

Laboratorium 12

Transformacja falkowa - właściwości i zastosowania

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1. Wstęp

Transformacja Fouriera stosuje w jądze funkcje sinusoidalne, natomiast transformacja falkowa stosuje funkcje (falki), które spełniają wymagania analizy częstotliwościowej. Funkcje okresowe (sin/cos) są dobre do określenia częstotliwości, ale nie w dziedzinie czasu. Transformacja falkowa służy do analizy sygnałów niestacjonarnych, gdyż dostarcza informacji o czasowo-częstotliwościowych zmianach sygnałów

2. Przebieg laboratorium

Zad 1

Obliczyć współczynnik d5 z zastosowaniem falki 'db2' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'db2';  
num = 5;  
  
% P20  
[c, l] = wavedec(P20, num, falka);  
[d5_P20] = detcoef(c, l, num)
```

```
d5_P20 = 1381x1  
    0.0991  
    0.5636  
    0.0769  
    0.1056  
   -0.1228  
   -0.0567  
    0.0412  
   -0.3364  
   -0.2354  
    0.2691  
        ⋮  
        ⋮
```

```
% P21  
[c, l] = wavedec(P21, num, falka);  
[d5_P21] = detcoef(c, l, num)
```

```
d5_P21 = 1381x1  
   -0.0882  
    0.4629  
   -0.2254  
   -0.5982  
   -0.2606  
    0.5902  
   -0.3898  
   -0.1755  
    0.2412
```

```
0.0027
⋮
```

```
% P23
```

```
[c, l] = wavedec(P23, num, falka);
[d5_P23] = detcoef(c, l, num)
```

```
d5_P23 = 1381×1
0.0201
-0.1864
0.2455
-0.0205
0.1849
-0.3301
-0.0386
-0.0009
-0.1847
-0.2398
⋮
```

```
% P24
```

```
[c, l] = wavedec(P24, num, falka);
[d5_P24] = detcoef(c, l, num)
```

```
d5_P24 = 1381×1
-0.0241
0.0732
-0.1612
0.0976
-0.5347
-0.3691
-0.0714
0.2332
0.4713
0.1872
⋮
```

```
% W20
```

```
[c, l] = wavedec(P20, num, falka);
[d5_W20] = detcoef(c, l, num)
```

```
d5_W20 = 1381×1
0.0991
0.5636
0.0769
0.1056
-0.1228
-0.0567
0.0412
-0.3364
-0.2354
0.2691
⋮
```

```
% W21
```

```
[c, l] = wavedec(P21, num, falka);  
[d5_W21] = detcoef(c, l, num)
```

```
d5_W21 = 1381x1  
-0.0882  
0.4629  
-0.2254  
-0.5982  
-0.2606  
0.5902  
-0.3898  
-0.1755  
0.2412  
0.0027  
:  
:
```

```
% W23
```

```
[c, l] = wavedec(P23, num, falka);  
[d5_W23] = detcoef(c, l, num)
```

```
d5_W23 = 1381x1  
0.0201  
-0.1864  
0.2455  
-0.0205  
0.1849  
-0.3301  
-0.0386  
-0.0009  
-0.1847  
-0.2398  
:  
:
```

```
% W24
```

```
[c, l] = wavedec(P24, num, falka);  
[d5_W24] = detcoef(c, l, num)
```

```
d5_W24 = 1381x1  
-0.0241  
0.0732  
-0.1612  
0.0976  
-0.5347  
-0.3691  
-0.0714  
0.2332  
0.4713  
0.1872  
:  
:
```

Zad 2

Obliczyć współczynnik a_4 z zastosowaniem falki 'coif2' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'coif2';
num = 4;

% P20
[c, l] = wavedec(P20, num, falka);
[d5_P20] = appcoef(c, l, falka, num)
```

```
d5_P20 = 2766×1
-0.7636
-0.7740
-0.7559
-0.7545
-0.7461
-0.8531
-0.1523
 0.0976
 0.1985
-0.1920
  ⋮
```

```
% P21
[c, l] = wavedec(P21, num, falka);
[d5_P21] = appcoef(c, l, falka, num)
```

```
d5_P21 = 2766×1
-0.0077
 0.0898
 0.0782
-0.0610
 0.0541
 0.0855
 0.0901
 0.1077
-0.1058
 0.2221
  ⋮
```

```
% P23
[c, l] = wavedec(P23, num, falka);
[d5_P23] = appcoef(c, l, falka, num)
```

```
d5_P23 = 2766×1
 0.4091
 0.3846
 0.3784
 0.4221
 0.3996
 0.4115
 0.1820
-0.2484
 0.0876
 0.1442
  ⋮
```

```
% P24
```

```
[c, l] = wavedec(P24, num, falka);
[d5_P24] = appcoef(c, l, falka, num)
```

```
d5_P24 = 2766×1
-0.1909
-0.2388
-0.1935
-0.1828
-0.2288
-0.2493
-0.0736
 0.1137
-0.1491
-0.1880
  ⋮
```

```
% W20
```

```
[c, l] = wavedec(P20, num, falka);
[d5_W20] = appcoef(c, l, falka, num)
```

```
d5_W20 = 2766×1
-0.7636
-0.7740
-0.7559
-0.7545
-0.7461
-0.8531
-0.1523
 0.0976
 0.1985
-0.1920
  ⋮
```

```
% W21
```

```
[c, l] = wavedec(P21, num, falka);
[d5_W21] = appcoef(c, l, falka, num)
```

```
d5_W21 = 2766×1
-0.0077
 0.0898
 0.0782
-0.0610
 0.0541
 0.0855
 0.0901
 0.1077
-0.1058
 0.2221
  ⋮
```

```
% W23
```

```
[c, l] = wavedec(P23, num, falka);
[d5_W23] = appcoef(c, l, falka, num)
```

```
d5_W23 = 2766×1
 0.4091
```

```

0.3846
0.3784
0.4221
0.3996
0.4115
0.1820
-0.2484
0.0876
0.1442
:

