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Images Fusion Based On Fuzzy Clustering

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Abstract— Image change detection is a process that analyzes images of the same scene taken at different times in order to identify changes that may have occurred between the considered acquisition dates. With the development of remote sensing technology, change detection in remote sensing images becomes more and more important. Among them, change detection in synthetic aperture radar (SAR) images exhibits some more difficulties than optical ones due to the fact that SAR images suffer from the presence of the speckle noise, so that's why we proposed an unsupervised distribution-free change detection approach for synthetic aperture radar (SAR) images based on an image fusion strategy and a novel fuzzy clustering algorithm. The image fusion technique is introduced to generate a difference image by using complementary information from a mean-ratio image and a log-ratio image. In order to restrain the background information and enhance the information of changed regions in the fused difference image, wavelet fusion rules based on an average operator and minimum local area energy are chosen to fuse the wavelet coefficients for a low-frequency band and a high-frequency band, respectively. A reformulated fuzzy local-information C-means clustering algorithm is proposed for classifying changed and unchanged regions in the fused difference image. It incorporates the information about spatial context in a novel fuzzy way for the purpose of enhancing the changed information and of reducing the effect of speckle noise. Experiments on real SAR images show that the image fusion strategy integrates the advantages of the log-ratio operator and the mean-ratio operator and gains a better performance. The change detection results obtained by the improved fuzzy clustering algorithm exhibited lower error than its preexistences.
Index Terms— RFLICM, MATLAB, KAPPA.

I. INTRODUCTION

In this project first we perform mean ratio and log ratio on two original images and performing DWT based fusion image using fusion rules and apply RFLCM and FLICM techniques on DWT based fusion image and finally compare the results of PCC and kappa values of both techniques. Image change detection is a process that analyzes images of the same scene taken at different times in order to identify changes that may have occurred between the considered acquisition dates. In the last decades, it has attracted widespread interest due to a large number of applications in diverse disciplines such as remote sensing, medical diagnosis and video surveillance. With the development of remote sensing technology, change detection in remote sensing images becomes more and more important. Among them, change detection in synthetic aperture radar (SAR) images exhibits some more difficulties than optical ones due to the fact that SAR images suffer from the presence of the speckle noise. However, SAR sensors are independent of atmospheric and sunlight conditions, which make the change detection in SAR images still attractive.

II. BLOCK DIAGRAM FOR OUR PROJECT

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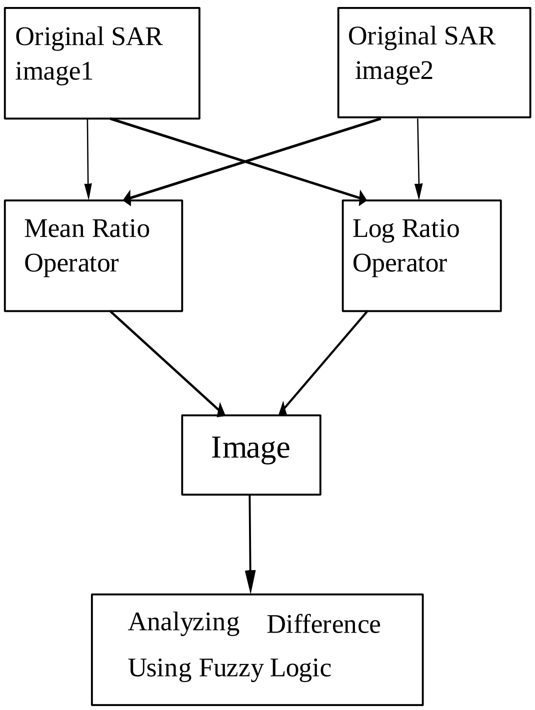


RFLICM Algorithm Steps:

Step 1) Set the number of the cluster prototypes, fuzzification Parameter m and the stopping condition ∈.

Step 2) Initialize randomly the fuzzy partition matrix.

Step 3) Set the loop counter b=0.

Step 4) Compute the cluster prototypes using (equation 6 in module2).

