USER INTERFACE FOR MATLAB IMPLEMENTATION OF WAVELET FILTER BANK BASED PERCEPTUAL AUDIO CODER

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Abstract

Presented paper describes graphical interface that was made for a new wavelet filter bank based wide band audio coder. This interface is used for testing of encoder and corresponding decoder implementations made in the Matlab environment. Interface enables source audio file encoding and reproduction, decoding of the coded data, its reproduction and conversion to standard audio file. These files will be used for performing both subjective and objective listening tests to examine perceived quality of the coder and to compare it with other perceptual audio coders.

1 Introduction

Wavelet filter bank based wide band audio coder uses wavelet filter bank (WFB) instead of Pseudo Quadrature Mirror Filter (PQMF) filter bank or Modified Discrete Cosine Transform (MDCT) which are used in the most systems for perceptual coding of wide band audio signals. WFB decomposes an input audio signal into several sub-bands to perform data compression in these sub-bands. Both PQMF and MDCT based perceptual coders suffers from the origin of disturbing artifacts, usage of WFB filter bank should suppress these artifacts.

Special user interface was designed for the purposes of testing of the coder's implementations. The interface simples encoding and decoding process together with a possibility of audio reproduction.

2 Wavelet Filter Bank Based Wide Band Audio Coder

User interface was made for the purpose of the testing of new implementations of Wavelet Filter Bank Based Wide Band Audio Coder. Block diagram as was presented in [1] may be seen in Fig. 1.

An input signal is decomposed by a **Wavelet Filter Bank** which has two stages to best fit properties of human hearing system. In the block diagram in Fig. 1 are these two stages shown separately. Wavelet Filter Bank has two outputs, from each stage one. The first output is used for signal analyses in the psychoacoustic model and the second one is further processed to be re-coded. Bandwidths of the bank outputs are designed to be close correlated with the theory of human hearing called *Critical bands* by Mr. Zwicker [4].

Psychoacoustic model analyses signal from the perceptual point of view. An input of the psychoacoustic model is a frequency dependant Masking Curve which describes border between perceptible and imperceptible sounds. Optional output of the psychoacoustic model is a frequency dependant Signal to Mask Ratio (SMR) which enumerate distance of a given frequency component from Masking Curve. There are two types of the psychoacoustic model designed for the coder. The first, simple, coder is taking into account hearing threshold [4] only. The second one is based on the ISO/IEC MPEG-1 Psychoacoustic Analysis Model 1 of MPEG 1 audio standard [5]. Both models are fully described in [1].

Signal decomposed by the second stage of the Wavelet Filter Bank is **Windowed** to divide signal into blocks. Further coding of the audio signal is performed in a block bases. Each block
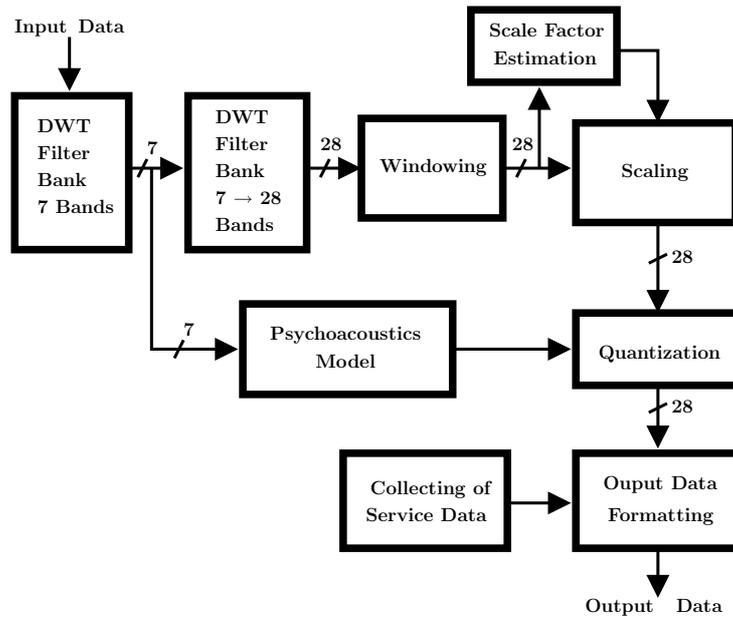
Figure 1: Block diagram of the Wavelet Filter Bank Based Wide-band Audio Coder. From [1].

has its time and scale (by its sub-band) position.

Values in each block are then normalized in **Scaling** coder's block to maximize coding efficiency.

Block named **Quantization** actually consists of two independent blocks. The first calculates **Bit Allocation** according to the analysis made by the **Psychoacoustic model** and scale factors used for the **Scaling**. Coding bits for each signal block are calculated by the **Bit Allocation**. The second part of the block performs quantization of the signal to the bit-depth given by the **Bit Allocation**.

