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Image Enhancement using Image Fusion Techniques

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Abstract: Image fusion is the combination of two or more different images to form a new image by using a certain algorithm. Image fusion is a process of generating a single fused image using a set of input images which are assumed to be registered. Input images could be multi sensor, multimodal, multi focal or multi temporal .Image Enhancement is to process the input image in such a way that the output image is more suitable for interpretation by the humans as well as by machines. Image enhancement is used for improving the visual quality of an image. This paper presents a literature review on some of the image fusion techniques and image enhancement techniques. Comparison of all the techniques concludes the better approach for its future research

Keywords: Image fusion, Image Enhancement, image fusion techniques, image enhancement techniques

I. INTRODUCTION

Image Fusion is a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data Important applications of the fusion of images include medical imaging, microscopic imaging, remote sensing, computer vision, and robotics. Multisensor data fusion has become a discipline which demands more general formal solutions to a number of application cases. Several situations in image processing require both high spatial and high spectral information in a single image. This is important in remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is data fusion.

The paper is organized as follows. Section 2 illustrates the related works, followed, in Section 3, by the description of fusion levels. Section 4 presents the techniques of image fusion. Section 5 represent image enhancement. . Section 6 represents performance measures.

II. IMAGE FUSION TECHNIQUES

Image fusion method can be broadly classified into two groups –

A. Spatial domain fusion method
B. Transform domain fusion

A. Spatial Domain:

Spatial domain methods directly process the pixels of an input image. An expression for spatial domain processing is given by the equation shown below:

$$g(x,y) = T[f(x,y)] \qquad (1.1\text{-}1)$$

Here, f(x, y) is the original image, g(x, y) is the processed image and T is an operator over neighbourhood of (x, y). The principal approach in defining a neighbourhood about a point (x, y) is to use a square or rectangular sub image area centred at (x, y). Spatial domain filtering can be used for smoothing and sharpening purposes.

B. Frequency Domain:

Frequency domain image enhancement involves modifying the Fourier transform of the image [1]. In frequency domain methods the original input image is first transformed into frequency domain using 2D Fourier transforms. The image is then processed in frequency domain. Finally, the output image is obtained using 2D inverse Fourier transforms. The block diagram showing the main steps in frequency domain image processing is shown below:

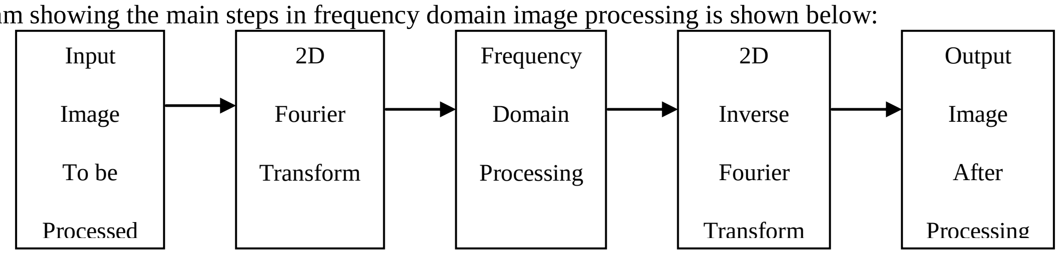

Figure 1.2 Frequency domain image processing

III. RELATED WORK

C. H. Hsieh et al. [2] presented an approach to detail aware contrast enhancement with linear image fusion. Two main stages are involved in this approach: the conventional histogram equalization (CHE) and linear image fusion (LIF).

X. Fang et al. [3] proposed a method to improve the enhancement result with image fusion method with evaluation on sharpness. Image enhancement can improve the perception of information

V. Vijayaraj, V. Younan et al. [4] proposed the idea of pixel level and feature level fusion. Co-registered QuickBird multispectral and panchromatic image data sets were used to analyze the advantages of pixel level and feature level fusion schemes.

C. Wang and Z. Ye [5] proposed a novel extension of histogram equalization, actually histogram specification, to overcome such drawback as HE. To maximize the entropy is the essential idea of HE to make the histogram as flat as possible

S. D. Chen and A. Ramli [6-7] proposed a generalization of BBHE referred to as Recursive Mean-Separate Histogram Equalization (RMSHE) to provide not only better but also scalable brightness preservation

Y. Wang, Q. Chen [8] presented a novel histogram equalization technique equal area dualistic sub image histogram equalization, is put forward in this paper. First, the image is decomposed into two equal area sub images based on its original probability density function

Y. T. Kim [9] proposed a novel extension of histogram equalization to overcome such drawback of the histogram equalization

D. Rajan and S. Chaudhuri [10] presented two new techniques of using data fusion, based on the modality of the data generation process, to generate a super resolved image from a sequence of low resolution image intensity data

IV. FUSION LEVEL

Image fusion can be performed roughly at four different stages: signal level, pixel level, feature level, and decision level. The concept of the four different fusion levels is described below:

- Signal level fusion: In signal-based fusion, signals from different sensors are combined to create a new signal with a better signal-to noise ratio than the original signals.
- Pixel level fusion: Pixel-based fusion is performed on a pixel-by-pixel basis. It generates a fused image in which information associated with each pixel is determined from a set of pixels in source images to improve the performance of image processing tasks such as segmentation.
- Feature level fusion: Feature-based fusion at feature level requires an extraction of objects recognized in the various data sources. It requires the extraction of salient features which are depending on their environment such as pixel intensities, edges or textures. These similar features from input images are fused.
- Decision-level fusion: it consists of merging information at a higher level of abstraction, combines the results from multiple algorithms to yield a final fused decision. Input images are processed individually for information extraction. The obtained information is then combined applying decision rules to reinforce common interpretation.

