Sample 11-2

画像ノイズ除去

ノイズの変換

画像処理特論

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動作確認: MATLAB R2023a

Image denoising

Transform of noise

Advanced Topics in Image Processing

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Verified: MATLAB R2023a

準備

(Preparation)

```
clear
close all
import msip.download_img
msip.download_img
```

```
kodim01.png already exists in ./data/
kodim02.png already exists in ./data/
kodim03.png already exists in ./data/
kodim04.png already exists in ./data/
kodim05.png already exists in ./data/
kodim06.png already exists in ./data/
kodim07.png already exists in ./data/
kodim08.png already exists in ./data/
kodim09.png already exists in ./data/
kodim10.png already exists in ./data/
kodim11.png already exists in ./data/
kodim12.png already exists in ./data/
kodim13.png already exists in ./data/
kodim14.png already exists in ./data/
kodim15.png already exists in ./data/
kodim16.png already exists in ./data/
kodim17.png already exists in ./data/
kodim18.png already exists in ./data/
kodim19.png already exists in ./data/
kodim20.png already exists in ./data/
kodim21.png already exists in ./data/
kodim22.png already exists in ./data/
kodim23.png already exists in ./data/
kodim24.png already exists in ./data/
See Kodak Lossless True Color Image Suite
```

パラメータ設定

(Parameter settings)

- sgm: ノイズ標準偏差 σ_w (Standard deviation of noise)
- nlevels: ウェーブレット段数 (Wavelet levels)

```
% Parameter settings
sgmuint8 = 30;
sgm = sgmuint8/255;
nlevels = 3;
```

画像の読込

(Read image)

```
u = im2double(imread('./data/kodim23.png'));
if size(u,3) == 3
    u = rgb2gray(u);
end
```

分析処理

(Analysis process)

直交ウェーブレット変換 Symlet を利用．(Uses Symlet, which is an orthogonal wavelet transform.)

```
% Preperation of filters for wavelets
iswtb = license('checkout','wavelet_toolbox');
if iswtb % Functions in Wavelet Toolbox are used
    dwtmode('per')
    wname = "sym4";
    [h0,h1,f0,f1] = wfilters(wname);
    %save(['./data/' char(wname) '.mat'],'h0','h1','f0','f1')
else
    import msip.ezwavedec2
    import msip.ezwaverec2
    S = load('./data/sym4.mat');
    h0 = S.h0;
    h1 = S.h1;
    f0 = S.f0;
    f1 = S.f1;
    clear H  F
    % Analysis bivariate filters
    H.h00 = h0(:)*h0(:).';
    H.h01 = h0(:)*h1(:).';
    H.h10 = h1(:)*h0(:).';
    H.h11 = h1(:)*h1(:).';
    % Synthesis bivariate filters
    F.f00 = f0(:)*f0(:).';
    F.f01 = f0(:)*f1(:).';
```

```
    F.f10 = f1(:)*f0(:).';
    F.f11 = f1(:)*f1(:).';
end
```

```
**********************
**  DWT 拡張モード: 周期化  **
**********************
```

分析処理 (Analysis process)

```
if iswtb
    [coefs,scales] = wavedec2(u,nlevels,h0,h1);
    % Reconstruction to check PR
    r = waverec2(coefs,scales,f0,f1);
else
    [coefs,scales] = ezwavedec2(u,nlevels,H);
    % Reconstruction to check PR%
    r = ezwaverec2(coefs,scales,F);
end
assert(norm(u-r,"fro")^2/numel(u)<1e-18,'Perfect reconstruction is violated.')
```

変換係数の配列化 (Alighment of coefficients)

```
uc = aligncoefs(coefs,scales);
```

観測画像

(Observation image)

```
v = imnoise(u,'gaussian',0,sgm^2);
```

分析処理 (Analysis process)

```
if iswtb
    [coefs,scales] = wavedec2(v,nlevels,h0,h1);
else
    [coefs,scales] = ezwavedec2(v,nlevels,H);
end

%% 変換係数の配列化
pos = 0;
dim = scales(1,:);
```

変換係数の配列化 (Alighment of coefficients)

