Image Quality Enhancement using SIDWT Algorithm

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ABSTRACT

The successful diagnosis of a disease depends on the accuracy of the image from medical mage modalities. Medical image fusion acts as a 'life saving tool'-thus it has emerged as a promising research field in recent years. The objective of medical imaging is to acquire a high resolution image with more information for the sake of diagnostic purposes. This paper proposes a hybrid fusion algorithm for multimodality medical images. There are two types of modalities one is 'Anatomy', which gives the information about functional details of cell activity in the organ, such as SPECT, PET. Structure without function is a corpse and function without structure is a ghost. Therefore, both of the Anatomy, Physiology and Metabolism images are investigated. So, this work makes fusion of CT and PET images. Specifically it aims at the gathering relevant, disparate and complementary data in one order to enhance the information apparent in the images, as well as to amplify the reliability of the interpretation. This leads to more accurate data and increased utility. In addition, it has been stated that combined data provides for robust operational performance such as increased confidence, reduced ambiguity, and improved reliability. This paper introduced a pixel level based 'Hybrid Concept' by integrating the conventional and advance fusion methods to overcome their demerits and enhance image processing qualities like PCA(Principal component analysis), DCT (Discrete Curvelet Transformation) to form aSIDWT (Shift Invariant Discrete Wavelet Transformation) SIDWT-PCA, SIDWT-DCT and proposing SIDWT-DCT-PCA. These are analytically examined, observed and compared the results among them using the performance matrices MSE, PSNR and ENTROPY and also STANDARD deviation.

***Keywords:CT,PET images, PCA,DCT,SIDWT-PCA,SIDWT-DCT,*SIDWT-DCT-PCA**

I.INTRODUCTION

Image fusion is a branch of data fusion where data appear in the form of arrays of numbers representing brightness, color, temperature, distance, and other scene properties. Such data can be two-dimensional (still images), three-dimensional (volumetric images or video sequences in the form of spatio-temporal volumes), or of higher dimensions. Early work inimage fusion can be traced back to the mid-eighties. Burt was one of the first to report the use of Laplacian pyramid techniques in binocular image fusion[1]. Burt and Adelson later introduced a new approach to image fusion based on hierarchical image decomposition. At about the same time, Adelson disclosed the use of a Laplacian technique in construction of an image with an extended depth of field from a set of images taken with a fixed camera but with different focal lengths. Later Toet and Toet et al. used different pyramid schemes in image[1][2] fusion.

These techniques were mainly applied to fuse visible and IR images for surveillance purposes . Some other early image fusion work are due to Lillquist disclosing an apparatus for composite visible/thermalinfrared imaging, Ajjimarangsee and Huntsberger suggesting the use of neural networks in fusion of visible and infrared images, Nandhakumar and Aggarwal providing an integrated analysis of thermal and visual images for scene interpretation, and Rogers et al. Describing fusion of LADAR and passive infrared images for target segmentation. Use of the discrete wavelet transform (DWT)[9] in image fusion was almost simultaneously proposed by Li et al. and Chipman et al.At about the same time Koren et al. described asteerable dyadic wavelet transform for image fusion. Also around the same time Waxman and colleagues developed a computational image fusion[3] methodology based on biological models of color vision and used opponent processing to fuse visible and infrared images.

The need to combine visual and range data in robot navigation and to merge images captured at different locations and modalities for target localization and tracking in defense applications prompted further research in image fusion[13]. Many other fusion techniques have been developed during the last decade. Today, image fusion algorithms are used as effective tools in medical, remote sensing, industrial, surveillance, and defense applications that require the use of multiple images of a scene. For recent surveys of image fusion theory [4] and applications, readers are referred to a paper by Smith and Heather and a collection of papers edited by Blum and Liu.Another excellent source that follows the evolution of image fusion[10] systems and algorithms over the last several years isthe special sessions on Image Fusion and Exploitation organized by Allen Waxman et al. at the Information Fusion[13] Conferences (2000–2004). The list of papers cited in this introduction is by no means exhaustive but it hopefullyprovides a flavor of some of the major developments in the field with a focus on recent advances and challenges.template called structuring element. It have basic operators like erosion, dilation, opening, closing, filling, cleaning, etc...So, overall this method is using with SWT. So, all related to image fusion with good quality and high resolution.