V. IMAGE FUSION TECHNIQUES

***A. SIMPLE AVERAGE*: -** It is a well documented fact that regions of images that are in focus tend to be of higher pixel Intensity. The value of the pixel P (i, j) of each image is taken and added. This sum is then divided by 2 to obtain the average. The average value is assigned to the corresponding pixel of the output image.

B. SELECT MAXIMUM:- The greater the pixel values the more in focus the image. Thus this algorithm chooses the in-focus regions from each input image by choosing the greatest value for each pixel, resulting in highly focused output. The value of the pixel P (i, j) of each image is taken and compared to each other.

C. FUSION USING PRINCIPLE COMPONENT ANALYSIS: The PCA image fusion method simply uses the pixel values of all source images at each pixel location, adds a weight factor to each pixel value, and takes an average of the weighted pixel values to produce the result for the fused image at the same pixel location. The PCA technique is useful for image encoding, image data compression, image enhancement, and pattern recognition and image fusion. It is a statistical technique that transforms a multivariate data set of inter-correlated variable into a data set of new uncorrelated linear combinations of the original variables. It generates a new set of axes which is orthogonal. By using this method, the redundancy of the image data can be decreased.

***D. MULTIRESOLUTION IMAGE FUSION*:** The IHS fusion converts a color MS image from the RGB space into the IHS color space. Because the intensity (I) band resembles a panchromatic (PAN) image, it is replaced by a high-resolution PAN image in the fusion. A reverse HIS transform is then performed on the PAN, together with the hue (H) and saturation (S) bands, resulting in an IHS fused image.

E. FUSION USING LAPLACIAN PYRAMID METHOD: The Laplacian pyramid fusion consists of an iterative process of calculating the Gaussian and Laplacian pyramids of each source image, fusing the Laplacian images at each pyramid level by selecting the pixel with the larger absolute value, combining the fused Laplacian pyramid with the combined pyramid expanded from the lower level, and then expanding the combined pyramids to the upper level.

F. FUSION USING GRADIENT PYRAMID METHOD: A gradient pyramid is obtained by applying a set of 4 directional gradient filters (horizontal, vertical, and 2 diagonal) to the Gaussian pyramid at each level. At each level, these 4 directional gradient pyramids are combined together to obtain a combined gradient pyramid that is similar to a Laplacian pyramid. The gradient pyramid fusion is therefore the same as the fusion using the Laplacian pyramid method except replacing the Laplacian pyramid with the combined gradient pyramid.

G. FUSION USING DISCRETE WAVELET TRANSFORMS METHOD: In the DWT-based fusion method, the source images are first transformed by DWT to their corresponding wavelet coefficient images at each scale level. Corresponding approximation coefficients and detail coefficients of the source images at each level are then fused, respectively, based on a certain fusion rule. This rule can be a simple addition or averaging, or a PCA-based weighted averaging. The fused approximation and detail coefficients at each level are used in the final reconstruction of a single output fused image by an inverse DWT.

H. EXPOSURE FUSION METHOD: In multi exposure fusion methods multiple snapshots of the scene under consideration are taken. Exposure fusion computes the desired image by keeping only the “best” parts in the multi-exposure image sequence. This process is guided by a set of quality measures, which we consolidate into a scalar-valued weight map. It is useful to think of the input sequence as a stack of images. The final image is then obtained by collapsing the stack using weighted blending. Quality measures are used for assigning weights. Many images in the stack contain flat, colourless regions due to under- and overexposure.

I. IMAGE ENHANCEMENT BY GRADIENT FUSION: This method is an extension of the method discussed Above. In this method a structure of the multiple images is calculated based on the gradient of the image and the Weight values described above. This structure tensor represents the geometrical information contained in the Multiple images and hence represents the edges of the desired image. The output fused image can be reconstructed from this structure tensor.

VI. IMAGE ENHANCEMENT

Image enhancement is to process the input image in such a way that the output image is more suitable for Interpretation by the humans as well as by machines. There are numerous techniques available in the literature for image enhancement depending on the specific application. Contrast enhancement by histogram equalization is one such technique. A histogram equalized image enhances the hard to perceive details of the original image. Nevertheless the original image contains useful information. As a result techniques like image fusion can be Used to preserve the details of both the images.

A. HISTOGRAM EQUALIZATION

The histogram of an image represents the frequency of occurrence of all the gray levels in an image. If n (k) is The frequency of kth intensity level and n is the total number of pixels in the gray-level image then the Normalized histogram is given by the equation

$$P(k) = n(k)/n$$

A disadvantage of using conventional histogram equalization (CHE) is it doesn't preserve the original brightness of the image.

VII. PERFORMANCE MEASURES

The performance - measures used in this paper provide some quantitative comparison among different fusion schemes, mainly aiming at measuring the definition of an image.

A. PEAK SIGNAL TO NOISE RATIO (PSNR):

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise That affects the fidelity of its representation

B. ENTROPY (EN):

Entropy is an index to evaluate the information quantity contained in an image. If the value of entropy becomes higher after fusing, it indicates that the information increases and the fusion performances are improved.

C. STANDARD DEVIATION:

It is the deviation about mean. It represents the dynamic range of values present in an image about the Mean.

D. AVERAGE GRADIENT:

It is used for measuring the clarity of the image

VIII. CONCLUSIONS

Image fusion is a component of data fusion when data type is strict to image format. Image fusion is an effective way for optimum utilization of large volumes of image from multiple sources A good fused image have both quality so the combination of DWT & spatial domain fusion method (like PCA) fusion algorithm improves the performance as compared to use of individual DWT and PCA algorithm but This method is complex in fusion algorithm. Required good fusion technique for better result. The fusion algorithm can be optimized for speed in future research. Future research can also be done to compare the performance of fusion algorithm on color images objectively.

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