where IHS converted in to HSV. In this method zero considering as black where as one considering as white during the conversion of the RGB to HIS space [4]. Formulation is

- Convert Multispectral from RGB to IHS
- Convert the I term with PAN
- Again converted in to RGB

IHS has preprocessing terms for resampling or registration of images. This process further back to RGB components so that multiresolution fusion takes under the process [7].This technique is basically enhanced or sharpening of image fusion through which enhances the features, color or intensity values where IHS gives good results on multispectral and panchromatic images. It is sometimes called HLS (Hue Luminance Saturation) or when conversion occurs it sometimes called HSV (Hue Saturation Value). In this method sometimes adding some data details to the spatial resolution then gives effective enhancement in the results or output[16].RGB

changes in to IHS values or intensity values easily measured . The disadvantage of HIS transformation is that it worked on three band multispectral images which have all the three bands of colors completely [10].

(2) Principal component analysis (PCA) based fusion**:** Principal Component Analysis is based on variables of data set whether the variables are correlated transformed in to uncorrelated .It would around axis in linear transformations from measure space to feature space.This technique finding patterns of high data resolution. It is basically pixel level fusion defined from multidimensional sets to lower level dimensions and measures the weight using Eigen vector rather than picking the largest Eigen value or pixel value of the image. Equation for this technique $Y=A^T X$,Where A is the matrix of normalized Eigen vector of covariance matrix of X. Where Y has a diagonal covariance matrix

PCA Algorithm

i. First split the panchromatic image in to further sub images.

ii. Produce the column vectors from the input images.

iii. Compute the covariance matrix of two columns which are of source images.

iv. Compute the Eigen vector and Eigen values of the input images

v. Normalized the column vectors of source images.

vi. Normalized the Eigen vector having weight values multiply the pixel values.

Vii Fuse the two scaled matrix will be the fused matrix or resultant matrix.

PCA process has two components of image are I1(x, y) and I2(x, y) these ate two Eigen vectors when they are computed through PCA it has resultant vector which is n*2.PCA process as shown in Fig. 1.

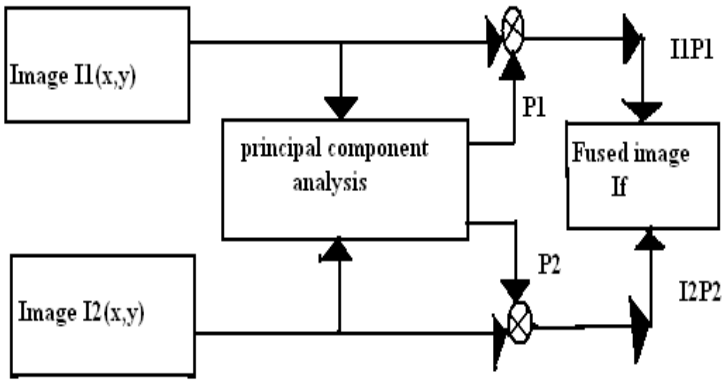

Fig 1. Diagram of PCA

(3) High-pass filtering method**:** High pass filtering is the ratio between the multispectral and panchromatic images or multitemporal images in which filters are worked as a kernel between the high or low level spectral ratio of the images. Calculate the mean and standard deviation of images [7].

(4) Discrete Cosine transforms (DCT): In this technique the original images are divided in to block then calculate the representations and average values of all DCT representations for its all corresponding blocks then taken the inverse cosine transforms to reconstruct the original images into fused images. [7].