```

```
% W24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_W24] = appcoef(c, l, falka, num)

```

```

d5_W24 = 2766×1
-0.1909
-0.2388
-0.1935
-0.1828
-0.2288
-0.2493
-0.0736
0.1137
-0.1491
-0.1880
:

```

Zad 3

Obliczyć współczynnik a8 z zastosowaniem falki 'coif2' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```

falka = 'coif2';
num = 8;

```

```
% P20
```

```

[c, l] = wavedec(P20, num, falka);
[d5_P20] = appcoef(c, l, falka, num)

```

```

d5_P20 = 183×1
-2.8530
-2.9342
-2.9387
-2.8723
-2.9204
-3.1563
-1.4812
0.1652
-0.0255
-0.0288
:

```

```
% P21
```

```
[c, l] = wavedec(P21, num, falka);
```

```
[d5_P21] = appcoef(c, l, falka, num)
```

```
d5_P21 = 183×1  
    0.1939  
    0.1687  
    0.1855  
    0.1757  
    0.1738  
    0.1805  
    0.1429  
    0.0222  
   -0.0499  
    0.0012  
        ⋮
```

```
% P23
```

```
[c, l] = wavedec(P23, num, falka);  
[d5_P23] = appcoef(c, l, falka, num)
```

```
d5_P23 = 183×1  
    1.5128  
    1.5246  
    1.5520  
    1.5102  
    1.5247  
    1.6618  
    0.7708  
   -0.0598  
   -0.0468  
   -0.0584  
        ⋮
```

```
% P24
```

```
[c, l] = wavedec(P24, num, falka);  
[d5_P24] = appcoef(c, l, falka, num)
```

```
d5_P24 = 183×1  
   -0.8086  
   -0.8031  
   -0.8261  
   -0.8123  
   -0.8037  
   -0.8739  
   -0.4292  
    0.0179  
    0.0452  
   -0.0725  
        ⋮
```

```
% W20
```

```
[c, l] = wavedec(P20, num, falka);  
[d5_W20] = appcoef(c, l, falka, num)
```

```
d5_W20 = 183×1  
   -2.8530  
   -2.9342
```

```
-2.9387  
-2.8723  
-2.9204  
-3.1563  
-1.4812  
0.1652  
-0.0255  
-0.0288  
⋮
```

```
% W21
```

```
[c, l] = wavedec(P21, num, falka);  
[d5_W21] = appcoef(c, l, falka, num)
```

```
d5_W21 = 183×1  
0.1939  
0.1687  
0.1855  
0.1757  
0.1738  
0.1805  
0.1429  
0.0222  
-0.0499  
0.0012  
⋮
```

```
% W23
```

```
[c, l] = wavedec(P23, num, falka);  
[d5_W23] = appcoef(c, l, falka, num)
```

```
d5_W23 = 183×1  
1.5128  
1.5246  
1.5520  
1.5102  
1.5247  
1.6618  
0.7708  
-0.0598  
-0.0468  
-0.0584  
⋮
```

```
% W24
```

```
[c, l] = wavedec(P24, num, falka);  
[d5_W24] = appcoef(c, l, falka, num)
```

```
d5_W24 = 183×1  
-0.8086  
-0.8031  
-0.8261  
-0.8123  
-0.8037  
-0.8739
```



```
-0.4292
0.0179
0.0452
-0.0725
⋮
```

Zad 4

Obliczyć współczynnik d10 z zastosowaniem falki 'haar' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'haar';
num = 10;
```

```
% P20
```

```
[c, l] = wavedec(P20, num, falka);
[d5_P20] = detcoef(c, l, num)
```

```
d5_P20 = 44×1
```

```
-0.0597
-0.0083
-0.0253
0.0581
-0.0581
-0.0466
0.0830
-0.0947
-0.0013
0.1108
⋮
```

```
% P21
```

```
[c, l] = wavedec(P21, num, falka);
[d5_P21] = detcoef(c, l, num)
```

```
d5_P21 = 44×1
```

```
0.0488
-0.0400
0.0597
0.0712
-0.0028
0.0540
0.0235
-0.0480
-0.0506
0.0524
⋮
```

```
% P23
```

```
[c, l] = wavedec(P23, num, falka);
[d5_P23] = detcoef(c, l, num)
```

```
d5_P23 = 44×1
```

```
-0.0235
```

```

0.0046
-0.0487
0.0381
-0.0262
-0.0110
0.0076
0.0690
-0.0208
-0.0073
⋮

