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Survey on Different Types of Images and Image Fusion Techniques

Mithila Gayatri M.
4th SEM, M.Tech, Computer Science, School of IT, JNTU-Hyderabad, Telangana, India

Abstract:
Image fusion is an image processing technique to combine two or more images of same scene with little dissimilarity to obtain much relevant image than the input images. Image fusion is a study which has undergone many evolutions since time; as such each case study contains different set of inputs and thus require different approaches of algorithm. This paper provides a literature survey on different types of images and image fusion process applied on them, along with a survey on types of color images taken for registration and their image fusion techniques. Widely accepted methods to perform image fusion are simple image fusion, pyramid decomposition based fusion, discrete transform based fusion. They are applied based on different input images and required characteristics in the output image.

Keywords: *Image fusion, fusion image models, discrete transform based fusion, pyramid decomposition based fusion, simple image fusion*

1. Introduction

Image fusion is an image processing technique to combine two or more images of same scene with little dissimilarity to obtain much relevant image than the input images. This method increases accuracy of the image, i.e. when two or more images are combined, the resultant image is much characterized and relevant. The new obtained image contains the characteristics of two former images under a single image. Image fusion is a study which has undergone too many evolutions since time, as such, each case study contains different set of inputs and thus require different approaches of algorithm. Image fusion is applied in various fields. They include remote sensing, satellite imaging, medical diagnosis, crime scene imaging, robotic vision, manufacturing industries, navigation and weapon detections, etc.; thus each case scenario has varied different types of image fusion algorithm and different image acquisition technique.

There are four steps of image fusion. In the first step, it includes acquiring for input images. This can be performed by capturing images in various ways. Second step involves the process of image registration. Third step includes the registered images to undergo process of algorithm and lastly, two resultant images are fused to obtain a single fused image, which contain higher characteristics in an image than initial input images.

For performing image fusion process, the input images can be taken under low light, noise, multi focused images etc. Thus they are characterized as multi view, multi focus, multi modal, multi temporal and restoration images. For different images there are different categories of fusion methods. For multi-view fusion, the images are taken from same modality and taken at same time but from different view points. Multimodal fusion images are taken with different sensors. Multi-temporal fusion of images are taken at different times in order to detect changes between them or to synthesize realistic images of objects which were not photographed in a desired time. Multi focus fusion images of a 3D scene taken repeatedly with various focal length. Fusion for image restoration includes fusion two or more images of same scene and modality, each of them blurred and noisy.

The levels of processing under image fusion are also categorized as feature level, pixel level, decision level and block level. Pixel level fusion is carried out on pixel by pixel basis where in each pixel is compared for obtaining resultant image. Decision level fusion process integrates information at higher level of abstraction, thus combines information to apply in various algorithms and resultant image is obtained. Block level fusion depends on neighboring fusion techniques. Feature level fusion operates on features of an image such as size, text, edge, pixel intensities, color ranges, etc.

2. Survey On Types Of Images And Their Fusion Techniques

In this paper, survey explains about different types of images and the type of fusion process which is applied on them. Basically, an image is formed as an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. In a grey scale image, each picture element has been assigned intensity that ranges from 0 to 255. Each pixel has a value from 0 (black) to 255 (white). In a true-color image assembled from three grey scale images colored red, green and blue. Such an image may contain up to 16 million different colors. For science communication, the two main color spaces are used which are RGB and CMYK.

The research work in this field is basically performed on gray scale and color images. Thus there different means to perform image fusion such as simple image fusion, pyramid decomposition based fusion, discrete transform based fusion. They are applied based on different input images and required of characteristics in the output image. Thus this paper provides a literature survey on different types of images and image fusion process applied on them.

Yong Yang [3] in his paper proposed method for multi-focus images. The fusion is performed by Discrete Wavelet Transform. His approach for multi focus images was to combine the coefficients of low frequency and high frequency sub bands separately and perform verification process. The performance assessment was done based on several conventional existing methods. The basic idea was to perform DWT on source images and treat the coefficients of low frequency and high frequency sub-bands separately and finally, a fused image is obtained by performing inverse DWT. Thus, this is the method applied by the author to perform image fusion on multi-focus images.

Vishnu Devi et al. [4] presented color image fusion for multi temporal images. In this approach, the authors aim was to recognize images of the same scene which were acquired at different times to evaluate changes in the scene or to obtain an image with less noise of the scene. Firstly, each of images was decomposed by 2-D discrete wavelet transform. At last, wavelet reconstruction is applied to synthesize one image which could contain more integrated accurate detail information.

Subitha V. et al. [5] presented fusion for multi resolution images. Multi-resolution analysis plays an important role in image processing, it provides a technique to decompose an image and extract information from coarse to fine scales. The color image fusion in this process is performed by integrating one or more color images to enhance clarity of the image. The application of color image fusion simplifies object identification and helps in better cognition. The author proposed a system of image fusion is done on color images by using the hybrid of Curvelet (CT) and Contourlet transform techniques. The proposed hybrid technique called Serial Contourlet Aiding Curvelet Transform (SCAC) is applied on color images. From the experiments performed, it was shown that the proposed technique works better than the single multi-resolution techniques in color images.

