A REVIEW: IMAGE FUSION USING DCT AND DWT

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Abstract— An image fusion is a kind of single process which combines the necessary or an efficient information from a set of different or similar input images into a single output image where, the resulting image is more accurate, informative and complete than any of the input images with certain algorithm. Apart from this, image enhancement is a process which is used to improve the quality of an image and increases the application of these input data images which is helpful in different fields of science such as medical imaging, microscopic imaging, remote sensing, computer vision, and robotics etc.In this paper we describe the main function of image fusion is to improve the good quality of an image by evaluating the sharpness. This is done by using wavelet techniques DCT & DWT are one of them. This survey paper mainly looks into the methods, techniques, advantages, disadvantages and applications, DWT and DCT which can be helpful for researcher in an image fusion concept. This fused image provides more accurate information about the real world which is helpful for human vision and machine perception or any further image-processing tasks in future.

Index Terms— Image fusion, Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT).

1 INTRODUCTION

IMAGE fusion is one of the important techniques which is also used in the field of digital image processing[5]. The process of image fusion works on the combining of necessary information from two or more images and then produces the single output image which has all required information than any input image [5][7][10]. It is the process of joining of two or more similar images to form a new image by using wavelet theory [4]. It uses in the various fields of science such as remote sensing, medical imaging, ocean surveillance and artificial neural networks etc. [3]. This process acquires the all of the features from the different input images and put in the single image which has accurate, complete and informative information than any input image. The input images could be of many types such as multi sensor, multimodal, multifocal and multi temporal. Image enhancement is the process of improving the good quality of an image in which different images are registered to form a single output image which has good quality and appropriate for the human being and the machine interpretation [2].

The image fusion process can be of two types – Spatial domain fusion method and the transform domain fusion method [7].Spatial domain fusion method is a kind of process which will immediately deals with the pixels of input images where, the pixel is a smallest unit of graphics. And, in the Transform domain fusion method, images are first changed into the frequency domain. After, it also helps in the evaluation of sharpening the image.

In now days, based on the wavelet transform theory the image fusion algorithm works faster as a recent decade. Wavelet Transform has good features in terms of time frequency. It can be applied successfully for image processing field [9]. The process of image fusion can be performed at three levels: pixel, Feature, and decision level [11]. The image fusion technique is used to obtain a lot of informative, accurate, complete and top quality image from two or more pictures [13]. The objectives of image fusion is to is reduce the data which will be lost during the fusion process because of the some physical parameters such as pixel intensity, echo and repetition time etc. increases the complexity of the pictures and another goal is to enhance the quality of an image in terms of sharpness [4].

Figure 1:- Concept of Image Fusion

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2 CLASSIFICATION OF AN IMAGE FUSION

Image fusion can be classified as follows:

2.1 Pixel Level:- In pixel level classification, image fusion is an implemented between an individual pixel values [15]. This level measures dot and pixels per inch but, sometimes it has different meanings especially for printer devices where, dpi is a measure of the printer density of dot and how many number of pixels in an input images involved called resolution. The benefits of image fusion at pixel level [16] is that the real quantities are directly included in the image fusion process [19].

2.2 Feature Level:- In feature level classification, image fusion is an implemented between the segmented portions of input images by examining the properties of pictures. Feature Level has various features such as edges, lines, and texture parameters etc [21]. This level is also used in image preprocessing for image splitting or to change the perception.

2.3 Decision Level:- In decision level classification, image fusion is an implemented between the segmented portions of input images by examining the initial object perception and their grouping. In decision level, the results calculated from different algorithms shows as a confidence rather than decisions, called as soft fusion. Otherwise, it is called hard fusion. The input images can be processed individually helps in the information extraction [24]. The decision level methods can be categorized as voting methods, statistical methods and fuzzy logic based methods. The decision level fusion methods are also used in the field of artificial intelligence. Ex- Bayesian inference, and Dempster-Shafer method.

3 IMPORTANCE OF IMAGE FUSION

Image fusion plays a crucial role in the real world. It can preserve all the useful information from the different source images into a one common image by joining the other different images to obtain the higher quality of an image and the efficient information [27]. It also helps to provide the reliability in the pictures. The image fusion process is needed to obtain the high quality or real image. Image fusion process also has capability to achieve the complementary information in fused image.

3.1 ADVANTAGES OF IMAGE FUSION

It provides appropriate information in the destination image by joining two or more source images. The image fusion is a very powerful process which provides reliability in the image [30]. It is also suitable for identification and recognition. It also helps in reduced the data i.e., storage required for image and the time transmission for image and fused image should be true in colour. And, the fused images also have good quality. The main advantage of image fusion process is to reduce the duplicacy [16].

