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SURVEY OF IMAGE FUSION ALGORITHM FOR ENHANCING THE QUALITY OF AN IMAGE AND ITS APPLICATION

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Abstract: Image fusion is a combination of two or more relevant images information and to form a single image. The final single image contain more informative than previous input images. Feature based image fusion is new area of research in the field of image fusion. The image fusion used lower content of image feature. The lower content of image feature such as color texture and dimension. The texture features are very important component of image. The processing and extraction of texture feature used various transform function such as wavelet transform function, Gabor transform function and many more signal based transform function. In the process of image fusion involve two and more image for the process of fusion. The fused image still image pervious quality as well as new feature and area of improved by new and adopted reference image.

Keywords: Image Fusion, Wavelet Transform, Swarm Optimization, Optimal Texture Feature

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INTRODUCTION

Computers have been widely used in our daily lives, since they can handle data and computation more efficiently and more accurately than humans. Therefore, it is natural to further exploit their capabilities for more intelligent tasks, for example, analysis of visual scenes (images or videos) or speeches (audios), which are followed by logical inference and reasoning. For we humans, such tasks are performed hundreds of times every day so easily from subconscious, sometimes even without any awareness. In computer vision applications, one of the challenging problems is the combining of relevant information from various images of the same scene without introducing artifacts in the resultant image. Since images are captured by the use of different devices which may have different sensors. Because of the different types of sensors used in image capturing devices and their principle of sensing and also, due to the limited depth of focus of optical lenses used in camera, it is possible to get several images of the same scene producing different information. Image registration is the process of systematically placing separate images in a common frame of reference so that the information they contain can be optimally integrated or compared. This is becoming the central tool for image analysis, understanding, and visualization in both medical and scientific applications. There are many image fusion methods that can be used to produce high-resolution multispectral images from a high-resolution panchromatic image and low-resolution multispectral images. Starting from the physical principle of image formation, Neural network and fuzzy theory is the two main methods of intelligence, the image fusion system based on these two methods of can simulate intelligent human behavior, do not need a lot of background knowledge of research subjects and precise mathematical model, But find the law to resolve complex and uncertainty issues on the basis of input and output data of objects. From these characteristics and the advantages, it can be seen that the use of the approach combined by neural networks and fuzzy theory can better complete the multi-sensor image pervasive fusion. Most of fusion algorithms for multispectral and panchromatic image such as: principal component analysis, contrast pyramid decomposition, IHS method, Brovey method, PCA method, wavelet transformation, Gaussian-Laplace pyramid, and so on.

2. LITERATURE SURVEY

Pixel-Level Image Fusion Scheme Based On Steerable Pyramid Wavelet Transforms Using Absolute Maximum Selection Fusion Rule.[1]

In this paper, author proposed a pixel-level image fusion scheme using multi resolution steerable pyramid wavelet transform. Wavelet coefficients at different decomposition levels

are fused using absolute maximum fusion rule. Two important properties shift invariance and self-reversibility of steerable pyramid wavelet transform are advantageous for image fusion because they are capable to preserve edge information and hence reducing the distortion in the fused image. Experimental results show that the proposed method improves fusion quality by reducing loss of relevant information present in individual images. For quantitative evaluation, they have used fusion metrics as fusion factor, fusion symmetry, entropy and standard deviation. They proposed a pixel level image fusion scheme using steerable pyramid wavelet transform. In the proposed method, two main steps have to be followed: one, the source images are decomposed into low pass and high pass sub-bands of different scale using steerable pyramid, and secondly, low pass sub band is divided into a set of oriented band pass sub-bands and a low pass sub-band.

The suitability of the proposed method is tested on multi focus and medical images. For this, they have presented two pair of images and their fusion results. The results are also tested on two different conditions; when images are free from any noise and other when they are corrupted with zero mean white Gaussian noise. From experiments, they observed that the proposed method performs better in all of the cases.

The performance is evaluated on the basis of qualitative and quantitative criteria. The main reasons to use steerable pyramid wavelet transform in image fusion are its shift invariance and rotation invariance nature. Further results show that the proposed method produces better results and applicable because steerable wavelet transform retain individual image information like edges, lines, curves, boundaries in the fused image.

Multispectral And Panchromatic Image Fusion Based On Genetic Algorithm And Data Assimilation.[2]

The framework of fusion based on data assimilation and genetic algorithm for multispectral and panchromatic image was presented. In the framework, Weights of indices of the various attributes were determined according to their important degree in the following processing; the objective function was composed of weights sum of various evaluation indices of image, then the objective function was optimized using genetic algorithm to obtain suitable images. Finally, the experiment about the fusions of panchromatic and multispectral image (Spot5, Quick Bird), prove the validity of this framework.

