Elektrik-Elektronik Mühendisliği
Dijital Sinyal İşleme
Deney-8

Yakup Demiryürek
180711049

(Güz 2021)

Amaç

Matlab'ın fdatool araç çubuğu yardımıyla üretilen filtre katsayıları kullanılarak bir müzik dosyası bas ve tiz seslere ayrılacaktır.

Ekipmanlar

- Matlab yüklü bilgisayar

DÇ

Özellikleri aşağıdaki gibi olan bir frekans düzenleyici sistemi tasarlanmıştır. Filtre katsayılarını üretirken matlab'ın fdatool araç çubuğundan yararlanılmıştır.

fs=44100Hz Kesim frekansı=1000Hz
Geçiş bandı=600-1400Hz
Alçak geçiren filtre= 0-600Hz arası geçirme bandı aralığı ve dalgalılığı 0.02dB;
1400Hz durdurma bandı köşesi ve zayıflatması 50dB (**Şekil 1**)
Yüksek geçiren filtre= 1.4-44.1kHz arası geçirme bandı aralığı ve dalgalılığı 0.02dB;
600Hz durdurma bandı köşesi ve zayıflatması 50dB (**Şekil 2**)
Pencere uzunluğu N;

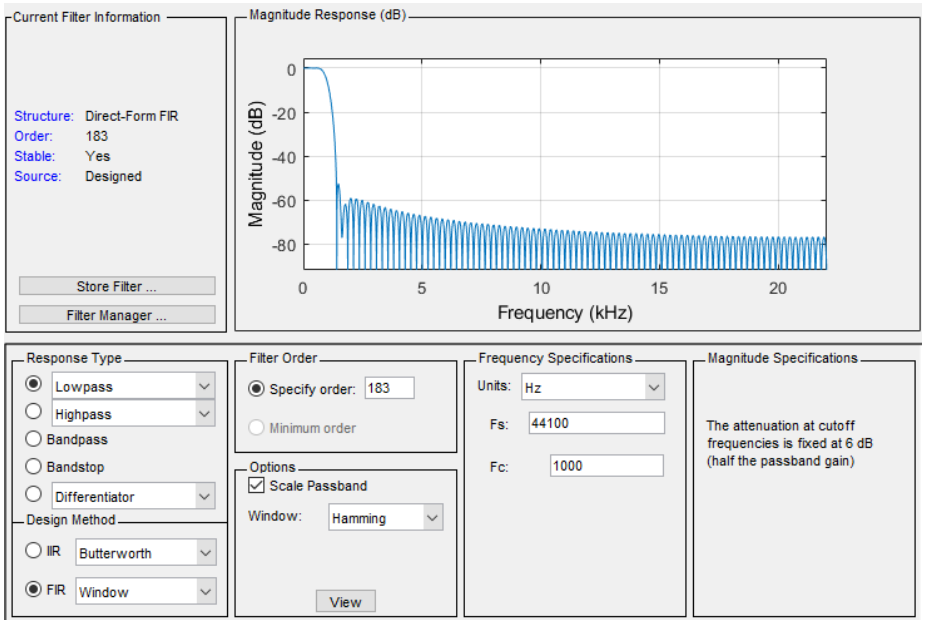
$$\Delta f = c/N$$

$$\Delta f_{alçak} = \frac{|f_{stop} - f_{pass}|}{f_s} = \frac{800}{44100} = 0.01814$$

$$\Delta f_{yüksek} = \frac{|f_{stop} - f_{pass}|}{f_s} = \frac{800}{44100} = 0.01814$$

$$N = 3.3/\Delta f_{alçak} \qquad N = 3.3/\Delta f_{yüksek}$$

$N = 181{,}918 \approx 182$ en yakın tek sayı 183 olduğundan N=183 alınır.

