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# Change Detection in SAR Images Based on FCM with Modified MRF Approach

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**Abstract:** This study proposes the change detection in syntactic aperture (SAR) images by using the Fuzzy C-Mean (FCM) clustering with the modified Markov Random Field (MRF) energy function. With the application of these methods the changed and unchanged regions can be identified. This approach works based on two important functions such as reducing noise in the image and modifying the membership functions for every pixels concerned. For reducing the effect of speckle noise and change detection, the proposed approach used to modify the objective function behalf of membership function where as the objective function is just returning the normal form of the FCM. By using like this, we will get the less consuming time that by recently improved FCM algorithm. The proposed method efficiently detecting the changes in the SAR image and the testing results proves that, the proposed method outperforms the existing implementations.

**Key words:** Fuzzy C-mean, Differentiate Image (DI), component, function, membership, approach

## INTRODUCTION

The image are acting very important role in the human life, like the image concepts are used by the camera, medical applications and the satellite. The satellite images have the change in each and every area. The satellite has been taken the images on the earth by using the satellite images only, we will come to know that where, the changes were taken place. For the two registered SAR images of the same area which was taken place at different time, we will come to know where the changes are taken place at different times. The procedure of the change detection in SAR images are divided in to three steps namely image pre-processing, generation of a Difference Image (DI) from multi temporal images and analysis of the DI. Where in the first step, we are going to do take the 2 SAR images of different time of the same size (coordinates should be same). The second and third step, we are going to operations on the both image where, it is important to remove the speckle noise in the image because the SAR image was having the noise in that image first going to remove the noise in the image. The noise free image was easy to find the change detection process. To overcome the defect inherently characterizing in SAR images in many literatures, researchers have tried to utilize different kinds of algorithms to reduce the corruption of the speckle noise. In the DI-generation step, the log-ratio operator and mean-ratio operator is often used because of its robustness and non sensitiveness to speckle noise. The standard FCM algorithms has function that is related to the membership and dissimilarity are going to minimized in each loop processes, the function that is usually going to refer as the objective function.

Being able to retain more information from the original image, FCM having the robust characteristics for ambiguity, the standard FCM algorithm is very sensitive to noise since, it is considering no information about spatial context.

**Literature review:** The image change detection of the SAR image was used to find the changes in the same area at different time taken. The image changing detection was used in the many concepts like video surveillance, tracking of moving objects and motion estimation. In (Gong *et al*., 2012), the approach is based on the formulation of the unsupervised change detection problem in terms of the Bayesian decision theory. Bruzzone and Prieto (2002), MRF was used to model the spatial context information considering for the change detection map is generated. Nielsen (2007) a novel automatic and unsupervised change-detection approach is presented. This method is based on a closed-loop process of preprocessing, comparison, analysis of change detection map. Bazi *et al.* (2005), a multisensory multivariate gamma distribution for detecting the SAR images is presented. Bovolo and Bruzzone (2005), similarity measure for automatic change detection in multitemporal SAR images is proposed. The images of two different dates are taken and by using the cumulated-based series expansion the changes between images are detected.

