Evaluating the key findings of Image Fusion Techniques

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Abstract

An objective of digital image fusion combine two or more source images to get a single digital image known as fused image. This fused image will be more informative for human as well as machine also. We can used the different methods of fusion has been proposed in literature both in spatial domain and wavelet domain. This paper will be propose a pixel level image fusion using multiresolution (BWT). The two more methods we can use in this paper is DCT and PCA. PCA based on fusion and sharpness of fused image. PCA performance evalution of proposed method used matric like: fusion factor, entropy, standard deviation, to get the better results. DCT will be suitable and time saving in real time system for fusion of multifocus images based on variance calculation.

Keyword: Image fusion, multi-focus images, registered image, BWT, PCA, DCT.

1. Introduction

The image fusion can be process to combine relevant information from two or more digital images into a single digital image. They create a new regrouping corresponding information of the original image. The image fusion will be useful to procedure for merging the single sensor image and multi-sensor images to improve the information which is more suitable for human and machine. The objective of fusion image is to merge the information from several images in order to produce image to conveys only useful information. It can be process the images obtained from the different sensors by specific algorithm to obtained resultant images is more clear, reliable and understandable.The discrete cosine transformation (DCT) is based on the methods of digital image fusion which is more suitable and time-saving in a real-time systems. In this paper, an capable approach for image fusion of multifocus digital image is presented which is based on variance calculated in bwt, pca and dct domain.

All the sensor networks will be produce, receive and transfer data. The visual sensor networks (VSN) will refers to the system with huge number of cameras that will be used to geographically spread resoures and monitoring of several points. In VSN sensors the cameras which can record the images or videos.

Image fusion has three different levels like: pixel, feature and decision. Pixel level is a low level of image fusion which is used to combine and analyzed data from different sources before original information. It is easy to implement. Feature level is a middle level of image fusion which extract very important features from an image like length, edge, shape, direction and segments. Decision level is a high level of image fusion in which points to actual target. It's methods are classified into two : first is Special domain fusion, second is Transform domain fusion. The averaging method, Brovery method, PCA (Principal Component Analysis), based method are special domain fusion method. But, the special domain fusion method produce special distortion in fused image. This problem can be solved by transform domain fusion method. Where, the DCT based method will be very efficient for image fusion.

The digital images which uesd in digital image fusion should be already registered. In pixel level digital image fusion technique is used to increase the special resolution of the multi-spectral image. Image fusion should be passes all the possible relevant information contain in the source images.

2. Image Fusion Technique

In image fusion technique the good information from fused image which gives quality and relevant information. It can be classified into two groups are:

1. Special Domain Fusion.
2. Transform Domain Fusion.

In the special domain fusion technique, it directly deals with the pixel value of an image. Pixel value will be manipulated to achieve desire result.

In frequency domain fusion method, the pixel value is transferred into domain fusion method by using dct and dft based fusion methods and image will enhanced by altered frequency component of an digital image. Image fusion will be apply in every field for relevant information. For example: microscopic image, medical image analysis, remote sensing application, computer vision, satellite image analysis. PCA (Principal Component Analysis), DCT (Discrete Cosine Transform), BWT (Biorthogonal Wavelet Transform) based methods under the spatial domain fusion approaches. Another important spatial domain fusion method is based on the high pass filtering technique. Transform domain fusion approach is more efficient for fused image using DCT (Discrete Cosine Transform).

Figure: 1 "Upper blurred image" [15]

Figure: 2 "Bottom blurred image" [15]

Figure: 3 "Fused image" [15]

Figure: 3 is Fused image show entire object to signifying of two given source images Figure 1 & 2.

3. Discrete Cosine Transform (DCT)

The DCT (Discrete Cosine Transform) based method of fusion are more suitable and time saving in real time system. An efficient approach for image fusion of the multifocus image will be based on various calculated in DCT domain has been presented. The fused image saved or transmitted in JPEG (Joint Photographic Experts Group) format, then fusion applied in DCT domain fusion will be more efficient. If we have to perform the JPEG coding on image then it can be subdivided into blocks of 8x8 pixels. The DCT will be performed on each and every block of image. The coefficient of image are then reordered into 1-dimensional array in crisscross manner. The compression has two stages: first, during quantization, second: During the entropy coding process. Where the JPEG (Joint Photographic Experts Group) decoding will be reverse process of coding. We refer to M and N as the output images of two cameras will be compress in JPEG coding standard in sensor agent and they will be transmitted to fusion agent of VSN (Visual Sensor Network).

