A Review of Different Techniques for Image Fusion

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Abstract— Image fusion is basically process of arranging data from couple of one or more image into single image. Main motive of this fusion is to protect all necessary and required information from each image used. The process of image fusion is basically applied to enhance the superiority of the input images. Till date the image fusion techniques were like DWT, DCT or pixels based are used. These techniques extracted some features of the image and then used them in future for fusion with other technique.

The author in this study provides a brief review to the terminology related to the process of fusion. This covers the basic information related to the image fusion, the various image fusion techniques such as DCT, PCA, Laplacian Pyramid and IHS etc. Along with this, the researches that has been done with image fusion is also included in this work. As the major objective of this study is to review the work that had been done in this domain with an objective to enhance the quality of final fused image.

Keywords— *Image processing, image fusion, Principal Component Analysis, Laplacian Pyramid.*

I. INTRODUCTION

With the progression in the technology, each and every field is switched to digitalization [1]. Hence increase in number of users leads to the induction in complications and faults in technology. Hence one of the solutions to these problems is image fusion. The principle of image fusion is to maintain the enrich section of the image. The meaningful information of the image can be preserved [2] by associating multiple images. On domain of the input images, there are no constraints or limitations. The input image can be related to multi focus, multi sensor or other domains [3].

Figure 1.1 Right Focused Image [4]

The image defines the example of image fusion. As there are two images which are not clearly visible, one is blurred from right angle and other is blurred from left angle.

Figure 1.2 Left Focused Image [4]

If we have both of the above shown images then ones have to save both of the images because the focus of both images is different to each other. To keep both of the images will lead to consume larger memory space. Moreover both of the images are incomplete also, as they contain some sort of irrelevant or noisy data in the form of obscure regions. The visual notion of above images is not clear. Hence the need of image fusion arises in this case. After combining the relevant segment of both of the images, the following fused image is obtained with striking or visible notion and worthwhile information [5].

Figure 1.3 Fused image [4]

In number of application cases, multi sensor data fusion has become a regulation which appeals more general formal solutions. In image processing it is mandatory to have both high spatial and high spectral information of an image. This is a pivotal requirement in remote sensing based applications [6].

I.   IMAGE FUSION TECHNIQUES

There are many techniques available for image fusion; some of them are as follows [7]:

a) DWT (Discrete Wavelet Transmission)

There is also development in the direction of wavelet based transformation with the enrichment in the technique of multi resolution analysis. The characteristics of wavelet based fusion techniques make it trendy among researchers [8]. This is an applicable technique for spatial and spectral prominence. While the operation of fusion, it specifically supports the devaluation of color exaggeration. The DWT is wavelets based image conversion technique, which implies on data vector that poses the length of integer power of two and convert it into the numerous distinct vectors of same length [9]. After modification, each component is analyzed and harmonized its resolution to its scale. This is also a frequency domain fusion technique.

a)   DCT(Discrete Cosine Transform)

It is a Discrete Cosine Transformation technique. It provides the better signal approximation on the specific coefficient values. Many algorithms use this technique for transforming the image and as well as for watermarking. The essential asset of this technique is that it has fast processing speed in comparison to other techniques [10]. In contrast to other image fusion techniques, DCT is found to be lossy image fusion mechanism.

a)   Laplacian Pyramid Image fusion technique

It works on the basis of pyramid structure. This structure contains the elements like blocks which are related to the various levels of the real image. The process of fragmentation is done by applying low pass filters which recursively filters the low level image. As the level moves upward the image become minor by preceding the length of the image.

a)   PCA (Principal Component Analysis)

It is a conversion method which converts the number of associated variables into the format of set of unassociated variable. It works effectively and efficiently in case of image compression and image classification. The conversion of associated variables is done with the help of mathematical calculations and functions. It leads to the succinct and best description of data set [11]. The function of PCA is implemented in the form of principal component.

a)   IHS Image Fusion Technique

It is a classic image fusion mechanism which works on the basis of three bands. Inherently it is based on the format of RGB true color space. The advantage of this technique is that it facilitates the admittance to the individual channel outline as name suggests I for intensity, H for hue and S for saturation [12].

II.   RELATED WORK

M. Prem Kumar (2011) [8], considering the issue of removal of impulsive noise from fused images a new technique has proposed. In the proposed technique, two images were fused together to form a single image and then a noise has been added to it. Hence, a hybrid filtering algorithm was introduced that combined the features to vector median and spatial median filters. The results were premeditated by considering the new non-references image quality assessment; GIQI i.e. Gradient based image quality index. The parameters were introduced to maintain the information resides in the fused image. The acquired result has been concluded that GIQI outperformed UIQI in case of non references image fusion.

