

Sample 6-2

標本化

単変量ダウンサンプリング

画像処理特論

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動作確認: MATLAB R2023a

Sampling

Univariate downsampling

Advanced Topics in Image Processing

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Verified: MATLAB R2023a

準備

(Preparation)

```
close all
```

間引き率の設定

(Setting the downsampling factor)

- M : 間引き率 (downsampling factor)

```
% Downsampling factor  
dFactor = 2;
```

入力数列の設定

(Setting an input sequence)

- $\{u[n]\}_n$: 入力数列 (input sequence)

```
% Create a sequence from sound data  
startIndex = 256;  
nInputSamples = 32;  
load gong;  
inputSeq = y(startIndex:startIndex+nInputSamples-1);  
load chirp;  
inputSeq = inputSeq + y(startIndex:startIndex+nInputSamples-1);
```

出力数列の計算

(Computation of the output sequence)

- $\{v[n]\}_n$: 出力数列 (output sequence)

$$v[m] = u[Mm], \quad m \in \mathbb{Z}$$

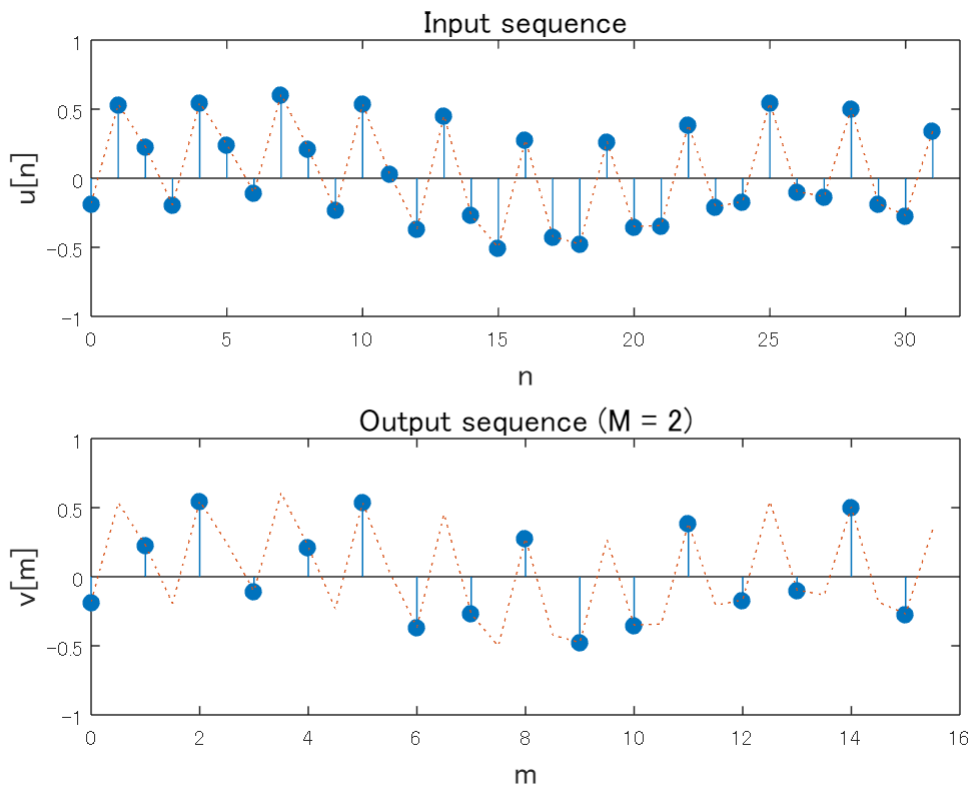
```
% Downsampling
outputSeq = downsample(inputSeq,dFactor);
nOutputSamples = length(outputSeq);
```

入出力数列の表示

(Display of the input and output sequences)

```
% Plot the input and output sequences
figure(1)
% Input sequence
subplot(2,1,1)
stem(0:nInputSamples-1,inputSeq,'filled')
hold on
plot(0:nInputSamples-1,inputSeq,':')
axis([0 nInputSamples -1 1])
title('Input sequence','FontSize',12)
xlabel('n','FontSize',12)
ylabel('u[n]','FontSize',12)
hold off

% Output sequence
subplot(2,1,2)
stem(0:nOutputSamples-1,outputSeq,'filled')
hold on
plot(0:1/dFactor:(nInputSamples-1)/dFactor,inputSeq,':')
axis([0 nInputSamples/dFactor -1 1])
title(sprintf('Output sequence (M = %d)',dFactor),'FontSize',12)
xlabel('m','FontSize',12)
ylabel('v[m]','FontSize',12)
hold off
```



入力数列の設定

(Setting the input sequence)

```
% Creation of a modulated Gaussian
w = 0; % Modulation frequency
nInputSamples = 128;
inputSeq = gausswin(nInputSamples);
inputSeq = inputSeq/sum(inputSeq);
inputSeq = inputSeq.*cos((0:(nInputSamples-1)).'*w);
```

出力数列の計算

(Computation of the output sequence)

$$V(e^{j\omega}) = \frac{1}{M} \sum_{k=0}^{M-1} U\left(e^{j\frac{(\omega-2\pi k)}{M}}\right)$$

```
% Downsampling
outputSeq = downsample(inputSeq,dFactor);
nOutputSamples = length(outputSeq);
```

入出力スペクトルの表示

(Display of the input and output spectrum)

```

% Display spectra
figure(2)
% Input spectrum
subplot(2,1,1)
[H,W] = freqz(inputSeq);
plot(W/pi,20*log10(abs(H)))
title('Input sequence','FontSize',12)
xlabel('\omega /\pi [rad]','FontSize',12)
ylabel('|U(e^{j\omega})| [dB]','FontSize',12)
axis([ 0 1 -70 30 ])
grid on

% Output spectrum
subplot(2,1,2)
[H,W] = freqz(outputSeq);
plot(W/pi,20*log10(abs(H)))
title(sprintf('Output sequence (M = %d)',dFactor),'FontSize',12)
xlabel('\omega /\pi [rad]','FontSize',12)
ylabel('|V(e^{j\omega})| [dB]','FontSize',12)
axis([ 0 1 -70 30 ])
grid on

```