In this paper, the fusion framework based on data as simulation and genetic algorithm for Multispectral image and panchromatic image was presented. Data assimilation can combine

the advantage of model operator and observe operator. Our proposed method can integrate the advantages of DWT and HIS, construct object function according to successive application to satisfy the aim of adaptively adjustment of fusion parameters. Standard deviation and aver-age gradient are chosen as object function. In general, the higher the value, the better the texture information. And two experiments (Spot, Quick bird) validate this framework. The experiment results show that our proposed fusion frame-work is feasible.

A Comparative Analysis of Image Fusion Methods.[3]

In this paper author presents a comprehensive framework, the general image fusion (GIF) method, which makes it possible to categorize, compare, and evaluate the existing image fusion methods. Using the GIF method, it is shown that the pixel values of the high-resolution multi spectral images are determined by the corresponding pixel values of the low-resolution panchromatic image, the approximation of the high-resolution panchromatic image at the low-resolution level. Many of the existing image fusion methods, including, but not limited to, intensity hue saturation, Brovey transform, principal component analysis, high-pass filtering, high-pass modulation, algorithm-based wavelet transform, and multi resolution analysis-based intensity modulation (MRAIM), are evaluated and found to be particular cases of the GIF method. The performance of each image fusion method is theoretically analyzed based on how the corresponding low-resolution panchromatic image is computed and how the modulation coefficients are set.

This paper proposes a framework, the GIF method. Under different assumptions on how the LRPI is computed and how the modulation coefficients are set, many existing image fusion methods, including, but not limited to, IHS, BT, HPF, HPM, PCA, ATW, and MRAIM, are shown to be particular cases of the GIF method. The performance of each method is determined by two factors: how the LRPI is computed and how the modulation coefficients are defined. If the LRPI is approximated from the LRMIs, it usually has a weak correlation with the HRPI, leading to color distortion in the fused image. If the LRPI is a low-pass filtered HRPI, it usually shows less spectral distortion. If the modulation coefficient is set as a constant value, the reflectance differences between the panchromatic bands and the multispectral bands are not taken into consideration, and the fused images bias the color of the pixel toward the gray. Methods in which the modulation coefficients are set following the GIF method can preserve the ratios between the respective bands, give more emphasis to slight signature variations, and maintain the radio-metric integrity of the data while increasing spatial resolution.

"Medical Image Registration Using Genetic Algorithm" [4]

This paper author addresses the image registration problem applying genetic algorithms. The image registration's objective is to define mapping that best match two set of points or images. In this work the point matching problem was addressed employing a method based on nearest-neighbor. The mapping was handled by affine transformations. This paper presents a genetic algorithm approach to the above stated problem of mis-registration. The genetic algorithm is an iterative process which repeatedly modifies a population of individual solutions. At each step, the genetic algorithm selects individual at random from the current population to be parents and uses them to produce the children for the next generation. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Over successive generations population 'evolves' toward an optimal solution. The algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population.

"Frame Rate Up Conversion Based On Variational Image Fusion"[5]

This paper author presents a new framework for motion compensated frame rate up conversion (FRUC) based on variational image fusion. The proposed algorithm consists of two steps: 1) generation of multiple intermediate interpolated frames and 2) fusion of those intermediate frames. In the first step, we determine four different sets of the motion vector field using four neighboring frames. We then generate intermediate interpolated frames corresponding to the determined four sets of the motion vector field, respectively. Multiple sets of the motion vector field are used to solve the occlusion problem in motion estimation. In the second step, the four intermediate interpolated frames are fused into a single frame via a variational image fusion process. For effective fusion, we determine fusion weights for each intermediate interpolated frame by minimizing the energy, which consists of a weighted-L1-norm based data energy and gradient-driven smoothness energy.

"A New Method Of Image Data Fusion Based On Fnn"[6]

A new approach of image data fusion based on fuzzy neural network (FNN) is presented in this paper. Here, neural network is a parallel information processing model, there are more adaptive and self-organization, and can accomplish the complexity of real-time computing and mass data retrieval, it demonstrate its unique superiority of image understanding, pattern

recognition and the handling of incomplete information. In the new approach, fuzzy theory has the advantages such as: easy-to-understand, flexible and inclusive of non-precise data, as well as using expert knowledge and based on the natural language. The fuzzy neural network system developed by us has used in multi-sensor image fusion, proved that the fusion is fast, effective, good, and can meet the real-time requirements of ubiquitous computing. In this paper, author studied and designed image data fusion new method based on fuzzy neural network, and take it apply to the multi-sensor color image, found that the fusion algorithm combined neural network and fuzzy theory is fast and effective, can meet the requirements of real-time and accuracy in pervasive computing, we think it will play an important role in image pervasive fusion.

