

FIR

COLLABORATORS

	<i>TITLE :</i> FIR		
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REVISION HISTORY

NUMBER	DATE	DESCRIPTION	NAME

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Chapter 1

FIR

1.1 Contents

The Finite Impulse Response Filter Designer V1.1

Contents

1. Installation
2. Purpose
3. How to use
4. Future Enhancements
5. Copyright
6. Thanks
7. References
8. History
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1.2 Installation

1. Installation

This is the third Aminet Release of the FilterDesigner.
To install the FIR Filter Designer V1.1, use
the installer script in this directory.

AmigaOS 2.x or up is required.

1.3 Purpose

2. Purpose

The problem of designing finite impulse response (FIR) digital

filters experienced great activity in the early 1970`s. Most of this work was directed at the problem of optimal filter design, in the weighted Chebyshev sense. The algorithm for this program, by McClellan, Parks and Rabiner, will design the optimal Chebyshev approximation for linear phase filters. The Chebyshev optimization is done very efficiently by means of the Remez exchange algorithm, and this particular FIR filter design program has found wide use.

1.4 How to use

3. How to use

Select the filter parameters or load a filter specification file (#?.FIR). Click on the design button and wait until the filter is designed. This can take up to a minute if you use a standard Amiga. With an A4000/40 however it takes only a few seconds.

The resulting filter parameters will be stored in an ASCII-file, located in:

```
T:FIR.OUTPUT
```

Please use one of the standard text viewers to have a look at this file.

If you select invalid filter parameters, the program will not do anything, except display a flashing screen.

Parameter Description

Filter-Type:	Bandpass Differentiator Hilbert Transformator
Filter-Length	3 to 128
Grid-Density	1 to 64
Bands	1 to 10
From	lower frequency of the specified Band
To	upper frequency of the specified Band
Value	0.0 to 1.0 0.0 means stopband 1.0 means passband
weight	weight for optimization

Note that the the frequency value is relative to the sampling frequency. Load example files (#?.FIR) for better understanding. The bands have to be sorted in ascending order.

1.5 Example

Example of a Bandpass

```
Filter-Type      Bandpass
Filter-Length    55
Grid-Density     16
Bands            5
```

	From	To	Value	Weight
Band 01	0	0.05	0	10
Band 02	0.1	0.15	1	1
Band 03	0.18	0.25	0	3
Band 04	0.3	0.36	1	1
Band 05	0.41	0.5	0	20

Example of a Differentiator

```
Filter-Type      Differentiator
Filter-Length    32
Grid-Density     16
Bands            1
```

	From	To	Value	Weight
Band 01	0	0.5	1	1

Example of a Hilbert Transformator

```
Filter-Type      Hilbert Transformator
Filter-Length    20
Grid-Density     16
Bands            1
```

	From	To	Value	Weight
Band 01	0.05	0.5	1	1

1.6 Future Enhancements

4. Future Enhancements

If enough Amiga users are interested in the FIRDesigner, i will add the following enhancements to this program:

- filtering of sound samples
- 1 dimensional and 2 dimensional filtering of pictures
- improved online help
- filter library

Feel free to send me suggestions, bug reports and your wish list.

1.7 Copyright

5. Copyright

This program is SHAREWARE !
If you use it, send me US\$ 15 or DM 20.

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1.8 Thanks

6. Thanks

James H. McClellan
Thomas W. Parks
Lawrence R. Rabiner

for the development of a powerful FORTRAN-Program which is able to design
"Optimum Finite Impulse Response Linear Phase Digital Filters"

1.9 References

7. References

Below is a small collection of related books and articles on Finite Impulse Response Filters:

W. Hess
Digitale Filter
Teubner Studienbücher
ISBN 3-519-16121-4

J.H. McClellan
Programs for Digital Signal Processing
Edited by the DSP Committee IEEE ASSPS
IEEE Press NY 1979

J.H. McClellan, T.W. Parks, L.R. Rabiner
A Computer Program for Designing Optimum FIR Linear Phase Digital Filters
IEEE Transactions on Audio and Electroacoustics
Vol. AU-21, No.6, December 1973

Oppenheim/Schafer
Zeitdiskrete Signalverarbeitung
R. Oldenbourg Verlag 1992
ISBN 3-486-21544-2

1.10 History

8. History

Date	Version	Type	Comments
----	-----	----	-----
01/05/96	V1.10	Release	Third AMINET Release - Versions for: MC 68000 MC 68020 MC 68040 - Updated the installer script - Now compatible with AudioLab16 (AudioLab16 copyright by Maurizio Ciccione) - Grids in the Prism window - Some redesigns and optimizations - Fixed Bug with too small workbench
15/04/96	V1.01	Release	ScientificAmigan Disk Library (Selected by Robert Pigford)
29/11/95	V1.01	Release	Second AMINET Release - Fixed several Enforcer Hits (Reported by Jukka Marin) - Fixed Bug with not updating gadgets - Recompiled with SAS/C V6.56 - Less Shareware Requesters

