Virtual Bass Toolbox

User's Guide

Adam J. Hill

School of Technology
University of Derby
Derby, UK

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1) Toolbox overview

The Virtual Bass Toolbox is an easy to use GUI written in MATLAB which allows virtual bass processing to be applied to sound files. Three types of virtual bass processing are available within the toolbox including: nonlinear devices (NLD), phase vocoders (PV) and hybrid methods (NLD + PV). The toolbox allows for extremely flexible virtual bass capabilities as well as thorough data analysis options.

This version of the toolbox has had functions sensitive to current research in the Audio Research Laboratory, University of Essex, removed so that the toolbox can be distributed freely among researchers. Under no circumstances may this toolbox be used in commercial/for-profit applications.

As an open source project, users are encouraged to improve the code in any way seen fit along with creating new functions for the toolbox. Any updates are welcome and can be emailed to Adam Hill for inclusion as updated versions on the website.

*** To run the toolbox, type *vbGUI* into the command prompt and hit enter. *******

2) System requirements

The Virtual Bass Toolbox was written entirely in MATLAB 7.6.0 (R2008a) running on Microsoft Windows. There are no guarantees of backwards compatibility to earlier versions of MATLAB or compatibility with Apple or Linux operating systems. Toolbox processing time depends on system capabilities and the maximum file size is governed by the amount of available memory to MATLAB.

3) Installation

If you download the MATLAB version of the toolbox, you simply need to set your current directory to the Virtual Bass Toolbox folder and then type *vbGUI* into the command prompt in MATLAB and hit enter. The GUI should appear after a few seconds.

If you wish to use the toolbox as a standalone application, you need to have the MATLAB compiler runtime (MCR) installed on your computer. This is available in the Virtual_Bass_Toolbox_vX_X_MCR_pkg file (approximately 230 MB). Once downloaded, double click on the file to extract the contents. MCRInstaller.exe will automatically launch to install MCR. Once this is complete you can run the toolbox by clicking on the application Virtual_Bass_Toolbox _vX_X.

If you already have MCR installed on your computer, you can download Virtual_Bass_Toolbox _vX_X_pkg which doesn't include the MCR installer (and is significantly smaller in size).

4) Graphical user interface (GUI) layout

The Virtual Bass Toolbox is laid out in an easy to use graphical user interface (GUI). If no code modification is desired, the toolbox can be operated entirely with the GUI (Figure 1). Each section of the GUI will be described in detail in the following sections of this guide.
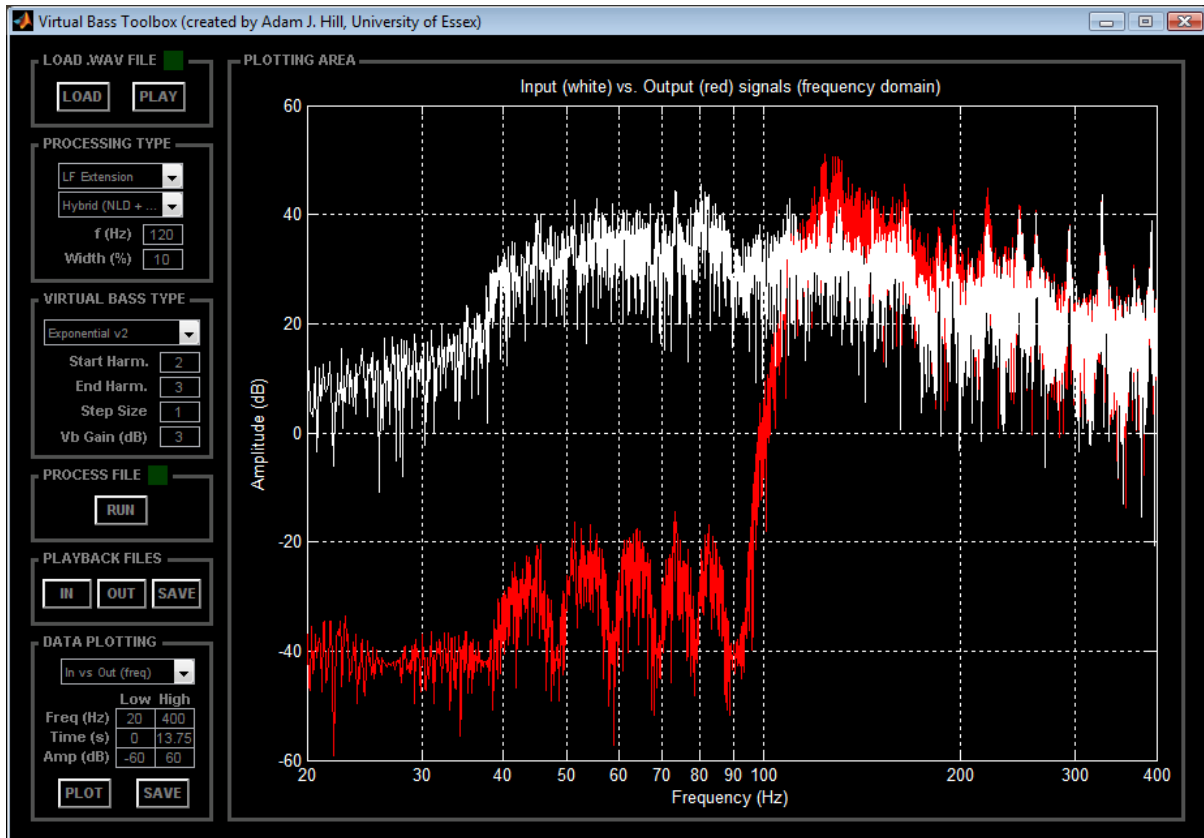