Deepak Kumar Sahu (2012) [9], described a process of image fusion that collaborated set of images and formed a single image. The primary idea of collaborating set of images is to provide more enhanced as well as informative image. Various types of techniques are used for image fusion. This work provided a brief introduction to the concept of image fusion and its various techniques. The techniques which were covered under this study was primitive fusion which includes Averaging method, select maximum and select minimum, DWT, PCA etc. The work was concluded by comparing various techniques of image fusion.

R. J. Sapkal (2012) [10], implemented their work in medical field to fuse the medical images by using the wavelet based image fusion techniques. In first section, a brief description to the concept of image fusion along with its mandatory terms was defined. The idea behind the proposed work was to introduce the image fusion using multi resolution wavelet transform along with various preprocessing techniques. The proposed work was implemented in the medical field as this area is considered as decision taken regarding the health of patient based upon the generated images. Hence, the work was helpful to refine the imaging technology used in this area. The outcome of the proposed work showed that it was superior in comparison with previous because the generated fused image contained more affluent information.

Sunil Kumar Panjeta (2012) [11], when two images are collaborated into a single image by focusing various parts of the image then the process is known as image fusion. Hence fused image is combination of various informative parts of two images. The primary idea of image fusion is to acquire more informative as well as enhanced image. This study provided a comprehensive review over various applications of image fusion and its techniques.

S. Zebhi (2012) [12], implemented the compressive sampling and PCA for image fusion. Compressive sensing proved as a huge exhilaration in the field of image processing field. In case when the signal under acquirement are sparse then the CS act as a substitute to shannon/nyquist sampling technique. The proposed method was suitable for fusing the compressed sensing images. Initially, 2D DCT method was applied to the input images and then the output of these images combined with sampling filters hence this leads to the compressed image. After receiving the compressed image, the inverse of DCT was applied to the image. Therefore, a fused image was obtained by applying

PCA fusion method. Noisy and multifocus images can also used as input images. Then the results showed the efficiency and promising performance of proposed work from various aspects such as visually and numerically. The proposed work also reduced the computational time due to no recovery process in the technique.

VPS Naidu (2012) [13], analyzed DCT based image fusion techniques. According to the study there are six types of fusion algorithms that falls under this category. From the analysis, it has been concluded that fusion algorithms will not be able to work effectively if the selected block size for the image is less than 8×8 or if similar to the block size of the image itself. The performance efficiency of various DCT based image fusion techniques were evaluated in this research. The result proved that DCT and DCTmx based image fusion techniques are better than the other techniques as they are simple to use and less complex to implement.

Dr. S. S. Bedi (2013) [14], image fusion is a tool that is used for combining more than two images if those images are not clearly visible or lacks somewhere. After combining these images a single image is created which contains rich information and is a form of enhanced image. The image fusion is proved as a milestone in medical field. Various scans like CT scans, MRI etc can be more enhanced by applying fusion techniques to them. The fused images lead to relevant diagnosing decisions. Domain based image fusion techniques like wavelet based transformation, curve let based transformations are in trend due to their some key points. This paper conducted an analysis of various domain based transformation techniques to find out the best suitable one for medical images on the basis of quality parameter. The paper presented various research work done in this field over the time such as image fusion by using various techniques, performance of the various research work in the form of various parameters such as quality assessment, structural similarity index measure, absolute error, Laplacian MSE etc.

Kusum Rani (2013) [15], In order to generate a single meaningful image from multiple incomplete images the process of image fusion is implemented. There are large number of techniques is available for image fusion and all leads to the image which contains more reliable and informatory contents. The focus of this work was to review the uses of different techniques along with pros and cons of DWT and Discrete Multi wavelet techniques for multi resolution images. The prestigious properties of DWT make it popular among various researchers and the multi wavelet is an extension of scalar wavelet and overcome various disadvantages of scalar wavelet technique. The comparison was performed between DWT and DMWT to evaluate the efficiency of both techniques.

III.   CONCLUSION

The image fusion is one of the most prominent topics among the research work. This is such a vast domain that a lot of developments could be possible in this to enhance the quality of the fused image. This study comprised of variousimage fusion techniques and the traditional work that has been done in past. On the basis of the collected data in this work, it can be concluded that the process of image fusion can be enhanced by applying various image processing techniques that can helps to retain the original content or information to the final fused image.

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