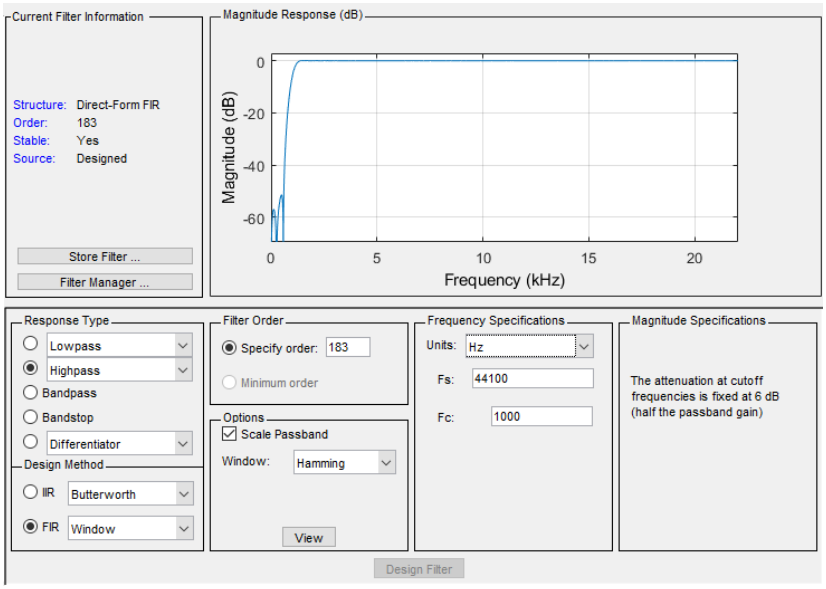


Şekil 1.Alçak-Geçiren Filtre

Kod;

```
a=audioread('matlab_odev.wav');
low=[0.000126354607046716 9.10681504960111e-05 5.32229325583169e-05 1.2697031258229e-05
-3.06117040353373e-05 -7.67423535037141e-05 -0.000125626673580549 -0.000177046141845925
-0.00023059260849465 -0.000285634831833599 -0.000341293055696839 -0.000396423579702054
-0.000449614983131131 -0.000499197297043984 -0.000543264986931074 -0.000579714122192265
-0.000606293583591829 -0.000620669611946402 -0.000620502448314952 -0.000603533276309508
-0.000567679169473629 -0.000511113328925203 -0.000432467189212309 -0.000330731774666485
-0.00020555325740184 -5.72203440446691e-05 0.000113241088146273 0.000304009437633842
0.000512428297372657 0.000734989816656743 0.000967342982942198 0.00120432870245164
0.00144004286928954 0.00166792784929296 0.00188089198630156 0.00207145588669119
0.0022319233763941 0.00235457417789445 0.00243187454797558 0.00245670137519815
0.00242257458313207 0.00232389214349605 0.00215616159245974 0.00191622168032238
0.00160244768292606 0.00121493397178482 0.000755647683894732 0.000228547751749441
-0.000360335855370526 -0.00100286707563483 -0.0016888163815868 -0.00240592355825711
-0.00314001196582355 -0.00387515440457443 -0.00459388943283197 -0.00527748570103002
-0.0059062505898745 -0.00645987821057721 -0.00691783067338539 -0.00725974548870015
-0.00746586106262123 -0.00751745151255031 -0.00739726148168022 -0.00708993129264106
-0.0065824026642289 -0.00586429532962842 -0.00492824524281297 -0.00377019563896579
-0.00238963301604441 -0.000789761113476182 0.00102239283957683 0.0030359439749695
0.00523619061197861 0.00760473134443119 0.0101196580188152 0.0127558225540781
0.0154851738892136 0.0182771597349675 0.0210991862901437 0.0239171276983461
0.0266958758020819 0.0293999197288671 0.0319939440447373 0.0344434336556511 0.0367152733422281
0.0387783297874587 0.040604004203405 0.0421667441778692 0.0434445041354136 0.0444191448225759
0.045076763462321 0.0454079476500058 0.0454079476500058 0.045076763462321 0.0444191448225759
0.0434445041354136 0.0421667441778692 0.040604004203405 0.0387783297874587 0.0367152733422281
