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```


Image and Video Processing Assignment - 5

```
clc;
clear all;
close all;
```

Question 1: Motion Blur through Degradation function

```
% I will first create the functions which are needed for
 implementation in
% other parts of the code. Finally, the entire code will be written
% together.
```

Motion Blur

```
% The function returns a motion blurred image

function [out] = motion_blur(img, T, a, b)
% img: input image
% T: the duration of exposure
% a: rate of motion in x-direction
```

```
% b: rate of motion in y-direction
%
% out: the motion blurred image

[m, n] = size(img);
u = linspace(0,m-1,m)' + 1e-16;
v = linspace(0,n-1,n) + 1e-16;

u = repelem(u, 1, n);
v = repelem(v, m, 1);

cord = a.*u + b.*v';

% The degradation model derived
H_uv = (T.*sin(pi*cord).*exp(-1i*pi*cord))./(pi*cord);

F_uv = fft2(img);

out_fft = F_uv .* H_uv;

out = real(ifft2(out_fft));

out = mat2gray(out);

end
```

Example: Motion Blur

```
% Read the input image as a double
orig_img = imread('cameraman.tif');
img = double(orig_img);

motion = motion_blur(img, 1, 0.05, 0.01);

figure('Name', 'Motion Blur');
subplot(121)
imshow(orig_img);
title('Original Image');

subplot(122)
imshow(motion);
title('Blurred Image');
```

Original Image

Blurred Image

Inverse Filtering

```
% The function returns a inverse filter image

function [out] = inverse_filter(img, T, a, b)
% img: input image
% T: the duration of exposure
% a: rate of motion in x-direction
% b: rate of motion in y-direction
%
% out: the restored image

[m, n] = size(img);
u = linspace(0,m-1,m)' + 1e-16;
v = linspace(0,n-1,n) + 1e-16;

u = repelem(u, 1, n);
v = repelem(v, m, 1);

cord = a.*u + b.*v';

H_uv = (T.*sin(pi*cord).*exp(-1i*pi*cord))./(pi*cord);
G_uv = fft2(img);
```

```
out_fft = G_uv ./ H_uv;

out = real(ifft2(out_fft));

out = mat2gray(out);

end
```

Example: Inverse Filtering

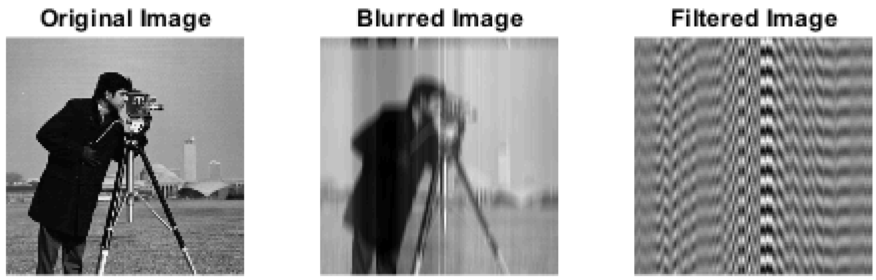
```
% Read the input image as a double
orig_img = imread('cameraman.tif');
img = double(orig_img);

motion = motion_blur(img, 1, 0.05, 0.01);
filtered = inverse_filter(motion, 1, 0.05, 0.01);

figure('Name', 'Inverse filtering');
subplot(131)
imshow(orig_img);
title('Original Image');

subplot(132)
imshow(motion);
title('Blurred Image');

subplot(133)
imshow(filtered);
title('Filtered Image');
```



Radial Inverse Filtering

```
% The function returns a radial inverse filtered image

function [out] = radial_inv_filter(img, T, a, b, D_th)
% img: input image
% T: the duration of exposure
% a: rate of motion in x-direction
% b: rate of motion in y-direction
% D_th: The threshold distance for the Butterworth filter
%
% out: the restored image

[m, n] = size(img);
u = linspace(0,m-1,m)' + 1e-16;
v = linspace(0,n-1,n) + 1e-16;

u = repelem(u, 1, n);
v = repelem(v, m, 1);

cord = a.*u + b.*v';

% The degradation function
H_uv = (T.*sin(pi*cord).*exp(-1i*pi*cord))./(pi*cord);
```

```
% The butterworth filter
D = sqrt(u.^2 + v.^2);
D_uv = 1./(1 + (D./D_th).^20);

G_uv = fft2(img);

out_fft = G_uv ./ H_uv;
out_fft = out_fft .* D_uv;

out = real(ifft2(out_fft));

out = mat2gray(out);

end
```

