Sample 7-2

幾何学処理

縮小処理

画像処理特論

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動作確認: MATLAB R2020a

Geometric image processing

Decimation

Advanced Topics in Image Processing

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Verified: MATLAB R2020a

準備

(Preparation)

```
close all
```

間引き率の設定

(Setting of downsampling factor)

- M: 間引き率 (downsampling factor)

```
% Downsampling factor
dFactor = 2;

% Downsampling phase
dPhase = 0;
```

平均フィルタのインパルス応答 (Impulse response of averaging filter)

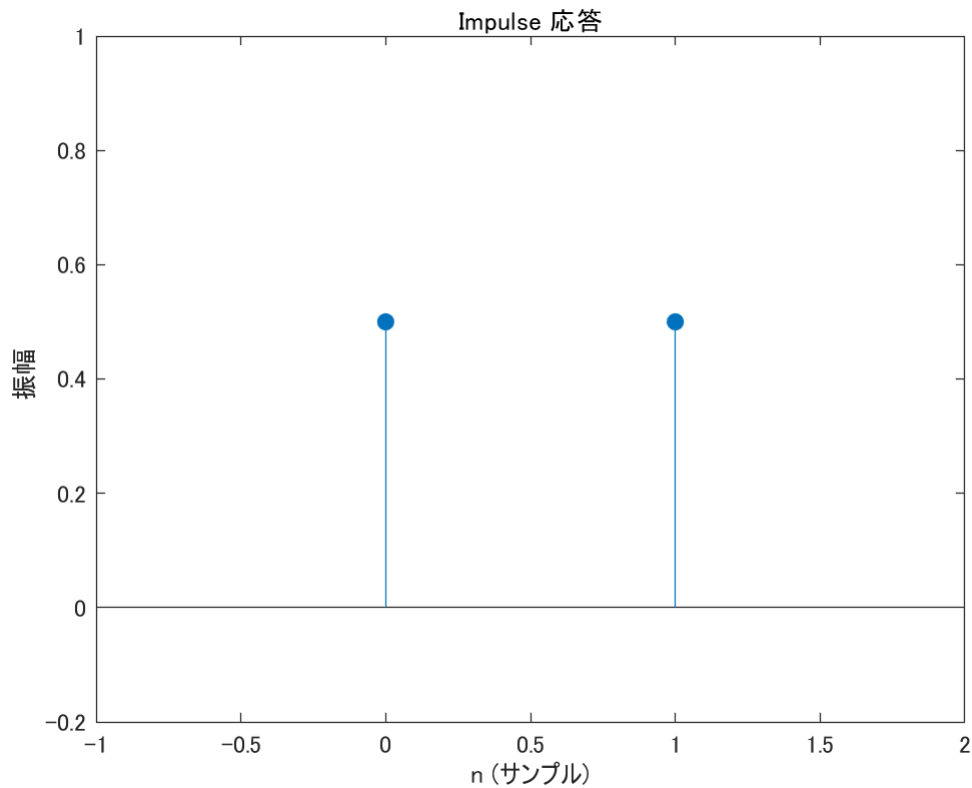$$h[n] = \begin{cases} \dfrac{1}{M} & 0 \le n \le M-1 \\ 0 & \text{otherwise} \end{cases}$$

- $\{h[n]\}_n$: インパルス応答 (Impulse response)

```
% Impulse response of averaging filter
h = ones(1,dFactor)/dFactor;
```
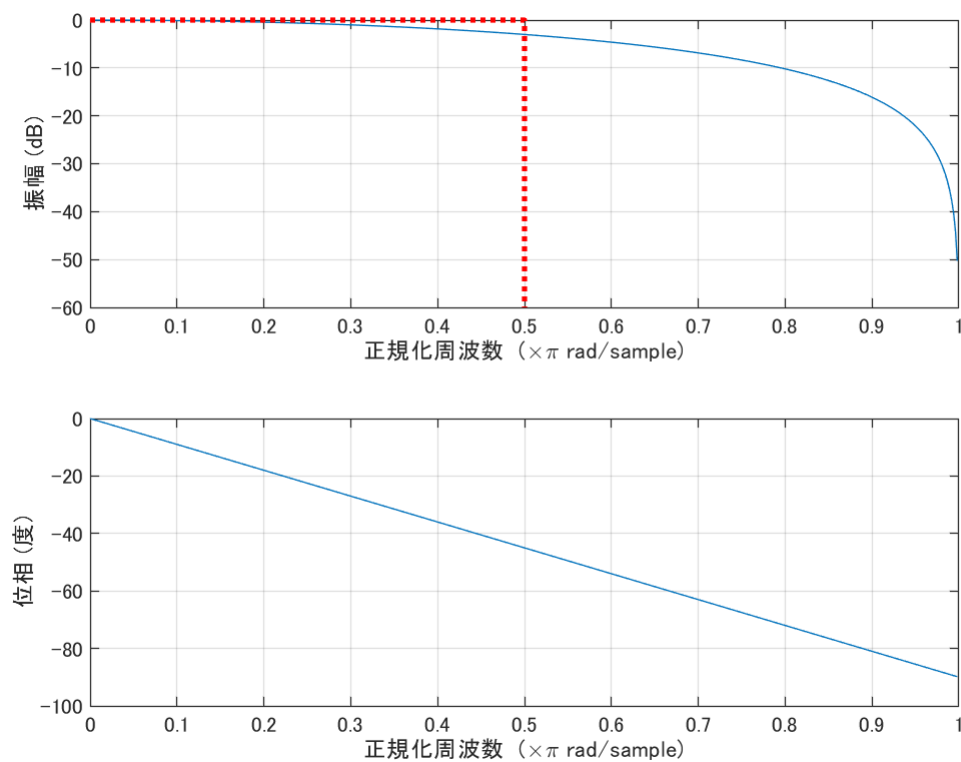
フィルタ特性の表示