0.0344434336556511 0.0319939440447373 0.0293999197288671 0.0266958758020819 0.0239171276983461
0.0210991862901437 0.0182771597349675 0.0154851738892136 0.0127558225540781 0.0101196580188152
0.00760473134443119 0.00523619061197861 0.00303594397496695 0.00102239283957683
-0.000789761113476182 -0.00238963301604441 -0.00377019563896579 -0.00492824524281297
-0.00586429532962842 -0.0065824026642289 -0.00708993129264106 -0.00739726148168022
-0.00751745151255031 -0.00746586106262123 -0.00725974548870015 -0.00691783067338539
-0.00645987821057721 -0.0059062505898745 -0.00527748570103002 -0.00459388943283197
-0.00387515440457443 -0.00314001196582355 -0.00240592355825711 -0.0016888163815868
-0.00100286707563483 -0.000360335855370526 0.000228547751749441 0.000755647683894732
0.00121493397178482 0.00160244768292606 0.00191622168032238 0.00215616159245974
0.00232389214349605 0.00242257458313207 0.00245670137519815 0.00243187454797558
0.00235457417789445 0.0022319233763941 0.00207145588669119 0.00188089198630156
0.00166792784929296 0.00144004286928954 0.00120432870245164 0.000967342982942198
0.000734989816656743 0.000512428297372657 0.000304009437633842 0.000113241088146273
-5.72203440446691e-05 -0.000205553257401840 -0.000330731774666485 -0.000432467189212309
-0.000511133289250203 -0.000567679169473629 -0.000603533276309508 -0.000620502448314952
-0.000620669611946402 -0.000606293583591829 -0.000579714122192265 -0.000543264986931074
-0.000499197297043984 -0.000449614983131131 -0.000396423579702054 -0.000341293055696839
-0.000285634831833599 -0.000230592608494650 -0.000177046141845925 -0.000125626673580549
-7.67423535037141e-05 -3.06117040353373e-05 1.2697031258229e-05 5.32229325583169e-05
9.10681504960111e-05 0.000126354607046716];
woofer=filter(low,1,a);
fs=44100;
N=length(woofer);
Ayk=abs(fft(woofer))/N;
f=(0:N/2)*fs/N;
Ayk(2:N)=2*Ayk(2:N);
plot(f,Ayk(1:N/2+1),'r');
ylabel('Genlik Spektrumu');
title('woofer');
xlabel('Frekans');
audiowrite('Lowpass.wav',woofer,fs);
sound(woofer,fs);
```

Alçak geçiren filtre katsayıları fdatool yardımıyla oluşturulmuştur.



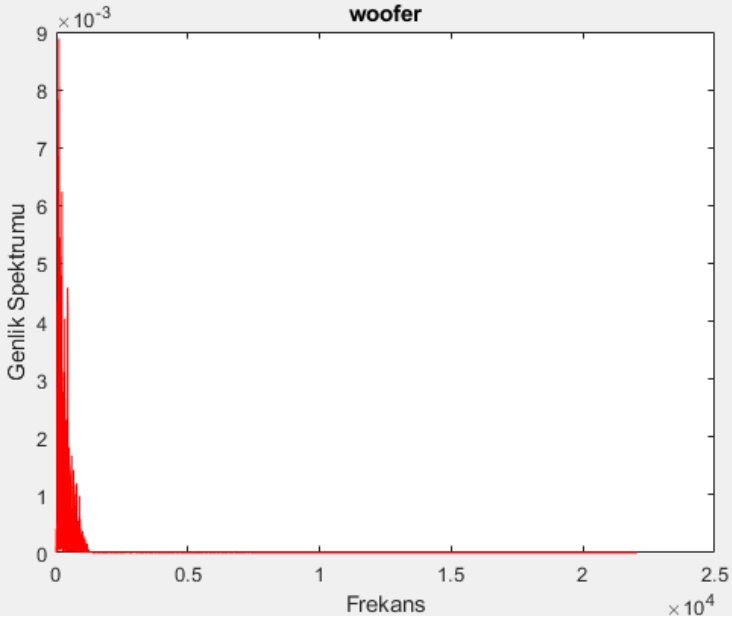
Şekil 2. Yüksek-Geçiren Filtre

Kod;