If we using the spatial domain methods images will be decoded and transferred to spatial domain. When we applying the fusion procedure on fused image will coding again in order to stored or transmitted to upper node.

The DCT domain will be reduced the complexity issue using two techniques are: DCT + Average and DCT + Contrast. In the DCT + Average is calculating the average of all dct coefficient of several images. In the DCT + Contrast, they will activated the level of contrast measure which calculated the 63 AC coefficients of blocks from the source images. Where, the contrast measures of every coefficient in source images are compared. Now the highest contrast value of coefficient is selected. The DCT (Domain Cosine Transform) block of output is made by the AC coefficient with highest contrast measures comparing and DC coefficient of every block of output average of DC coefficient to corresponding block in the source images. The contrast measure of every coefficient algorithm is complex.

In this reduce the complication of real time application and quality of output image, using image fusion technique in DCT domain. Where, the DCT coefficient is used to contrast activity measure of the variance of 8x8 block calculations. Then, CV (Consistency Verification) stage increase quality of fused image. The simulation result and comparisons of image quality improved and reduced the computation complexity.

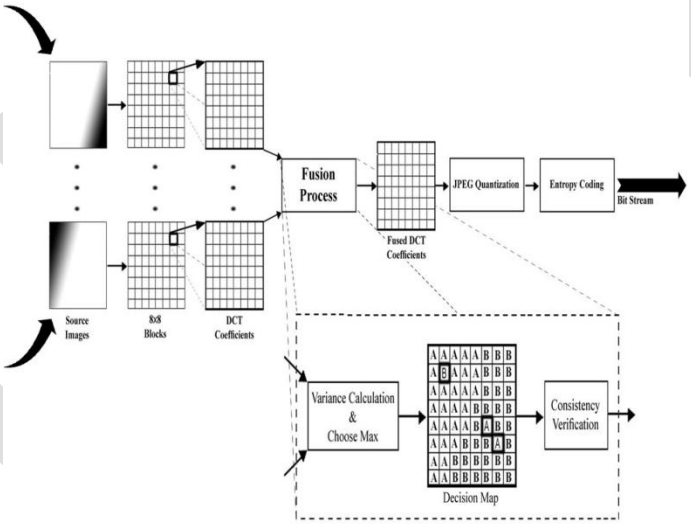

Figure: 4 "DCT Domain" [3]

The 2-D Discrete cosine transform of an image block f(x,y) of size N x N is given by equations:

$$F(u,v) = \frac{2}{N} c(u)(v) \sum_{y=0}^{N-1} \sum_{x=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)u\pi}{2N}\right]$$

$X \cos\left[\frac{(2y+1)v\pi}{2N}\right]$ (11)

where u, v = 0,1,....,N-1 and

$$c(u) = \begin{cases} \frac{1}{\sqrt{2}}, & if\ u = 0 \\ 1, & if\ u \neq 0 \end{cases} \quad (1)$$

The inverse transform can be defined as:

$$f(x,y) = \frac{2}{N}\sum_{v=0}^{N-1}\sum_{u=0}^{N-1} c(u)c(v)F(u,v)\cos\left[\frac{(2x+1)u\pi}{2N}\right]$$

$X \cos\left[\frac{(2y+1)v\pi}{2N}\right]$ (13)

where x, y = 0,1, …, N-1. Here F(0,0) is the DC coefficient and it corresponds to the mean value of that image block. The remaining coefficients are AC coefficients.

Figure: 5(a) [5] "Left Blurred Image"

Figure: 5(b) [5] "Right Blurred Image"

Figure: 5(c) [5] "DCT based image fusion"

The key step is to fuse the DCT Representations of multi-focus images into a single fused image. The input images are divided into blocks of size 8x8 and the DCT coefficients of each block is computed. Then the fusion rule is applied.