Block named **Collecting of Service Data** collects all the information that is needed for the decoding process. This information especially consists of scale factors and bit-depths of each signal block.

Output Data Formatting system block multiplexes coded audio data and all the service information from **Collecting of Service Data** system block.

2.1 Matlab implementation

Wavelet Filter Bank Based Wide Band Audio Coder as was described in previous chapter and in [1] was implemented in Matlab environment. Implementation uses Wavelet Toolbox in Wavelet Filter Bank implementation. In addition to the block diagram shown in Fig. 1 is in Matlab implementation used internal entropy coder because for formation of the output data stream is used standard Matlab **save** function together with standard Matlab 'mat' file format.

3   User interface for the coder

Special user interface was designed for the WFB audio coder. Main window of the interface is shown in Fig. 2.
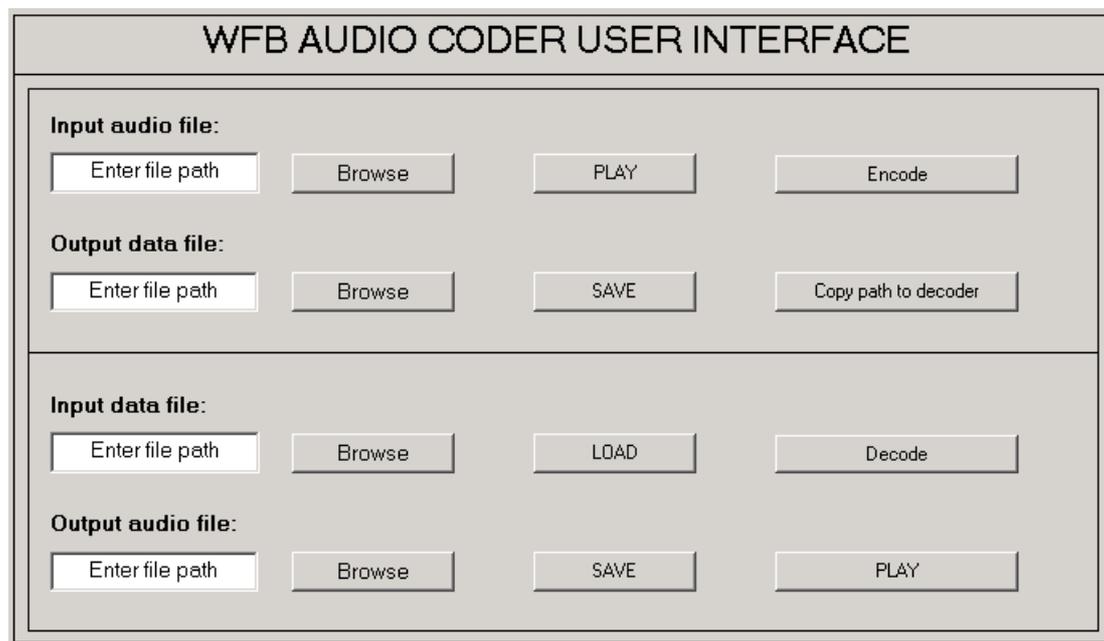

Figure 2: Main window of the designed user interface.

3.1   File encoding

Top half of the application window is used for an audio file encoding.

For selecting file to encode it is necessary to fill in the left box by a file's path. It is possible to fill in path manually or by a *Browse* button. Browse button uses standard *uigetfile* environment for a path box filling.

PLAY button replays selected file. Standard *wavread* and *wavplay* environments are used for audio reproduction. This functionality may be therefore used in Windows operating systems only.

ENCODE button starts file encoding by calling WFB encoder script. This script analyzes audio file and encode it. Encoded data is not stored in the file, but in Matlab variables only.

SAVE button saves encoded data into file using Matlab internal entropy coder. Output file may be defined in the second path box. Saving performs special script that uses Matlab *save* or *fwrite* together with *fopen* and *fclose* functions depending on the used implementations.

By the button labeled *Copy path to decoder* may be copied path from the output data file path field into the path for file decoding.

3.2   File decoding

Lower part of the application window is used for the process of the data decoding.

LOAD and *Decode* buttons start decoding process of the file given in the first path field by calling *decode.m* script. Decoded audio data is again stored in Matlab variables not a particular file on a hard drive.

SAVE button performs storing of the decoded audio data into file. Standard Matlab *wavwrite* function is used for audio file creation. Saved output audio file may be replayed by the *PLAY* button.

4   Conclusion

Special user interface for purposes of testing and evaluation of new implementations of the Wavelet Filter Bank Based Wide Band Audio Coder was designed. It is expected to be used for encoding and decoding of audio files. User interface was designed to be independent of the particular implementation of the coder. Coder may be improved or even redesigned without any influence to the user interface and therefore designed interface may be used for any implementation of any coder.

User interface will be improved in the future to better suit for usage. It is expected to extend user interface with a function for analyses of the error signal.

References

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5   Acknowledgement

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