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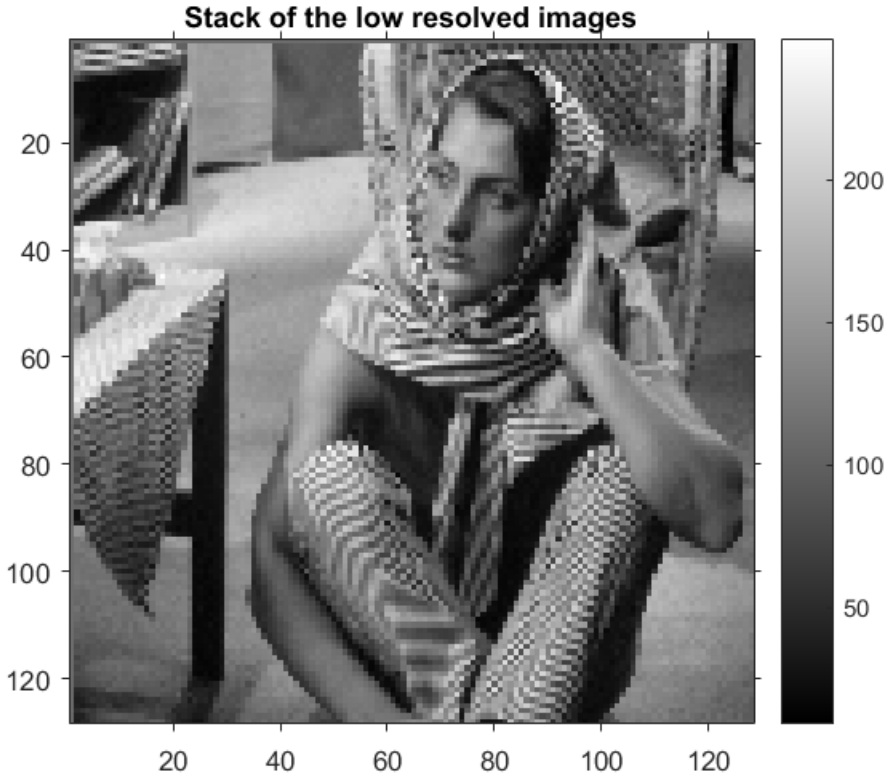
Exercise 4 report, title "image super resolution", Ntambaazi Tonny_CIMET : ...,

```
clear;close all;clc
I=double(imread('barbara.png'));
figure('Name','I');imshow(I,
[],'InitialMagnification','fit');colorbar;axis on;title('I');
 title('Original image');
f=4; % should be even % f stands for down sampling factor tht will be
 used for ceating down resolved images
aff=1; % boolean for display
```

