APPLICATIONS OF IMAGE FUSION AND CHANGE DETECTION TECHNIQUES: A REVIEW

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Abstract: The Land use/ Land cover changes in urban areas, forest cover, coastal line and the surface of the earth is changing everyday due to natural and manmade causes. Change detection involves quantifying remarkable effect on multi temporal data set. Accurate change detection of different area is extremely important to promote better decision making. It can be detected from remote sensing images which is obtained at regular interval of satellite imaging by performing image fusion and change detection techniques. This paper reviews algorithms of various applications of image fusion and change detection techniques and their drawbacks. Although many algorithms were proposed, the results are inconsistent. Therefore, it is necessary to develop new algorithm for various image fusion and change detection and to remove the noises.

Index Terms **- Image fusion, change detection, multitemporal images, Applications.**

I.INTRODUCTION

Image Fusion is a process of combining two or more images into a single image. The resultant fused image will be more informative for visual perception .Change detection method is classified into supervised and unsupervised method which is used for processing the images. In supervised change detection, a training set are required for the learning process. These training sets are obtained from the ground truth data [1].In unsupervised change detection, the multi temporal images are needed and in this method no ground truth is needed [2]. The process of change detection is widely used in diverse domains like land use/cover change , motion detection, forest and vegetation dynamics , disaster monitoring , agricultural surveys, environmental monitoring, analysis of urban changes, medical diagnosis, remote sensing, video surveillance. A wide range of change detection techniques have been introduced in the literature. It is more important to focus on the unsupervised change detection than the supervised one due to the massive growth of the geographic database. At present, many unsupervised change detection techniques have been proposed. Some of them are image algebra, image classification, transformation of the multitemporal images. However, no existing approach is optimal and suitable to all cases, so it is always a big challenge to select a suitable algorithm for a specific application [3-5]

II. IMAGING TECHNIQUES

Based on how the input images are acquired, fusion techniques can be classified into 4 types.
2.1 Multi sensor image fusion : It combines the images taken by different sensors.
2.2 Multi temporal image fusion: It integrates the images taken at different times in order to detect changes between them.
2.3 Multi focus image fusion : It deals with 3D scene taken repeatedly with various focal lengths.
2.4 Multi view image fusion : It integrates the images from the same modality and same time but from different viewpoints.

III. APPLICATIONS OF IMAGE FUSION AND CHANGE DETECTION

3.1 Dry land cover area Image Fusion and Change Detection

The Discrete Wavelet Transform (DWT) is simple, more condensed, highly directional and provides unique information at each resolution and more suitable for image fusion process when compared with multiscale fusion. Kernel K-means clustering has been performed on the fused image for obtaining change detection map with more accuracy [6]. The multitemporal image fusion using Contourlet transform which has the property of multiresolution, localization, directionality anisotropy and local brightness, etc. and also provide edge preserving ,smoothness in a fused difference image. It will also remove shift variant which occurs in the fusion of images. Contourlet transform is better than discrete wavelet transform (DWT) for fusion. Fuzzy clustering for change detection map has been accomplished on the fused image to find out Percentage cross correlation (PCC) and accuracy [7]. When compared with nonsubsampled contourlet transform (NCT),dual-tree complex wavelet transform (DTC), and local entropy saliency model (LESM) , frequency tuned saliency detection method gives accurate region of changing with more informations

and less false alarms and better accuracy. The wavelet transform for fusion and frequency tuned saliency detection method are used for finding change detection map [8]. Stationary wavelet transform (SWT)for fusion decomposes the image into different sub band images and provides higher efficiency than Discrete Cosine Transform (DCT). In Discrete Cosine Transform (DCT), images are separated into number of blocks which has the low frequency information and the information loss is occurred due to averaging method. Probabilistic Neural network (PNN) which is simpler and low complexity has been used for change detection map. Performance was analyzed based on Peak Signal to Noise Ratio (PSNR) and Root Mean Square Error (RMSE) [9].