## MATERIALS AND METHODS

**Proposed system:** The architecture of the proposed system is shown in Fig. 1. The image supposed to be

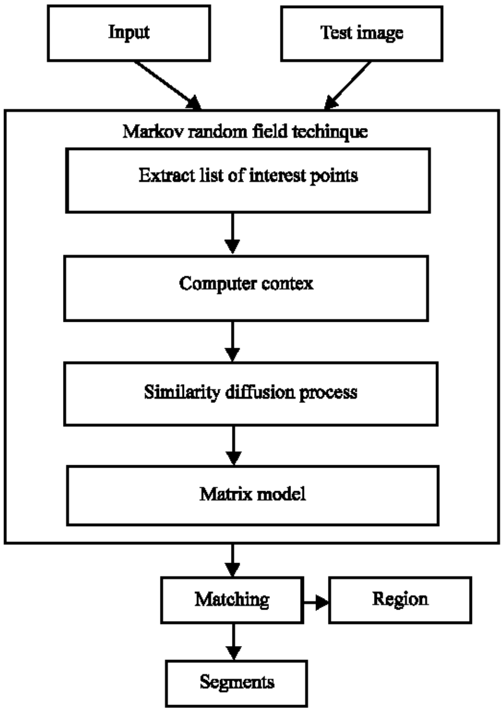


Fig. 1: Architecture flow diagram of the system

detecting the changes is taken as a input image and the other image which has been taken a day before or older one is a test image. The proposed approach consists of Markov random field technique and other matching process. The list of interest points are extracted and segmentation of the images into various regions. The reduction of speckle noise can detect the real changes as well as mitigate the effect of speckle noises (dot spots or patches). Computational is simplicity, when the segmentation of image has lot of regions to calculate the differences between two images. Approach modifies the membership of each and every pixel according to a novel form of the MRF energy function through which the neighbors of each and every pixel with their relationship (Fig. 2).

**Data sets:** For experimental results, we have taken the two data sets that are Ottawa and Berlin data sets. These data sets which was acquired by the two different times from May and August 1997 and presents the area where, the floods are affected (Fig. 3).

**Compared algorithms and parameter test:** To assess the effectiveness the proposed changes was has taken by the detection approach (written as MRFFCM), a parameter test and some experimental results are carried out. In this

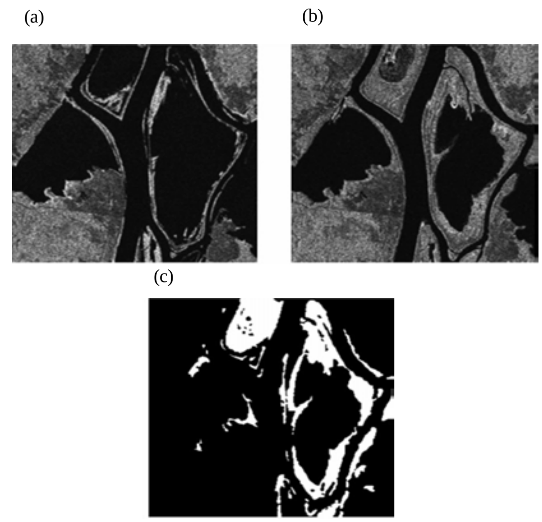


Fig. 2: Ottawa dataset: a) Image acquired in May 1997; b) Image acquired in August 1997 and c) Ground-truth image

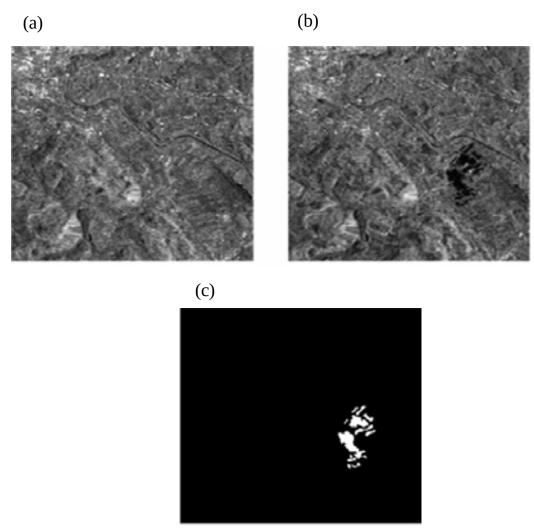


Fig. 3: Bern dataset: a) Image acquired in April 1999; b) Image acquired in May 1999 and c) Ground-truth image

study, we are going to divide the closed the intervals [0,1] into X segments and the parameter value of X influenced the final result by comparing the the FCM algorithm was the first compared algorithm and it is a fundamental one. This FCM experiment is carryout by the information provided by the neighbourhood pixels will yield better results.