Example: Radial Inverse Filtering

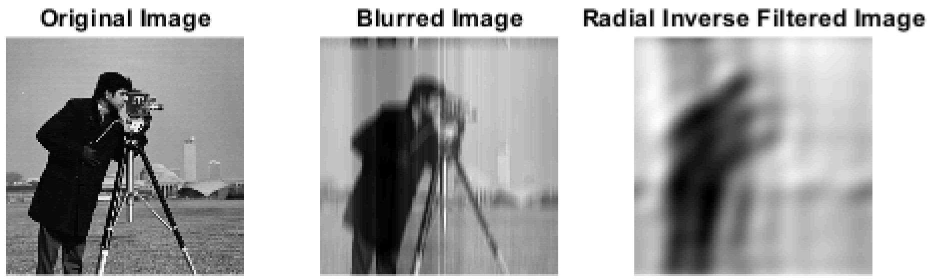
```
% Read the input image as a double
orig_img = imread('cameraman.tif');
img = double(orig_img);

motion = motion_blur(img, 1, 0.05, 0.01);
filtered = radial_inv_filter(motion, 1, 0.05, 0.01, 9);

figure('Name', 'Radial Inverse filtering');
subplot(131)
imshow(orig_img);
title('Original Image');

subplot(132)
imshow(motion);
title('Blurred Image');

subplot(133)
imshow(filtered);
title('Radial Inverse Filtered Image');
```



Weiner Filtering

```
% The function returns a weiner filtered image

function [out] = weiner_filter(img, T, a, b, K)
% img: input image
% T: the duration of exposure
% a: rate of motion in x-direction
% b: rate of motion in y-direction
% K: constant for weiner filtering
%
% out: the restored image

[m, n] = size(img);
u = linspace(0,m-1,m)' + 1e-16;
v = linspace(0,n-1,n) + 1e-16;

u = repelem(u, 1, n);
v = repelem(v, m, 1);

cord = a.*u + b.*v';

H_uv = (T.*sin(pi*cord).*exp(-1i*pi*cord))./(pi*cord);
G_uv = fft2(img);
```

```
out_fft = G_uv .* ((abs(H_uv).^2)./(H_uv .* (abs(H_uv).^2 + K)));

out = real(ifft2(out_fft));

out = mat2gray(out);

end
```

Example: Weiner Filtering

```
% Read the input image as a double
orig_img = imread('cameraman.tif');
img = double(orig_img);

motion = motion_blur(img, 1, 0.05, 0.01);
filtered = weiner_filter(motion, 1, 0.05, 0.01, 0.04);

figure('Name', 'Weiner filtering');
subplot(131)
imshow(orig_img);
title('Original Image');

subplot(132)
imshow(motion);
title('Blurred Image');

subplot(133)
imshow(filtered);
title('Weiner Filtered Image');
```

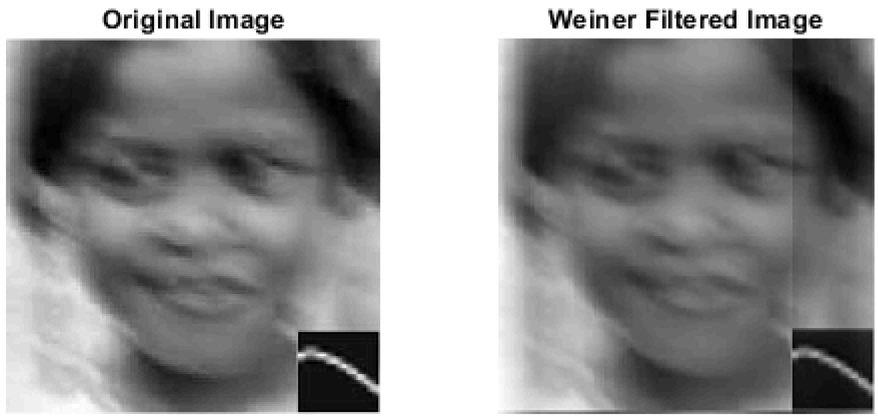
Example: Weiner Filtering on Facial Images

```
% Read the input image as a double
orig_img = imread('face-image.jpg');
img = double(rgb2gray(orig_img));

filtered = weiner_filter(img, 0.004, 0.001, 0.01, 0.01);

figure('Name', 'Weiner filtering');
subplot(121)
imshow(orig_img);
title('Original Image');

subplot(122)
imshow(filtered);
title('Weiner Filtered Image');
```



Conclusion

Through this experiment we investigated motion blurring and how can we come up with basic degradation models which describe the blurring. The first part of the experiment we introduced motion blurring in an image through our derived degradation function. Then we used inverse filtering to remove the effects of the blurring. But it is clear that during inverse filtering all values get saturated and hence the required image is not visible. To reduce the saturation we use radial inverse filtering in which the output spectrum is again passed through a Butterworth filter to remove very high values.

One of the better methods which gives the best results of all the filtering processes is the weiner filter. I also demonstrate its applicability on a motion blurred facial image.

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