Figure 1 Virtual Bass Toolbox GUI layout

5) LOAD .WAV FILE section

Figure 2 Layout of the LOAD .WAV FILE section

LOAD   Opens window to select .wav file for processing. If the chosen file is stereo, only the left channel will be used (this version of the toolbox only processes files in mono)

PLAY   Plays back the selected file (after conversion to mono)

The indicator box (green box in Figure 2) remains red until an appropriate .wav file is loaded. If an error occurs during the loading process, the box will turn yellow. Once an appropriate file is loaded, the box turns green.
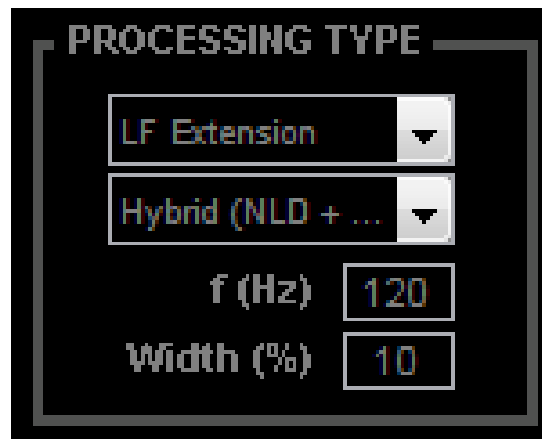
6) PROCESSING TYPE section

Figure 3 Layout of the PROCESSING TYPE section

1ˢᵗ MENU   Selects method of virtual bass processing from the following choices:

1) LF Extension – Virtual bass replaces signal content below a specified frequency, *f*
2) LF Boost – Virtual bass enhances signal content below a specified frequency, *f*
3) PEQ Extension – Virtual bass replaces signal content within a narrow band centered at a specified frequency, *f*, and a bandwidth corresponding to a set percentage of *f*
4) PEQ Boost - Virtual bass enhances signal content within a narrow band centered at a specified frequency, *f*, and a bandwidth corresponding to a set percentage of *f*

2ⁿᵈ MENU   Selects the virtual bass method from the following choices:

1) Nonlinear device (NLD)
2) Phase vocoder (PV)
3) Hybrid (NLD + PV)

f   Cutoff frequency (Hz) for LF extension/boost and center frequency for PEQ extension/boost

Width   Determines bandwidth for PEQ extension/boost with a range of

f – f*width/100 to *f + f*width/100*

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7) VIRTUAL BASS TYPE section

Figure 4 Layout of the VIRTUAL BASS TYPE section

MENU   Nonlinear device (NLD) processing method. Options include:

1) Half-wave rectifier
2) Full-wave rectifier
3) Harmonic synthesizer
4) Clipper
5) Exponential v1
6) Exponential v2
7) Fuzz Exponential v1
8) Fuzz Exponential v2
9) Arc-tangent square root

Start Harm. Phase vocoder (PV) lowest harmonic component for the virtual bass harmonic distortion

End Harm. Phase vocoder (PV) highest harmonic component for the virtual bass harmonic distortion

Step Size Step size (in harmonics) between start and end harmonics used in harmonic distortion generation

VB Gain Virtual bass gain (dB) relative to the spectral energy levels of the unprocessed signal

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8) PROCESS FILE section

Figure 5 Layout of the PROCESS FILE section

RUN   Button to carry out virtual bass processing

The indicator box (green box in Figure 5) remains red until the run button is pressed, causing the box to turn yellow. The box will remain yellow until processing is complete, at which point it turns green.

