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A REVIEW ON AN EFFICIENT MULTI-FOCUS IMAGE FUSION SCHEME BASED ON PCNN

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ABSTRACT:

This paper presents a study of different techniques of Multi-Focus Image Fusion based on Pulse Coupled Neural Networks. The different ways of fusion of images are discussed in detail along with its respective concerts such as edge, texture, better contrast and many application oriented approaches.

KEYWORDS: Multi-Focus, Image Fusion, PCNN

I. INTRODUCTION:

In applications of digital cameras, when a lens focuses on a subject at a certain distance, all subjects at that distance are sharply focused. The objects which are not at the same distance are out of focus and theoretically are not sharp. This is because of a finite depth of field. To obtain an image with every object in focus, an image fusion technique is required to fuse the images taken from the same scene under different focal settings. The fused image gives a better view for human or machine perception.

During the last decade, a number of techniques for multi-focus image fusion have been proposed. A simple image fusion method is to take the average of the source images pixel by pixel. In recent years, many researchers have recognized the multi scale decompositions (MSD) methods are very useful for image fusion. In MSD domain, the discrete wavelet transform (DWT) becomes the most popular and important MSD method in image fusion due to the fact that the DWT has many advantages, such as localization and direction. Relative to the DWT, the lifting wavelet transform (LWT) can overcome the shortcomings of wavelet.

Apart from the MSD discussed above, the fusion rules, i.e., selection principles for different subband coefficients are another key issue in the MSD-based image fusion algorithms. Pulse coupled neural network is a novel artificial neural network model. It has been efficiently applied to image processing in applications such as image segmentation, image fusion, and image recognition. It is characterized by the global coupling and pulse synchronization of neurons. These characteristics benefit image fusion which makes use of local image information. The value of single pixel in spatial or MSD domain is used to motivate one neuron. In addition, because each neuron has one input, usually multiple PCNN models are needed when applied to image fusion.

II. HISTORY:

From the review of related work and published literature, it is observed that many researchers have performed Image Fusion by applying different techniques like using multiscale decomposition method, discrete wavelet transform, Lifting Stationary Wavelet Transform, Non Subsampled Contourlet Transform, Principal Component Analysis, Pulse Coupled Neural Networks.

In order to effectively retain details and suppress noise, a multi-focus image fusion method based on Surfacelet transform and compound PCNN can be used. Surfacelet transform is used to decompose the original image into a number of different frequency band sub-images. Compound PCNN model is a combined model of PCNN and dual-channel PCNN which is to select the fusion coefficients from the decomposed coefficients. The fusion coefficients are decided by compound PCNN. The objective evaluation indexes show that this method is superior to the traditional image fusion methods. [Baohua Zhang, 2013]

Based on the PCNN model and contrast modulation method, a new multi-focus image fusion method is given. The characteristic of image region clustering enhances the veracity of contrast. Then using the normalization contrast modulation gets two fusion images. Finally, use local variance to get the new fusion image.The experiment indicates that the fusion image contains more information about the edge, texture and detail, and it has a better contrast. Compared with the common methods, the innovative method embodies better fusion performance in information, standard and average grads. [Xiaorui Wang, 2012]

For the fusion problem of the multifocus images of the same scene, a novel scheme is developed based on lifting stationary wavelet transform (LSWT) and a new

m-channel pulse coupled neural network (PCNN). In order to overcome the shortcoming of PCNN which is not convenient and economical for a real system, a new m-channel PCNN is used to fuse the subband coefficients of LSWT. The algorithm has been used to merge several sets of multi-focus images; both visual and quantitative analysis show that, comparing with conventional image fusion algorithms, it can provide a more satisfactory fusion outcome. [Zhaofei LI, 2012]

A novel image fusion algorithm based on orientation information measure and lifting stationary wavelet transform (LSWT) is given, aiming at solving the fusion problem of multi focus images. For choosing the low frequency subband coefficients, a new sum-modified-Laplacian (*NSML*) of the orientation information measure is proposed and used as the focus measure to fuse the low frequency subband. When choosing the high frequency subband coefficients, a novel feature contrast of the orientation information measure, which can effectively restrain the influence of noise and can be used as the activity-level measurement to select coefficients from the sharpness parts of the high frequency subimages, is proposed. Experimental results indicate that the given fusion approach cannot only extract more important visual information from source images, but also effectively avoid the introduction of artificial information. It significantly outperforms the traditional fusion methods in fusion multi focus clean images and multi focus noisy images, in terms of both visual quality and objective evaluation. [Huafeng Li, 2011]