```

```
% P24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_P24] = detcoef(c, l, num)

```

```

d5_P24 = 44×1
-0.0924
0.1219
-0.0622
-0.0650
0.0118
-0.0445
-0.1189
0.0157
0.1002
-0.0974
⋮

```

```
% W20
```

```

[c, l] = wavedec(P20, num, falka);
[d5_W20] = detcoef(c, l, num)

```

```

d5_W20 = 44×1
-0.0597
-0.0083
-0.0253
0.0581
-0.0581
-0.0466
0.0830
-0.0947
-0.0013
0.1108
⋮

```

```
% W21
```

```

[c, l] = wavedec(P21, num, falka);
[d5_W21] = detcoef(c, l, num)

```

```

d5_W21 = 44×1
0.0488
-0.0400
0.0597
0.0712
-0.0028

```

```

0.0540
0.0235
-0.0480
-0.0506
0.0524
⋮

```

```
% W23
```

```

[c, l] = wavedec(P23, num, falka);
[d5_W23] = detcoef(c, l, num)

```

```

d5_W23 = 44×1
-0.0235
0.0046
-0.0487
0.0381
-0.0262
-0.0110
0.0076
0.0690
-0.0208
-0.0073
⋮

```

```
% W24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_W24] = detcoef(c, l, num)

```

```

d5_W24 = 44×1
-0.0924
0.1219
-0.0622
-0.0650
0.0118
-0.0445
-0.1189
0.0157
0.1002
-0.0974
⋮

```

Zad 5

Obliczyć współczynnik d10 z zastosowaniem falki 'dmey' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```

falka = 'dmey';
num = 10;

```

```
% P20
```

```

[c, l] = wavedec(P20, num, falka);
[d5_P20] = detcoef(c, l, num)

```

```
d5_P20 = 143×1
```

```

0.0492
-0.0077
0.0144
-0.0089
0.0001
0.0005
0.0069
0.0047
-0.0002
-0.0097
:

```

```
% P21
```

```

[c, l] = wavedec(P21, num, falka);
[d5_P21] = detcoef(c, l, num)

```

```

d5_P21 = 143x1
0.0430
-0.0146
-0.0224
0.0199
-0.0094
-0.0049
0.0224
-0.0151
0.0177
0.0234
:

```

```
% P23
```

```

[c, l] = wavedec(P23, num, falka);
[d5_P23] = detcoef(c, l, num)

```

```

d5_P23 = 143x1
0.0030
-0.0059
0.0152
-0.0138
0.0085
0.0031
-0.0166
0.0096
-0.0070
-0.0082
:

```

```
% P24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_P24] = detcoef(c, l, num)

```

```

d5_P24 = 143x1
-0.0502
0.0012
-0.0345
0.0169

```

```

-0.0142
-0.0010
 0.0361
-0.0034
 0.0231
 0.0272
  ⋮

```

```
% W20
```

```

[c, l] = wavedec(P20, num, falka);
[d5_W20] = detcoef(c, l, num)

```

```

d5_W20 = 143×1
 0.0492
-0.0077
 0.0144
-0.0089
 0.0001
 0.0005
 0.0069
 0.0047
-0.0002
-0.0097
  ⋮

```

```
% W21
```

```

[c, l] = wavedec(P21, num, falka);
[d5_W21] = detcoef(c, l, num)

```

```

d5_W21 = 143×1
 0.0430
-0.0146
-0.0224
 0.0199
-0.0094
-0.0049
 0.0224
-0.0151
 0.0177
 0.0234
  ⋮

```

```
% W23
```

```

[c, l] = wavedec(P23, num, falka);
[d5_W23] = detcoef(c, l, num)

```

```

d5_W23 = 143×1
 0.0030
-0.0059
 0.0152
-0.0138
 0.0085
 0.0031
-0.0166
 0.0096

```

```
-0.0070
-0.0082
⋮
```

```
% W24
[c, l] = wavedec(P24, num, falka);
[d5_W24] = detcoef(c, l, num)
```

```
d5_W24 = 143×1
-0.0502
0.0012
-0.0345
0.0169
-0.0142
-0.0010
0.0361
-0.0034
0.0231
0.0272
⋮
```

Zad 6

Obliczyć współczynnik a8 z zastosowaniem falki 'bior3.5' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'bior3.5';
num = 8;
```

```
% P20
[c, l] = wavedec(P20, num, falka);
[d5_P20] = detcoef(c, l, num)
```

```
d5_P20 = 183×1
1.2580
0.5708
-0.0000
-0.5708
-1.2580
-1.4479
-0.5166
-0.4096
-0.2229
0.0471
⋮
```

```
% P21
[c, l] = wavedec(P21, num, falka);
[d5_P21] = detcoef(c, l, num)
```

```
d5_P21 = 183×1
0.4123
0.2233
-0.0000
```

```

-0.2233
-0.4123
-0.3349
0.0551
0.2735
0.2800
0.0655
:

```

```
% P23
```

```

[c, l] = wavedec(P23, num, falka);
[d5_P23] = detcoef(c, l, num)

```

```

d5_P23 = 183×1
-0.6191
-0.1924
0.0000
0.1924
0.6191
0.5697
-0.3632
-0.1160
0.0246
-0.4330
:

```

```
% P24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_P24] = detcoef(c, l, num)

```

```

d5_P24 = 183×1
0.8077
0.4799
0.0000
-0.4799
-0.8077
-0.7261
-0.3478
-0.5390
-0.3152
0.1298
:

```

```
% W20
```

```

[c, l] = wavedec(P20, num, falka);
[d5_W20] = detcoef(c, l, num)

```

```

d5_W20 = 183×1
1.2580
0.5708
-0.0000
-0.5708
-1.2580
-1.4479
-0.5166

```

```

-0.4096
-0.2229
0.0471
⋮

```

```
% W21
```

```

[c, l] = wavedec(P21, num, falka);
[d5_W21] = detcoef(c, l, num)

```

```

d5_W21 = 183×1
0.4123
0.2233
-0.0000
-0.2233
-0.4123
-0.3349
0.0551
0.2735
0.2800
0.0655
⋮

```

```
% W23
```

```

[c, l] = wavedec(P23, num, falka);
[d5_W23] = detcoef(c, l, num)

```

```

d5_W23 = 183×1
-0.6191
-0.1924
0.0000
0.1924
0.6191
0.5697
-0.3632
-0.1160
0.0246
-0.4330
⋮

```

```
% W24
```

```

[c, l] = wavedec(P24, num, falka);
[d5_W24] = detcoef(c, l, num)

```

```

d5_W24 = 183×1
0.8077
0.4799
0.0000
-0.4799
-0.8077
-0.7261
-0.3478
-0.5390
-0.3152
0.1298

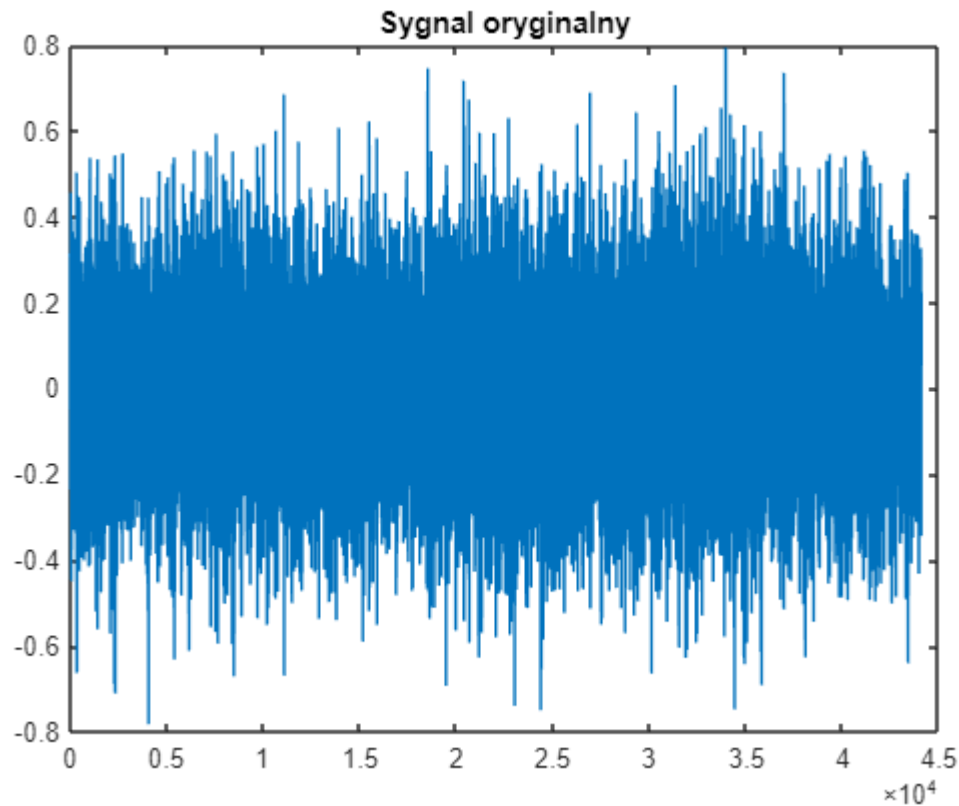
```


