Evaluating the Short Comings of Digital Image Fusion Techniques

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Abstract: This paper has presents a survey on the different image fusion techniques. The purpose of image fusion in multi-focus cameras to merge information from multiple images of the same landscape in order to deliver the multi focused image. Image fusion methods like discrete cosine transform are extra suitable and acceptable in real-time systems using DCT based standards of still image or video. This paper presents a well-organized approach for fusion of multi-focus images based on variance calculated in discrete cosine transform domain. The overall aim is to discover the gaps in existing literature and suggesting a suitable method to reduce the gaps of existing techniques.

Index Terms: *Image fusion, Multi-focus, Visual Sensor, DCT, and PCA.*

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1. Introduction

Visual sensor network [2] is a network of spatially distributed smart camera appliance able of processing and fusing images of a landscape from a variety of perspective into several forms further helpful than the single images. A visual sensor network may be a kind of wireless sensor system. The network usually consists of the cameras themselves, which have several local image processing, transmission and storage space potential, and perhaps additional central computers, where image information from many cameras is more fused. Visual sensor networks too offer a number of advanced services to the client so that the huge quantity of information can be refined into information of interest using specific queries.

The main dissimilarity between visual sensor networks and other kinds of sensor networks is the environment and quantity of data the single sensors obtain: mainly sensors, cameras are directional in their field of view, and they catch a huge quantity of visual information which might be partially processed separately of data from other cameras in the network.

2. Visual Sensor Fusion

Visual sensor fusion [3] is the merging of sensory image information or data obtain from sensory information from different origin such that the resultant data is in some perception superior than would be feasible when these origins were used independently. It means more perfect, more absolute, or more trustworthy, or refer to the outcome of arising sight, example stereoscopic vision.

Direct fusion is the fusion of sensor data from a set of heterogeneous or homogeneous sensors, soft sensors, and the past standards of sensor information, while indirect fusion uses information sources like previous information regarding the surroundings and human input.

3. Image Fusion

Image fusion [4] is a procedure of combining the related information from multiple images into a single image where the fused image will be more useful and accomplish than some of the input images. Image fusion means the combining of multiple images into a sole image that has the utmost information contented without producing facts that are missing in a given image. It is now probable to get information from multi-origin images to create a high class fused image with spatial and spectral information. The outcome of image fusion is a fresh image that keeps the most attractive information and characteristics of input image. Some conditions in image processing want high spatial and high spectral motion in a single image. In remote sensing, multi sensor fusion is used to attain high spatial and spectral motion by merging images from multiple sensors. The fused image can have balancing spatial and spectral resolution characters.

4. Adaptive Histogram Equalization

Adaptive histogram equalization is a computer image processing technique used to recover contrast in images. Adaptive histogram equalization is an excellent contrast enhancement for both natural images and medical images and other initially non visual images It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute lightness value of the image. In image fusion process, fusion process may degrade the sharpness of the fused image so to overcome this problem of poor brightness adaptive histogram equalization will be used to enhance the results further. We can say that adaptive histogram equalization

will come in action to preserve the brightness of the fused image.

Need of adaptive histogram equalization: Convert the reference image to cosine transform. Then inverse cosine transform is applied to reference image. When inverse cosine transform is applied then noise is occurred in fused image then adaptive histogram is applied to remove noise and color artifacts which will introduced due to transform domain method i.e. DCT

5. Image Fusion Technique

Fig 1.1(a) Right blurred image [1]

Fig.1.1 (a) is showing the right blurred image and fig.1.2 (b) is showing the left blurred image. The objective is to unite important information from various images into a single image that is more informative for both visual perception and computer processing

Fig 1.1 (b) Left blurred image [1]

A. Discrete wavelet transform

The discrete wavelet transform of image signals produce a non-redundant image representation; it can provide better spatial and spectral localization of image information as compared to other multi resolution representations. Therefore, the DWT based method has been popular widely used for image fusion. The basic idea of image fusion based on DWT is to perform multi resolution decomposition on each source image; the coefficients are then performed with a certain fusion rule. After that, the fused image is obtained by performing the inverse DWT (IDWT) for the corresponding combined wavelet coefficient.

$$\psi_{a,b,}\ (t)=\frac{1}{\sqrt{a}}\psi\left(\frac{t-a}{a}\right),(a,b\epsilon R),a>0$$

Fig 1.2 DWT based image fusion [1]

B. Discrete cosine transform

The technique uses a contrast measure as selection criterion to combine the several blurred images in a single good quality image. This contrast measure is based on the transformation of the image from the spatial domain to the frequency domain through the computation of the DCT. The DCT technique is a algorithm that work on the frequency domain. This technique divide the image in fixed size blocks in order to decide which source image should be selected to constitute the final resulting image. DCT is an important transformation used in digital image processing. DCT based image fusion are more suitable and time saving in real time system using DCT based standard of still image or video. DCT based fusion is one of the best applications of the DCT based algorithms.