(5) Discrete wavelet transforms (DWT): This method works on different conditions. Merge the maximum and minimum approximations with its coefficients bands. DWT has two input function which I1 and I2 they are decomposed in to four levels of images. In DWT low resolution bands are replaced by the selected bands in which decomposition occurs till then transformation completed. DWT improves the spatial resolution or improves the quality of images after fusion. Decomposition levels of DWT are shown in Fig. 2

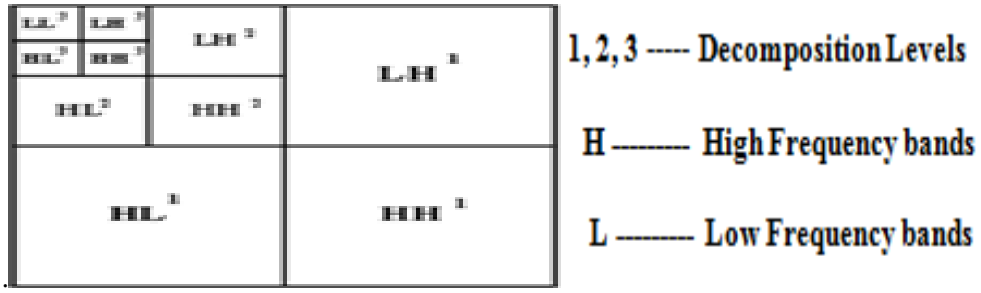

Fig. 2 Decomposition levels of DWT

DWT transformation always gives better results in the formation of fused images through its wavelet functions decomposition. Its basic formation is easily computed at the low pass and high pass of digital images through which decomposition of the images into four levels of coefficients bands gives effective results.

(6) Laplacian Pyramid: Laplacian is a pattern approach for the image and it works on difference between low pass filters and high pass filters. Its information is not only for edges, boundaries and it uses the LL bands rather wavelet does not use LL bands for fusion in wavelet values taken according to assumptions or approximation values whether it is maximum value or minimum value according to average weight results should be count. Without using LL sub bands contrast of images is not clear for laplacian its necessary to use the LL bands integrate SF with Wavelet Transformation.

$$F(x,y) = \begin{cases} A_i(x,y), & if\left|A_{i(x,y))}\right| > \left|B_{i(x,y)}\right| \\ B_i(x,y), & Otherwise \end{cases}$$

Where A and B are the input images and F is the fused image and $0 \leq i \leq N-1$

Laplacian pyramids basically not used only for pixels it is also for pattern levels of images. The feature level selects the some features from the pattern of images where decomposition occurs at that image region.Laplacian calculates the difference between low pass images at successive levels or layers of decomposition in which laplacian is used to fuse the images where inverse wavelet is basically used to merge the images [10].Laplacian is generally enhances the classical laplacian pyramids it evaluates the performance between down sampling and up sampling levels of images it is basically exposure boosting of images which detail of image layers which are worked for laplacian pyramids[10].

VI. RESULT& DISCUSSION

In this paper we calculate the below listed parameters through which analyze the comparison of techniques with their parmetric results of **PSNR** (Peak Signal Noise Ratio) to be used for the quality of the images with lossy compression fused image has less amount of noise it is much better in vision as per the arithmetic aspects of approximation to human perception. If PSNR value is high then the quality of reconstructed image is better than original image. The PSNR between two images having 8 bits per pixel or sample in terms of decibels (dBs) **, MSE**(Mean Square Erro) which is defined as noise it should be minimize in terms of quality measures through which fused image is more efficient. **SD** (standard Deviation) SD is related to variance but it is a square root of variance. Both variance and standard deviation are mean measures in mathematically way, where variance is the square of the unit of data. **MI** (Mutual Information) is the common information of both the source images then it would give a better way to know how much the both source images are similar to each other or have some similar features.

Table 1. Performance paramaters of image fusion methods

METHODS	PSNR	MSE	MI	SD
IHS	59.7002	0.0697	1.0497	19.0015
PCA	56.9076	0.1325	0.3299	19.0046
DWT	69.9432	0.0066	2.2558	21.0030
DCT	59.8919	0.0667	0.8074	19.0043
LAPLACIAN PYRAMID	62.4528	0.0370	0.5711	21.0025

VII. CONCLUSION AND FUTURE SCOPE

In this paper all the techniques of image fusion are discussed and also explained the working of all methods. Overall this survey paper suggests that the proposed work on image fusion is used by laplacian pyramid with shift variant and shift invariant so that better results should come out and proposed work expertimental with the real world colored images. So that enhancement in this image fusion may be used in smart or digital technology.

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