⋮

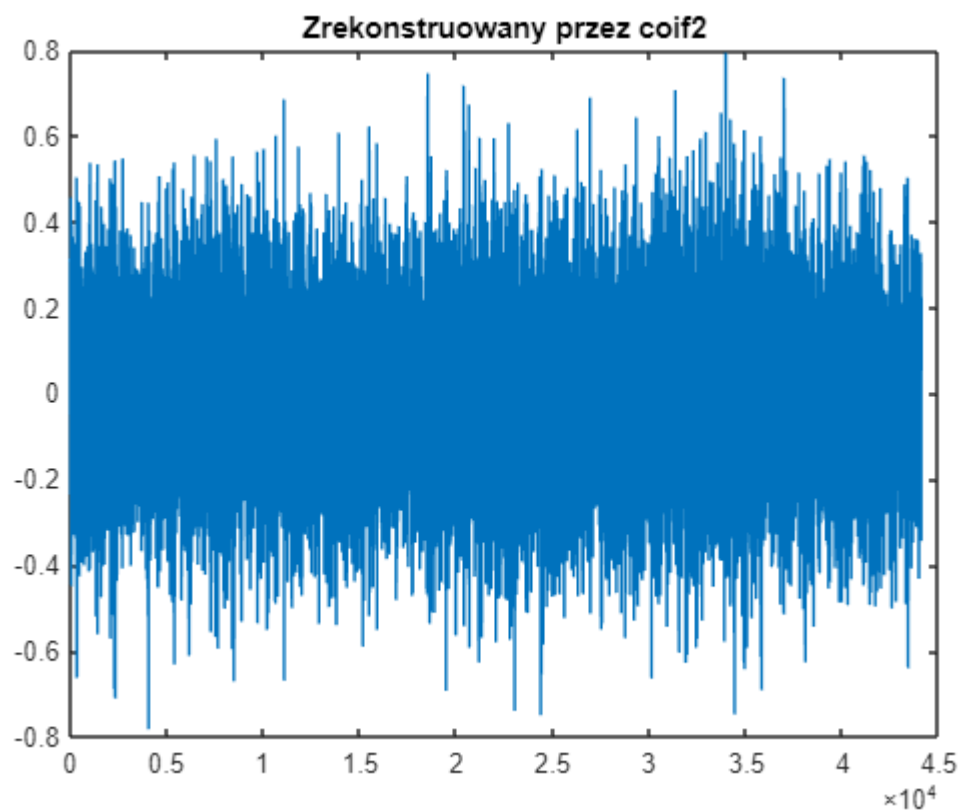
Zad 7

Wykonać dekompozycję obrazu 'wiatrak_20.wav' funkcją `wavedec()`, `waverec()`. Do tego celu zastosować falkę 'coif2'. Następnie zrekonstruować obraz falką 'coif2'. Proszę zaobserwować różnice. Proszę użyć 12 stopnia dekompozycji.

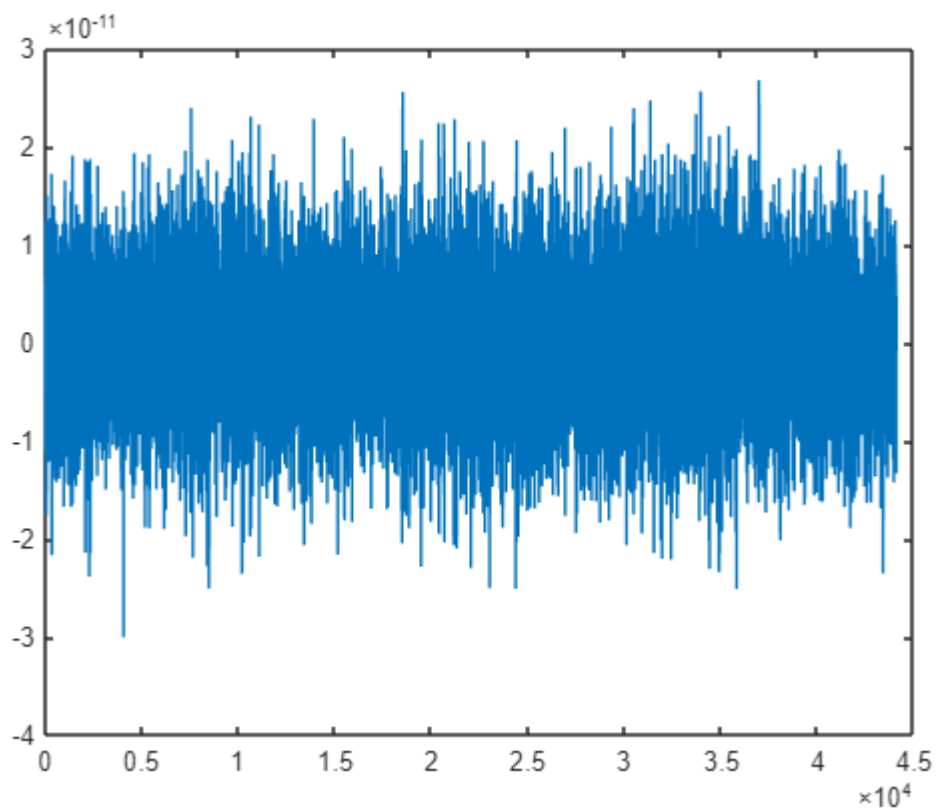
```
figure(1), plot(W20), title('Sygnał oryginalny');
```



```
[c,1] = wavedec(W20,6, 'coif2');  
  
Rec = waverec(c,1,'coif2');  
figure(2), plot(Rec), title('Zrekonstruowany przez coif2');
```