- Installer Script
- Added Pattern in Filerequester
- More Examples

21/07/95 V1.00 Release First AMINET Release

1.11 Output for Bandpass.FIR

DEVIATION = 0.000734
DEVIATION = 0.006316
DEVIATION = 0.021567
DEVIATION = 0.026203
DEVIATION = -0.032680
DEVIATION = -0.034435
DEVIATION = -0.034448
DEVIATION = -0.034448

FINITE IMPULSE RESPONSE (FIR)
LINEAR PHASE DIGITAL FILTER DESIGN
FILTER TYPE: BANDPASS FILTER
FILTER LENGTH = 55

***** IMPULSE RESPONSE *****

H(1) = 1.066267E-03 = H(55)
H(2) = 6.377732E-03 = H(54)
H(3) = 3.575602E-03 = H(53)
H(4) = -9.067776E-03 = H(52)
H(5) = -9.090722E-03 = H(51)
H(6) = 2.915573E-03 = H(50)
H(7) = 3.963771E-03 = H(49)
H(8) = 1.117204E-02 = H(48)
H(9) = 1.164679E-02 = H(47)
H(10) = -9.963073E-03 = H(46)
H(11) = -9.238414E-03 = H(45)
H(12) = -2.040640E-02 = H(44)
H(13) = -1.946051E-02 = H(43)
H(14) = 3.124302E-02 = H(42)
H(15) = 6.304561E-03 = H(41)
H(16) = -2.048280E-02 = H(40)
H(17) = 6.574080E-03 = H(39)
H(18) = -1.120240E-03 = H(38)
H(19) = 4.195695E-02 = H(37)
H(20) = 3.578428E-02 = H(36)
H(21) = 3.474480E-02 = H(35)
H(22) = 7.149640E-02 = H(34)
H(23) = -1.713883E-01 = H(33)
H(24) = -1.825505E-01 = H(32)
H(25) = 7.405902E-02 = H(31)
H(26) = -1.031742E-01 = H(30)
H(27) = 2.571671E-02 = H(29)
H(28) = 3.781355E-01 = H(28)

	BAND 1	BAND 2	BAND 3	BAND 4
LOWER BAND EDGE	0.000000	0.100000	0.180000	0.300000
UPPER BAND EDGE	0.050000	0.150000	0.250000	0.360000
DESIRED VALUE	0.000000	1.000000	0.000000	1.000000
WEIGHTING	10.000000	1.000000	3.000000	1.000000
DEVIATION	0.003444	0.034448	0.011482	0.034448
DEVIATION IN DB	-49.256573	0.294179	-38.798996	0.294179

	BAND 5
LOWER BAND EDGE	0.410000
UPPER BAND EDGE	0.500000
DESIRED VALUE	0.000000
WEIGHTING	20.000000
DEVIATION	0.001722
DEVIATION IN DB	-55.277172

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

0	0.243616	0.032366	0.044642
0.1	0.108929	0.126786	0.142411
0.18	0.18558	0.197857	0.213482
0.243616	0.25	0.3	0.312277
0.350223	0.36	0.41	0.41558
0.445714	0.463571	0.481428	0.5

#####

1.066267E-03
 6.377732E-03
 3.575602E-03
 -9.067776E-03
 -9.090722E-03
 2.915573E-03
 3.963771E-03
 1.117204E-02
 1.164679E-02
 -9.963073E-03
 -9.238414E-03
 -2.040640E-02
 -1.946051E-02
 3.124302E-02
 6.304561E-03
 -2.048280E-02
 6.574080E-03
 -1.120240E-03
 4.195695E-02
 3.578428E-02
 3.474480E-02
 7.149640E-02
 -1.713883E-01
 -1.825505E-01
 7.405902E-02
 -1.031742E-01
 2.571671E-02

```
3.781355E-01
2.571671E-02
-1.031742E-01
7.405902E-02
-1.825505E-01
-1.713883E-01
7.149640E-02
3.474480E-02
3.578428E-02
4.195695E-02
-1.120240E-03
6.574080E-03
-2.048280E-02
6.304561E-03
3.124302E-02
-1.946051E-02
-2.040640E-02
-9.238414E-03
-9.963073E-03
1.164679E-02
1.117204E-02
3.963771E-03
2.915573E-03
-9.090722E-03
-9.067776E-03
3.575602E-03
6.377732E-03
1.066267E-03
```