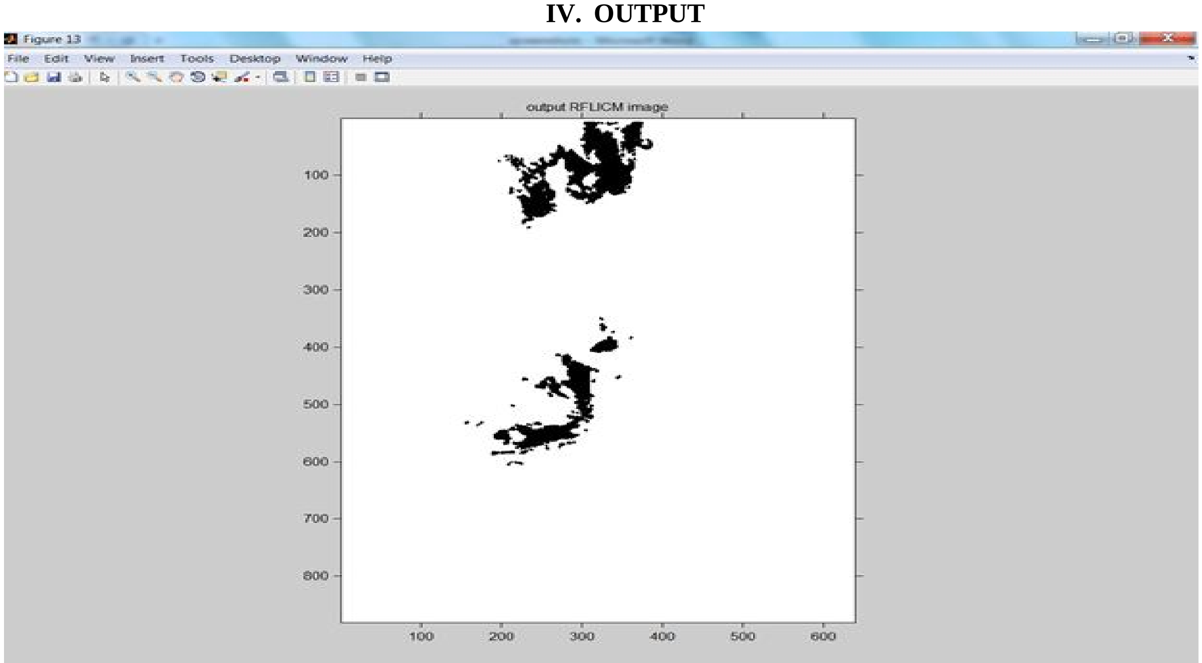
Step 5) Calculate the fuzzy partition matrix using (equation 5 in module2).

Step 6) Max $(U^{(b)} - U^{(b-1)}) < \in$ stop; **Step 7)**otherwise, set b=b+1, and go to step 4.

III. WORKING OPERATION

The working of our project is, by giving two satellite input images, our project generates gray scale images and then it find mean ratio operator and log ratio operator based on it. LFICM is algorithm is applied to generate difference between these two gray scale images. This output will be given as input for RLFICM algorithm, and it will generate more accuracy in output

IV. OUTPUT



RFLICM Output Image

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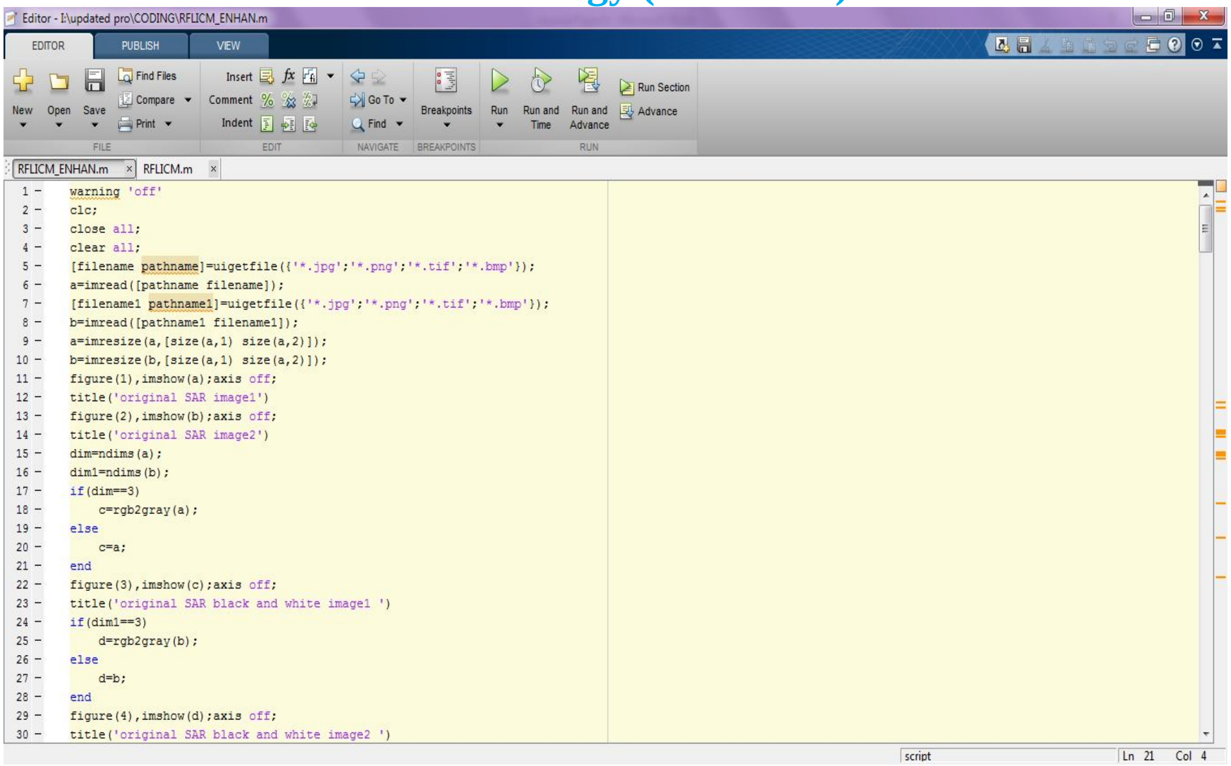