Part 1.1 Simulation of a stack of images

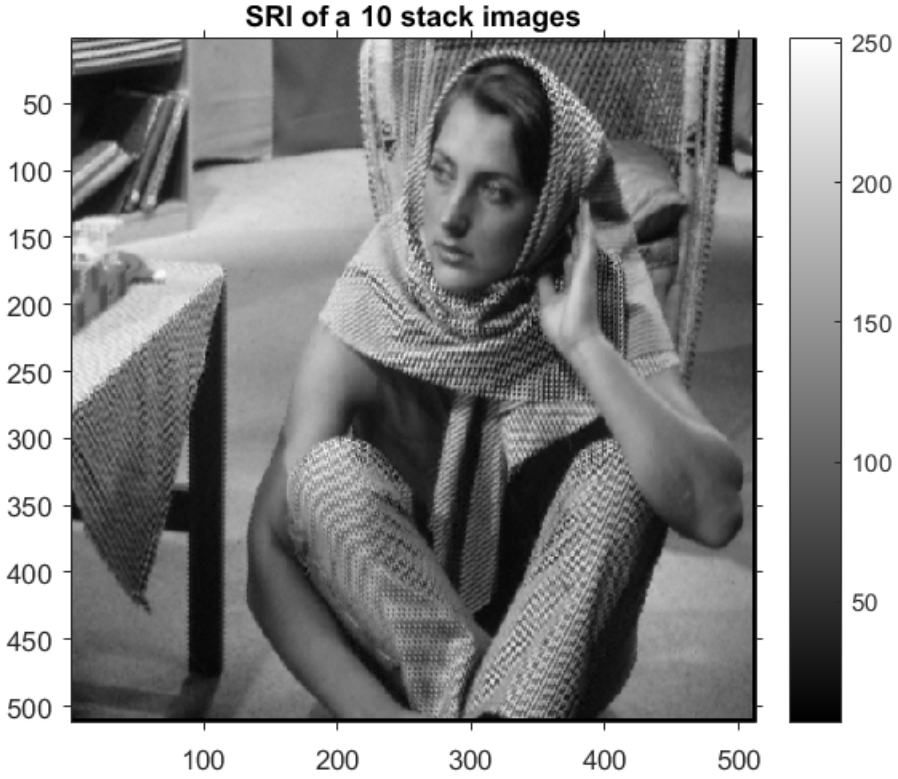
```
Nim=50;
% Nim is the number of images that are interpolated to form
% the super resolved images: These are used to create a stack
 containing 50
% images

%Initializing matrices I1 & I2 for creating the image stack...
I1=zeros(size(I,1),size(I,2),Nim);
I2=zeros(round(size(I,1)/f),round(size(I,2)/f),Nim);

txty=f*rand(2,Nim)-(f/2);
txty(:,1)=[0,0];
if aff==1 ,figure('Name','pile d''images'),end

% Creating a stack of low resolved images

for c=1:Nim
    xform = [ 1  0  0;        0  1  0;   txty(1,c) txty(2,c)  1 ]; %??
    tform_translate = maketform('affine',xform); %??
    I1(:,:,c)= imtransform(I, tform_translate,'XData',[1
 size(I,2)],'YData',[1 size(I,1)],'FillValues',mean(I(:)));%??
    I2(:,:,c)=I1(1:f:end,1:f:end,c);%??
    if aff==1,    imshow(I2(:,:,c),
[],'InitialMagnification','fit');colorbar;axis on;title(sprintf('image
 n° %d',c));pause(0.1),end
                  title('Stack of the low resolved images');
%     figure; imshow(I2(:,:,c));
end

% There are artifacts in the pants and scarf on the down sampled image
 because
% the stripes in the original image appear as uneven overlap of the
 pixels creating
% a more of the metaphorical paint in some places than others which
 causes
% hence showing artifacts in the down sampled image compared to the
% original image.
```