4. PCA (Principal Component Analyses)

PCA (Principal Component Analyses) is a well known scheme for extract and reduce the dimension for fused image. PCA is mathematical tool for transform a number of correlated variables into a many uncorrelated variables. PCA is a lot of used in image compression and image classification. The image fusion using PCA to achieve by weighted sum of source images, where the weighted is obtained by the normalized vector of the metrics of source images. It's useful in information is not only based at one pixel they will be also present the features like: size, shape, region and edge etc. The first principal component accounts they are maximum variance as possible along the direction. The second principal component is lying the subspace perpendicular of the first principal component. The third principal component has maximum variance direction in subspace perpendicular to first two and so on.

In this flow diagram of PCA based on image fusion, there are two input images (I1 and I2) arranged in column. Where the P1 and P2 are normalized components of source images. If is the fused image (IF) obtained by PCA normalized/ computed as: **IF = P1I1 + P2I2.**

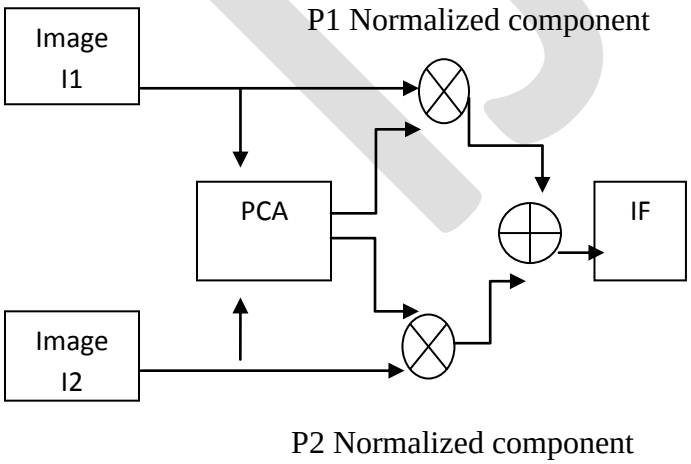

Figure: 6 "Flow diagram in image fusion scheme PCA"

Let us assume that X is a d-dimensional random vector that has zero is empirical mean. Let V be the Projection Vector which can be computed as $Y= V^T X$ with subsequent constrictions:

Covariance of Y(cov(Y)) is a diagonal. Inverse of V is equivalent to its transpose ($V^{-1}=V^T$). Applying matrix algebra,

$$cov(Y) = E\{YY^T\} \quad (2)$$

$$cov(Y) = E\{(XV^T)(V^T X)^T\} \quad (3)$$

$$cov(Y) = E\{(XV^T)(VX^T)\} \quad (4)$$

$$cov(Y) = V^T\, cov(X)V \quad (5)$$

MuItiply both sides of equation (4) by V. The following will be obtained:

$$V\, cov(Y) = VV_T\, cov(X)V = cov(X)V \quad (6)$$

Substitute equation (4) into the equation (5).

We obtain:

$$[\lambda_1 V_1, \lambda_2 V_2 \dots\dots\dots \lambda_d V_d] =$$

$$[cov(X)V_1, cov(X)V_2, \dots\dots\dots cov(X)V_d] \quad (7)$$

The following can thus be drawn from the above equations:

$$\lambda_i V_i = cov(X)V_i \quad (8)$$

where, i =1, 2, ... , d and V_i is an eigenvector of cov(*X)*.

Normalized components P_1 and P_2 are calculated from the obtained eigenvector value. The fused image is computed by equation:

$$I_f(x,y) = P_1 I_1(x,y) + P_2 I_2(x,y),y) \quad (9)$$

The covariance matrix C of X i.e. $C=XX^T$ mean of expectation = cov(X). Then calculate the eigen-vectors V and eigen-value D of C and sort them by decreasing eigen-value. Both V and D are dimension 2 x 2. Consider the first column of V which corresponds to larger eigen-value to compute P_1 and P_2 as :

$$P_1 = \frac{V(1)}{\sum V} \quad (10)$$

$$P_2 = \frac{V(2)}{\sum V} \quad (11)$$

Figure: 6(a) [5] "PCA based image fusion"

5. BWT (Biorthogonal Wavelet Transform)

BWT (Biorthogonal Wavelet Transform) multiresolution scheme using the pixel level image fusion. The coefficient of wavelet at different level decomposition of fused image using fusion rule. There are two important properties wavelet symmetry and linear phase of BWT because, there will be capable for preserve the information of edge and reduce the distortion in fused image. There performance will be multifocus and multimodal images free from any kind of noise. There algorithm will complex process for large number of any data, large number of memory space and they will be costly for real time image application. Where the BWT based properties used is linear phase and symmetry phase. The Biorthogonal wavelet system is designed to achieve the symmetry property and reconstruction by using wavelet filter FIR (Finite Impulse Response). The Biorthogonal uses separate the wavelet and scaling function for analysis image. It is decomposition and reconstruction of the source images.

