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A Survey on Hybrid Function of Image Fusion and Super-Resolution Techniques

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Abstract:
The multiple source images of similar information by applying signal transmission and fusion techniques, which integrates with accurate information. The efficiency of the low quality input image resolution can be improved by a specific step called super resolution. A novel work flow of combining image fusion and super resolution depends upon the application of using signals with sparse representation. The sparse representation technique follows transforming and decomposing an input image into differentiated frequency components based on sub-band separation. Obtained image coefficients are fused with their respective high and low frequency components. A hybrid image with high resolution information is obtained by fusing the high and low frequency components,results an image for processing

1. Introduction

A single image of more information and limited error can be produced by fusing pixels of two or more images of a particular scene. Different images of the same scene can be perceived by using multiple sensors. The fused image will be represented in the format capable for computer processing. Image fusion can be performed by means of wavelet transform, complex wavelet transform, non subsampled contourlet transform etc.

Super resolution is the process of improving the resolution of an image. A high resolution image gives more information when compared with the low resolution image. Image interpolation is the most popular technique followed for improving the resolution of an image. Recently a neighbour embedding and learning based methods helps in the process of image super-resolution.

Traditionally, image fusion and super resolution are being performed separately, where the artefacts are carried out with the result. A process of sparse representation is introduced for applying image fusion and super resolution simultaneously. Sparse representation is the process of dividing the input images into patches and representing it in a sparse coefficient. Represented sparse coefficients are compared with the coefficients of an over complete dictionary and the assumed pixel will be replaced in the output image.

2. Methodology

Processing the image and gathering the hidden information from a noised or blurred image can be carried out by various methods. Various techniques such as image fusion and super resolution enhances the image quality to show the hidden information in processing the image.

A method of reconstructing a low resolution image into a high resolution through image interpolation is proposed by Lei Zhang and Xiolin Wu [6]. Images are separated based on pixels and regions. The pixels are processed by fusing the respected pixel of another image of a same scene. A method of pixel and region based processing is proposed by J.J Lewis, R.J. O'Callagan, S. G. Nikolov, D. R. Bull, N. Canagarajah [1]. An images with multifocal quality eg: image capturing foreground and background separately are fused by means of nonsubsampled contourlet transform is proposed by Q.Zhang, B.Guo[2]. An image fusion carried out by variable-weight fusion rule by taking fluorescent image and its corresponding phase contrast image, which shows the information clearly with its edges is proposed by T.Li, Y.Wang[3]. The multiscale directional bilateral filter and shift invariant image decomposition scheme is being used to fuse visible image and infrared image is proposed by Jianwen Hu, Shutao Li[4].

3. Analysis Of Different Algorithms and Techniques

3.1. An Edge Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion

Discrete Wavelet Transform (DWT) is implemented to both input image and the enhanced image, results in the decomposition of each input image. This is represented in the illustrations such as horizontal, vertical, and diagonal coefficients. The two decomposition levels are high and low levels. The DWT consists of different decomposition levels, corresponds to the same signal representation for each input signal. Only the same pixel values of the similar are fused. In image fusion, it is essential that the signal information from all the constituents are to be aligned and registered by combining the signals, since data fusion and the image classification refers to the same pixel locations. There is a problem in image fusion, as edge alignment mismatch in the fused outputs. This is significant in signals where the edges are different.

3.1.1. Advantages

- Image fusion is achieved with a greater correlation and the higher level of Mean Standard Deviation (MSD).
- Performance validation methods such as Root Mean Square Error (RMSE) detection and many other parameters validation are produced.

3.1.2. Disadvantages

- If the pixel values are get distorted, the exact image fusion cannot be achieved, so it depends on the pixel levels.
- It is wavelet transformation dependant. It depends on the change in pixel levels that contains pixel difference and classification.

3.2. Pixel And Region Based Image Fusion With Complex Wavelets

In numerous imaging cameras the face images acquire with higher resolution. Images are taken in the visible signals tend to have greater accuracy in the low light conditions. Thus, redundant images from a two pair of dissimilar sets can be fused together which can be termed to be fused image. This preserves all relevant images from the original data. Image fusion techniques can be termed to be at one of various categories such as pixel, signal, feature and symbolic level. At pixel-level, images are constructed by taking out individual pixel levels. Various classifications of pixel-based image fusion algorithms are proposed. A method of accomplishing feature level fusion is with a region-based morphological scheme. An image is segmented to produce a set of regional vectors. Various properties of these pixel levels can be accounted and used to determine features from which images are included in the morphological images. The techniques have advantages over pixel substituted algorithms in which intelligent fusion rules can be considered based on the normal features of the signals. Various fusion rules are based on combining groups of pixels, which forms the regions of an image. Thus, more useful tests for choosing the fused image, based on various properties can be implemented. The feature information extracted from the signals could be used to register the images. Region based fusion strategies could use estimation of object detection to track the fused features of frames to be quickly predicted from some fully fused frames.