Pixel level image fusion

This is most his simple technique in image fusion done at lowest level. In this combine the values and intensities of two input images based on its average, gives the single resultant image. The main advantage of pixel level fusion[7] is that the original measured quantities are directly involved in the fusion process[6].According to the stage at which image information is integrated, image fusion algorithms can be categorized[8] into pixel, feature and decision levels. Pixel-level fusion generates a fused image in which information content associated with each pixel is determined from a set of pixels in source images. Feature-level fusion[1] requires the extraction of special features which are depending on their environment such as pixel intensities, edges or textures. These similar features from the input images are fused. Decision- level fusion higher level of fusion. Input images are processed individually for information extraction. Generally these algorithms can be categorized into spatial domain fusion and transform domain fusion[4]. There are SIDWT, DWT[5], DCT type transform techniques. So, most of we are using simple minimum, simple maximum and simple average type basic image fusion techniques and PCA[3] , which is using in spatial domain techniques. When we are using transform domain then we have to use parameters like, PSNR, ENTROPY, etc... For wavelet transforms, SF and SD this parameters are using in SWT technique[2] .This ratio are decided the different results between different methods. So morphological processing is collection non-linear operations related to the shape or morphology of features in an image.

II. PROPOSED MODEL: FUSION DOMAIN

SIDWT (Shift Invariant discrete wavelet transform)

The discrete wavelet transform is not shift-invariant due to the underlying down-sampling process. Hence, in practice, their performance quickly deteriorates when there is slight object movement or when the source images cannot be perfectly registered. To overcome this problem a Shift Invariant Discrete Wavelet Transform (SIDWT)[20] can be used novel multimodal image fusion method using Shift invariant Discrete Wavelet Transform (SIDWT) and Support Vector Machines (SVM)[20]. SIDWT is used for multiresolution decomposition and a trained SVM is used to select salient features in the image. Support Vector Machines are a set of related supervised learning methods that analyse data and recognize patterns, used for classification. A Support Vector Machine[20] performs classification by constructing an *N*dimensional hyper plane that optimally separates the data into two categories. In a two class problem, it aims to maximise the width of the margin between the classes, so that the distance

from the decision boundary to the nearest data point on each side is maximized.

If {*x*i} is a set of points in an N dimensional space with corresponding classes {*y*i: *y*i {-1, 1}} then the training algorithm attempts to place a hyperplane between points where yi = 1 and points where yi = -1.The foundations of Support Vector Machine have been developed by Vapnik (1995) and are gaining popularity due to many attractive features and promising empirical performance. The term SVM[20] is typically used to describe classification and regression with support vector methods. In the problem of separating the set of training vectors belonging to two separate classes,

D = { (x1, y1),…, (x1, y1)},x c ….(1)

where xi are the inputs yi are the corresponding outputs.

The SVM first maps the input vector into feature space and separates the various classes by constructing a hyperplane

(w, x) + b = 0……… (2)

The set of vectors is said to be optimally separated by the hyperplane , if it is separated without error and the distance between the closest vector to the hyperplane is maximal ,where the parameters w, b are constrained by, mini|(w, xi) + b| = 1 …..(3)

Minimizing "w" is equivalent to minimizing 1\2 "w"^{2} and the use of this term makes it possible to perform Quadratic Programming (QP) optimization. This involves solving the problem that maximizes,

$L_D \div \Sigma^L$

i=1 αi — 1/2 Σ^Li,j=1 αiαj yiyj(xi, xj)….. (4)

such that 0 ≤ αi ≤ C , and Σ^L 1 αiyi = 0 for i = 1,2 … , L . where C is a regularization parameter chosen to reflect the knowledge of the noise on the data, ai‘s are support vectors SVM makes use of a kernel function K(xi, xj)=(xi, xj) that performs the non-linear mapping into feature space.

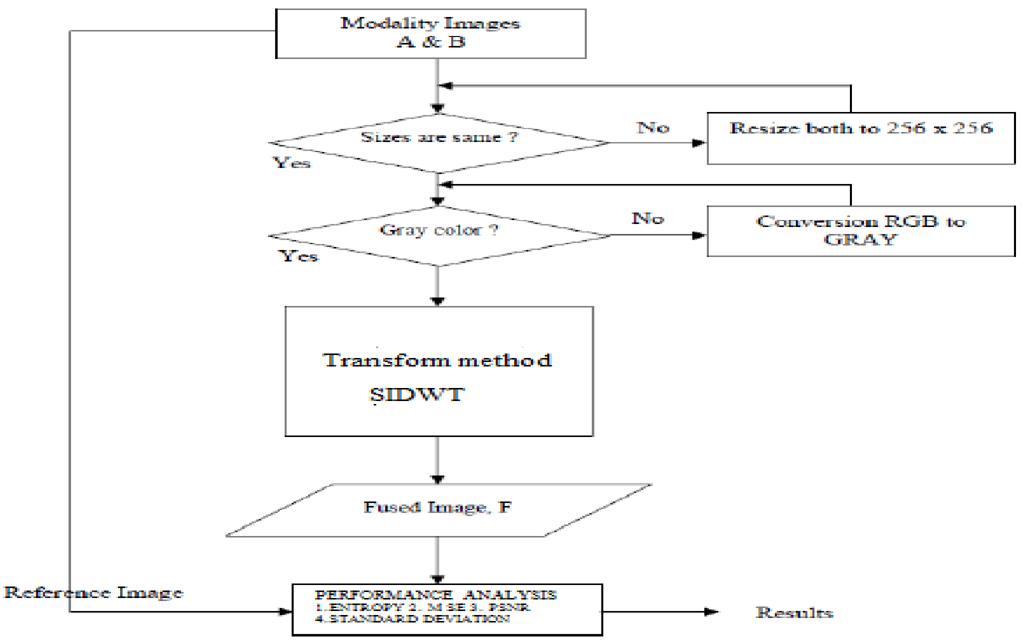
In this paper Gaussian radial basis function is used and is given by

