Unsupervised Method for Change Map Generation

Harshada Mahulkar
ME(Computer Engineering)
Shah and Anchor kutchhi Engineering College
Mumbai, India
harshada.mahulkar@gmail.com

***Abstract*—** Change detection is the process of automatically identifying and analyzing region that have undergone spatial or spectral changes from multi temporal images. Detecting and representing change provides valuable information of the possible transformations a given scene has suffered over time. Change detection is used in several applications (eg. Disaster management, deforestation, urbanization, etc). In this paper a new unsupervised method for change map generation is proposed. Here two multitemporal images are taken as input. In the first step of the approach, absolute-valued difference image and absolute-valued log-ratio image is calculated from co-registered and radiometrically corrected multi-temporal images. These difference images are fused using Discrete Wavelet Transform (DWT). Then, min-mean normalization is applied to the filtered data. The normalized data is clustered into two groups using K-means clustering algorithm as changed pixels and unchanged pixels. To show effectiveness of proposed system, fused image data is given to Principal Component Analysis (PCA) and clustering is done using K-means algorithm. This result is compared with earlier process to show effectiveness of proposed system.

Keywords- *Unsupervised, change detection, DWT, PCA, k-means, Remote sensing, Image difference, image ratioing.*

*****

I. INTRODUCTION

In recent year, the vast improvement and availability of multitemporal satellite images give rise to enhancement as well development of various applications related to urbanization, environmental monitoring, land cover management. Change detection plays very important roles in such application. In Change detection, Supervised and Unsupervised learning mechanism are more prominently used. In past decade so many improvisation has been introduced in those methods. Supervised change detection is based on training set. Unsupervised mechanism is automated change detection process in which, training set is not required. Later approach is proposed in this paper. The change data are generated using following methods as image differencing, image ratioing, PCA, DWT, CVA. Most of the unsupervised change detection methods are developed using image differencing algorithm. Image differencing algorithm detects changes based on pixels by pixels subtractions, the new image obtained is called difference image. The computed difference image is such that the values of the pixels associated with land cover or land use changes present values significantly different from those of the pixels associated with unchanged areas. In this paper, an effective approach of unsupervised change map generation has introduced. In which difference image and ratio image is used. This two images are fused using DWT with various wavelets families. This fused image is clustered into changed and unchanged pixels data using k-means clustering algorithm.

Comparative measurements is done using another unsupervised method, in which fused image data features extraction is done using PCA, changed and unchanged pixels are clustered using k-means clustering algorithm. In Unsupervised method, difference image, PCA and k-means clustering is used [1] which generate change map. On other hand other methods like DWT, backtrack search algorithm [5] can be used. To calculate difference image in unsupervised methods, image differencing [1], ratioing[2], PCA, etc can be use[9].

II. PROPOSED METHODOLOGY

The proposed system approach is as follows:

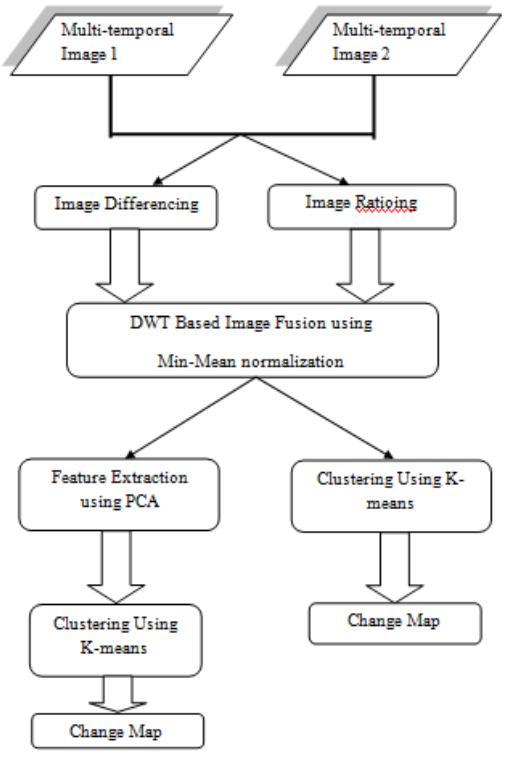

Figure1. Proposed approached

A. *Image differncing*

To calculate difference image using multitemporal input images, image differencing algebraic operation is performed. Using pixel level subtraction i.e.difference image. The computed difference image includes changed pixel and unchanged pixel data.

B. *Image Ratioing*

Image ratioing is used to minimize scattered effect in change detection process. In this process multitemporal images ratioing is performed.

C. *DWT*

The next steps is fused difference image and ratio image using DWT based on approximation coefficient and details coefficient. Images are merged from wavelet decompositions at level 5 using db1,db2,db3,db4,db5,db6,db7,db8,db9,db10 and haar by taking two different fusion methods: fusion by taking min for approximation and mean for detailing.