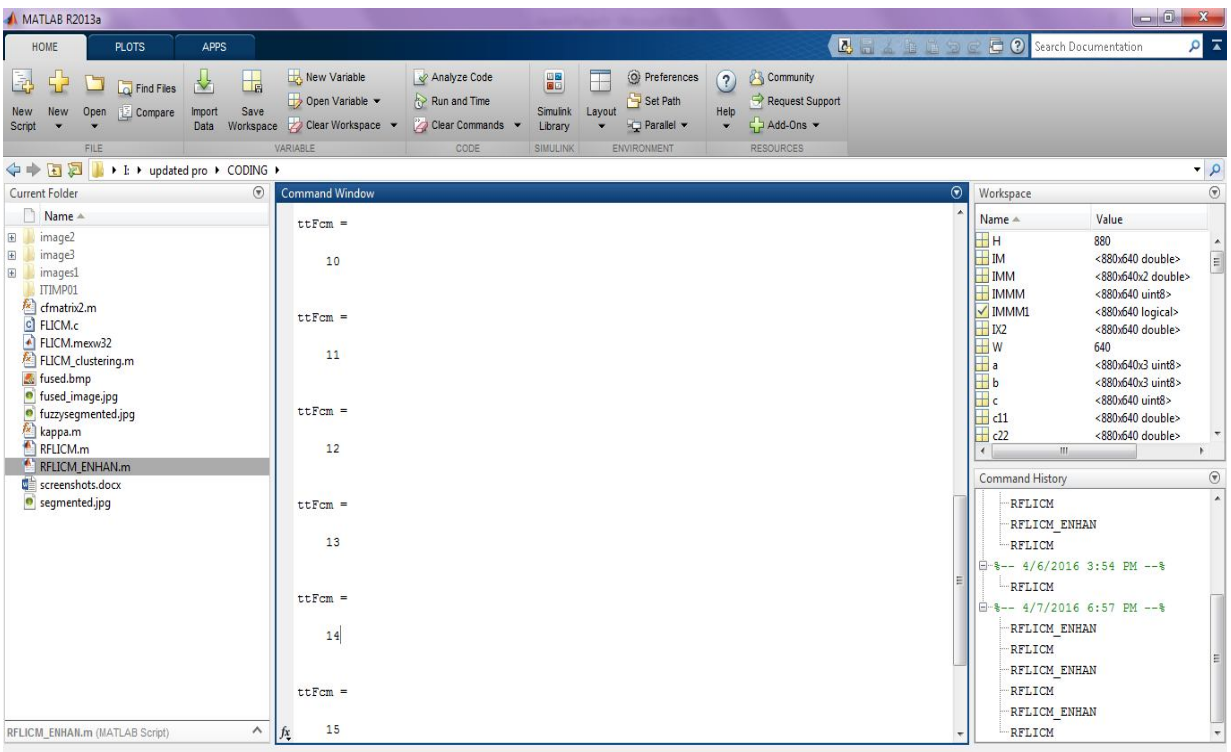

V. CODING

tic warning 'off' clc; close all; clear all;
[filenamepathname]=uigetfile({'*.jpg';
'*.png';'*.tif';'*.bmp'});
a=imread([pathname filename]);

