

## Sample 7-2

### 幾何学処理

縮小処理

画像処理特論

村松 正吾

動作確認: MATLAB R2020a

### Geometric image processing

Decimation

Advanced Topics in Image Processing

Shogo MURAMATSU

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)

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

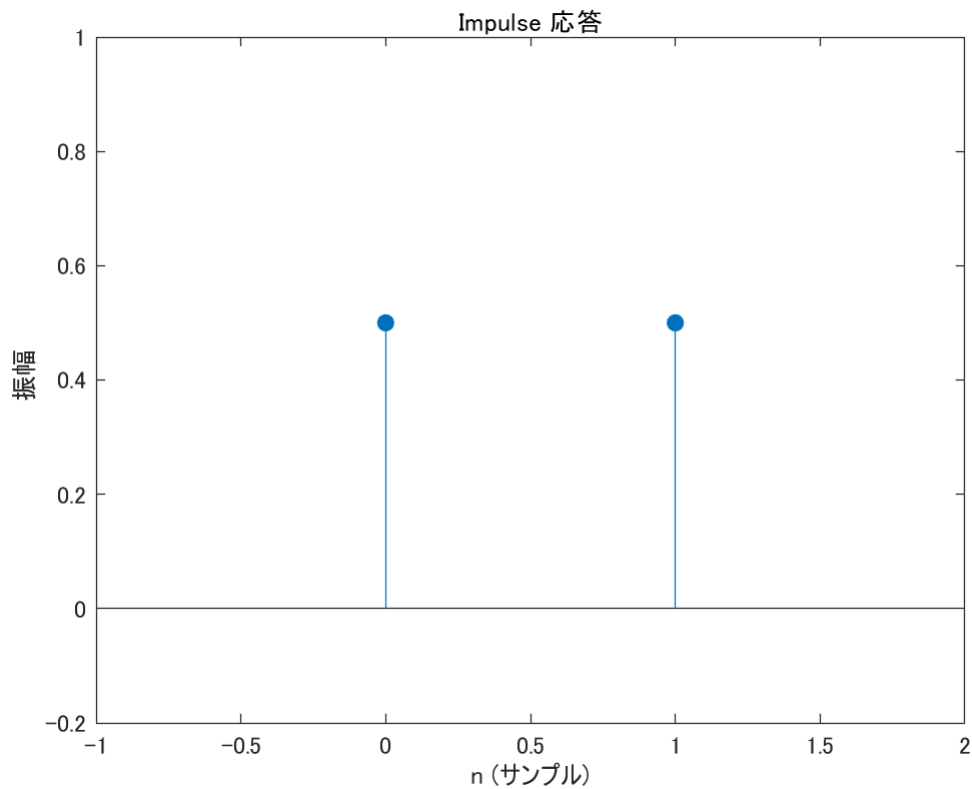
- $\{h[n]\}_n$ : インパルス応答 (Impulse response)

```
% Impulse response of averaging filter  
h = ones(1,dFactor)/dFactor;
```

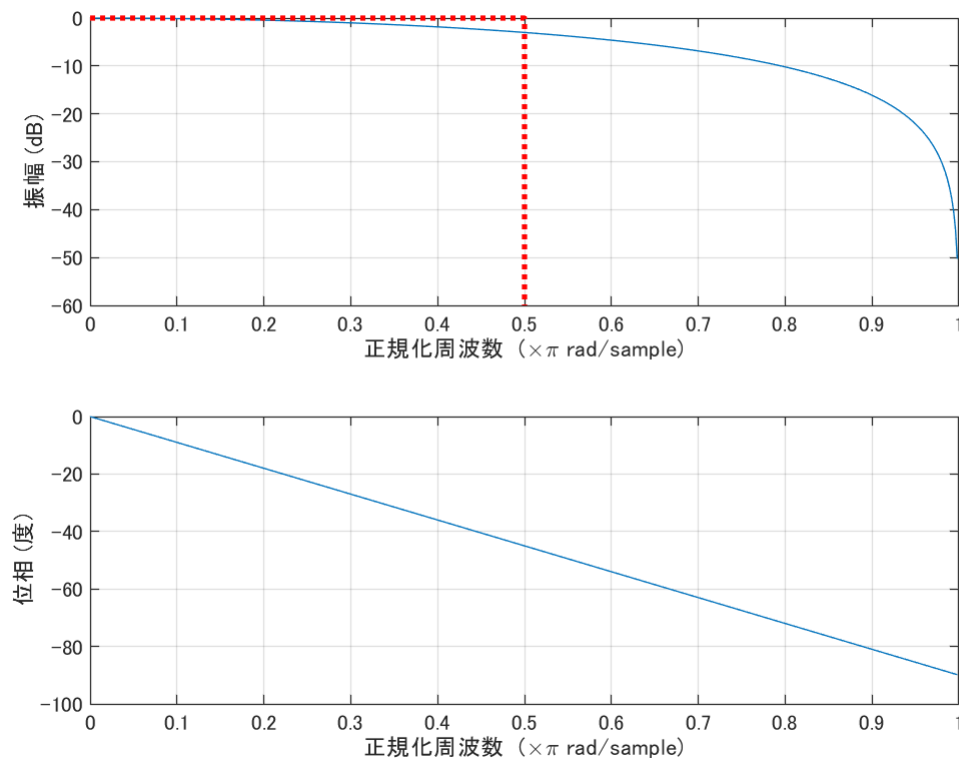
## フィルタ特性の表示

(Display of filter characteristics)