Part 2.1 Pixel super-resolution of the image stack

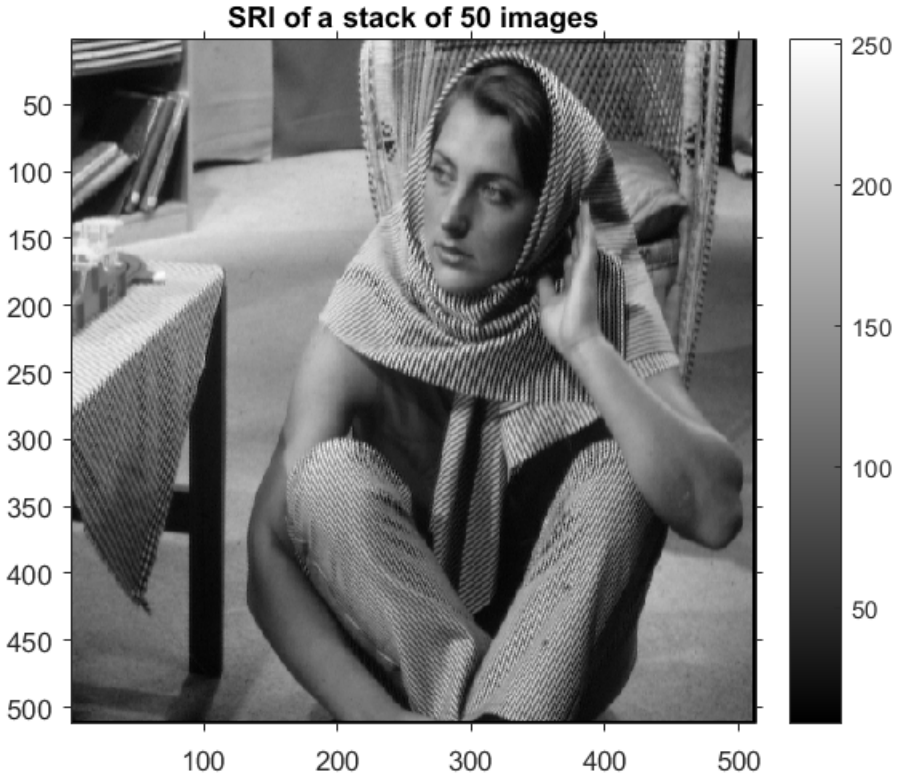
```
%
[X,Y]=meshgrid(1:f:size(I,2),1:f:size(I,1));
[Xi,Yi]=meshgrid(1:size(I,2),1:size(I,1));
Xt=zeros(size(X,1),size(X,2)*Nim);Yt=Xt;datat=Xt;

% Interpolating 10 low resolved to create a super resolved image
for c=1:10 % NimSR is the number of images considered to calculate
% the SR image
Xt(:,(size(X,2)*(c-1)+1):(size(X,2)*(c)))=X-txty(1,c);
Yt(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=Y-txty(2,c);
datat(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=I2(:,:,c);
end

% Building the super resolved image
ISR = griddata(Xt,Yt,datat,Xi,Yi,'cubic');

[x_i,y_i] = size(ISR);
figure; imshow(ISR,
[],'InitialMagnification','fit');colorbar;axis on;title('');pause(0.1);
 title('SRI of a 10 stack images');
```

```
Warning: Duplicate x-y data points detected: using average values for
 duplicate
points.
```



Computing the super resolution with 50 images

```
%
[X,Y]=meshgrid(1:f:size(I,2),1:f:size(I,1));
[Xi_50,Yi_50]=meshgrid(1:size(I,2),1:size(I,1));
Xt=zeros(size(X,1),size(X,2)*Nim);Yt=Xt;datat=Xt;

% Interpolating 30 low resolved to create a super resolved image
for c=1:50 % NimSR is the number of images considered to calculate
% the SR image
Xt(:,(size(X,2)*(c-1)+1):(size(X,2)*(c)))=X-txty(1,c);
Yt(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=Y-txty(2,c);
datat(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=I2(:,:,c);
end

% Building the super resolved image
ISR_50 = griddata(Xt,Yt,datat,Xi_50,Yi_50,'cubic');

[x_i_50,y_i_50] = size(ISR);
figure; imshow(ISR_50,
[],'InitialMagnification','fit');colorbar;axis on;title('');pause(0.1);
 title('SRI of a stack of 50 images');
```



Part 2.2

Comments: Here, the increase in the number of the low resolved images used in creation of the super resolves increases the overall appearance of the image: This is observed as an image stack of 10 was used followed by a 50 image stack: The 50 image stack shows less artifacts around the pants as well as the scarf. There are also better details of the shadows on the super resolved image created from 50 image stack compared to that of 10 image stack. This is because the more lower resolved images used; the more is the proper interpolation of pixels preventing uneven overlap of the pixels hence decreasing the error of correlation

Part 2.3 Calculating the mean squares:

```
% Displaying the mean square evolution
NimSR = 50;
X_plot = zeros(NimSR,2);

hold on;
for c=10:10:NimSR % NimSR is the number of images considered to
 calculate
% the SR image
Xt(:,(size(X,2)*(c-1)+1):(size(X,2)*(c)))=X-txty(1,c);
Yt(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=Y-txty(2,c);
datat(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=I2(:,:,c);
    ISR = griddata(Xt,Yt,datat,Xi,Yi,'cubic');
    I_h = I(1:(x_i-3),1:(y_i-3));
```