"Optimization Of Image Fusion Using Genetic Algorithms And Discrete Wavelet Transform"[7]

In this paper, author want to propose a fuse visual and thermal satellite images. In order to provide enhanced information, we have investigated techniques of image fusion to obtain the most accurate information. This paper presents a technique which will produce an accurate fused image using discrete wavelet transform (DWT) for feature extraction and using Genetic Algorithms (GAs) to get the more optimized combined image. The performance of the proposed image fusion scheme is evaluated with mutual information (MI), root mean square error (RMSE), and it is also compared to the fused image that is generated by using Pixel Level GA based Image Fusion (PLGA_IF) and Discrete Wavelet Transform based Image Fusion (DWT_IF) techniques. PLGA_IF, DWT_IF and the proposed DWT-GA_IF methods were discussed and compared. Simulation results conducted with DWT-GA_IF demonstrate that the proposed image fusion technique outperforms the existing image fusion techniques based on MI and RMSE. The simulation results show that DWT_IF is the most computationally expensive method while DWT-GA_IF is computationally inexpensive when compared to the investigated methods. The proposed technique is more accurate and improves in the aspect of information loss which is a drawback of many other techniques. When incorporating the feature extraction technique from DWT_IF as well as the efficiency from PLGA_IF, the results improve the accuracy of the fused image which could be beneficial to weather forecasting.

"An Improved Medical Image Fusion Algorithm Based On Wavelet Transform"[8]

In this paper, the traditional method of wavelet fusion is improved and a new algorithm of medical image fusion is presented. When choosing high frequency coefficients, the regional edge intensities of each sub-image are calculated to realize adaptive fusion. The low frequency coefficient choosing is based on edges of images, so that the fused image can preserve all

useful information and appears clearly. We apply the traditional and improved fusion algorithms based on wavelet transform to fuse images and also evaluate the fusion results. Experimental results show that this algorithm can effectively retain detail information of original images and enhance their edge and texture features. This new algorithm is better than traditional fusion algorithm based on wavelet transform. The edge and contour of the image target region is important, in the medical image, different edge represent boundaries of different tissues and organs. The improved fusion algorithm of multi-modality medical image based on DWT is presented in this paper. The high frequency and low frequency coefficients are studied respectively. This method prevent the average in fused proceeding, extract abundant information, important features and boundary information from source images. The experimental results show that the new method is very effective and provides good performance in fusing medical image, providing diagnosis information more accurately and effectively.

"Medical Image Fusion Algorithm Based On Clustering Neural Network"[09]

This paper author proposes a new image fusion algorithm based on clustering analysis for clinical image processing. According to the present image fusion algorithm, pixels of origin images are classified into clustering feature pixels and secondary pixels base on clustering analysis. Feature pixels have more useful medical information we need; secondary pixels have background information of the image. In the new algorithm, build different fusion rules on two types of pixels, rules of feature pixels base on partial gradient and rules of secondary pixels base on average gray. A great deal of experiments have done to testify feasibility of new algorithm, the result show fusion image has more information than origin images and improves the quality of the origin image, fusion image also protects characters of the image and heightens the visual impact, new algorithm is effective. The paper has proposed a new image fusion algorithm based on clustering analysis. The relative experimental results show that new algorithm outperforms simple algorithm for medical images. There is a positive correlation between entropy and average gradient. By using of this method, both reliability and visibility are achieved and the visual impact is enhanced. Therefore, the advantages of the proposed algorithm in this thesis are proved.

"Implementation And Comparison Of Image Fusion Using Discrete Wavelet Transform And Principal Component Analysis"[10]

In this Paper author considers two fusion techniques Discrete Wavelet Transform (DWT) and Principal Component Analysis, fusion methods for these two techniques has been proposed and also the effectiveness is compared. In DWT the two images to be fused are decomposed at different levels and their approximation and detail co-efficient are calculated, a fusion scheme is used to combine these co-efficient and then Inverse of DWT is taken to reconstruct the image. In PCA the principal components of the two images are extracted and a fusion scheme is proposed to fuse these principal components to reconstruct the image. Finally comparison of these two techniques is performed on the basis of some evaluation criteria and the decision has drawn that which technique is better. The principles of the merger have been around for many years, and the application of this technique is not limited to medical imaging. The military has used the fusion of infrared images from visible light to detect camouflaged targets. The daily weather report includes a satellite image merged with a geographic map. Fusion Software is like glue, bringing together images from multiple devices, including dual-mode scanners and PACS systems and now even planning systems for radiation therapy. The relationship between the software and hardware of the merger will become more intertwined in the future, and radiological practices only benefit from it. There are, of course, the limits of what is possible with any fusion methodology. The extreme differences between the imaging studies will always create problems. The use of (non-linear) deformable techniques introduces a degree of flexibility and expands the range of possibilities, but the fact is that the quality of the images fusion depends on the quality of the data being merged.