Manfred Ehlers [6] presented efficient processing technique for remote sensing programs such as Landsat, SPOT, MOS, ERS, JERS, and the space platform's Earth Observing System (Eos) which are based on a variety of imaging sensors that will provide timely and repetitive multi-sensor earth observation data on a global scale. Visible, infrared and microwave images of high spatial and spectral resolution will eventually be available for all parts of the earth. This paper discusses fusion techniques that have proved successful for synergistic merging of SPOT HRV, Landsat TM and SIR-B images. Examples are given for integrative rectification, enhancement of cartographic feature extraction and improvement of spatial resolution.

Karl G. Baum, et. al. [7] provided fusion for multi modal color images which are applied in many situations where it is desirable and advantageous to acquire medical images in more than one modality. In some situations a side by side comparison of the images provides enough information, but in other situations it may be considered a necessity to have the exact spatial relationship between the modalities presented to the observer. In order to accomplish this, the images need to first be registered and then combined (fused) to create a single image. Color tables are used to convert the grayscale MRI image and grayscale PET image to color images.

Peter Reinartz et al. [10] presented general fusion framework for multi-resolution, multi-sensor image fusion. Multi-resolution fusion are also known as pan sharpening which aim to include spatial information from a high resolution image to a low resolution image, while preserving spectral properties of low resolution image. Large number of algorithms and methods has been introduced to solve this problem. A general framework for image fusion has been introduced, which consists of three main steps: low image interpolation, fusion performed in Fourier/ spectral domains and finally histogram matching. Thus through experiments it has been confirmed to be suitable on some applications.

Richa Singh et al, [11] proposed fusion algorithm for multi spectral magnetic resonance imaging which are applied in field of medical science for capturing characteristics of brain images. Since DWT preserves different frequency images in stable form and allows localization in time and frequency domain, DWT has been used for many multi modal medical images. Thus, the author has investigated the utility of redundant DWT to fuse properties of different modalities in images.

Anish et al. [12], presented an survey on multi-focus image fusion methods. Multi-focus Image fusion is process of coalescing information of two or more images of a scene, where the resultant image thus obtained has a result *"all-in-focus"* image. The main intension of applying multi-focus imaging is to overcome problem of depth of field of cameras. The first step for all multi-focus image fusion algorithm is calculating the focus measure of the source images. For multi-focus image fusion, many distinctive focus measurements are used, for e.g. Histogram entropy(HE) method, Energy Of Image Gradient (EOG), Tenengrad, Spatial Frequency (SF) and Laplacian energy (EOL), M2 focus measure, SML, Grey-level Variance (GLV) ,DCT-Based focus measures, etc, which measure the variation of pixel frequency. Thus images are calculated and thus resultant fused image is obtained.

Ulrich Michel et al.[8], provided technique to combine spatial structure of high resolution of panchromatic image with spectral information of low resolution of multi spectral image to produce high resolution of multi spectral image. In this study, an IHS based fusion with adaptive filtering in the Fourier domain, can preserve the spectral
characteristics of the multispectral image also for multi sensor data. The fused images are compared visually and quantitatively to evaluate the spectral preservation and spatial improvement in the images.

Shaveta Mahajan et al [2], provided a comparative analysis general fusion techniques. In this paper an efficient approach for fusion of multi-focus images based on variance calculated in DCT domain is presented. This paper has presented related work on different image fusion techniques. The author describe that the main goal of image fusion in multi-focus cameras to integrate the information from several pictures of the identical scene in order to deliver only the multi focused image. An efficient approach for fusion of multi-focus images based on variance calculated in DCT domain has been presented. Thus, they have suggested for the use of filters in the process of image fusion, since they found that the existing literatures have neglected the problem of noise which will be presented in fused image due to integration of two images.

Anjali Malviya et al. [13], discussed in their paper on the goal of their image fusion process was to integrate complimentary multisensory, multi-view, multi temporal image into one new image. The objective of this papers aims at reducing redundancy in the output while increasing the characteristics of relevant information. Thus, the paper presented pixel based and region based fusion schemes. An area based maximum selection rule, and consistent verification steps were used for feature selection. The performance evaluation was performed based on objective metrics and results were found promising

3. Analysis and Conclusion

This paper has presented a survey on types of color images taken for registration and their image fusion techniques. Since image fusion does not comprise of a single algorithm; i.e, each application requires different approach. However, purpose of image fusion may vary, depending upon the resultant output. Thus, it is a challenging study. From the analysis made by above literature survey is that no fusion algorithm is self sufficient. There are many imaging technologies and thus different application. Depending upon the use of the given application, some users may wish a fusion outcome that would show more color details, some may desire more analysis or mapping; while some may want improved accuracy of application; and some others may wish for a visually beautiful and appealing fused color image, solely for visualization purposes. Hence, a combination of qualitative and quantitative assessment approach may be the correct way to find out which fusion algorithm is most appropriate for an application.

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