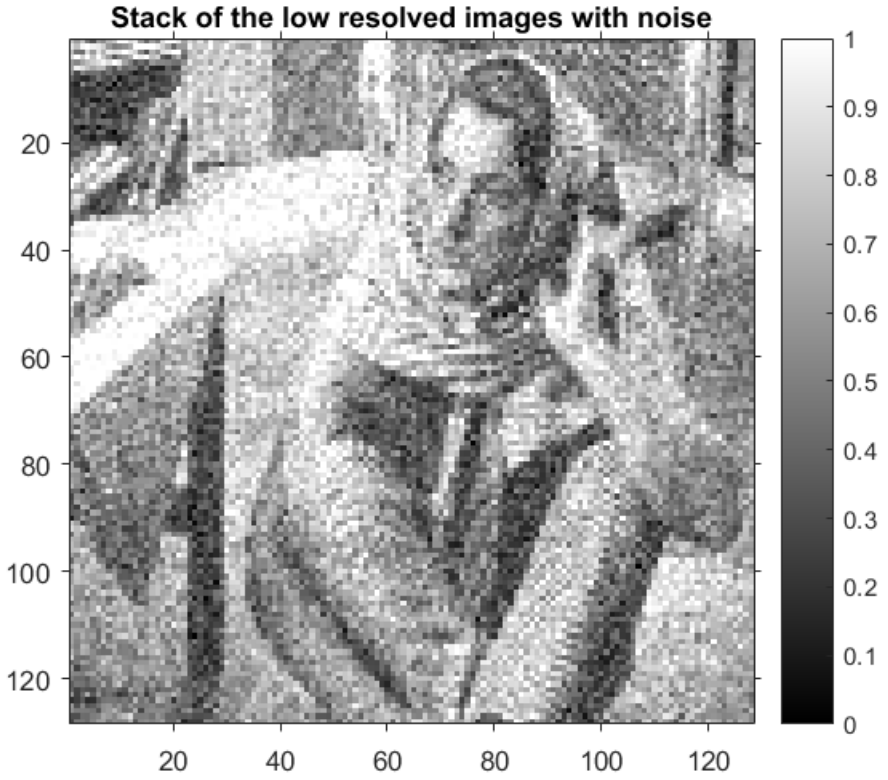
```
    ISR = ISR(1:(x_i-3),1:(y_i-3));


end
Meansquare =  sqrt (mean(mean((I_h-ISR).^2)));
Meansquare
```