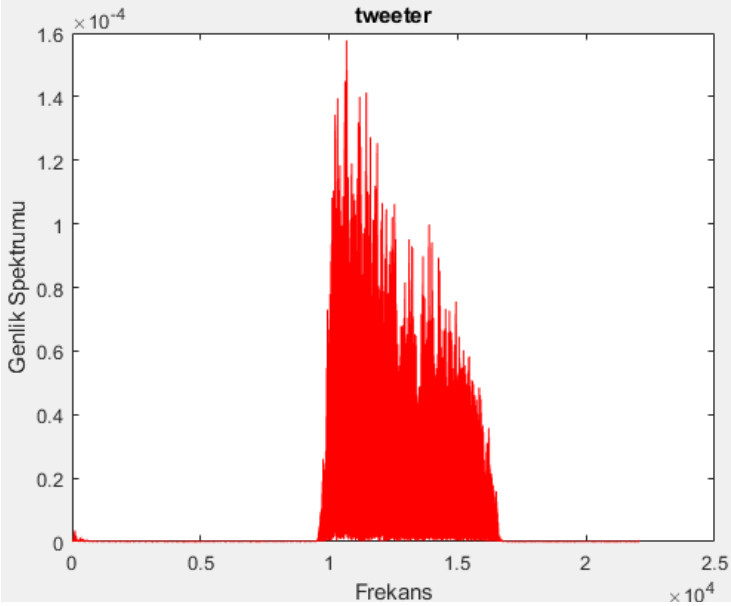
```
a=audioread('matlab_odev.wav');
high=[0.00023726653964045 8 0.000183339867330075 -0.000187266015541044 -0.00025278545483228
0.000117387659771334 0.000310416990578806 -2.62059055020501e-05 -0.000350043201770773
-8.65291720951272e-05 0.000362792768175674 0.000218020046068777 -0.000337980729161539
-0.000360725948942519 0.000264945677098868 0.00050131097334336 -0.000135651625789016
-0.000620644307277844 -5.2342488775546e-05 0.000695118386825194 0.000293084490713085
-0.000699341880156522 -0.000570204348422842 0.000610017590539332 0.000856232688249508
-0.000410567445405644 -0.00111369701693338 9.58579316250371e-05 0.00129820415457259
0.000323752669130649 -0.00136342562435654 -0.000819849778905394 0.00126758318016176
0.00134558909421165 -0.000980729790489541 -0.00183800503187287 0.000491884319598237
0.00222317159232546 0.000185052179650329 -0.00242399836955172 -0.00100766375907788
0.00237003706083682 0.00190457776958031 -0.00200830192359741 -0.00277881847638242
0.00131382614634697 0.00351513949709973 -0.000298532366258557 -0.00399102400145896
-0.000982977730784778 0.00409053243349047 0.00243190003598291 -0.0037197190659398
-0.00390877393815909 0.00282199509671372 0.00524237987458995 -0.00139164167014386
-0.00624366625108575 -0.000516291645105927 0.00672376474429893 0.00278121434824923
-0.00651459735471248 -0.00521839703503259 0.00549016203076975 0.00758695956760928
-0.00358637270327314 -0.00960410142365699 0.0008173747703421 0.010964421995914
0.00271340875399198 -0.0113623789541789 -0.00680860101121987 0.0105151742872366
0.0111786800529394 -0.00818260014501625 -0.0154489616172416 0.00417941116648162
0.0191682602929087 0.00162601093301591 -0.0218118223254695 -0.0093373697807584
0.0227624841777921 0.0191038557403544 -0.0212304657501567 -0.0313053126365739
0.0159934699230029 0.0470692280561144 -0.0045031497374154 -0.0701232700747017
-0.0211580626746314 0.117419717182612 0.110797687081282 -0.484002817252732 0.484002817252732
-0.110797687081282 -0.117419717182612 0.0211580626746314 0.0701232700747017 0.0045031497374154
-0.0470692280561144 -0.0159934699230029 0.0313053126365739 0.0212304657501567
-0.0191038557403544 -0.0227624841777921 0.0093373697807584 0.0218118223254695
-0.00162601093301591 -0.0191682602929087 -0.00417941116648162 0.0154489616172416
0.00818260014501625 -0.0111786800529394 -0.0105151742872366 0.00680860101121987