3.2.1. Advantages

- DWT has greater accuracy. The wavelet transformation gives the exact location of image classification and the image registration.
- Fusion rules are of greater redundancy thus it reduces the sensitivity and noise dependency.

3.2.2. Disadvantages

- The evaluation factor mainly depends on the various image classification characteristics, so the root mean square deviation and other parameters depend upon the image used.
- The characteristics changes depend on the Ground Truth and the edge detection. The edges does not reach to the tolerance level.

3.3. Multi focus Image Fusion using the Non Sub-sampled Contourlet transform

A number of techniques for multifocus image fusion have been proposed during the last decades. A simplest approaches is to operate directly on input images, pixel-by-pixel, using operators such as the weighted averaging. This leads to many undesired effects such as loss of contrast. Many researchers have recognized that Multi-Scale Transforms (MST) are very useful for image fusion. The reconstruction of the fused image is done by taking an inverse transform. The decomposition levels of the reconstruction and the fusion rules are the needed components of MST-based image fusion algorithms. The commonly used MST methods includes the Discrete Wavelet Transform (DWT) and the Laplacian Pyramid (LP) transform. For one dimensional smooth signal, wavelets have been established, because it provides the representation for these signals. This is not the case of two dimensions. As a result of a separable extension from 1D base, two dimensional (2D) separable wavelets are good at isolating the discredited at edge points, but cannot effectively denotes the line and the curve discontinuities. Moreover separable wavelets impart only limited directional information, thus it cannot represent the directions of the edges accurately. The general fusion rule is the approximation level which denotes that the coefficients with standard and the absolute value are termed as the morphological multi-scale coefficients, while other coefficients are eliminated.

3.3.1. Advantages

- The sub-band separation depends on low pass, high pass levels,band pass and band stop levels thus it gives the greater amount of accuracy.
- Image fusion and the other morphological processes are carried out with basic and fundamental algorithms by identifying the physical parameters.

3.3.2. Disadvantages

- The sampled and non sampled algorithms can't give the detailed coefficient levels, so possibility of error occurrence and tolerance level can meet the desired level.
- The optical transfer function can't meet the requirements of the exact identification of the tolerance levels.

3.4. Biological Image Fusion Using A NSCT Based Variable-Weight Method

The Intensity-Hue-Saturation (IHS) method derives the gray image for the intensity component of the color image and thus handles the fusion of gray level and the color image. The implementation of the GIHS method from the traditional IHS method gives the specific location. It can be extended to some methods, such as, the Principal Component Analysis (PCA) method and similar IHS methods. Generally, color images are the combination of three monochrome channels labeled as RGB image (red, green, blue). They can be converted into IHS color space based on planar values, which is more consistent. The intensity component in the IHS space is termed as the mean average values of three channels in the RGB space. While the gray image and the color images are fused,their intensity components are denoted as IG, IC and IF respectively. An efficient multi-scale image representation forms the foundation of many image processing tasks, such as the compression, denoising and image fusion. The contourlet transform (CT) is the state-of-art of multi-scale analysis techniques. Aside from the true two-dimensional (2D) filtering for the image expansion, the flexible directional filtering is to capture the geometrical structure of the image. By allocating the redundancy and the invariance, leads to less sensitivity to the image shift can be targeted in the NSCT. Compared to the Counterlet Transformation, the Gibbs phenomenon suppress the coefficient modification to a great extent, since the interpolation of many filter techniques replaces the image decimation.

3.4.1. Advantages

- This method gives the exact estimation of the fusion rule as it is developed with the use of Neural Networking (NN).
- NSCT and Gibbs rules are more robust in nature.

3.4.2. Disadvantages

- Intensity based image fusion techniques depend on the contrast level. So, the acquisition level of images cannot be levelled and it fully depend on the level of contrast.

3.5. The Multi-Scale Directional Bilateral Filter and its application to multi-sensor Image Fusion

The goal of image fusion is to integrate features from two or more input images to the fused image. Three components of image fusion algorithm are detection, comparing and transferring the significant features of images such as edge detection, detailed coefficients and directions. The algorithm possesses preserving edges and capturing directional information. Hence, the technique can be employed to identify the important features. The brightness changes of the image is reflected in the edge and contrast of the images result in large variation. The brightness of the image has been changed to many transformation levels. Somehow, if the edge or object corresponds to a certain direction, the directional filter with the same direction gives large response. Thus, the transform values of this technique can be applied to measure the salient features and the largest absolute transform values in representing these features. This filter is constructed by combining the Multi-scale Bilateral Filters with non sampled level. This is firstly applied to the original image to obtain the detail sub-bands and the approximation sub-band.