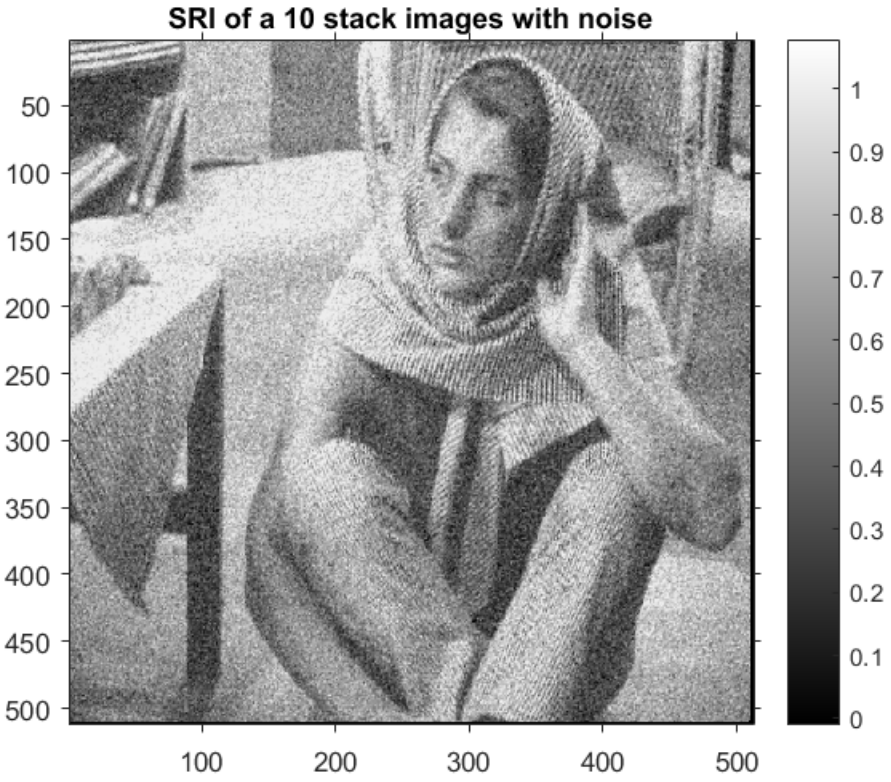
```
Meansquare =

    6.1025
```

Part 3 Influence of the noise on pixel super-resolution

```
clear all;

I=double(imread('barbara.png'));
f=4; % should be even % f stands for ????
aff=1; % boolean for display


Nim=10;
% Nim is the number of images that are interpolated to form
% the super resolved images: These are used to create a stack
 containing 50
% images

%Initializing matrices I1 & I2 for creating the image stack...
I1=zeros(size(I,1),size(I,2),Nim);
I2=zeros(round(size(I,1)/f),round(size(I,2)/f),Nim);

txty=f*rand(2,Nim)-(f/2);
txty(:,1)=[0,0];
if aff==1 ,figure('Name','pile d''images'),end

% Creating a stack of low resolved images

for c=1:Nim
    xform = [ 1  0  0;        0  1  0;   txty(1,c) txty(2,c)  1 ]; %??
    tform_translate = maketform('affine',xform);
    I1(:,:,c)= imtransform(I, tform_translate,'XData',[1
 size(I,2)],'YData',[1 size(I,1)],'FillValues',mean(I(:)));
    I2(:,:,c)= I1(1:f:end,1:f:end,c);
    % adding noise to the image

    I2(:,:,c) = imnoise (I2(:,:,c)/255, 'gaussian', 0.2);
    if aff==1,
```

```
        imshow(I2(:,:,c),
[],'InitialMagnification','fit');colorbar;axis on;title(sprintf('image
 n° %d',c));pause(0.1),end
        title('Stack of the low resolved images with noise');
%     figure; imshow(I2(:,:,c));
end


% super-resolution of the image stack

%
[X,Y]=meshgrid(1:f:size(I,2),1:f:size(I,1));
[Xi,Yi]=meshgrid(1:size(I,2),1:size(I,1));
Xt=zeros(size(X,1),size(X,2)*Nim);Yt=Xt;datat=Xt;

% Interpolating 10 low resolved to create a super resolved image
for c=1:10 % NimSR is the number of images considered to calculate
% the SR image
Xt(:,(size(X,2)*(c-1)+1):(size(X,2)*(c)))=X-txty(1,c);
Yt(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=Y-txty(2,c);
datat(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=I2(:,:,c);
end

% Building the super resolved image
ISR = griddata(Xt,Yt,datat,Xi,Yi,'cubic');

[x_i,y_i] = size(ISR);
figure; imshow(ISR,
[],'InitialMagnification','fit');colorbar;axis on;title('');pause(0.1);
 title('SRI of a 10 stack images with noise');

%  Adding noise to the images cause a drop in the performance
 especially as
%  the noise level increases.However increase in the noise causes a
%  reduction in the super resolution of the resultng image
%  The resulting calculated super resolved image however
%  improves the image and shows better result with reduced noise
 compared
%  to the original image stack....
```