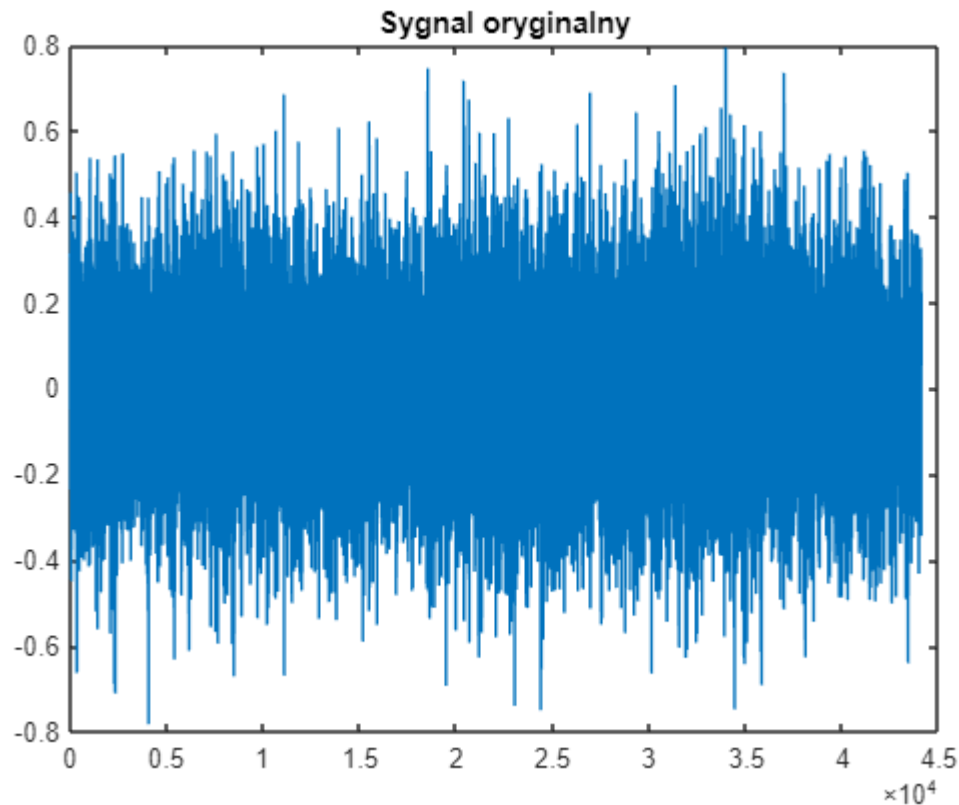
```
roznica = W20 - Rec;  
figure(3), plot(roznica);
```



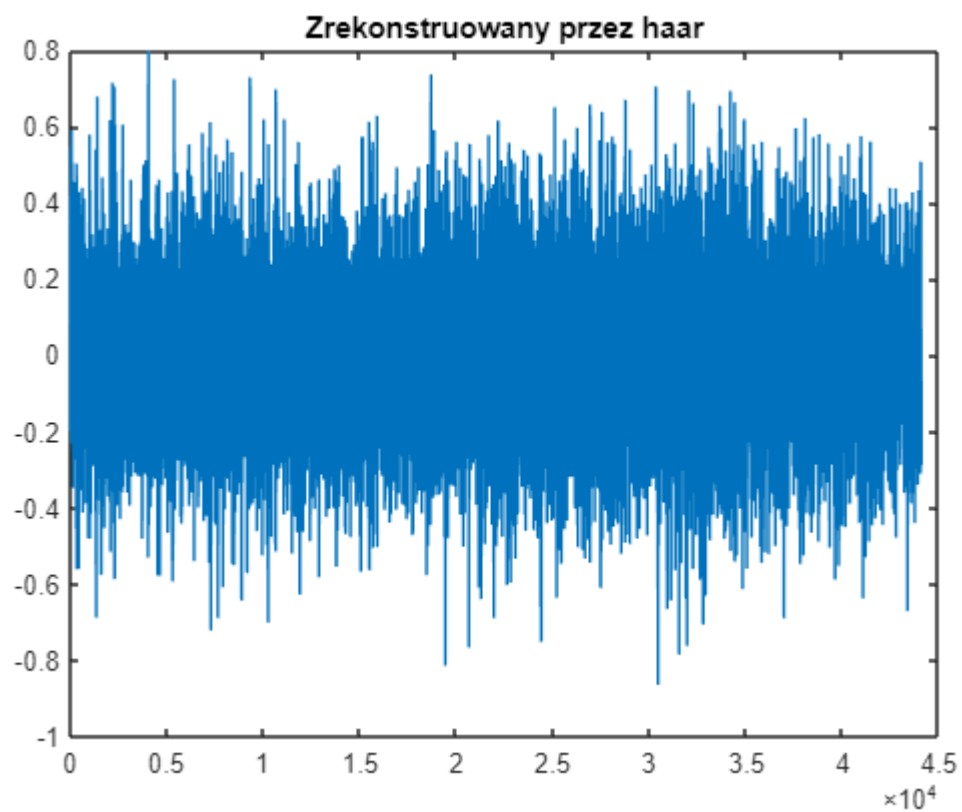
Zad 8

Wykonać dekompozycję obrazu 'wiatrak_20.wav' funkcjami `wavedec()`, `waverec()`. Do tego celu zastosować falkę 'coif2'. Następnie zrekonstruować obraz falką 'haar'. Proszę zaobserwować różnice. Proszę użyć 12 stopnia dekompozycji.

