

Sample 3-2

平滑化／先鋭化処理

移動平均とラプラシアン

画像処理特論

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動作確認: MATLAB R2023a

Image smoothing/sharpening

Moving averages and Laplacian

Advanced Topics in Image Processing

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Verified: MATLAB R2023a

サンプル画像の準備

(Preparation of sample image)

```
close
% Reading original image
I = im2double(imread('cameraman.tif'));
figure(1)
imshow(I)
title('Original')
```



移動平均フィルタ

(Moving average filter)

以下に 3×3 サイズの平均値カーネルを示す。

(The averaging kernel of size 3×3 is shown below.)

$$\mathbf{f} = \frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

```
% Kernel size setting
```

```
hsize = 3;
```

```
% Generating the filter kernel
```

```
f = fspecial('average',hsize)
```

```
f = 3x3
```

```
    0.1111    0.1111    0.1111
    0.1111    0.1111    0.1111
    0.1111    0.1111    0.1111
```

```
% Moving average filter
```

```
J = imfilter(I,f);
```

```
% Show the result
```

```
figure(2)
```

```
imshow(J)
```

```
title(['Moving averaging filter of size ' num2str(hsize) '\times' num2str(hsize)])
```

Moving averaging filter of size 3 × 3



ガウシアンフィルタ

(Gaussian filter)

3 × 3 サイズのガウシアンフィルタの定義を以下に示す。

(The definition of a Gaussian filter of size 3 × 3 is given below.)

$$\mathbf{f} = \frac{1}{\sum_{j=-1}^1 \sum_{i=-1}^1 g(i, j)} \begin{pmatrix} g(-1, -1) & g(-1, 0) & g(-1, 1) \\ g(0, -1) & g(0, 0) & g(0, 1) \\ g(1, -1) & g(1, 0) & g(1, 1) \end{pmatrix},$$

ただし、 σ を標準偏差として

(where let σ be a standard deviation and)

$$g(p_1, p_2) = \exp\left(-\frac{p_1^2 + p_2^2}{2\sigma^2}\right).$$

```
% Setting of kernel size and standard deviation
```

```
hsize = 3;
```

```
sigma = 0.5;
```

```
% Generating the filter kernel
```

```
f = fspecial('gaussian',hsize,sigma)
```

```
f = 3x3
```

```
    0.0113    0.0838    0.0113
    0.0838    0.6193    0.0838
    0.0113    0.0838    0.0113
```

```
% Mesh plot of the Gaussian kernel
```

```
[x,y] = meshgrid(-ceil(hsize/2-1):floor(hsize/2),-ceil(hsize/2-1):floor(hsize/2));
```

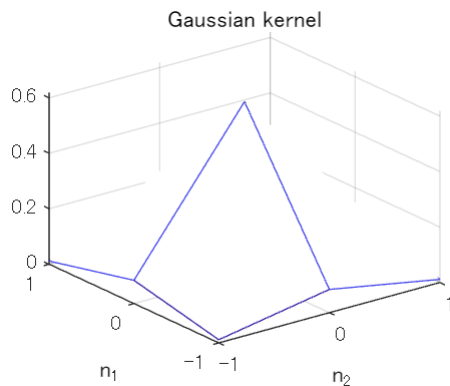
```
figure(3)
```

```
mesh(x,y,f)
```

```
title('Gaussian kernel')
```

```
xlabel('n_2')
```

```
ylabel('n_1')
```



```
% Gaussian filtering with IMFILTER
```

```
J = imfilter(I,f);
```

```
% Show result
```

```
figure(4)
```

```
imshow(J)
```

```
title(['Gaussian filer (IMFILTER) of size ' num2str(hsize) '\times' num2str(hsize)
', where \sigma = ' num2str(sigma)])
```

aussian filter (IMFILTER) of size 3×3 , where $\sigma = 0$.



```
% Gaussian filtering with IMGAUSSFILT
K = imgaussfilt(I,sigma);

% Kernel size
hsize = 2*ceil(2*sigma)+1;

% Show the result
figure(5)
imshow(K)
title(['Gaussian filter (IMGAUSSFILT) of size ' num2str(hsize) '\times'
num2str(hsize) ', where \sigma = ' num2str(sigma)])
```

aussian filter (IMGAUSSFILT) of size 3×3 , where $\sigma =$



ラプラシアンフィルタ

(Laplacian filter)

以下に 4 近傍ラプラシアンカーネルを示す。

(The four neighborhood Laplacian kernel is shown below.)

$$\mathbf{f} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

```
% Shape parameter setting
alpha = 0;
```

```
% Generating the filter kernel
f = fspecial('laplacian',alpha)
```

```
f = 3x3
    0     1     0
    1    -4     1
    0     1     0
```

```
% Laplacian filtering
```

```
J = imfilter(I,f);
```

```
% Show the result with bias
```

```
figure(6)
```

```
imshow(J+.5)
```

```
title(['Laplacian filter, where \alpha = ' num2str(alpha)])
```

Laplacian filter, where $\alpha = 0$



アンシャープマスクフィルタ

(Unsharp mask filter)

以下に 4 近傍ラプラシアンカーネルを示す。

(The four neighborhood Laplacian kernel is shown below.)

$$\mathbf{f} = \begin{pmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

```
% Shape parameter setting
```

```
alpha = 0;
```

```
% Generating the filter kernel
```

```
f = fspecial('unsharp',alpha)
```

```
f = 3x3
    0    -1     0
   -1     5    -1
    0    -1     0
```

```
% Unsharp mask filtering
```

```
J = imfilter(I,f);
```

```
% Show result
figure(7)
imshow(J)
title(['Unsharp mask filter, where \alpha = ' num2str(alpha)])
```

Unsharp mask filter, where $\alpha = 0$



ソーベルフィルタ

(Sobel filter)

ソーベル水平フィルタカーネル

(Sobel horizontal filter kernel)

$$\mathbf{f} = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

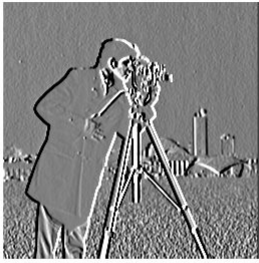
```
% Generating the filter kernel
f = fspecial('sobel');
f = rot90(f,-1)
```

```
f = 3x3
    -1     0     1
    -2     0     2
    -1     0     1
```

```
% Sobel horizontal filtering
H = imfilter(I,f);

% Show result with bias
figure(8)
imshow(H+.5)
title('Sobel horizontal filter')
```

Sobel horizontal filter



ソーベル水平フィルタカーネル

(Sobel vertical filter kernel)

$$\mathbf{f} = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$

```
% Generating the filter kernel
```

```
f = fspecial('sobel');
```

```
f = flipud(f)
```

```
f = 3x3
```

```
  -1   -2   -1  
   0    0    0  
   1    2    1
```

```
% Sobel vertical filtering
```

```
V = imfilter(I,f);
```

```
% Show result with bias
```

```
figure(9)
```

```
imshow(V+.5)
```

```
title('Sobel vertical filter')
```

Sobel vertical filter