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```
[filename1 pathname1]=uigetfile({'*.jpg';
'*.png';'*.tif';'*.bmp'};
b=imread([pathname1 filename1]);
b=imresize(b,
[size(a,1) size(a,2)]); figure(1),
imshow(a);axis off;
title('original SAR image1')
figure(2),imshow(b);
axis off; title('original SAR image2')
dim=ndims(a);
dim1=ndims(b); if(dim==3)
   c=rgb2gray(a);
 else
 c=a; end figure(3),imshow(c);axis off; title('original SAR black and white image1 ') if(dim1==3)     d=rgb2gray(b); else     d=b; end figure(4),imshow(d);axis off; title('original SAR black and white image2 ') e1=mean2(c); f1=mean2(d); mean_ratio=1-min(e1/f1,f1/e1);     log_ratio=log(f1)-log(e1);     g1=im2bw(c,abs(mean_ratio));     h1=im2bw(d,abs(log_ratio)); figure(5),imshow(g1);axis off; title('mean ratio operator') figure(6),imshow(h1);axis off; title('log ratio operator')
[ca,ch,cv,cd]=dwt2(g1,'db1');
[ca1,ch1,cv1,cd1]=dwt2(h1,'db1');
dd=zeros(size(ca,1),size(ca,2));
 for i=1:size(ca,1)
for j=1:size(ca,2) dd(i,j)=ca(i,j)+ca1(i,j)/2;
endenddd5=zeros(size(ch,1),size(ch,2));
dd6=zeros(size(ch1,1),size(ch1,2));

dd7=zeros(size(cv,1),size(cv,2));     dd8=zeros(size(cv1,1),size(cv1,2));     dd9=zeros(size(cd,1),size(cd,2)); dd10=zeros(size(cd1,1),size(cd1,2));   for   i5=1:size(ch,1)   for   j5=1:size(ch,2)     dd5(i5,j5)=(ch(i5,j5)).^2; dd6(i5,j5)=(ch1(i5,j5)).^2;     dd7(i5,j5)=(cv(i5,j5)).^2;     dd8(i5,j5)=(cv1(i5,j5)).^2;     dd9(i5,j5)=(cd(i5,j5)).^2; dd10(i5,j5)=(cd1(i5,j5)).^2;   end   end   dd11=zeros(size(ch,1),size(ch,2));     dd12=zeros(size(ch1,1),size(ch1,2)); dd13=zeros(size(cv,1),size(cv,2));


for  i6=1:size(ch,1)   for  j6=1:size(ch,2)     if  (dd5(i6,j6)<dd6(i6,j6))     dd11(i6,j6)=ch(i6,j6);     else dd11(i6,j6)=ch1(i6,j6);     end   end  end  for  i7=1:size(cv,1)   for  j7=1:size(cv,2)     if  (dd7(i7,j7)<dd8(i7,j7)) dd12(i7,j7)=cv(i7,j7);   else     dd12(i7,j7)=cv1(i7,j7);   end  end end for i8=1:size(cd,1)
 for j8=1:size(cd,2)   if (dd9(i8,j8)<dd10(i8,j8))     dd13(i8,j8)=cd(i8,j8);   else     dd13(i8,j8)=cd1(i8,j8);   end  end end  fused_image=idwt2(dd,dd11,dd12,dd13,'db1');  figure(7),imshow(fused_image);axis  off;  title('DWT  based  Fused  Image') imwrite(fused_image,'fused.bmp')
%%


IM=double(fused_image); imwrite(IM,'fused_image.jpg'); [maxX,maxY]=size(IM);
IMM=cat(3,IM,IM);
%%%%%%%%%%%%%%%%
cc1=8; cc2=250;
tt=0; while(tt<15)    tt=tt+1;
c11=repmat(cc1,maxX,maxY);    c22=repmat(cc2,maxX,maxY);
 if tt==1      test1=c11; test2=c22;    end    c333=cat(3,c11,c22);
ree=repmat(0.000001,maxX,maxY);    ree1=cat(3,ree,ree);    distance=IMM-c333;    distance=distance.*distance+ree1;
```