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



```
% 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)

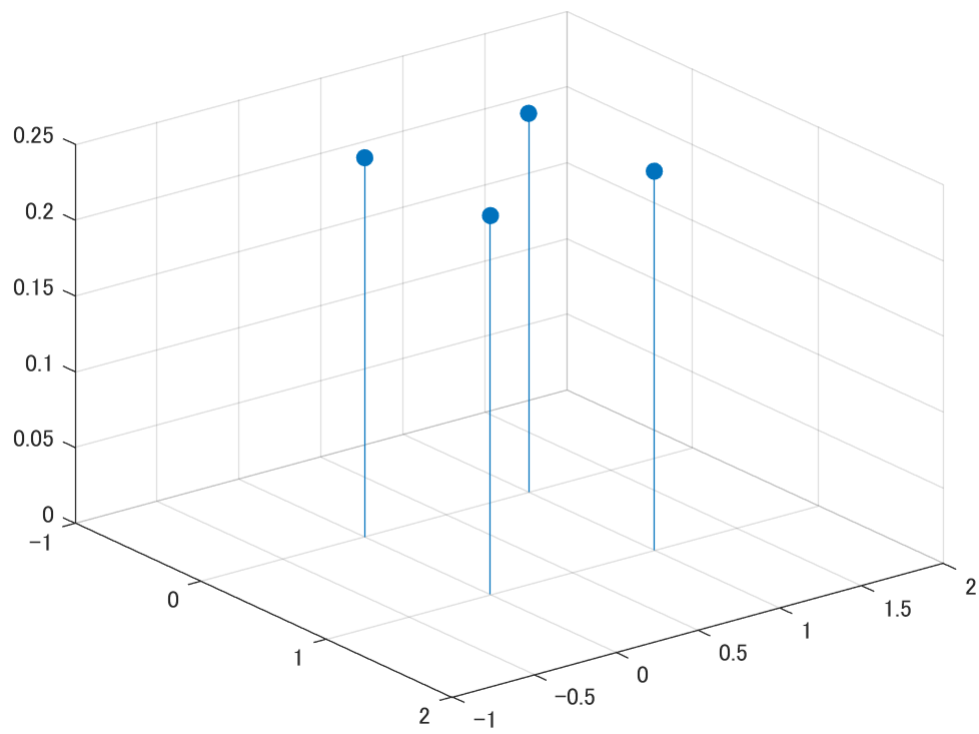
$$v[\mathbf{m}] = \sum_{\mathbf{k} \in \mathbb{Z}^2} h[\mathbf{k}] u[\mathbf{M}\mathbf{m} - \mathbf{k}] = \frac{1}{|\det \mathbf{M}|} \sum_{\mathbf{k} \in \mathcal{N}(\mathbf{M})} u[\mathbf{M}\mathbf{m} - \mathbf{k}]$$

$$h[\mathbf{n}] = \begin{cases} \frac{1}{|\det \mathbf{M}|} & \mathbf{n} \in \mathcal{N}(\mathbf{M}) \\ 0 & \text{otherwise} \end{cases}$$

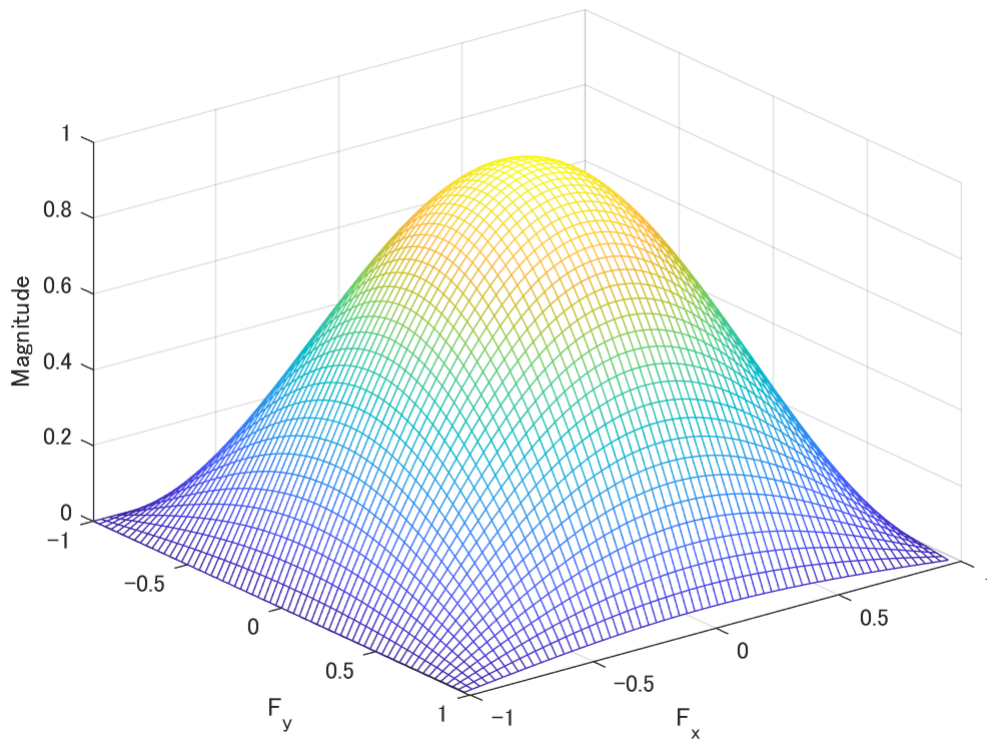
Note that if  $\mathbf{M} = \text{diag}(M, M) \Rightarrow |\det \mathbf{M}| = M^2$  and  $\mathcal{N}(\mathbf{M}) = \{0, 1, \dots, M-1\}^2$ .

```
% 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];
```



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



```
% 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)

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

Original



縮小画像 (Decimated image)

```
% 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)



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