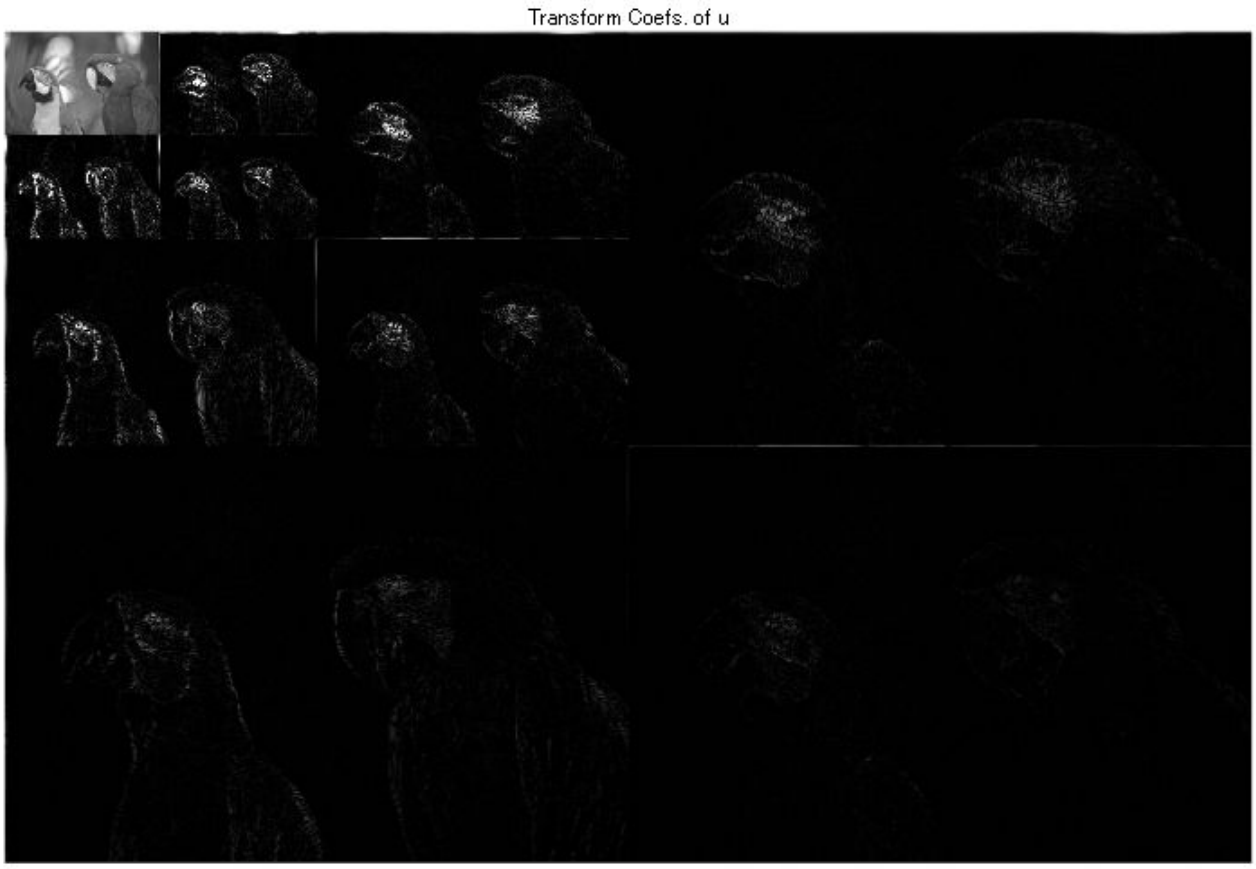
```
vc = aligncoefs(coefs,scales);
```

画像表示

(Image show)