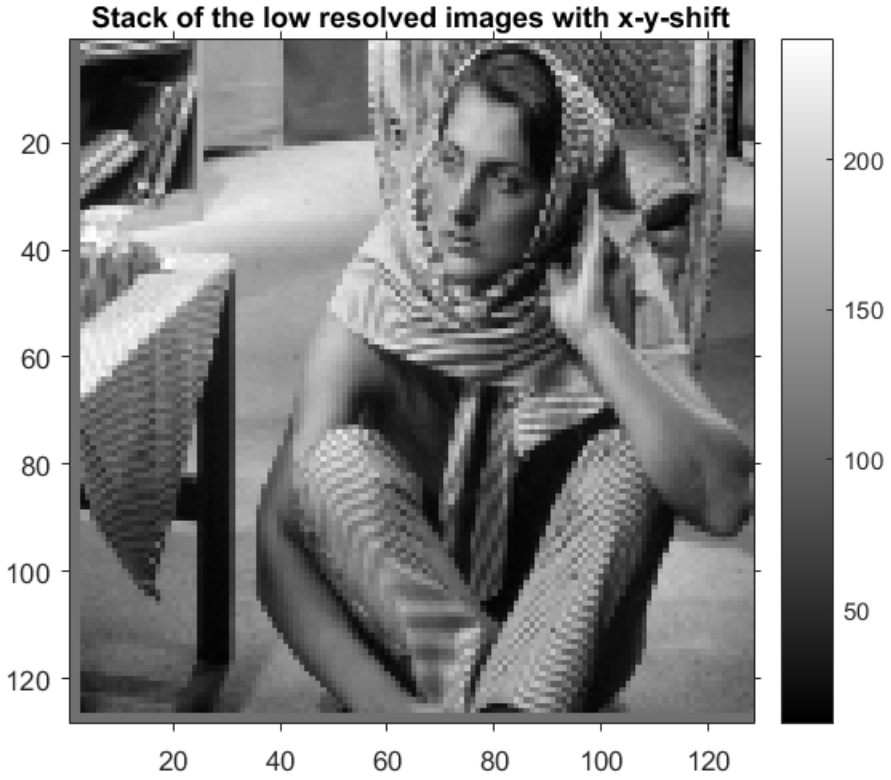

Stack of the low resolved images with noise
20
40
60
80
100
120
20
40
60
80
100
120
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

