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 one aspect of the present invention in 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.

According to another aspect of the present invention in 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

signal by obtaining a noise signal in response to the noise-blending parameter, modifying the regenerated signal by adjusting amplitudes of the regenerated spectral components according to the estimated spectral envelope and the noise-blending parameter, and combining the modified regenerated signal with the noise signal; and obtaining a time-domain representation of the reconstructed signal corresponding to a combination of the spectral components in the adjusted regenerated signal with spectral components in the frequency-domain representation of the baseband signal.

Another aspect of the present invention is a method for generating a reconstructed audio signal having a baseband portion and a highband portion, the method comprising: deformatting an encoded audio signal into a first part and a second part; extracting, from the first part, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter; extracting, from the first part, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion and the number of the spectral components of the baseband portion may vary dynamically; decoding the first part to obtain a decoded baseband audio signal, wherein the decoding includes 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 second part, 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, wherein a frequency resolution of the estimated spectral

envelope is adaptive; 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.

Another aspect of the present invention is an audio decoder generating a reconstructed audio signal having a baseband portion and a highband portion, the audio decoder comprising: a deformatter for extracting a first part and a second part from an encoded audio signal; an extractor for obtaining, from the first part, temporal envelope information, wherein the temporal envelope information includes coefficients representing a reconstruction filter; an extractor for obtaining, from the first part, spectral components of the baseband portion, wherein the spectral components of the baseband portion do not include spectral components of the highband portion and the number of the spectral components of the baseband portion may vary dynamically; a decoder for obtaining a decoded baseband audio signal from the first part, 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 second part, 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, wherein a frequency resolution of the estimated spectral envelope is

adaptive; 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.

Other aspects of the present invention are described below and set forth in the claims.

The various features of the present invention and its preferred implementations may be better understood by referring to the following discussion and the accompanying drawings in which like reference numerals refer to like elements in the several figures. The contents of the following discussion and the drawings are set forth as examples only and should not be understood to represent limitations upon the scope of the present invention.

BRIEF DESCRIPTION OF DRAWINGS

Fig.1 illustrates major components in a communications system.

Fig. 2 is a block diagram of a transmitter.

Figs. 3A and 3B are hypothetical graphical illustrations of an audio signal and a corresponding baseband signal.

Fig. 4 is a block diagram of a receiver.