D. *PCA*

Feature vector space is created using PCA. PCA (Principle Component Analysis) is defined as an orthogonal linear transformation that transforms the data to a new coordinate system such that the greatest variance comes to lie on the first coordinate, the second greatest variance on the second coordinate and so on. Each Coordinate in Principle Component Analysis is called Principle Component.

E. *Clustering Algorithm*

Clustering will segregate data into changed and unchanged pixels. K-means forms clusters using same principal.

Algorithm for K-means clustering is as follows:

1. Randomly select ‘c’ as cluster
2. Calculate distance between each data point and cluster center ‘c’.
3. Assign data point to each cluster near by ‘c’.
4. Number of times to repeat the clustering, each with a new set of initial centroids. A positive integer.
5. Recalculate the distance between each data point and new obtained cluster centers.
6. No data points was reassign then stop else repeat step 3.

III. EXPERIMENTATION AND RESULTS

Four sets of multitemporal images are taken which includes Alabama, Sao Paulo, Bangladesh and synthetic images.

Step 1 : Image differencing : first image is subtracted with second image.

Step 2 : Image Ratioing : Multitemporal image division is performed.

Step 4: Image Fusion : Fused difference image and ratio image with DWT, five – level DWT is applied on the both images.

Step 5 : PCA and K-means : Clustering formation is done on fused image. On other hand feature extraction is done on fused image and then clustering is performed.

Step 6 : Change Map: Changed pixels and unchanged pixels data is clustered using k=2.

As shown in figure 1 and figure 2, change map is calculated as shown. Fig. A1 change map generated using DWT, K-means method with k=2 and Fig. B1 change map is generated using DWT, PCA and K-means with k=2. Similarly, Fig. C1 is change map generated using DWT and k-means clustering. Fig D1 change map is generated using DWT, PCA and k-means. Fig. E1 is change map generated using DWT and k-means clustering. Fig F1 change map is generated using DWT, PCA and k-means. Fig. G1 is change map generated using DWT and k-means clustering. Fig H1 change map is generated using DWT, PCA and k-means.

IV. PERFORMANCE EVALUATION

To calculate performance evaluation ground truth needs to be established using absolute-valued difference between image 1 and image 2. The resulted binary change detection mask can be obtained. Following defined quantities are used to compare change map agiant ground truth map.

True positive (TP), False positive (FP), True Negative (TN), False negative (FN), Correct classification (PCC)[21].

TABLE I. PERFORMANCE EVALUATION OF PROPOSED METHOS

Multitemporal data set	Actual no. of change Pixels	Calculated no. of change pixels	TP	FP	TN	FN	PCC (%)
Alabama Tornado Path DWT+ k-means	376847	440406	376747	63659	43753	63559	76.773 %
DWT+PCA +k-means	376847	557946	376847	181099	43753	181099	53.730 %
Saopaulo DWT+k-means	2992112	870186	870186	0	1312342	2121926	50.704 %
DWT+PCA +k-means	2992112	607179	607179	0	1312342	2384933	44.594 %
Bangladesh Flood (haar) DWT+kmeans	6771877	568836	568836	0	3308123	6203041	38.462 %
DWT+PCA +k-means	6771877	606162	606162	0	3308123	6165715	38.83 %
Synthetics images DWT+k-means	6868913	590502	590502	0	3637327	6278411	40.241 %
DWT+PCA +K-means	6868913	643110	643110	0	3637327	6225803	40.742 %

V. CONCLUSION

In the proposed methods , five level discrete wavelet transform (DWT) is applied on difference image and ratio image, which are used to fused for further processing. In fused image PCA and k-means clustering algorithm is applied which clustered data into changed pixels and unchanged pixels. Based on the result DWT and PCA based unsupervised change detection shows improvement and enhancements for future.

ACKNOWLEDGMENT

My sincere thanks to Mr. Pankaj Choudhury, MD(i-free India, Mumbai), for supporting me in my project.

REFERENCES

[1] Turgay Celik, "Unsupervised Change Detection In Satellite Images Using Principal Component analysis and k-Means clustering", IEEE Geoscience and Remoete Sensing Letters VOL.6 NO.4, OCTOBER(2009).

[2] Francesca Bovolo, Member, IEEE, and Lorenzo Bruzzone, Senior Member, IEEE, "A Split-Based Approach to Unsupervised Change Detection in Large-Size Multitemporal Images: Application to Tsunami-Damage Assessment", IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 45, NO. 6, JUNE 2007.

[3] Lorenzo Bruzzone, Member, IEEE, and Diego Fernàndez Prieto, Student Member, IEEE, "Automatic Analysis of the Difference Image for Unsupervised Change Detection" , IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, VOL. 38, NO. 3, MAY 2000.

[4] Richard J. Radke, Member, IEEE, Srinivas Andra, Student Member, IEEE, Omar Al-Kofahi, and Badrinath Roysam, Member, IEEE, Student Member, IEEE," Image Change Detection Algorithms:A Systematic Survey", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 14, NO. 3, MARCH 2005.