0.0113623789541789 -0.00271340875399198 -0.010964421995914 -0.0008173747703421
0.00960410142365699 0.00358637270327314 -0.00758695956760928 -0.00549016203076975
0.00521839703503259 0.00651459735471248 -0.00278121434824923 -0.00672376474429893
0.000516291645105927 0.00624366625108575 0.00139164167014386 -0.00524237987458995
-0.00282199509671372 0.00390877393815909 0.0037197190659398 -0.00243190003598291
-0.00409053243349047 0.000982977730784778 0.00399102400145896 0.000298532366258557
-0.00351513949709973 -0.00131382614634697 0.00277881847638242 0.00200830192359741
-0.00190457776958031 -0.00237003706083682 0.00100766375907788 0.00242399836955172
-0.000185052179650329 -0.00222317159232546 -0.000491884319598237 0.00183800503187287
0.000980729790489541 -0.00134558909421165 -0.00126758318016176 0.000819849778905394
0.00136342562435654 -0.000323752669130649 -0.00129820415457259 -9.58579316250371e-05
0.00111369701693338 0.000410567445405644 -0.000856232688249508 -0.000610017590539332
0.000570204348422842 0.000699341880156522 -0.000293084490713085 -0.000695118386825194
5.2342488775546e-05 0.000620644307277844 0.000135651625789016 -0.00050131097334336
-0.000264945677098868 0.000360725948942519 0.000337980729161539 -0.000218020046068777
-0.000362792768175674 8.65291720951272e-05 0.000350043201770773 2.62059055020501e-05
-0.000310416990578806 -0.000117387659771334 0.00025278545483228 0.000187266015541044
-0.000183339867330075 -0.000237266539640458];
```

```
tweeter=filter(high,1,a);
fs=44100;
N=length(tweeter);
Ayk=abs(fft(tweeter))/N;
f=(0:N/2)*fs/N;
Ayk(2:N)=2*Ayk(2:N);
plot(f,Ayk(1:N/2+1),'r');
ylabel('Genlik Spektrumu');
title('tweeter');
xlabel('Frekans');
audiowrite('Highpass.wav',tweeter,fs);
sound(tweeter,fs);
```

Yüksek geçiren filtre katsayıları fdatool yardımıyla oluşturulmuştur. Elde edilen tweeter (**Şekil 3**) ve woofer (**Şekil 4**) verilerinin tek yanlı genlik spektrumları matlab'de çizdirilmiştir.



Şekil 3.Woofer spektrum



Şekil 4.Tweeter spektrum

Sonuç

Veriler incelendiğinde woofer için elde edilen sonuçlar ile orijinal ses dosyası karşılaştırıldığında bas seslerin ön plana çıktığı duyulmaktadır. Tweeter için elde edilen sonuçlar ile orijinal ses dosyası karşılaştırıldığında tiz seslerin ön plana çıktığı duyulmaktadır. Matlab kodları ile birlikte elde edilen sesler dosya içine koyulmuştur.