DCT are important to application in engineering, science and image compress. For simplicity, DCT can convert the spatial domain image to frequency domain image. Contrast can be defined as the variation in luminance and/or colors between the pixels in an image, which makes scene objects more distinguishable. Strictly speaking, contrast is not directly related focus but it has a strong relationship with good quality in images. The technique uses a contrast measure as selection criterion to combine the several blurred images in a single good quality image. This contrast measure is based on the transformation of the image from

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the spatial domain to the frequency domain through the computation of the DCT.

Two dimensional DCT transform of an N×N image block f (x, y) [8] is given as

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

Where u,v= 0,1,….,N-1 and
The inverse transform is defined as

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

Fig 1.3 DCT based Image fusion [1]

C. Principal component analysis

PCA is a mathematical tool which transforms a number of correlated variables into a number of uncorrelated variables. The PCA is used extensively in image classification and image compression. The PCA involves a mathematical formula that transforms a number of correlated variables into a number of uncorrelated variables called principal components. It computes a compact and optimal description of the data set. The first principal component accounts for as much of the variance in the data as possible and each succeeding component accounts for as much of the remaining variance as possible. First principal component is taken to be along the direction with the maximum variance. The second principal component is constrained to lie in the subspace perpendicular of the first. Within this Subspace, this component points the direction of maximum variance. The third principal component is taken in the maximum variance direction in the subspace perpendicular to the first two and so on

Fig1.4 PCA based image fusion [1]

Output image taken by the DCT and PCA based image fusion with nonlinear enhancement. The image has contained the balanced color and brightness as the original images to be fused. The quality of output image is fairly superior with our proposed method with respect to all the techniques discussed.

Fig 1.5 Final proposed image [1]

6. Literature Survey

R. Amutha et al. (2014) [9]has analyzed that easy and well-organized multi-focus image fusion system clearly planned for wireless visual sensor systems prepared with resource constrained, hazardous setting like battlefields . The fusion of multi-focus images is based on higher valued Alternating Current coefficients calculated in Discrete Cosine Transform domain. Discrete cosine transform overcomes the computation and energy restriction of low power devices and is investigated in terms of image quality and computation energy. Simulations are performed using Atmel Atmega128 processor of Mica 2 mote to measure the resultant energy savings. It verify the significant efficiency

improvement of the proposed method in output quality and energy consumption, when compared with other fusion techniques in DCT domain

Vivek Kumar gupta et al. (2013) [10] has discussed that in remote sensing program the raising accessibility of space endured sensors provide motivation for different image fusion algorithms. Remote sensing image fusion design at integrating the information relay by data gained which hide different parts of the electromagnetic spectrum at different spatial, temporal and spectral determination; we can acquire multi-temporal, multi-resolution and multi-frequency image information for purpose of feature extraction, modeling and classification. The fused picture is much serviceable for human knowledge. Fused image is more useful for automatic computer analysis task for example feature extraction, segmentation and object recognition.

Om parkash et al. (2013) [11] has analyzed that the objective of image fusion is to bring applicable information out of two or more images of the same location into a single image which is much informatory and is more appropriate for human knowledge. Spatial domain based operations manufacture spatial distortions in the fused image. Spatial domain distortion can be completely managed by the use of wavelet transform based image fusion processes. Using absolute maximum fusion rule wavelet coefficients at distinct decomposing levels are fused. Two weighty attributes wavelet symmetry and linear phase of BWT have been took advantages (exploited) for image fusion because they are able to protect edge information. It has been proved that the wavelet transform method enhance fusion quality by reducing loss of important information usable in single images.

Mohammed Hossny et al. (2013) [12] has discussed that image fusion process combine multiple images into an individual informative image. Image fusion metrics have developed from image processing variance metrics. In Image fusion metrics: evolution in a nutshell the evolution of objective image fusion performance metrics and their subjective and objective validation. It explain in what manner fusion performance metric develop beginning with image dissimilarity metrics, its understanding into image fusion contexts, it restrict weighting element and the validation operation.

Kiran parmar et al. (2012) [13] has analyzed that the design is to enhance the image content by fusing images like computer tomography and magnetic resonance imaging images; magnetic resonance imaging provides high quality information on soft tissue whereas computed tomography provides superior information about heavy tissue. Fusing these two types of images generate a complex image which is more informative than other signals provided by an individual modality. Image fusion has become a usual operation used within medical diagnostics and therapy. Fast Discrete Curve let Transform using Wrapper algorithm based image fusion technique, has been execute, examine and compared with Wavelet based Fusion Technique. Fusion of images extract at different purposes, intensity and by different techniques helps doctor to withdraw the characteristics that may not be usually visible in an individual image by distinct modalities.

Rahul K Kher et al. (2012) [14] has discussed that the plan is to upgrade the image content by fusing images like computer tomography and magnetic resonance imaging images, so as to supply more information to the physician and clinical therapy planning system. The goal is to demonstrate the application of wavelet transformation to multimodality medical image fusion. This work protect the selection of wavelet function, the use of wavelet based fusion algorithms on medical image fusion of computer tomography and medical resonance imaging, execution of fusion regulation and the fusion image standard evaluation. The fusion performance is based on the root mean square error and peak signal to noise ratio.