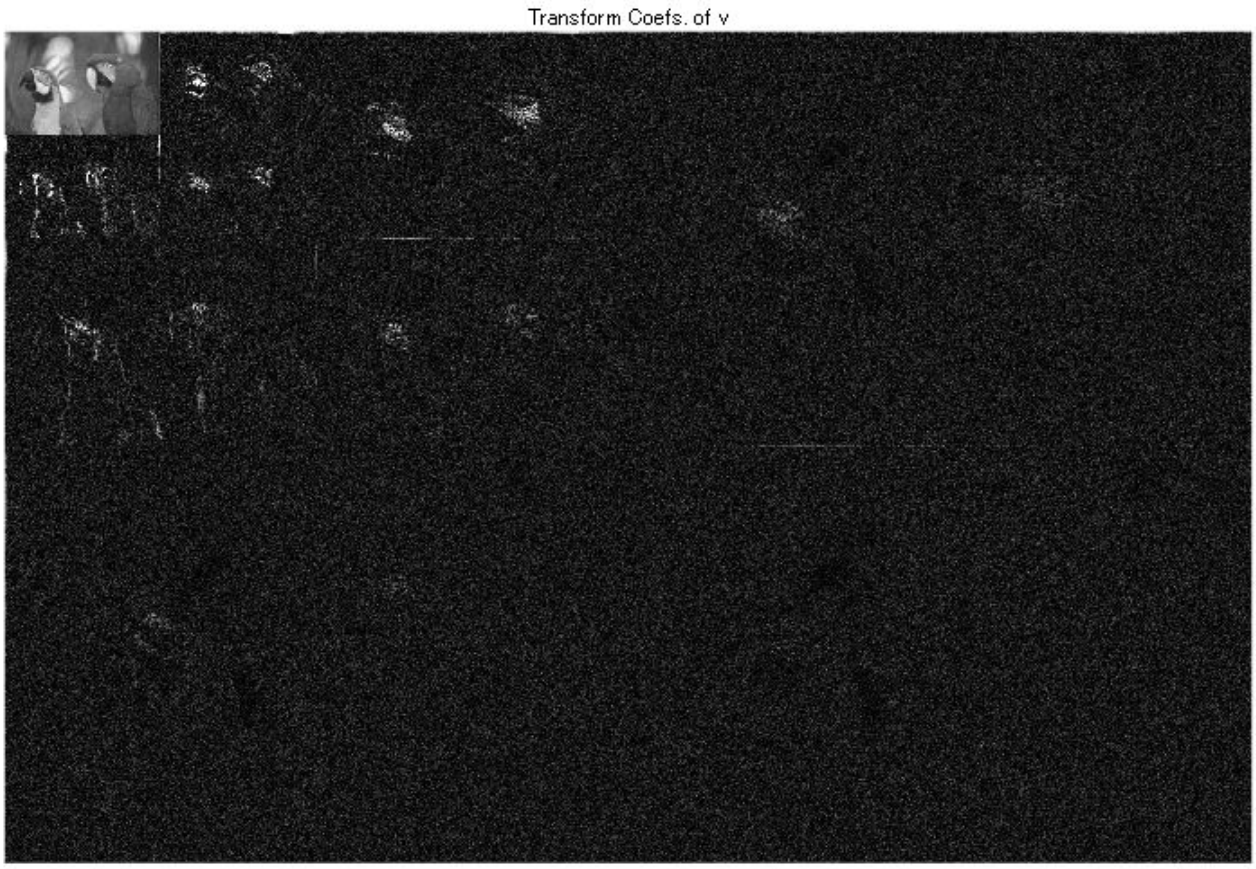
```
figure
imshow(u);
title('Original image u')
```


```
figure
imshow(abs(uc))
title('Transform Coefs. of u')
```




```
figure
imshow(v)
title(sprintf('Noisy image v : PSNR = %5.2f [dB]',psnr(u,v)))
```


```
figure
imshow(abs(vc))
title('Transform Coefs. of v')
```



関数定義

(Definition of function)

変換係数の配列化 (Alighment of coefficients)

```
function c00 = aligncoefs(coefs,scales)
nlevels = size(scales,1)-2;
pos = 0;
dim = scales(1,:);
nel = prod(dim);
c00 = reshape(coefs(pos+1:pos+nel),dim)/(2^nlevels);
pos = nel;
for ilv = 1:nlevels
    dim = scales(ilv+1,:);
    nel = prod(dim);
    %
    c01 = abs(reshape(coefs(pos+1:pos+nel),dim));
    pos = pos + nel;
    %
    c10 = abs(reshape(coefs(pos+1:pos+nel),dim));
    pos = pos + nel;
    %
```

```
    c11 = abs(reshape(coefs(pos+1:pos+nel),dim));
    pos = pos + nel;
    %
    c00 = [ c00 c01; c10 c11 ];
end
end
```