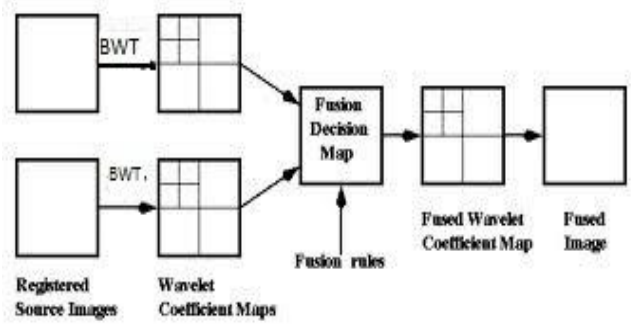

Figure: 7 "Biorthogonal Image fusion scheme"

The wavelet transforms w of the two registered input images I_1 (x, y) and I_2 (x, y) together with the fusion rule μ . Then, the inverse wavelet transform w^{-1} is computed, and the fused image I (x, y) is reconstructed:

$$I(x,y) = w^{-1}(\mu(w(I_1(x,y)), w(I_2(x,y))))) \quad (12)$$

Figure: 7(a) [5] "BWT based image fusion"

6. Literature Survey

The image fusion is used for the image processing system. There are various methods of image fusion have been proposed in the literature survey for reduce the blurring effect on images. The image fusion methods will enhance the quality of the image. There are three different levels of fusion that is pixel, features and decision. Its methods can be classified into: special domain fusion and transform domain fusion. These can be solved the problem for blurring effect in images. A brief verification of the literature is given below:

Parkash,O et al. (2013) [1] In this paper the author will be discuss that two methods of image fusion: first, spatial domain and second, wavelet domain. Parkash,O et al. (2013) [1] has shown that the multiscale wavelet decomposition is very effective for image fusion. The BWT produce better results and very applicable for useful information for image like: edge, lines, curves and boundaries.

Shaveta et al. (2014) [2] has discussed that the image fusion technique like: DCT, PCA. It has been shown that the DCT based method for image fusion very suitable and time saving in real-time system. But it has neglected the problem of noise by calculating the DCT domain due to integration of two images.

Desale, R.P et al. (2013) [3] explained that the image fusion is process of combining the useful information from a set of images into a single fused image, there resultant will be more informative and complete than any kind of input images. This paper has discussed that the formulation, process of flow diagram and algorithm of PCA, DCT and DWT based image fusion techniques.

Patil,U et al.(2011) [4] has focused on the image fusion algorithm using hierarchical PCA. The image fusion is a process of combining the two or more source images to get the informative (fused) image. PCA is a well know scheme for feature extraction and reduce the dimension of source images and fusion using wavelet and PCA fusion technique and carryout the performance of fusion methods using different quality measures for variety of data sets. PCA is a better for fusion of multimodal image.

Akbari et al.(2010) [5] has shown that the goal of digital image fusion is to merge the data from several images. They will be discuss the DCT based methods of image fusion is very suitable and time saving in the real time system using the on still image or video. It has been presented the variance calculation in DCT of multi-focus images. The quality has been improved and thus reduced the complexity of comparison with DCT based fusion techniques on multi-focus images is proposed. The source images are in JPEG format is more efficient. The method without CV (consistency verification) is a bit weak.

7. Conclusion

This paper has presented the related work on the different digital image fusion techniques. The objective of image fusion in multi-focus camera to get the useful information from fused image. One can use different method like: BWT, PCA, DCT. The DCT methods of fusion are proved that for more suitable and time saving in the real time system still pictures or videos. DCT will be efficient approach to calculate the DCT domain on multifocus images. In the existing literature it has been found that the issue of noise has been neglected in fused images. Noise may be introduced in focused images due to the integration of two or more source images. So, in future we will integrate image fusion techniques with some well-know filters.

8. References

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