specific, relying on characteristics of speech that are not suitable for music and other forms of audio, or require extensive computational resources that cannot be implemented economically.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide for the processing of audio signals to reduce the quantity of information required to represent a signal during transmission or storage while maintaining the perceived quality of the signal. Although the present invention is particularly directed toward the reproduction of music signals, it is also applicable to a wide range of audio signals including voice.

According to a first aspect of the present invention, there is provided a method for generating a reconstructed audio signal having a baseband portion and a highband portion, the method comprising: extracting, from an encoded audio signal, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter; extracting, from the encoded audio signal, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion; obtaining a decoded baseband audio signal, wherein the obtaining includes decoding the encoded audio signal by filtering in a frequency domain at least some of the spectral components of the baseband portion with the reconstruction filter using the temporal envelope information to shape a temporal envelope of the baseband portion; extracting, from the encoded audio signal, a noise parameter and an estimated spectral envelope of the highband portion; obtaining a plurality of subband signals by filtering the decoded baseband audio signal; generating a high-frequency reconstructed signal by copying a number of consecutive subband signals of the plurality of subband signals; obtaining an envelope adjusted high-frequency signal by adjusting, based on the estimated spectral envelope of the highband portion, a spectral envelope of the high-frequency reconstructed signal; generating a noise component based on the noise parameter, wherein the noise parameter indicates a level of noise contained in the highband portion; obtaining a combined high-frequency signal by adding the noise component to the envelope adjusted high-frequency signal; and obtaining a time-domain reconstructed audio signal by combining the decoded baseband audio signal and the combined high-frequency signal;

wherein the method is implemented by an audio decoding device comprising one or more hardware elements.

According to a second aspect of the present invention, there is provided an audio decoder generating a reconstructed audio signal having a baseband portion and a highband portion, the audio decoder comprising: an extractor for obtaining, from an encoded audio signal, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter; an extractor for obtaining, from the encoded audio signal, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion; a decoder for obtaining a decoded baseband audio signal by decoding the encoded audio signal, wherein the decoder includes a reconstruction filter for processing at least some of the spectral components of the baseband portion using the temporal envelope information to shape a temporal envelope of the baseband portion; an extractor for obtaining, from the encoded audio signal, a noise parameter and an estimated spectral envelope of the highband portion; a filter for obtaining a plurality of subband signals from the decoded baseband audio signal; a generator for creating a high-frequency reconstructed signal by copying a number of consecutive subband signals of the plurality of subband signals; an envelope adjuster for obtaining an envelope adjusted high-frequency signal by adjusting, based on the estimated spectral envelope of the highband portion, a spectral envelope of the high-frequency reconstructed signal; a noise generator for generating a noise component based on the noise parameter, wherein the noise parameter indicates a level of noise contained in the highband portion; a combiner for obtaining a combined high-frequency signal by adding the noise component to the envelope adjusted high-frequency signal; and a synthesizer for obtaining a time-domain reconstructed audio signal by combining the decoded baseband audio signal and the combined high-frequency signal; wherein the audio decoder comprises one or more hardware elements.

Embodiments of the present invention disclose a transmitter, an output signal is generated by obtaining a frequency-domain representation of a baseband signal having some but not all spectral components of the audio signal; obtaining an estimated spectral envelope of a residual signal having spectral components of the audio signal that are not in the baseband signal; deriving a noise-blending parameter from a measure of noise content of the residual signal; and

assembling data representing the frequency-domain representation of the baseband signal, the estimated spectral envelope and the noise-blending parameter into the output signal.

