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

村松 正吾

動作確認: MATLAB R2020a

Image smoothing/sharpening

Moving averages and Laplacian

Advanced Topics in Image Processing

Shogo MURAMATSU

Verified: MATLAB R2020a

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 $3\times 3$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 = 3×3
    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 filer of size ' num2str(hsize) '\times' num2str(hsize)])
```

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)

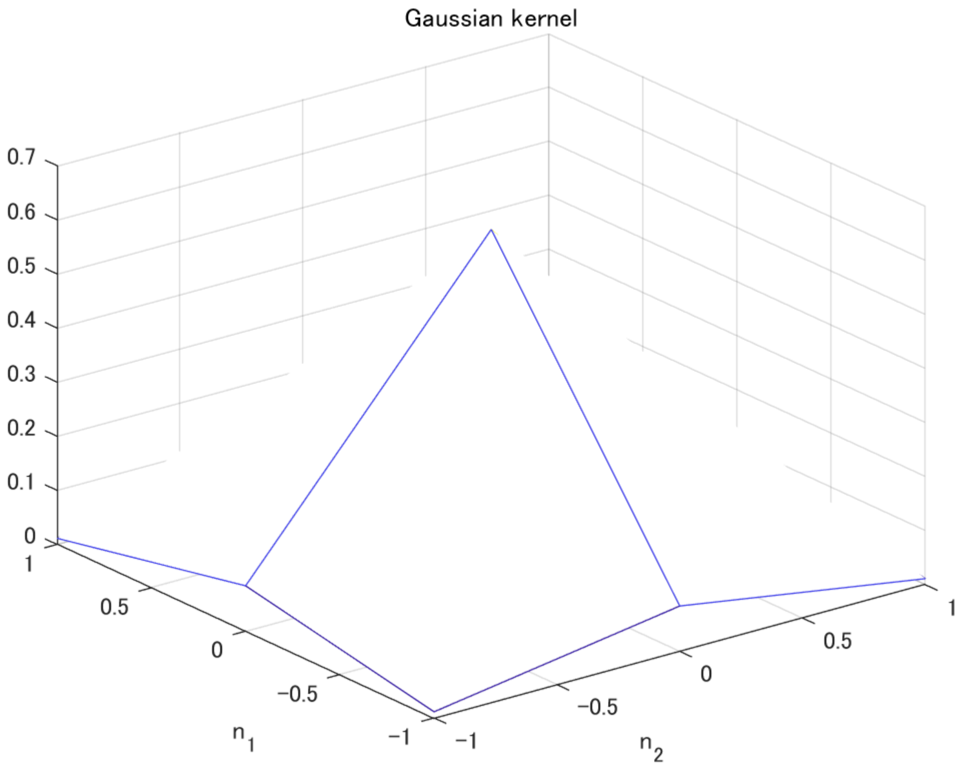
$$g(p_1,p_2) = \exp\left(-\frac{p_1^2+p_2^2}{2\sigma^2}\right).$$

```
% Setting of kernel size and standard deviation
hsize = 3;
sigma = 0.5;

% Generating the filter kernel
f = fspecial('gaussian',hsize,sigma)
```

```
f = 3×3
    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 \si
```

Gaussian filer (IMFILTER) of size 3×3, where σ = 0.5

```
% 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 filer (IMGAUSSFILT) of size ' num2str(hsize) '\times' num2str(hsize) ', where
```

ıaussian filer (IMGAUSSFILT) of size 3×3, where σ = 0.

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.)

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

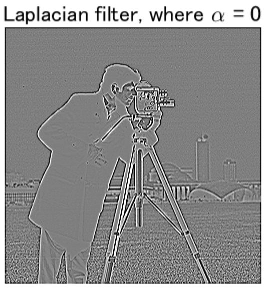
```
% Shape parameter setting
alpha = 0;

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

```
f = 3×3
     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)])
```



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.)

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

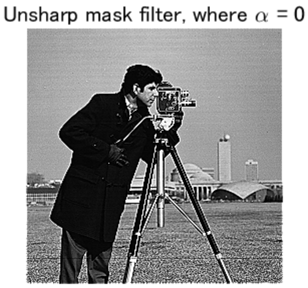
```
% Shape parameter setting
alpha = 0;

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

```
f = 3×3
     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)])
```



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)

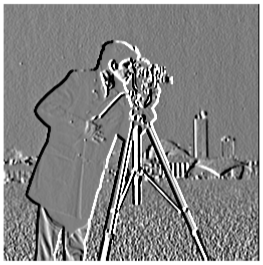
$$\mathbf{f} = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

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

```
f = 3×3
    -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)

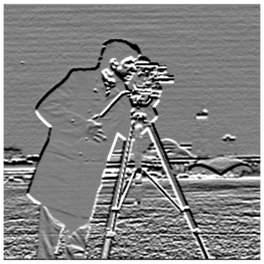
$$\mathbf{f} = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$$

```
% Generating the filter kernel
f = fspecial('sobel');
f = flipud(f)
```

```
f = 3×3
    -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