k(x, xr)=exp(-(s-sfn2/2o2))……. (5)

where x and xr denote the training patterns given.

The basic algorithm consists of first the two input images checks their size and color. If they are in same size and graycolor. After applying SIDWT transform we get output.

The flowchart of SIDWT as shown in below Figure .



The Hybrid algorithms:

SIDWT-PCA

The process flow diagram shows the integration of the two methods SIDWT and PCA to get a hybrid algorithm SIDWT-PCA.

The algorithm is explained below:

- As an initial step, the both images are resized to same size and mapping of RGB tOgray done.
- The SIDWT is applied.
- Resultant will be the fused coefficients.
- Then, to reconstruct fused image apply inverse SIDWT to obtain the final fused image F.
- Using fused image F and reference image calculate the MSE, PSNR, and Entropy.

SIDWT-DCT

The FDCT and SIDWT algorithms are integrated to give a new one called DCTSIDWThybrid algorithm.
The algorithm is explained below:

• Initially, the pre-processing steps are applied to get same sized images and mapped togray images.

• Using the FDCT Wrapping algorithm,findthe C1{1, i }{1,j} and C2{1, i}{1, j} curvelet coefficients

• As a fusion rule apply the SIDWT (refer section C) to obtain the fused Curvelet-SIDWT coefficient.

• Reconstruction of image is by applying inverse FDCT wrapping. The resultant is thefused image of both modality images.

• Finally, perform qualitative and quantitative analysis. Using reference image andfused image.

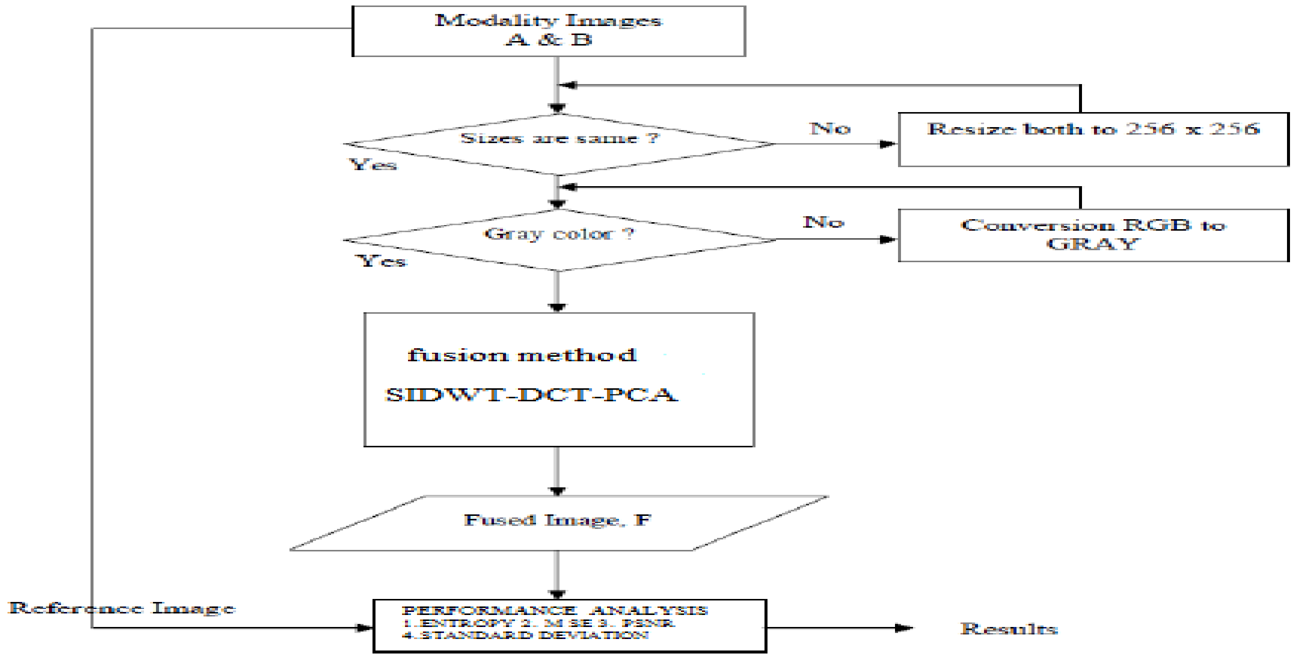
SIDWT-DCT-PCA

The hybrid algorithm: DWT-DCT-PCA

This hybrid algorithm is combination of DWT, FDCT and PCA; to integrating the all the features, merits having among each others. Also over comes the problem faced among the methods.
The algorithm is given as below:

- The registered medical images of different modality, image A and B. Let consider these images are M1, M2.
- These are mapped to a RGB to graycolors, following with resizing both to same size 256 x 256 dimensions.
- Now, apply DWT algorithm to get a set of 4 decomposed frequency band coefficients for each images.
- For each respective image‘s decomposed frequency band coefficients, apply FDCT wrapping transformation to get respective curvelet descriptor coefficients of all set of decomposed coefficients.
- Using, the PCA as a fusion rule to selectively combine the coefficients decomposed in previous step to form fused pca_ct_dwt coefficients. To regenerate, sets of frequency bands from above stage‘s resultants are applied with inverse FDCT wrapping to respective coefficients.
- After getting a set of four fused frequency coefficients, apply inverse DWT to reconstruct the final fused image, F.
- Using M1 as reference image and final fused image F, the performance analysis is done.

  The Flowchart of SIDWT-DCT-PCA is shown below.



III..Results& Discussions:

Take the two input images i.e. CT and PET images of same size. After loading images we get results as shown in below.

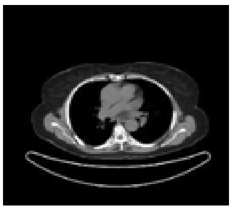


Figure1: CT image output

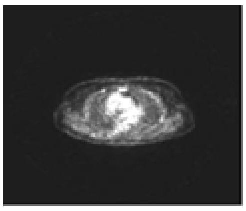


Figure2: PET image

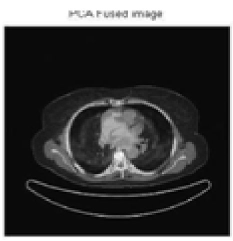


Figure3:PCA Output

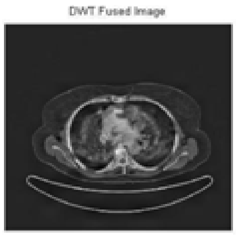


Figure4:DWT

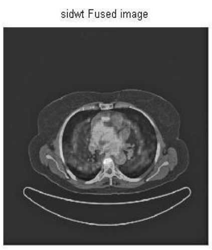


Figure5:SIDWT

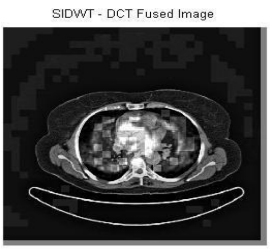


Figure6:SIDWT-DCT

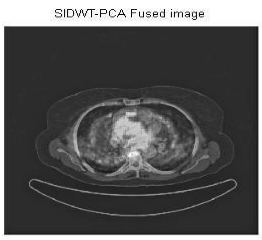


Figure7:SIDWT-PCA

This is the output of SIDWT-DCT-PCA transform method. Its gives high entropy,PSNR and low MSE, standard deviation compared to SIDWT-DCT-PCA hybrid transform.The entropy value of SIDWT-DCT-PCA is 26.81, entropy value is 3.81 and MSE value is 135.35, the standard deviation is 109.09. The quality evaluation & analysis is done through given below tabulation of calculated values and graphs using some matrices like MSE, PSNR, and entropy. However the results given by the tests and analysis, quite uneven among the algorithms used. But, it has given better results for hybrid algorithms. And also some psycho visual tests were carried out to express the subjective measures, given satisfactory results; the fused image contained the information of both CT & PET. There need a post processing for best isuals. And also fused image requiresless space (memory) than two modality images. The hybrid algorithms also preserved the merits of each and among each other overcame their limitations.

Table :Comparision table for proposed hybrid transforms

S.NO	TRANSFORM METHOD	PSNR	ENTROPY	MSE	STANDARD DEVIATION
1	SIDWT	26.31	3.43	152.24	98.74
2	SIDWT_PCA	26.37	3.39	151.06	101.12
3	SIDWT_DCT	26.98	3.91	131.10	111.87
4	SIDWT_DCT_PCA	26.81	3.81	135.35	109.09

IV.CONCLUSION

The quality evaluation & analysis is done through tabulation of calculated values and graphs using some matrices like MSE, PSNR, and entropy. However the results given by the tests and analysis, quite uneven among the algorithms used. But, it has given better results for hybrid algorithms.

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