Embodiments of the present invention disclose a receiver, an audio signal is reconstructed by receiving a signal containing data representing a baseband signal, an estimated spectral envelope and a noise-blending parameter; obtaining from the data a frequency-domain representation of the baseband signal; obtaining a regenerated signal comprising regenerated spectral components by translating spectral components of the baseband in frequency; adjusting phase of the regenerated spectral components to maintain phase coherency within the regenerated signal; obtaining an adjusted regenerated

Claims

1. A method for generating a reconstructed audio signal having a baseband portion and a highband portion, the method comprising:

extracting, from an encoded audio signal, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter;

extracting, from the encoded audio signal, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion;

obtaining a decoded baseband audio signal, wherein the obtaining includes decoding the encoded audio signal by filtering in a frequency domain at least some of the spectral components of the baseband portion with the reconstruction filter using the temporal envelope information to shape a temporal envelope of the baseband portion;

extracting, from the encoded audio signal, a noise parameter and an estimated spectral envelope of the highband portion;

obtaining a plurality of subband signals by filtering the decoded baseband audio signal;

generating a high-frequency reconstructed signal by copying a number of consecutive subband signals of the plurality of subband signals;

obtaining an envelope adjusted high-frequency signal by adjusting, based on the estimated spectral envelope of the highband portion, a spectral envelope of the high-frequency reconstructed signal;

generating a noise component based on the noise parameter, wherein the noise parameter indicates a level of noise contained in the highband portion;

obtaining a combined high-frequency signal by adding the noise component to the envelope adjusted high-frequency signal; and

obtaining a time-domain reconstructed audio signal by combining the decoded baseband audio signal and the combined high-frequency signal;

wherein the method is implemented by an audio decoding device comprising one or more hardware elements.

2. The method of claim 1 wherein the plurality of subband signals is generated with one or more Quadrature Mirror Filters (QMF).

3. The method of claim 1 wherein the encoded audio signal is decoded using an inverse modified Discrete Cosine Transform (DCT).

4. The method of claim 1 wherein the noise parameter is represented in a form of a normalized ratio.

5. The method of claim 4 further comprising converting the normalized ratio to an amplitude value.

6. The method of claim 1 further comprising limiting an amount of envelope adjustment of the high-frequency reconstructed signal.

~~7. The method of claim 6 further comprising compensating for the limiting by boosting the combined high-frequency signal.~~

~~8~~7. The method of claim 1 further comprising ~~smoothing~~modulating, based on a parameter extracted from the encoded audio signal, an amount of envelope adjustment of the high-frequency reconstructed signal.

~~9~~8. An audio decoding device comprising one or more hardware elements that implement the method of claim 1 by executing a sequence of instructions.

~~10~~9. A non-transitory computer-readable medium containing instructions that when executed by an audio decoding device comprising one or more hardware elements, cause the audio decoding device to implement the method of claim 1.

~~11~~10. An audio decoder generating a reconstructed audio signal having a baseband portion and a highband portion, the audio decoder comprising:

an extractor for obtaining, from an encoded audio signal, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter;

an extractor for obtaining, from the encoded audio signal, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion;

a decoder for obtaining a decoded baseband audio signal by decoding the encoded audio signal, wherein the decoder includes a reconstruction filter for processing at least some of the spectral components of the baseband portion using the temporal envelope information to shape a temporal envelope of the baseband portion;

an extractor for obtaining, from the encoded audio signal, a noise parameter and an estimated spectral envelope of the highband portion;

a filter for obtaining a plurality of subband signals from the decoded baseband audio signal;

a generator for creating a high-frequency reconstructed signal by copying a number of consecutive subband signals of the plurality of subband signals;

an envelope adjuster for obtaining an envelope adjusted high-frequency signal by adjusting, based on the estimated spectral envelope of the highband portion, a spectral envelope of the high-frequency reconstructed signal;

a noise generator for generating a noise component based on the noise parameter, wherein the noise parameter indicates a level of noise contained in the highband portion;

a combiner for obtaining a combined high-frequency signal by adding the noise component to the envelope adjusted high-frequency signal; and

a synthesizer for obtaining a time-domain reconstructed audio signal by combining the decoded baseband audio signal and the combined high-frequency signal;

wherein the audio decoder comprises one or more hardware elements.