Pulse Coupled Neural Networks (PCNN) have characteristics in accord with human vision properties, Non subsampled Contourlet Transform (NSCT) can overcome the lacking of Shift-invariance in Contourlet Transform. So NSCT was used associated with PCNN in image fusion algorithms to make full use of their characteristics. Original images were decomposed to get the coefficients of low frequency subbands and high frequency subbands. The coefficients of low and high frequency subbands were processed by a modified PCNN. Matching degree of original images and spatial frequency were defined and used respectively in fusion rules. Fusion image was obtained by NSCT inverse transformation. [Yu-rongGe and Xi-ning Li, 2010]

Medical image fusion plays an important role in clinical applications such as image-guided surgery, image-guided radiotherapy, noninvasive diagnosis, and treatment planning. In order to retain useful information and get more reliable results, a novel medical image fusion algorithm based on pulse coupled neural networks (PCNN) and multi-feature fuzzy clustering is proposed. It makes use of the multi-feature of image and combines the advantages of the local entropy and variance of local entropy based PCNN. The proposed image fusion method can better preserve the image details and robustness and significantly improve the image visual effect than the other fusion methods with less information distortion. [Xiaoqing Luo, 2012]

Image processing using Pulse Coupled Neural Network includes the theory and application of two cortical models: the PCNN (pulse coupled neural network) and the ICM (intersecting cortical model). These models are based upon biological models of the visual cortex and it is prudent to review the algorithms that strongly influenced the development of the PCNN and ICM. The PCNN is a neural network algorithm that produces a series of binary pulse images when stimulated with a grey scale or color image. [T. Lindblad, 2005]

The method of Image fusion using Multi resolution Approach combines the multi resolution transform and local phase coherence measure to measure the sharpness in the images. The performance of the fusion process was evaluated with mutual information, edge-association and spatial frequency as quality metrics and compared with Laplacian pyramid, DWT (Discrete Wavelet Transform) and bilateral gradient based sharpness criterion methods etc. The multi resolution transform along with the gradient information of the images to measure the strength and phase coherence which are the deciding factors in measuring sharpness of the image. [G Geetha and S. Raja Mohammad, 2012]

In order to evaluate the information of the input images with better quality of image, a new criterion is proposed to give better quality of image using PCA, by denoising and bilateral gradient based sharpness criterion that is evaluated using the gradient information of the images. Then the proposed method is further exploited to perform weighted aggregation of multi focus images. The experimental results show that the proposed method is better than the other method in terms of quality matrices like Mutual information, spatial frequency and Average difference. [Sukhdip Kaur, 2012]

A new region based multi focus image fusion method could be more meaningful than pixel-based fusion methods. The fusion process contains the following steps. Firstly, multi focus images are fused using the simple average method. Then the intermediate fused image is segmented using the normalized cut method. Then the two source images are segmented according to the segmenting result of the intermediate fused image. Finally, the corresponding segmented regions of the source images are fused according to their spatial frequencies. The proposed method is more robust to

misregistration or slight motion of the object than the pixel-based method. [Shutao Li and Bin Yang, 2008]

A novel contrast-based image fusion algorithm is given in the wavelet domain for noisy source images. Novel features of the proposed fusion method are the noise reduction taking into consideration the linear dependency among the noisy source images and introducing an appropriate modification of the magnitude of the wavelet coefficients depending on the noise strength. Results show that the performance of this fusion method is better than that of other methods in terms of several frequently-used metrics. [Rahman, S.M.M., 2010]

The variational models in pixel domain and wavelet domain are presented for fusion and denoising of noisy multifocus images. In pixel domain, the problem is formulized as minimizing a weighted energy function. The total variation is used as regularity constraint for noise reduction. A new family of weight functions for fusion is given that are based on the local average modulus of gradients and the power transform. In wavelet domain, the problem is formulized as shrinkage of weighted wavelet coefficients of source images. Weight functions are based on local average modulus of intra- and inter- scale wavelet coefficients and the power transform. The experiments are made to verify the effectiveness of the given fusion methods. [Wei-Wei Wang, 2008]

From the careful study of reported work, it is observed that a number of techniques for multi-focus image fusion have been proposed. To obtain an image with every object in focus, an image fusion technique is required to fuse the images. The purpose of image fusion is to combine information from multiple images into a single image that ideally contains all the important features from each of the original images. During the fusion process, all the important visual information found in the input images must be transferred into the fused image without introduction of artifacts.

Considering all these constraints regarding the need of Image Fusion, the research has been taken to design an efficient multi-focus image fusion based on pulse coupled neural networks.

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