Runtime note: Approximate runtime for a 15 second .wav file:

- Nonlinear device   =   15 s
- Phase vocoder   =   45 s
- Hybrid (NLD + PV)   =   60 s

Runtime for a full length song using hybrid processing is generally around 30 minutes.
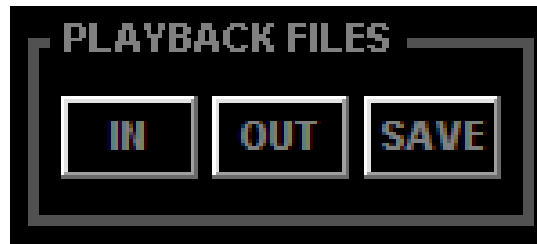
9) PLAYBACK FILES section

Figure 6 Layout of the PLAYBACK FILES section

IN   Plays the pre-virtual bass signal (high-passed input for LF extension, full-range for LF/PEQ boost, notch filtered for PEQ extension)

OUT   Plays the virtual bass processed signal

SAVE   Prompts for a file name and then saves the processed signal to a mono .wav file (44.1k/16)
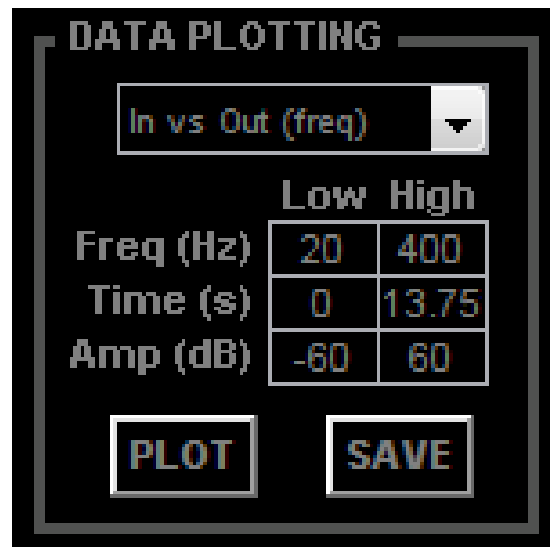
10) DATA PLOTTING section

Figure 7 Layout of the DATA PLOTTING section

MENU   Selects which variety of plot to use. Options include:

1) Input vs. output (frequency domain)
2) Input vs. output (time domain)
3) Input (frequency domain)
4) Input (time domain)
5) Output (frequency domain)
6) Output (time domain)
7) Virtual bass algorithm output (frequency domain)
8) Virtual bass algorithm output (time domain)

Freq   Low/high limits (Hz) for x-axis frequency response plotting

Time   Low/high limits (s) for x-axis time domain plotting

Amp   Low/high limits for y-axis amplitude (dB) for all plots

PLOT   Button to display the plot with the specified options

SAVE   Prompts for a file name and then saves to current plot as a .fig

11) References and disclaimer

References   Hybrid virtual bass processing techniques –

Hill, A.J.; M.O.J. Hawksford. "A hybrid virtual bass system for optimized steady-state and transient performance." Proc. 2nd CEEC (IEEE Xplore), Colchester, UK. September, 2010.

PEQ virtual bass processing techniques –

Hill, A.J.; M.O.J. Hawksford. "Wide-area psychoacosutic correction for problematic room modes using non-linear bass synthesis." 129th AES Convention, San Francisco, USA. November, 2010.

Nonlinear device polynomials –

Oo, N.; W.S. Gan. "Analytical and perceptual evaluation of nonlinear devices for virtual bass system." 128th AES Convention. London, UK. May, 2010.

Disclaimer   This software is part of an ongoing research project, therefore no guarantees can be made for an error-free piece of software. Be sure to validate all results if using the toolbox to aid research.