The FLICM and RFLICM algorithm was the second and third algorithm that was introduced by Nielsen (2007) and Gong *et al.* (2012), respectively. These two algorithms are characterizing by the objective function with no artificial parameters. This method is a complicated form These two experiments are designed in MEFFCM algorithm for the low time complexity

The rest of the algorithms are about the energy functions, the energy function is getting by the mean of the membership for entire neighbors without consider the centre locating in a homogeneous region or a heterogeneous region:

$$B_{ik} = -x\sum_{n\in\theta_k} \theta(y_k - x_n) = -x\times z_{ik} \quad (1)$$

where, r is a changing parameter in the iteration process and yields:

$$x^{j+1} = \text{argmax} \sum_{i=u,\, c} \sum_{k\in l} [u^j_{ik} \times \pi^j_{ik}(x)] \quad (2)$$

These experiments are to demonstrated by the superiority of the energy function in MRFFCM to those in the other algorithm.

## RESULTS AND DISCUSSION

The PF (Positive False) and NF (Negative False), PT (Positive True) and Negative True (NT), Overall Error(OE), Kappa Coefficient (KC) is calculated according to the calculation given by Gong *et al.* (2012). The range of the KC value is from 0-1. The two datasets which are experimented on and the deliberate and cogent criterion KC is employed here. Figure 4 shows final maps for the experiments on the Bern dataset.

Table 1 lists the evaluation metrics of the proposed approach. The results show, it outperforms all the compared algorithms in KC and PCC. In Fig. 5 many white noises exist emerge on the background that is due to MRFEM in which all the neighbors of the membership function are counted. The new membership is considering for the influenced adjacent points that are polluted by noise.

The results on the Ottawa dataset are shown and listed in Fig. 6 and Table 2. For the Ottawa dataset, Figand Table 2 shows that, the proposed MRFFCM that obtains the best values of PF, NF, OE, PCC and KC. To sum up, the proposed approach will fit the two situations where the changed area appears centralized (the Bern dataset) and scattered 9the Ottawa dataset) and it also verifies its relatively far-ranging applicability.

Figure 6 and 7 show the comparison of the proposed approach with other existing approaches. The proposed approach the error value is always better than the others.

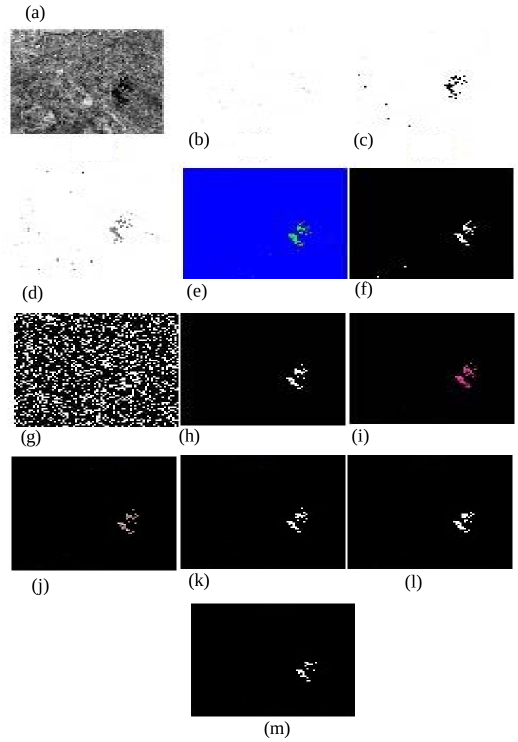


Fig. 4: Final Maps of the Bern dataset generated by: a) SAR image; b) mean ratio; c) log ratio; d) Differentiate Image (DI); e) HSVimage; f) FCM; g) Blurr-image; h) Modified MRFFCM; i) RGB; j) Proposed MRFFCM and k) MRFFCM black and white (l, m) final output of MRFFCM

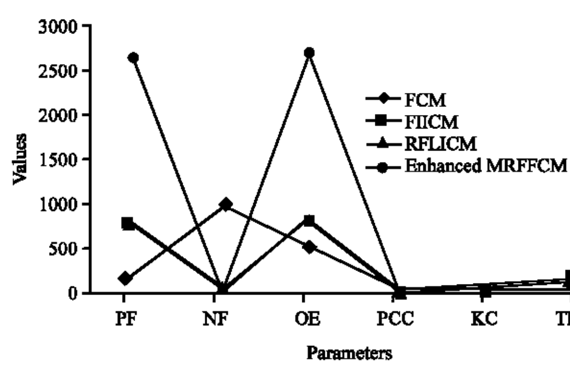


Fig. 5: Comparison graph for various approaches (Bern dataset)