```
da=1./distance;

da1=da(:,:,1)+da(:,:,2);     distance1=distance(:,:,1).*da1;     u1=1./distance1;     distance2=distance(:,:,2).*da1; u2=1./distance2;   ccc1=sum(sum(u1.*u1.*IM))/sum(sum(u1.*u1));     ccc2=sum(sum(u2.*u2.*IM))/sum(sum(u2.*u2)); tmpMatrix=[abs(cc1-ccc1)/cc1,abs(cc2-ccc2)/cc2];   pp=cat(3,u1,u2);  for i9=1:maxX     for j9=1:maxY     if max(pp(i9,j9,:))==u1(i9,j9)
IX2(i9,j9)=1; else

IX2(i9,j9)=2;

end

end

end

%%%%%%%%%%%%%%

if max(tmpMatrix)<0.0001

break; else     cc1=ccc1;     cc2=ccc2;     end  for i10=1:maxX     for j10=1:maxY     if IX2(i10,j10)==2 IMMM(i10,j10)=254;


 else

IMMM(i10,j10)=8;     end    end end
%%%%%%%%%%%%%%%%%

%figure,imshow(uint8(IMMM)); output=uint8(IMMM); imwrite(output,'segmented.jpg'); end
for i11=1:maxX    for j11=1:maxY

if IX2(i11,j11)==2 IMMM(i11,j11)=200;

else

IMMM(i11,j11)=1;    end   end end
%%%%%%%%%%%%%%%%%

IMMM=uint8(IMMM); IMMM1=im2bw(IMMM);
for JJ2=1:size(IMMM1,1) for KK2=1:size(IMMM1,2) if(IMMM1(JJ2,KK2)==1) IMMM1(JJ2,KK2)=0;

else

IMMM1(JJ2,KK2)=1; end end end figure(8),imshow(IMMM1);axis off; title('Ground truth image');
%% RFLICM

cNum = 3; m = 2; winSize = 3; maxIter = 500; thrE    = 0.001;
[H,W] = size( fused_image ); imageFileName='fused.bmp';
[imOut,iter] = FLICM_clustering
( imageFileName, cNum, m, winSize, maxIter, thrE );
 disp(sprintf('Total Iterations = %d',iter));
figure(9),
imshow(imOut,[]);axis off;
title('FLICM output image ');
U = rand( H, W, cNum-1 )*
(1/cNum); U(:,:,cNum) = 1 - sum(U,3);
ssum=zeros(length(3*size(U,1)
*size(U,2)),1); cc=zeros(length(3*size(U,1)
```

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```
*size(U,2)),1); ssum1 = zeros(cNum,1);
G=zeros(length(3*size(U,1)
*size(U,2)),1);
c1=var(fused_image)./(mean2(fused_image))^2;
for i3=1:size(U,1) for j3=1:size(U,2)
for k3=1:cNum                ssum(i3,j3,k3)=U(i3,j3,k3).^m;                cc(i3,j3,k3) = (U(i3,j3,k3).^m)*
(fused_image(i3,j3));                ssum1(k3)=cc(i3,j3,k3)/ssum(i3,j3,k3);                end end
end  for i4=1:size(U,1)
for j4=1:size(U,2)
for k4=1:cNum
if (c1(1,j4)^(j4)>=mean2(c1))
G(i4,j4,k4)=                1/(2+min((c1.^(j4)/c1).
^2,(c1/c1.^(j4)).^2))*
(1U(i4,j4,k4)).
*norm(fused_image(i4,j4)-ssum1(k4)).^2;
else
G(i4,j4,k4)=
1/(2min((c1.^(j4)/c1).^2,(c1/c1.^(j4)).^2))
*(1U(i4,j4,k4)).*norm(fused_image(i4,j4)-ssum1(k4)).^2;                end
end
end
end
V=zeros(length(3*size(U,1)*size(U,2)),1);      for i5=1:size(U,1)        for j5=1:size(U,2)
for k5=1:cNum V(i5,j5,k5)=U(i5,j5,k5);                U(i5,j5,k5)=1/((norm(fused_image(i5,j5)ssum1(k5))
.^2+G(i5,j5,k5))/(norm(fused_image(i5,j5)-ssum1(k5))
.^2+G(i5,j5,k5))).^(1/(m-
1)); if (max(V(i5,j5,k5)-U(i5,j5,k5))<thrE)
break; end  end  end
 end     figure(10),imshow(U);     title('RFLICM     output     in     HSV')     cmap2=hsv2rgb(U);     dd21=rgb2gray(cmap2);
dd22=im2bw(dd21,graythresh(dd21)); for JJ1=1:size(U,1) for KK1=1:size(U,2) if(dd22(JJ1,KK1)==1) dd22(JJ1,KK1)=0;
else
dd22(JJ1,KK1)=1; end end end   dd23=imerode(dd22,strel('diamond',1));   figure(11),imshow(dd23);   title('RFLICM output')
[confmatrix] = cfmatrix2(IMMM1(:),dd23(:));
TP=(confmatrix(4))/(confmatrix(3)+confmatrix(4));
FP=(confmatrix(2))/(confmatrix(1)+confmatrix(2));
TN=(confmatrix(1))/(confmatrix(1)+confmatrix(2));
FN=(confmatrix(3))/(confmatrix(3)+confmatrix(4)); PCC=(TP+TN)/(TP+FP+TN+FN);
disp(['Percent correct classification of RFLICM =' num2str(PCC)]); ghh=im2bw(imOut,graythresh(imOut)); [confmatrix1] =
cfmatrix2(IMMM1(:),ghh(:));
TP1=(confmatrix1(4))/(confmatrix1(3)+confmatrix1(4));
FP1=(confmatrix1(2))/(confmatrix1(1)+confmatrix1(2));
```