3. LIMITATION IN IMAGE FUSION

The main requirement of the fusion process is to identify the most significant features in the input images and to transfer them without loss of detail into the fused image. Depending on different fields of the applications, they have different objectives and goals for using image fusion: 1. Reduce noise, improve Signal–to–Noise-Ratio (SNR) by averaging pixel values over several images; 2. Improve spatial resolution (super resolution); 3. Extend the spatial domain, such as the mosaic algorithm; 4. Extend the image values qualitatively such as registration of the images for different spectral bands to a vector-values (multi-spectral) image; 5. Visualize high dimensional images (multi-and hyper-spectral) as false-color images; 6. Design fusions which are merged from different physical principles such as range image, thermal image, sonar image, and Ground Penetrating Radar (GPR), Ultra Sound Sensor (US), and X-ray image.

The object of image fusion is to obtain a better visual understanding of certain phenomena, and to introduce or enhance intelligence and system control functions. Many advantages of multi sensory data fusion such as improved system performance (improved detection, tracking and identification, improved situation assessment, and awareness), improved robustness (lessens or redundancy and graceful degradation), improved spatial and temporal coverage, shorter response time, and reduced communication and computing, can be achieved. The extent of the visual information contained in the input images that is preserved in the fused image is also a significant measurement of the image fusion performance.

4. SOFTWARE USED

To investigate the effectiveness of the method for image fusion based on wavelet transform function and particle of swarm optimization. We used MATLAB software 7.14.0 and some reputed image used for experimental task such as the name given head image, head CT image, head MRI image, Heart image and Hand image.

For the evaluation of experimental process used some standard parameter. There are different types of object quality or distortion assessment approaches. The fused images are evaluated, taking the following parameters into consideration. Root Mean Square error (RMSE).

5. APPLICATIONS

Pan-sharpening: remote sensors produce multi-spectral images with low spatial resolution and panchromatic images with high spatial resolution. Pan-sharpening is an image fusion application in which we generate a multi-spectral image with high spatial resolution by fusing together the multi-spectral and panchromatic images.

IHS Pan-sharpening: The most widely-used component-substitution pan-sharpening technique is based on the intensity-hue-saturation (IHS) transformation. This is, however, only used when the multi-spectral image has exactly three bands corresponding to the colors *R*, *G* and *B*. In the IHS transformation, the intensity *I* represents the total amount of the light in the image. An intensity image often has the appearance of a panchromatic image.

Ensemble Color Image Segmentation: This is an image fusion application in which combine several simple image segmentation algorithms to obtain a state-of-the-art image segmentation algorithm. The goal of image segmentation is to decompose the input image into a set of meaningful or spatially coherent regions sharing similar attributes. The algorithm is often a crucial step in many video and computer vision applications such as object localization or

recognition. A simple image segmentation is the *K*-means cluster algorithm in which we divide the pixels into *K* clusters.

STAPLE: Simultaneous Truth and performance Level Estimation: STAPLE (Simultaneous Truth and Performance Level Estimation) algorithm. This is a method for fusing together several segmented images and is based on the expectation-maximization (EM) algorithm. The STAPLE procedure uses the expectation-maximization (EM) algorithm to iteratively estimate the quality of the individual segmentations. The final segmentation is then computed with these individual segmentation qualities taken into account by weighting the decisions made by a reliable segmentation algorithm higher than ones made by a less reliable algorithm.

Biometric Technologies: biometric technology to be the automated use of physiological, or behavioral, characteristics to determine, or verify, an individual's identity and use the word biometric to refer to any human physiological, or behavioral, characteristic which possesses the properties such as Universal, Unique, Permanent, Collectable, Reliable, Acceptable, Non-circumvent able.

6. CONCLUSION

Image fusion can be defined as a combination of images from different sources (image sensors and cameras) aimed to obtain more informative or a more precise knowledge of the image. In other words, it is used to generate a result which describes the scene "better" than any single image with respect to relevant properties. In this paper we present the back ground details about the image fusion technology and limitation. We are trying to overcome the above limitation in image fusion using the feature based optimization technique also used feature selection and feature optimization process. The feature selection and feature optimization used particle of swarm optimization technique.

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