3.2 DISADVANTAGES OF IMAGE FUSION

The disadvantages of image fusion processes are noise can be generate during the fusion of the images. And, the processing of the data of images during fusion process will be slow [4]. More than two or more source images are required to produce a single output images. It also has lacking of visibility at night.

3.3 APPLICATIONS OF IMAGE FUSION

Image fusion is used in the various fields of science such as medical diagnosis, navigation guidance**,** military & ocean surveillance and artificial neural networks etc. Fused images are mostly used in the fields of robotics for finding the variations of frequency in the images and also used in the satellite imaging for capture accurate and appropriate images.

4 CATEGORIES OF IMAGE FUSION

Image fusion process can be classified according to the nature of the images:-

4.1 Multi-view fusion:- It is a type of image fusion in which the images are fused in same manner, but taken at the same time under a various conditions [17].

4.2 Multi-temporal fusion:- It is a type of image fusion in which the images are fused in same manner but taken at different times [23]. In multi-temporal fusion, the fusion process is done by the subtracting of two or more images, and the main goal of this fusion process is to observe changes in the scene at different times.

4.3 Multi-modal fusion: - It is a type of image fusion in which the images are fused are in different manner [6]. And, the main goal of multi-modal fusion is to fused image that contains lot of information from different manner without losses the overall properties of the image [18].

4.4 Multi-focus fusion:- It is a type of image fusion in which the images are divided into segments and the fusion is applied to those segments to obtain the high quality fused image [12].

5 LITERATURE REVIEW

According to VPS Naidu the process of integrating of information from the two kind of images one has good spectral information and the others have high geometric resolution into single images is a very attractive thing in image processing, is known as image fusion [21]. In this paper, he proposed the theory of image fusion algorithm based on wavelet transform such as DWT and DCT is used to improve the geometric resolution of the images in which two images are firstly decomposed into sub-images with different frequency and finally these sub images are reconstructed into the resulting image with all the features of different decomposed images. In his experiment he take two images to verify the algorithm, the first image composed of SPOT multispectral images with the resolution of 20m, and the second image with the resolution 10m. He proposed that the result image has not only good spectral information but also has good geometric information [22].
Anjali Malviya et.al. [5] an image fusion is the process of acquiring the all of the essential features of the two or more im-

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age to form a single image as a resulting image. They proposed that in today's era lot of work is done in the field of image fusion and used in various application such as medical imaging and multi spectra sensor image fusing etc. and the various image techniques are used for the image fusion such as wavelet transform, IHS and PCA based methods etc [28]. In their experiment, they conclude that the wavelet transform is one of the best approach to extract the features by the transformation and decomposition of the images but this method is not efficient for retain the edge information.

Huaxun Zhang et.al. [15] one of the most important applications of image processing is in image fusion. It is a technique which is used for combining essential information from two or more similar images into a one single image which has plentiful information. They proposed that the fused image contains more information than any of the input images.Kapil Joshi et.al. [31] describes the basic concept of image fusion using DWT concepts. The fused image has both characteristics such as complimentary spatial and spectral resolution. This method can apply in remote sensing application as well as satellite imaging application [23]. In their work, they proposed that the two images are fused based on the wavelet transform using different fusion techniques. The objective of the fusion technique is to fuse two images in such a way that the resulting image get better result which contains all of the essential features than any of the input image. In their experiment they conclude the statistical parameters like peak signal to noise ratio, entropy, standard deviation and root mean square error to propose their method.

K. Kannan et.al. [20] Image fusion is a one of the popular method in image fusion technique which provides better quality fused image for interpreting the image data. In their proposed work they apply color image fusion using wavelet transform for securing data through asymmetric encryption scheme and image hiding [25]. They used the components of a color image corresponding to different wavelengths (red, green and blue) which are fused together using DWT for obtaining a better quality color image. The fused color components are encrypted using amplitude in Fresnel transform domain, and the individual color component transform into different cover images to disguising information of input image to an attacker. In their experiment, they proposed that color image fusion using wavelet transform is used for security applications which help in hiding of image. They used Discrete Harr wavelet transform for color image fusion.