(Display of filter characteristics)

```matlab
% Impulse response
figure(1)
impz(h)
ax = gca;
ax.XLim = [-1 length(h)];
ax.YLim = [-0.2 1];
```


% Impulse 応答

```matlab
% Frequency response
figure(2)
freqz(h)
ax = gca;
hold on
line([0 1/dFactor 1/dFactor],[0 0 ax.YLim(1)],...
    'LineStyle',':','LineWidth',2,'Color','red');
hold off
```
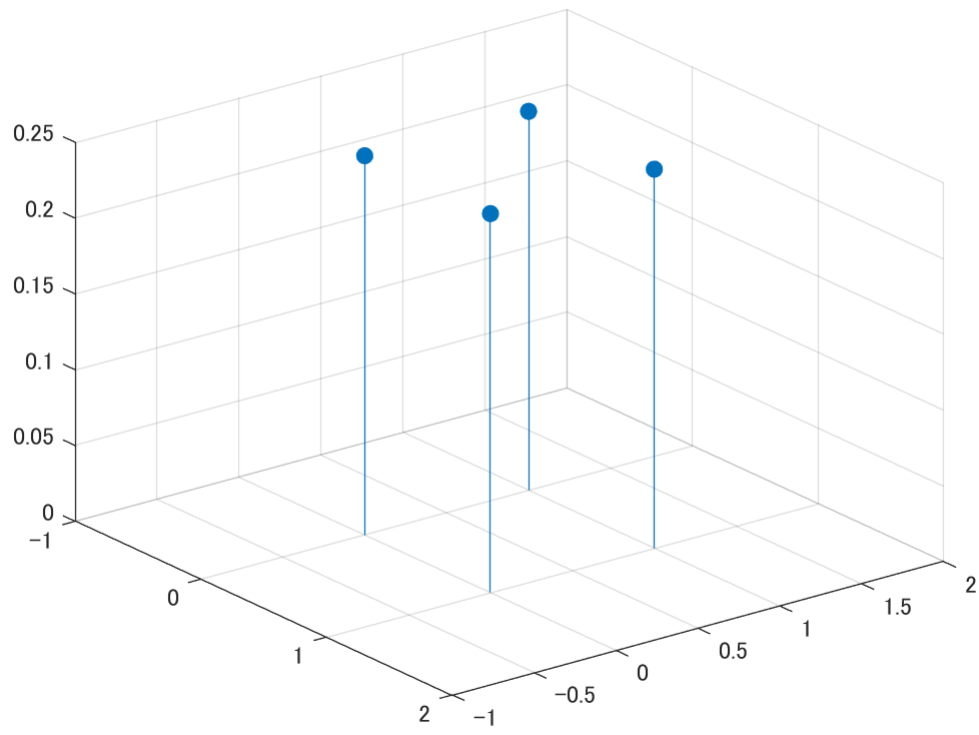
画像への適用