[5] Ataseve, Civivioglu, Besdok, Ozkan, "A New Supervised Change Detection approach Bassed On DWT Image Fusion and Backtracking Search Optimization Algorithm for Optical Remote Sensing Data", The International archives of the Photogrammerty, Remote Sensing and Spatial Information Science, VOL XL-7,2014.

[6] Turgey Celik, Zeki Yetgin, "Change detection without image computation based on multiobjective cost function optimization", Turk J Elec & Comp Sci, Vol.19, No.6,2011.

[7] Civicioglu, Atasever, Ozkan, Besdok, karkinli, Kesikoglu, "Performance Comparision Of Evolutionary Algorithms For Image Clustering", ISPRS Technical Commisiion VII Symposium, 29 Sep- 2Oct 2014, Istanbul, Turkey.

[8] K. Singh, Akansha Mehrotra, M.J.Nigam and Kirat Pla, "Unsupervised Change Detection from Remote Sensing Images Using Hybrid Genetic FCM", IEEE Trans, 2013.

[9] Singh, A., 1989. Review Article Digital change detection techniques using remotely- sensed data. International Journal of Remote Sensing 10, 989–1003.

[10] Abhishek Bhatt, "Seminar on a Review of Change Detection Techniques", [online], http://www.slideshare.net/abhishekbhatt/a-review-of-change-detectiontechniques [Accessed : December 2014].

[11] MathWorks[Matlab]

[12] Wikipedia

[13] Lehigh University,"Investigation of Image Fusion", Electrical Engineering and Computer Science Department, [online], http://www.ece.lehigh.edu/SPCRL/IF/image_fusion.htm [Accessed:2015].

[14] "k-means clustering", [online], http://www.onmyphd.com/?p=k-means.clustering&ckattempt=2 [Accessed: 2015].

[15] A.K. Jain, M.N.Murty, P.J. Flynn, "Data Clustering : A Review", ACM Computing Surveys, Vol. 31, No. 3, September 1999.

[16] Mu-Yu Lu, "Clustering Algorithms", [online], https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&cad=rja&uact=8&ved=0CEcQFjAGahUKEwim6q-s_bfIAhUFkJQKHVl6BSg&url=http%3A%2F%2Fwww.cs.sjsu.edu%2Ffaculty%2Flee%2Fcs157b%2FMu_Yu_Lu_Clustering_Algorithms.ppt.

[17] "A Tutorial on Clustering algorithms", [online], http://home.deib.polimi.it/matteucc/Clustering/tutorial_html/index.html [Accessed:2015]

[18] "clustering k-means example", [online], http://mnemstudio.org/clustering-k-means-example-1.htm [Accessed 2015].

[19] Sebastian Raschka, "Implementing PCA". [online], http://sebastianraschka.com/Articles/2014_pca_step_by_step.html, [Accessed 2015].

[20] Nasa image gallery, [online], http://www.nasa.gov/multimedia/imagegallery/index.html [Accessed:2014]

[21] Rekha Jadhav, 'Advanced Change Detection in Satellite Images using DWT', IJRTE, vol-3, Isssue-5, November 2014.

ISSN: 2321-8169
6699 - 6702

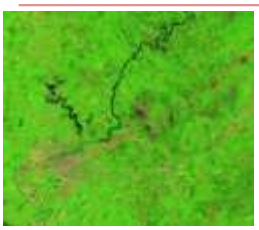
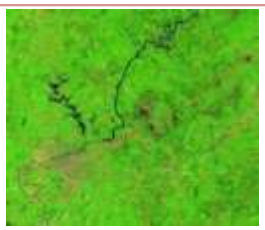

Fig. A. Fig. B Fig. C Fig. D

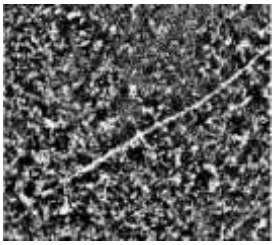
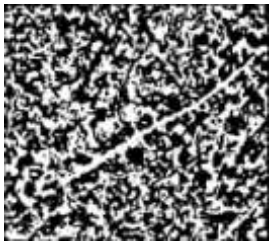

Fig. A1 Fig. B1 Fig. C1 Fig. D1

Figure 1. From clockwise A and B are images of Abama forest change area with respect to time 2000and 2011 , C,D are images of Saopaulo taken in year 1986 and 2013, A1,B1,C1 and D1 are change map obtained.




Fig. E Fig. F Fig. G Fig. H


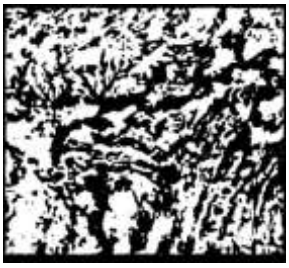

Fig. E1 Fig. F1 Fig. G1 Fig. H1

Figure 2. clockwise E and F are images of Bangladesh area taken in year 2012 and 2014, G,H are images of Synthetic images taken in 2015 with different time stamp, E1,F1,G1 and H1 are change map.