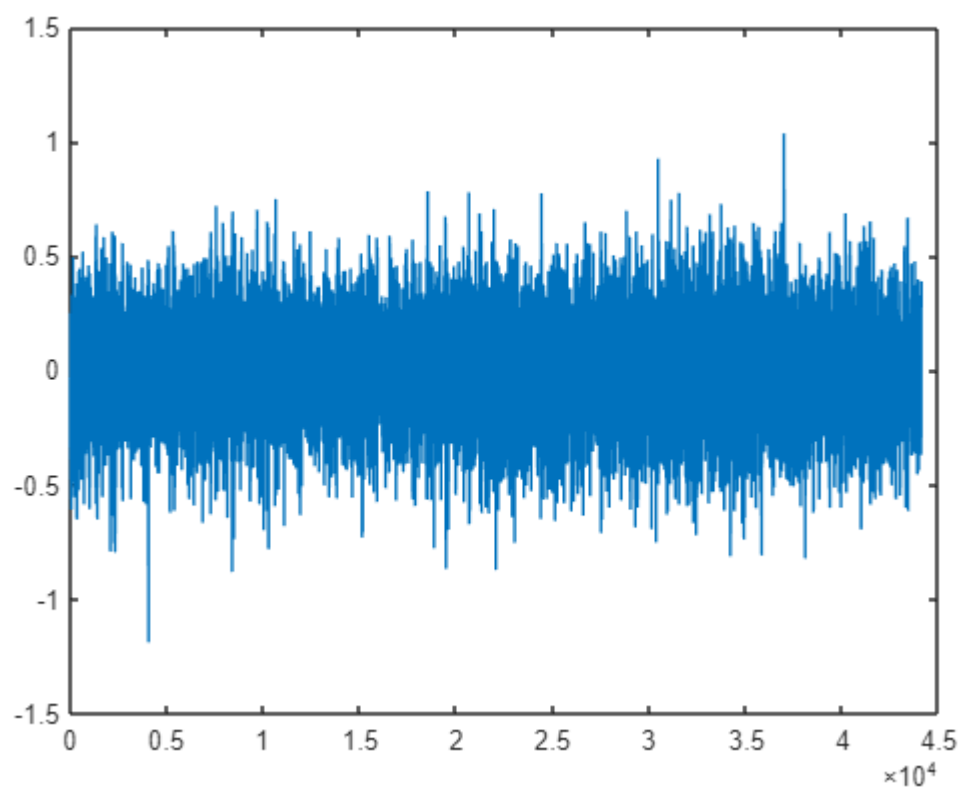
```
figure(1), plot(W20), title('Sygnał oryginalny');
```



```
[c,l] = wavedec(W20,6, 'coif2');  
  
Rec = waverec(c,l,'haar');  
figure(2), plot(Rec), title('Zrekonstruowany przez haar');
```



```
roznica = W20 - Rec;  
figure(3), plot(roznica);
```



Zad 9

Obliczyć współczynnik a12 z zastosowaniem falki 'sym2' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'sym2';  
num = 12;
```

```
% P20
```

```
[c, l] = wavedec(P20, num, falka);  
[d5_P20] = appcoef(c, l, falka, num)
```

```
d5_P20 = 13×1  
-6.0615  
-5.4489  
-0.0280  
-0.0563  
-0.0351  
-0.0220  
0.0180  
-0.0464  
-0.0022  
0.0116  
⋮  
⋮
```

```
% P21
```

```
[c, l] = wavedec(P21, num, falka);  
[d5_P21] = appcoef(c, l, falka, num)
```

```
d5_P21 = 13×1  
-10.4008  
-9.2888  
-0.0588  
-0.0549  
0.0850  
-0.0106  
-0.0371  
-0.0272  
-0.0633  
-0.0020  
⋮  
⋮
```

```
% P23
```

```
[c, l] = wavedec(P23, num, falka);  
[d5_P23] = appcoef(c, l, falka, num)
```

```
d5_P23 = 13×1  
10.5749  
9.4315  
-0.0491  
0.0030  
0.0188  
0.0083  
0.0023  
-0.0364
```

```
-0.0107
-0.0195
⋮
```

```
% P24
```

```
[c, l] = wavedec(P24, num, falka);
[d5_P24] = appcoef(c, l, falka, num)
```

```
d5_P24 = 13×1
```

```
-2.9775
-2.6853
0.0101
0.0134
0.0200
0.0414
0.0212
-0.0261
-0.0198
-0.0244
⋮
```

```
% W20
```

```
[c, l] = wavedec(P20, num, falka);
[d5_W20] = appcoef(c, l, falka, num)
```

```
d5_W20 = 13×1
```

```
-6.0615
-5.4489
-0.0280
-0.0563
-0.0351
-0.0220
0.0180
-0.0464
-0.0022
0.0116
⋮
```