3.2 Wet land Cover area Image Fusion and Change Detection

Sparse fusion method is preferred for fusion of images and constrained k means clustering for change detection map. The computational time taken by the constrained k means clustering is less compared with fuzzy c means clustering and yields better result based on PCC and OE [10]. Modified Discrete Wavelet Transform (MDWT) based image fusion method is better on qualitatively and quantitatively when compared with pixel averaging DWT based fusion method. Fuzzy c means clustering algorithm gives the change detection map accurately and it is based on Percentage correct classification or Accuracy (PCC) and Kappa coefficient (Kc) [11].Cross-fusion method, which increases the accuracy of change detection and reduces the error detection, using Gram-Schmidt adaptive (GSA) algorithm is recommended for fusion of images and normalized difference index image method for obtaining change detection map [12].

3.3 Disaster Image Fusion and Change Detection

Smoothing Filter based Modulation (SFIM) technique gives good result compared with other techniques. Maximum likelihood classifier is used for change detection. Errors of Omission and Errors of commissions are calculated.(landslide) [13]. Decision level fusion for image fusion and support vector data description (SVDD) classifier which gives great flexibility and an acceptable level of accuracy (tsunami) are used for change detection map [14].

3.4 Forest Cover area Image Fusion and Change Detection

Dempster - Shafer statistical theory which is faster than cluster method and gives good results for fusion of images. Grey Level Co-occurrence Matrix (GLCM) method is efficient to find small changes in the forest cover and its features are used for change detection [15].

IV. ANALYSIS

There are many typical applications for image fusion and change detection. The Existing methods can be expandable for many applications like medical imaging, remote sensing, and video surveillance etc... In order to evaluate the fusion results obtained from different methods, the assessment measures are employed. Every technique has its own benefits and drawbacks. So further investigation is essential to sort out this issue. Most of the techniques are not focusing on the fused image noise. The Quality of the fused images will be reduced by the noises and it will lead to false image in the change detection. Hence, it is necessary to eliminate noises which are present in the fused images. In real life, the fusion techniques find many applications. But in the existing methods, the fused images are not stored properly. Proper storage is necessary for further retrieval of the fused image to reduce the processing time.

V. ASSESSMENT MEASURES USED

Various Image Assessment Measures were used in the review papers.

5.1 Root Mean Square Error (RMSE): It is the commonly used reference-based assessment metric. When the value of the RMSE is small, the fusion algorithm performance will be better. It is given by:

$$\mathrm{RMSE} = \sqrt{\frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\left(R(m,n) - F(m,n)\right)^2}$$

Were R (m, n) and F (m, n) are the reference (MR) and fused images respectively and M and N are image dimensions.

5.2 Peak Signal to Noise Ratio (PSNR): It is the ratio between the maximum possible power of a signal and the power of corrupting noise. When the value of the PSNR is higher, the fusion algorithm performance will be better. The PSNR of the fusion result is given by:

$$\mathrm{PSNR} = 10*\log10\ (255*255/\mathrm{MSE})$$

5.3 Entropy (EN): It is often calculated to measure the information content of the image. A higher value of Entropy display better fusion results. The entropy of an image is calculated using the formulae:

$$\mathrm{EN} = -\sum_{i=0}^{L-1} p_i \log_2 p_i$$

where L is the maximum intensity value for a pixel in the image (in this case 255) and p_i is the normalized histogram frequency of the fused image.

5.4 Standard Deviation (SD): It is often used to measure the contrast in the fused image. A higher value of SD represents that the image has a high contrast and vice versa.

5.5 Percentage correct classification (PCC): It identifies the overall accuracy of the proposed method by means of detecting the changed pixels as changed and unchanged pixels as unchanged.

VI. CONCLUSION

This paper covers various application for image fusion and change detection . It shows that, further experimental validation is necessary to improve the accuracy of the change detection map as the results were affected by noises and the fused images are not stored properly. For the primary impact factors, Selection of suitable change detection techniques is required. Accordingly, it is important to develop a new algorithm to eradicate noises in the fused image and to get a proper accuracy in the detection of changes.

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