TN1=(confmatrix1(1))/(confmatrix1(1)+confmatrix1(2));

FN1=(confmatrix1(3))/(confmatrix1(3)+confmatrix1(4)); PCC1=(TP1+TN1)/(TP1+FP1+TN1+FN1);
disp(['Percent correct classification of FLICM =' num2str(PCC1)]); g2=imresize(g1,[size(U,1) size(U,2)]);
[confmatrix2] = cfmatrix2(IMMM1(:),g2(:));

TP2=(confmatrix2(4))/(confmatrix2(3)+confmatrix2(4));

FP2=(confmatrix2(2))/(confmatrix2(1)+confmatrix2(2));

TN2=(confmatrix2(1))/(confmatrix2(1)+confmatrix2(2));

FN2=(confmatrix2(3))/(confmatrix2(3)+confmatrix2(4)); PCC2=(TP2+TN2)/(TP2+FP2+TN2+FN2);
disp(['Percent correct classification of MEAN RATIO =' num2str(PCC2)]); h2=imresize(h1,[size(U,1) size(U,2)]); [confmatrix3] = cfmatrix2(IMMM1(:),h2(:));
TP3=(confmatrix3(4))/(confmatrix3(3)+confmatrix3(4));

FP3=(confmatrix3(2))/(confmatrix3(1)+confmatrix3(2));

TN3=(confmatrix3(1))/(confmatrix3(1)+confmatrix3(2));

FN3=(confmatrix3(3))/(confmatrix3(3)+confmatrix3(4)); PCC3=(TP3+TN3)/(TP3+FP3+TN3+FN3);
disp(['Percent correct classification of LOG RATIO =' num2str(PCC3)]); disp('KAPPA for RFLICM') kappa(confmatrix); disp('KAPPA for FLICM') kappa(confmatrix1); toc

VI. CONCLUSION

In this project, we have presented a novel SAR-image change detection approach based on image fusion and an improved fuzzy clustering algorithm, which is quite different from the existing methods. First, for the wavelet fusion approach that we proposed, the key idea is to restrain the background (unchanged areas) information and to enhance the information of changed regions in the greatest extent. On the other hand, the information of background obtained by the log-ratio image is relatively flat on account of the logarithmic transformation. Hence, complementary information from the mean-ratio image and the log ratio image is utilized to fuse a new difference image. Compared with other existing methods (mean ratio and log ratio), the proposed approach can reflect the real change trend as well as restrain the background (unchanged areas). Second, in contrast with the log-ratio image and the mean-ratio image, the estimation of the probability statistics model for the histogram of the fused difference image may be complicated since it incorporates both the log-ratio and mean-ratio image information at different resolution levels. Here, the RFLICM algorithm that incorporates both local spatial and gray information is proposed, which is relatively insensitive to probability statistics model. The RFLICM algorithm introduces the reformulated factor as a local similarity measure to make a tradeoff between image detail and noise. Compared with the original algorithms, RFLICM is able to incorporate the local information more exactly. The experiment results show that the proposed wavelet fusion strategy can integrate the advantages of the log-ratio operator and the mean-ratio operator and gain a better performance. The change detection results obtained by the RFLICM exhibited less spots than its preexistence (i.e., FLICM) since it is able to incorporate the local information more exactly.

VII. ACKNOWLEDGEMENT

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