1.12 Output for Differentiator.FIR

```
DEVIATION = 0.001310
DEVIATION = 0.005829
DEVIATION = 0.006130
DEVIATION = 0.006202
```

```
FINITE IMPULSE RESPONSE (FIR)
LINEAR PHASE DIGITAL FILTER DESIGN
FILTER TYPE: DIFFERENTIATOR
FILTER LENGTH = 32
```

```
***** IMPULSE RESPONSE *****
```

```
H( 1) = -6.271307E-04 = -H( 32)
H( 2) = 8.563357E-04 = -H( 31)
H( 3) = -4.241865E-04 = -H( 30)
H( 4) = 3.990139E-04 = -H( 29)
H( 5) = -4.343722E-04 = -H( 28)
H( 6) = 4.996944E-04 = -H( 27)
H( 7) = -5.963505E-04 = -H( 26)
H( 8) = 7.327703E-04 = -H( 25)
H( 9) = -9.300249E-04 = -H( 24)
H( 10) = 1.227003E-03 = -H( 23)
```

$H(11) = -1.701281E-03 = -H(22)$
 $H(12) = 2.527233E-03 = -H(21)$
 $H(13) = -4.160115E-03 = -H(20)$
 $H(14) = 8.129457E-03 = -H(19)$
 $H(15) = -2.253910E-02 = -H(18)$
 $H(16) = 2.026653E-01 = -H(17)$

	BAND 1
LOWER BAND EDGE	0.000000
UPPER BAND EDGE	0.500000
DESIRED SLOPE	1.000000
WEIGHTING	1.000000
DEVIATION	0.006202

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

0.001953	0.5	0.066406	0.099609
0.164063	0.197266	0.230469	0.263672
0.330078	0.363281	0.394531	0.427734
0.486328	0.5		

#####

$-6.271307E-04$
 $8.563357E-04$
 $-4.241865E-04$
 $3.990139E-04$
 $-4.343722E-04$
 $4.996944E-04$
 $-5.963505E-04$
 $7.327703E-04$
 $-9.300249E-04$
 $1.227003E-03$
 $-1.701281E-03$
 $2.527233E-03$
 $-4.160115E-03$
 $8.129457E-03$
 $-2.253910E-02$
 $2.026653E-01$
 $-2.026653E-01$
 $2.253910E-02$
 $-8.129457E-03$
 $4.160115E-03$
 $-2.527233E-03$
 $1.701281E-03$
 $-1.227003E-03$
 $9.300249E-04$
 $-7.327703E-04$
 $5.963505E-04$
 $-4.996944E-04$
 $4.343722E-04$
 $-3.990139E-04$
 $4.241865E-04$
 $-8.563357E-04$

6.271307E-04

1.13 Output for Hilbert.FIR

DEVIATION = 0.004165
 DEVIATION = 0.016426
 DEVIATION = 0.020038
 DEVIATION = 0.020556

FINITE IMPULSE RESPONSE (FIR)
 LINEAR PHASE DIGITAL FILTER DESIGN
 FILTER TYPE: HILBERT TRANSFORMATOR
 FILTER LENGTH = 20

***** IMPULSE RESPONSE *****

H(1) = 1.602632E-02 = -H(20)
 H(2) = 1.417333E-02 = -H(19)
 H(3) = 2.045249E-02 = -H(18)
 H(4) = 2.873692E-02 = -H(17)
 H(5) = 3.985263E-02 = -H(16)
 H(6) = 5.533331E-02 = -H(15)
 H(7) = 7.854278E-02 = -H(14)
 H(8) = 1.182376E-01 = -H(13)
 H(9) = 2.066413E-01 = -H(12)
 H(10) = 6.347561E-01 = -H(11)

	BAND 1
LOWER BAND EDGE	0.050000
UPPER BAND EDGE	0.500000
DESIRED VALUE	1.000000
WEIGHTING	1.000000
DEVIATION	0.020556

EXTREMAL FREQUENCIES--MAXIMA OF THE ERROR CURVE

0.05	0.24375	0.103125	0.146875
0.24375	0.29375	0.346875	0.396875
0.5			

#####

1.602632E-02
 1.417333E-02
 2.045249E-02
 2.873692E-02
 3.985263E-02
 5.533331E-02
 7.854278E-02
 1.182376E-01

2.066413E-01
6.347561E-01
-6.347561E-01
-2.066413E-01
-1.182376E-01
-7.854278E-02
-5.533331E-02
-3.985263E-02
-2.873692E-02
-2.045249E-02
-1.417333E-02
-1.602632E-02

1.14 Filter Library

9. Filter Library

If you have designed good filters for special purposes, you can send them to me via e-mail, including a short description, for example about the application you use them in, or special characteristics. I will then include them in a filter library and distribute them together with the program. Remember to send only the #?.FIR files, saved by this program, so other people can modify your filters.

Thanks... (e-mail: harald.zottmann@ntc.nokia.com)