Then, the detail sub-bands are fed into a NonSubsampled Directional Filter Bank(NSDFB) so that the direction information is captured. The combined scheme of shift-invariant are nonsubsampled. In addition, the Non Subsampled Contourlet Transform (NSCT), which has been employed for image processing applications.

However, compared with the NSCT, this method has the following advantages. Due to the pixel substitution levels of the filters changes, the multi-scale transform is adaptive. This acquires the better capturing of all the edges in a detailed manner. Next to that, there is no need to design the pyramid and the other filter techniques. At last, the reconstruction of the multi-scale transformation is simpler, which only needs the operation of additional factors and the other parameters.

3.5.1. Advantages

- The decomposition factors are of using many transformation levels such as Complex Wavelet transformation, discrete transformation and other morphological filters which leads to irregular regions.

3.5.2. Disadvantages

- The transformation techniques gives the fused images,but it cannot gives the detailed levels of pixels.

3.6. Image Decomposition via the Combination of Sparse Representations and a Variation Approach

The dictionaries leads to sparse representations for a wide family of signals. The decomposition level is incompatible because it does not perform sparse representation for the proper signals. There are inner connection between the instances and the quantitative experiments. The low validated images should be attributed to the poor performance in restraining the background, blurred in nature and very poor aspect ratio, information absence and the awful artifacts. Among the rules implemented under the Generalized Inverse Histogram Shifting frame, the IHS method replaces the intensity of images by contrasting the images based on the color levels. It can be inferred that the IHS method loses most luminance information of the images and assimilates the fused image to the phase contrast image more than any other methods, in which the substitution is performed partially.

3.6.1. Advantages

- The usage of Histogram technique and the sparse representation and the variance tolerance representation gives the hybrid function of the image fusion and the sparse representation
- Similarities can be identified easily based on the pixel substitution technique.

3.6.2. Disadvantages

- Histogram technique cannot meet the basic requirements of the Gibbs phenomenon, so the hybrid function cannot achieved with greater efficiency.

Title of the Paper	Objective	Methodology	Algorithm	Input	Output	Demerits
Multifocus image fusion using the nonsubsampled contourlet transform	Increasing depth of focus	Fusing multifocus images	NonSubSampled Contourlet transform	Camera images with different level focus	Focussed image	Computational complexity and high memory consumption
Biological image fusion using a NSCT based variable	Combining details of two or more images of same scene	Fusing images with variable weights	NonSubSampled Contourlet transform	Fluorescent image and its corresponding contrast image	Fused detailed image	Magnetic resonance image and positron emission Tomographic images cannot be used
Pixel-level image fusion with simultaneous orthogonal matching pursuit	Integrates image details from different scene	Fusing images to overlap patches in an image	Sparse Representation	Sensor Images	Enhanced information in the scene	Higher computational load
Super-Resolution Through Neighbor Embedding	High resoluted image	Improving resolution in a low resolution image	Super Resolution	Cell phone images	Super resoluted image	Resembles other learning methods
Image Super Resolution via Sparse Representation	High resoluted image	Improving resolution using sparse representation	Super Resolution, Sparse Representation	Surveillance Image	Super Resoluted image	Optimal dictionary size
Matching pursuits with time frequency dictionaries	Matching the signal structure	Extracting pattern from noisy signals	Matching Pursuit	Noisy Signal	Noise free signal	Classical algorithms do not converge
Learning Low-Level vision	Estimating scenes from images	Improving resolution and increasing details	Super resolution	Camera Image	Super Resoluted Image	Shaded images are restricted
An Edge Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion	Preserving edges in a super resolution image	Guiding edges in an image interpolated image	Image Interpolation	Digital Image	Super Resoluted Image	Output images virtually indistinguishable

Table 1: Analysis of denoising techniques

4. Conclusion

The performance of image fusion and super-resolution techniques are dependent on sparse representation. The proposed techniques avoids the generation of human artifacts produced by image fusion or super-resolution as in the traditional two stage process. Further, the complexity in computing the parameters is much easier than performing image fusion and super resolution separately. Studies on various types of input images exhibit the superiority in the proposed technique performing fusion primarily on the super resolution strategies based on interpolation and representation of sparse images. The sparsity assumption that fails to take the structure of the sparse images into concern. It will derive the particular structure of different sparse images and further improved the performance of image fusion algorithms. The hybrid function techniques of image fusion and super resolution techniques produces useful output and all the parameters are evaluated.

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