Table 1: Values of the evaluation criteria of the bern dataset

| Variables | PF | NF | OE | PCC | KC | TIS |
|---|---|---|---|---|---|---|
| FCM | 190 | 949 | 539 | 0.9941 | 0.7464 | 10.60 |
| FIICM | 724 | 84 | 808 | 0.9911 | 0.8045 | 137.60 |
| RFLICM | 723 | 61 | 784 | 0.9913 | 0.8132 | 139.40 |
| Enhanced | 2606 | 6 | 2612 | 0.9904 | 1.0000 | 30.37 |
| MRFFCM | - | - | - | - | - | - |

Table 2: Values of the evaluation criteria of the Ottawa dataset

| Variables | PF | NF | OE | PCC | KC | TIS |
|---|---|---|---|---|---|---|
| FCM | 422 | 2319 | 2741 | 0.9730 | 0.8935 | 12.3.00 |
| FIICM | 2608 | 369 | 2977 | 0.9707 | 0.9052 | 156.7.00 |
| RFLICM | 2381 | 469 | 2850 | 0.9719 | 0.9075 | 161.3.00 |
| Enhanced | 2248 | 113 | 2361 | 417.1927 | 1.0000 | 73.3154 |
| MRFFCM | - | - | - | - | - | - |

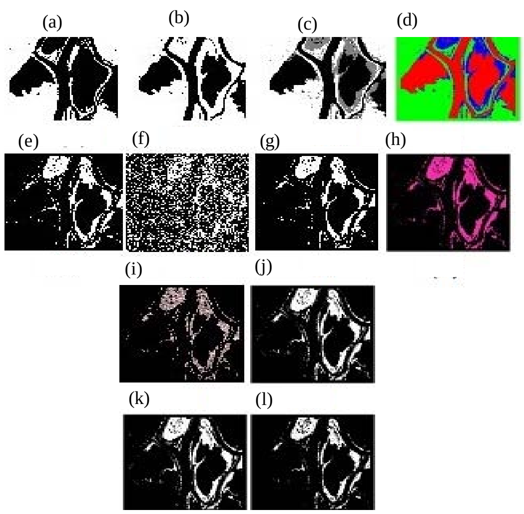


Fig. 6: Final Maps of the Ottawa dataset generated by: a) FCM; b) FLICM; c) RFLICM; d) MRFEM; e) MRFSM; f) MRFN and g) proposed MRFFCM

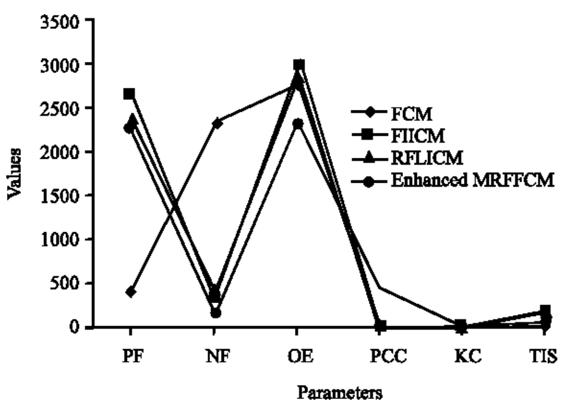


Fig. 7: Graph for comparing various approaches; Comparison of enhanced MRFFCM with other methods

## CONCLUSION

An enhanced method of change detection approach in SAR images has been presented in this study. This novel approach is basically built on the mathematical analysis such as the knowledge of elementary function and LSM. The new approach does not consider the use of any prior knowledge about the scene but consider only the use of the grey level intensity and therefore is an unsupervised approach. The main advantages of our change detection approach are in terms of superiority in reducing speckle noises and computational simplicity. The proposed method efficiently detects the changes in the image. The system is tested with various data set and the result proves that the proposed method is very promising one.

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