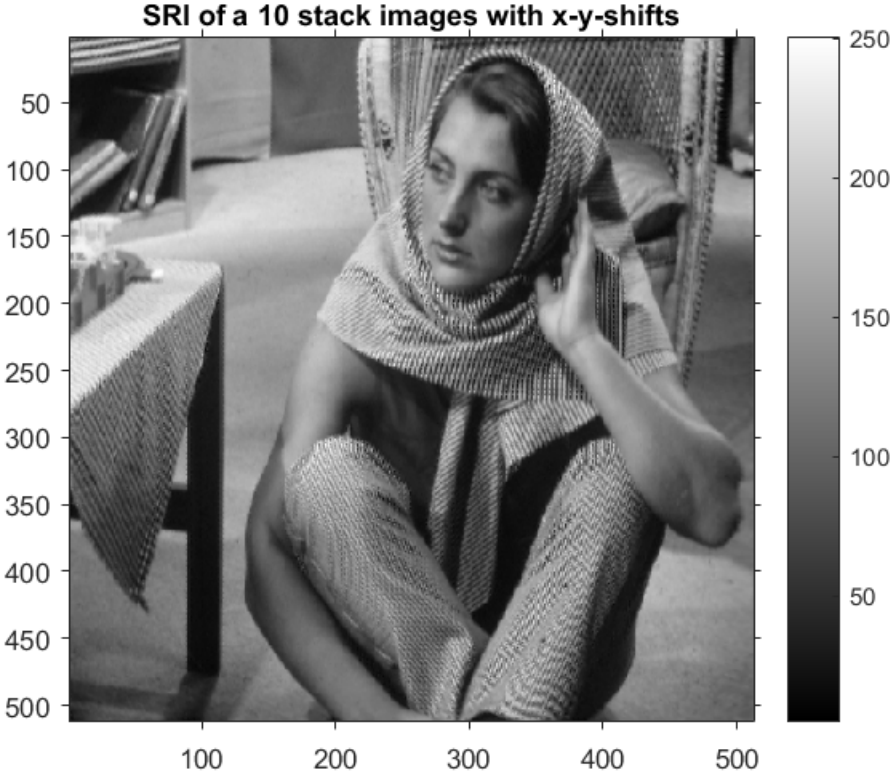

SRI of a 10 stack images with noise
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Part 4 Pixel super-resolution of the image stack assuming that shiftsare not known accurately estimated

```
clear all;

I=double(imread('barbara.png'));
f=4; % should be even % f stands down sampling factor
aff=1; % boolean for display
alpha = 20;

Nim=10;
% Nim is the number of images that are interpolated to form
% the super resolved images: These are used to create a stack
 containing 50
% images

%Initializing matrices I1 & I2 for creating the image stack...
I1=zeros(size(I,1),size(I,2),Nim);
I2=zeros(round(size(I,1)/f),round(size(I,2)/f),Nim);

txty= f*rand(2,Nim)-(f/2);
txty(:,1)=[0,0];

% Shifting the txty values, ie adding noise to this in the stack
txty = txty + alpha*randn(size(txty));
if aff==1 ,figure('Name','pile d''images'),end

% Creating a stack of low resolved images

for c=1:Nim
    xform = [ 1  0  0;        0  1  0;   txty(1,c) txty(2,c)  1 ]; %??
    tform_translate = maketform('affine',xform);
    I1(:,:,c)= imtransform(I, tform_translate,'XData',[1
 size(I,2)],'YData',[1 size(I,1)],'FillValues',mean(I(:)));
    I2(:,:,c)= I1(1:f:end,1:f:end,c);

    if aff==1,
        imshow(I2(:,:,c),
[],'InitialMagnification','fit');colorbar;axis on;title(sprintf('image
 n° %d',c));pause(0.1),end
        title('Stack of the low resolved images with x-y-shift');
%     figure; imshow(I2(:,:,c));
end


% super-resolution of the image stack

%
[X,Y]=meshgrid(1:f:size(I,2),1:f:size(I,1));
[Xi,Yi]=meshgrid(1:size(I,2),1:size(I,1));
```

```
Xt=zeros(size(X,1),size(X,2)*Nim);Yt=Xt;datat=Xt;

% Interpolating 10 low resolved to create a super resolved image
for c=1:10 % NimSR is the number of images considered to calculate
% the SR image
Xt(:,(size(X,2)*(c-1)+1):(size(X,2)*(c)))=X-txty(1,c);
Yt(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=Y-txty(2,c);
datat(:,(size(Y,2)*(c-1)+1):(size(Y,2)*(c)))=I2(:,:,c);
end

% Building the super resolved image
ISR = griddata(Xt,Yt,datat,Xi,Yi,'cubic');

[x_i,y_i] = size(ISR);
figure; imshow(ISR,
[],'InitialMagnification','fit');colorbar;axis on;title('');pause(0.1);
 title('SRI of a 10 stack images with x-y-shifts');

Meansquare =  sqrt (mean(mean((I-ISR).^2)));
Meansquare

% The change of the x-y-shift matrix, causes a change on the position
 of
% the low undersampled images but there seems no practicle effect
 observed
% resulting super resolved image: while the MSE decreases gradually
 with
% the value of the used sigma


Meansquare =

   12.2359
```


Stack of the low resolved images with x-y-shift
20
40
60
80
100
120
20
40
60
80
100
120
200
150
100
50


SRI of a 10 stack images with x-y-shifts
50
100
150
200
250
300
350
400
450
500
100
200
300
400
500
250
200
150
100
50

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