```
% W21
```

```
[c, l] = wavedec(P21, num, falka);
[d5_W21] = appcoef(c, l, falka, num)
```

```
d5_W21 = 13×1
```

```
-10.4008
-9.2888
-0.0588
-0.0549
0.0850
-0.0106
-0.0371
-0.0272
-0.0633
-0.0020
⋮
```

```
% W23
```

```
[c, l] = wavedec(P23, num, falka);  
[d5_W23] = appcoef(c, l, falka, num)
```

```
d5_W23 = 13×1
```

```
10.5749  
9.4315  
-0.0491  
0.0030  
0.0188  
0.0083  
0.0023  
-0.0364  
-0.0107  
-0.0195  
⋮
```

```
% W24
```

```
[c, l] = wavedec(P24, num, falka);  
[d5_W24] = appcoef(c, l, falka, num)
```

```
d5_W24 = 13×1
```

```
-2.9775  
-2.6853  
0.0101  
0.0134  
0.0200  
0.0414  
0.0212  
-0.0261  
-0.0198  
-0.0244  
⋮
```

Zad 10

Obliczyć współczynnik d12 z zastosowaniem falki 'sym2' dla: wiatrak_20.wav, wiatrak_21.wav, wiatrak_23.wav, wiatrak_24.wav, przekladnia20.wav, przekladnia21.wav, przekladnia23.wav, przekladnia24.wav

```
falka = 'sym2';  
num = 12;
```

```
% P20
```

```
[c, l] = wavedec(P20, num, falka);  
[d5_P20] = detcoef(c, l, num)
```

```
d5_P20 = 13×1
```

```
-0.2829  
1.3502  
0.0033  
-0.0617  
-0.0143  
-0.0035  
0.0055  
0.0433
```

```
-0.0019
-0.0346
:
```

```
% P21
```

```
[c, l] = wavedec(P21, num, falka);
[d5_P21] = detcoef(c, l, num)
```

```
d5_P21 = 13×1
-0.4967
 2.5062
 0.0001
-0.0533
 0.0399
-0.0138
 0.0137
 0.0289
-0.0295
-0.0063
:
```

```
% P23
```

```
[c, l] = wavedec(P23, num, falka);
[d5_P23] = detcoef(c, l, num)
```

```
d5_P23 = 13×1
 0.4978
-2.6198
 0.0496
-0.0595
 0.0168
 0.0487
-0.0051
 0.0044
 0.0325
 0.0574
:
```

```
% P24
```

```
[c, l] = wavedec(P24, num, falka);
[d5_P24] = detcoef(c, l, num)
```

```
d5_P24 = 13×1
-0.1423
 0.6197
 0.0059
-0.0146
 0.0474
 0.0419
-0.0730
-0.0190
-0.1116
 0.0176
:
```



```
% W20
[c, l] = wavedec(P20, num, falka);
[d5_W20] = detcoef(c, l, num)
```

```
d5_W20 = 13×1
-0.2829
 1.3502
 0.0033
-0.0617
-0.0143
-0.0035
 0.0055
 0.0433
-0.0019
-0.0346
  ⋮
```

```
% W21
[c, l] = wavedec(P21, num, falka);
[d5_W21] = detcoef(c, l, num)
```

```
d5_W21 = 13×1
-0.4967
 2.5062
 0.0001
-0.0533
 0.0399
-0.0138
 0.0137
 0.0289
-0.0295
-0.0063
  ⋮
```

```
% W23
[c, l] = wavedec(P23, num, falka);
[d5_W23] = detcoef(c, l, num)
```

```
d5_W23 = 13×1
 0.4978
-2.6198
 0.0496
-0.0595
 0.0168
 0.0487
-0.0051
 0.0044
 0.0325
 0.0574
  ⋮
```

```
% W24
[c, l] = wavedec(P24, num, falka);
[d5_W24] = detcoef(c, l, num)
```

```

d5_W24 = 13x1
-0.1423
 0.6197
 0.0059
-0.0146
 0.0474
 0.0419
-0.0730
-0.0190
-0.1116
 0.0176
  :

```

3. Pytania

1) W jaki sposób zastosować falki do ekstrakcji cech?

Robi się transformację falkową i analizuje współczynniki - bierze się wysokie współczynniki, żeby mieć mniej cech do analizy.

2) Jakie parametry falek możemy zmieniać w toolboxie?

W samym toolboxie `_waveletAnalyzer_` możemy wybrać rodzaj falki i poziom dekompozycji.

3) Czym różnią się współczynniki a_1 , d_1 , d_2 , d_3 , d_4 , d_5 ?

Współczynniki $d_j(k)$ zawierają informację o wysokich częstotliwościach oraz tworzą zbiór detali. Natomiast współczynniki $a_j(k)$ zawierają informację o niskich częstotliwościach, czyli stanowią aproksymację sygnału.

4) Czym różni się transformacja falkowa od filtrów?

Są w stanie doskonale zrekonstruować funkcje o kształtach wielomianów liniowych i wyższych rzędów takich jak prostokąt, ciasto, wielomiany drugiego rzędu.