6 DISCRETE WAVELET TRANSFORM (DWT)

The discrete wavelet transform method is one of the fusion method of the images in which the source images are firstly transformed by DWT to their corresponding coefficients of wavelet images by every scale level. After, it the fusion of source images corresponding to wavelet coefficient of the source images takes place based on a certain fusion rule [9]. This rule can be of simple addition or averaging. The wavelet coefficient of the fused image at each level produces the final construction of a single output image by taking an inverse of DWT. Wavelet transform theory is based on the compression of the image [13]. Wavelet theory can also be applied to fusion of the image by using the multi-resolution analysis (MRA) [31]. Multi-resolution wavelet transform provides an intermediate representation between the Fourier and Spatial representations. It is used to provide high visual quality in both spatial and Fourier domains [11]. 2-D Discrete Wavelet Transformation (DWT) is used to convert the image from the spatial transform domain to the frequency transform domain. DWT uses two channel filter bank for fusing the image. 1-D discrete wavelet transformation (DWT) can also be used along the rows and the columns of the pictures to generate a 2-D decomposition of image. This wavelet transform (DWT) decomposes the images into various frequency components such as low-low, low-high, high-low and high-high frequency components. In DWT image fusion, DWT process can be apply to input images to get coefficients of wavelet to produce an appropriate image. Finally, the inverse of DWT is taking and applied for the reconstruction of final fused image [31]. In DWT, image fusion techniques are used to perform a very basic operation like pixel selection, addition, subtraction or averaging. The basic operations, used to decomposes the input images into set of functions which are further called wavelets. In DWT, wavelet transform of image is computed, then modifications are made at final step then, inverse of wavelet is taken to get high quality image as a resulted image [21].

7 RESULTS

The given results are getting from the following equation.
e. g. the dilation equation

$$\phi(x) = \sum_{k=-\infty}^{\infty} a_k \phi(Sx - k). \quad \text{(i)}$$

Where, S is a scaling factor. Moreover, the area between the function must can be normalized and scaling function must can be orthogonal to its integer translates e. g.

$$\int_{-\infty}^{\infty} \phi(x)\phi(x+l)dx = \delta_{0,l} \quad \text{(ii)}$$

After introducing some more conditions (as the restrictions above does not produce unique solution) we can obtain results of all this equations, e. g. finite set of coefficients k which define the scaling function and also the wavelet. The wavelet can be obtained from the scaling function as

$$\psi(x) = \sum_{k=-\infty}^{\infty} (-1)^k a_{N-1-k} \psi(2x - k) \quad \text{(iii)}$$

Where, N is an even integer. The set of wavelets than forms an ortho normal basis which we use to decompose signal Note that usually only few of the coefficients a k are nonzero which simplifies the calculations.

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Figure 2:- Experimental work on DWT

8 DISCRETE COSINE TRANSFORM (DCT)

The Discrete Cosine Transform (DCT) plays an important role in the compression of images in the form of Moving Pictures Expert Groups (MPEG) and Joint Video Team (JVT) etc. Discrete Cosine Transform (DCT) is used to transform the spatial domain [9][29][30] image into the frequency domain image. The coefficients of the images are represented by the alternating current (AC) values and Direct Current Values (DC). Red, Green, Blue (RGB) image can be divided into the blocks of images with the size of 8*8 pixels. Then, the images are group in the matrices of image is divided and grouped by the matrices of red, green and blue and transformed to the grey scale image [7]. Discrete cosine transform (DCT) plays a crucial role in the digital image processing. In DCT, images are divided into non-overlapping blocks of size N*N and the coefficients of the DCT [9] are calculated for each block and then apply the fusion rules to get higher quality fused image. These techniques cannot be perform well while using the algorithms with block size less than 8x8 and also has the block size equivalent to the image size itself. The advantage of DCT is that it is a very simple algorithm [29] and can be used for real time application transformations [9].

Figure 3:- Experimental work on DCT

9 DIFFERENCES BETWEEN DCT AND DWT

DISCRETE COSINE TRANSFORM	DISCRETE WAVELET TRANSFORM
Discrete Cosine Transform is a wavelet method used to point a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies.	Discrete Wavelet Transform is used to separate the images into a pixel.
DCT plays the important role in the applications of science and engineering e.g. robotics etc.	DWT plays the important role in the image processing techniques especially lossless image compression.
It is widely used in image compression and accepted in the multimedia.	It works as a mathematical tool that decomposes an image signal into a representation.
DCT has numbers of applications in science and engineering especially lossy compression techniques (e.g. mpeg.jpg)	It operates over maximum clock frequency of 90.197 mhz respectively.
In DCT, wavelet transform decomposes the images into various components such as low-low, low-high, high-low and high-high frequency components.	Inherent multi-resolution nature, wavelet coding schemes for application where scalability and tolerable degradation are important.

Table 1:- Comparions between DCT and DWT

10 CONCLUSION

This paper puts forward on image fusion algorithm based on wavelet DWT and DCT. Image fusion is the combination of different data to obtain a high quality simage. It is an efficient way for optimum utilization of large volumes of data from various sources. This fusion algorithm can also be optimized for future research. The Future research of this paper is based on the comparing of the performance of fusion algorithm on color images. It also includes multi resolution analysis (MRA) ability in wavelet transform and also has better identification ability for the edge feature of waiting describing images in the curvelet transform. The Fusion increases the efficiency of images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. In this paper ,we used a set of image processing images like medical images and remote sensing images. It is hoped that the techniques can be extended for coloured images and for fusion of multiple sensor images. Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable techniques are used for image enhancement.

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