Wang Xin et al. (2011) [15] has studied that image fusion based on Contour let transform will make a pseudo-Gibbs effect for the absence of translation invariance. We proposed a procedure which merge Contour let transform with image blocking fusion to explain this matter. There is a new fusion rule based on Contour let transform which was offer to get the beginning fused image. Source images and the initial fused image were separated into identical size image blocks. The source image pieces, which were much close to the corresponding beginning fused image pieces, were selected as the concluding fused image blocks. For the frontier segment between the clear segment and blurring one, the beginning fusion results were kept. It has been prove that this procedure can remove the image distortion appear from Contour let transform deficiency of translation invariance. The fusion effect is effective than the effect of image blocking and Contour let transform fusion methods.

Ujwala Patil et al. (2011) [16] proposed that combining two or more registered images of the identical location to obtain many instructive images is called image fusion. Principal component analysis is a popular strategy for feature extraction and dimension reduction. Image fusion algorithm merges pyramid and principal component analysis techniques and takeaway the quality analysis of hierarchical principal component analysis fusion algorithm without allusion image. There is a growing need for the quality

analysis of the fusion algorithms. We demonstrate fusion using wavelet and principal component analysis fusion techniques and takeout production analysis for these fusion techniques using dissimilar quality measures for variation of data sets and show that suggests image fusion using hierarchical principal component analysis is good for the fusion of multimodal imaged.

Dr.M.N.Giri Prasad et al. (2011) [17] has analyzed that almost all areas of medical detection are impacted by the digital image processing. When an image is processed for visual explanation, the human eye is decided how effectively a specific method works. Clinical application challenging Radiotherapy plan, for example, frequently benefits from the supportive information in images of different modalities. For medical identification, Computed Tomography issues the foremost information on denser tissue. Magnetic Resonance Image issues good information on soft tissue. Wavelet transform fusion is defined by considering the wavelet transforms of the certified input images jointly with the fusion rule. The inverse wavelet transform is calculated, and the fused image is reconstructed. Although wavelets split some ordinary properties, each wavelet has a distinctive image decompression and reconstruction characteristics that lead to different fusion results. However if a wavelet transform and a conventional transform like Principal Component Analysis transform is integrated, superior fusion outcome may be attained. The fusion results are correlated visually and statistically to display that wavelet integrated operation can upgrade the fusion outcome.

Ahmed Abd-el-kader et al. (2011) [18] has discussed that curve let transform is a newly-establish multi-scale transforms, which is further satisfactory for objects with curves. Image fusion means the merging images into an image that has the extreme information without creating features that are fictional in the particular images. Two well-known applications of image fusion are found; fusion of multi-focus images and fusion of multi exposure images. Fusion results were evaluated and balanced according to three measures of performance; the entropy (H), the mutual information (MI) and the amount of edge information (QABIF). The three performance measures have shown that the curve let based image fusion algorithm provides superior fused image than the wavelet algorithm.

Xing Su-xia et al. (2011) [19] has proposed that infrared and visible image fusion technology can upgrade the image difference, and increase the night eyesight effectual. The repeated infrared and visible images from the similar landscape were distorted by non-sub sampled contour let transform; follow the estimated mass averaged, high-frequency feature mechanism in accordance with the weighted of the regional standard deviation portion; then the fusion image is acquired by reverse non-sub sampled contour let transform; the fusion images were compare with the outcome acquired by Laplace transform, wavelet transform and contour let transform during a huge numeral of trails, and the strength examination was done through the noise experiment. Non-sub sampled contour let transform can attain superior fusion result, and high strength**.**

7. Gaps in Literature Survey

The related work on image fusion algorithms has shown that the most of existing algorithms are time consuming in nature and also degrades the brightness of the fused images. The main reason behind this is that the most of researchers have neglected one of the following or both:

1. No appropriate image enhancement technique is used to overcome the poor brightness of the fused image.
2. No transform domain method is used to speed up the fusion algorithms.
3. No method is considered for complex background images so it becomes difficult to fused images with complex background.

8. Conclusion and future work

The main objective of image fusion is to merge information from multiple images of the same landscape in order to deliver only the helpful information. The discrete cosine transforms (DCT) based methods of image fusion are extra fit and acceptable in real-time systems using discrete cosine transform based standards of still images. In future a well-organized approach for fusion of multi-focus images based on variance calculated in DCT domain is presented. This proposed work will integrate the higher valued Alternating Current (AC) coefficients calculated in Discrete Cosine Transform (DCT) domain based fusion with principle component analysis (PCA) and adaptive histogram equalization to reduce the color artifacts which will be introduced due to the transform domain method i.e. DCT. The fusion process may degrade the sharpness of the fused images so to control this problem adaptive histogram equalization will also be used to improve the results further.

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