(Application to images)

$$v[\mathbf{m}] = \sum_{\mathbf{k} \in \mathbb{Z}^2} h[\mathbf{k}] u[M\mathbf{m} - \mathbf{k}] = \frac{1}{|\det \mathbf{M}|} \sum_{\mathbf{k} \in \mathcal{N}(\mathbf{M})} u[\mathbf{M}\mathbf{m} - \mathbf{k}]$$

$$h[\mathbf{n}] = \begin{cases} \dfrac{1}{|\det \mathbf{M}|} & \mathbf{n} \in \mathcal{N}(\mathbf{M}) \\ 0 & \text{otherwise} \end{cases}$$
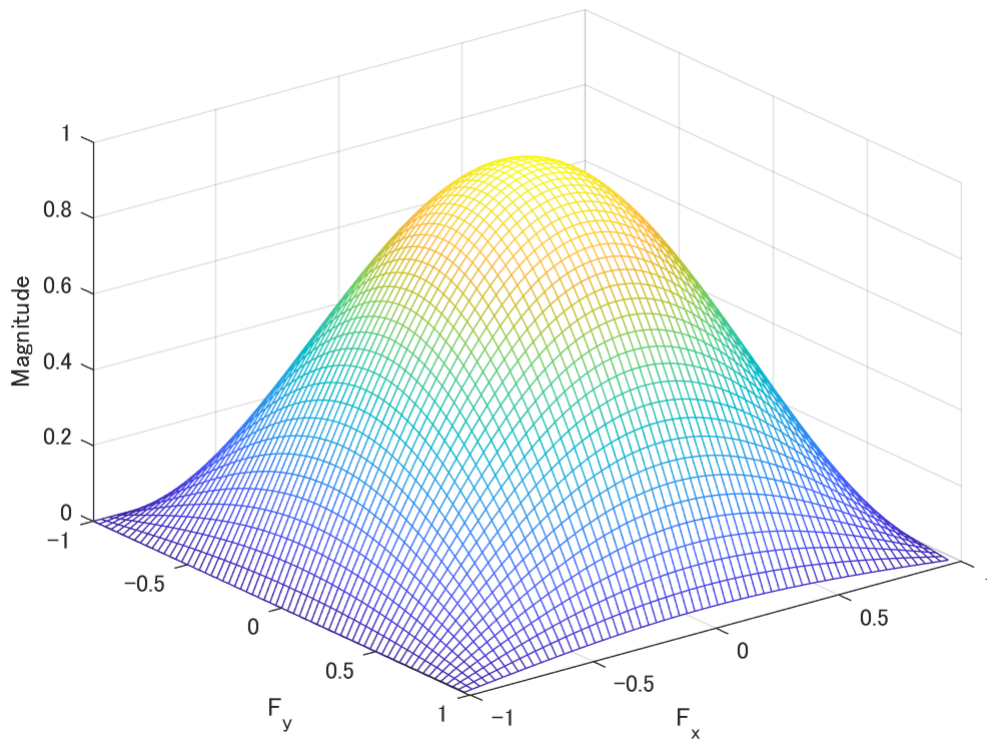
Note that if $\mathbf{M} = \mathrm{diag}(M, M) \Rightarrow |\det \mathbf{M}| = M^2$ and $\mathcal{N}(\mathbf{M}) = \{0, 1, \cdots, M - 1\}^2$.

```
% Reading an image
u = imread('cameraman.tif');

% Generating the average filter
h = fspecial('average',dFactor);
figure(3)
stem3(0:(dFactor-1),0:dFactor-1,h,'filled')
axis ij
ax = gca;
ax.XLim = [-1 dFactor];
ax.YLim = [-1 dFactor];
```

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```
figure(4)
freqz2(h)
axis ij
```

```matlab
% Bivariate downsampling function
downsample2 = @(x,n,phase) ...
    shiftdim(downsample(...
    shiftdim(downsample(x,...
    n(1),phase(1)),1),...
    n(2),phase(2)),1);

% Box-averaging with filtering and downsampling
v = downsample2(imfilter(u,h,'conv','symmetric'),dFactor*[1 1],dPhase*[1 1]);

% Box-averaging with IMRESIZE
y = imresize(u,1/dFactor,'box');
```

画像表示

(Display image)

原画像 (Original)

```matlab
figure(5)
imshow(u)
title('Original')
```

Original

縮小画像 (Decimated image)

```matlab
% Definition of MSE
mymse = @(x,y) sum((x-y).^2,'all')/numel(x);

% Display results
figure(6)
subplot(1,3,1)
imshow(v)
title('Decimation w/o IMRESIZE')
subplot(1,3,2)
imshow(y)
title('Decimation w/ IMRESIZE')
subplot(1,3,3)
imshow(imabsdiff(v,y))
title(['Absolute difference (MSE = ' num2str(mymse(v,y)) ')'])
```
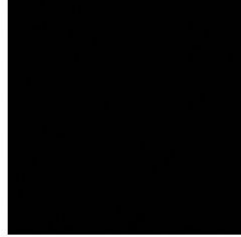
Decimation w/o IMRESIZE　　Decimation w/ IMRESIZE　　Absolute difference (MSE = 0)