Claims

~~[Claim 1]~~

1. A computer-implemented method for processing an audio signal, the method comprising:

receiving an encoded low-frequency range signal corresponding to the audio signal;

decoding the encoded signal to produce a decoded signal having an energy spectrum of a shape including an energy depression;

performing filter processing on the decoded signal, the filter processing separating the decoded signal into low-frequency range band signals;

performing a smoothing process on the decoded signal, the smoothing process smoothing the energy depression of the decoded signal;

performing a frequency shift on the smoothed decoded signal, the frequency shift generating high-frequency range band signals from the low-frequency range band signals;

combining the low-frequency range band signals and the high-frequency range band signals to generate an output signal; and

outputting the output signal,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.

~~[Claim 2]~~

2. A computer-implemented method as in claim 1, wherein the encoded signal further comprises energy information for the low-frequency range band signals.

~~[Claim 3]~~

3. A computer-implemented method as in claim 2, wherein performing the frequency shift is based on the energy information for the low-frequency range band signals.

~~[Claim 4]~~

4. A computer-implemented method as in claim 1, wherein the encoded signal further comprises SBR (spectral band replication) information for the high-frequency range bands of the audio signal.

~~[Claim 5]~~

5. A computer-implemented method as in claim 4, wherein performing the frequency shift is based on the SBR information.

~~[Claim 6]~~

~~A computer-implemented method as in claim 1, wherein the encoded signal further comprises smoothing position information for the low-frequency range band signals.~~

~~[Claim 7]~~

6. A computer-implemented method as in claim ~~6~~5, wherein performing the smoothing process on the decoded signal is based on the smoothing position information for the low-frequency range band signals.

~~[Claim 8]~~

7. A computer-implemented method as in claim 1, further comprising:

performing gain adjustment on the frequency-shifted smoothed decoded band signal.

~~[Claim 9]~~

8. A computer-implemented method as in claim ~~8~~7 wherein the encoded signal further comprises gain information for the low-frequency range bands signals.

~~[Claim 10]~~

9. A computer-implemented method as in claim ~~9~~8, wherein performing gain adjustment on the frequency-shifted decoded signal is based on the gain information.

~~[Claim 11]~~

10. A computer-implemented method as in claim 1, further comprising:

computing the average energies of the low-frequency range band signals.

~~[Claim 12]~~

11. A computer-implemented method as in claim 1, wherein performing a smoothing process on the decoded signal further comprises:

computing an average energy of a plurality low-frequency range band signals;

computing a ratio for a selected one of the low-frequency range band signals by computing a ratio of the average energy of the plurality of low-frequency range band signals to the energy for the selected low-frequency range band signal; and

performing a smoothing process by multiplying the energy of the selected low-frequency range band signal by the computed ratio.

~~[Claim 13]~~

12. A computer-implemented method as in claim 1, wherein the encoded signal is multiplexed.

~~[Claim 14]~~

13. A computer-implemented method as in claim ~~14~~12 further comprising:

demultiplexing the multiplexed encoded signal.

~~[Claim 15]~~

14. A computer-implemented method as in claim 1, wherein the encoded signal is encoded using an AAC (Advanced Audio Coding) scheme.

~~[Claim 16]~~

15. A device for processing an audio signal, the device comprising:

a low-frequency range decoding circuit configured to receive an encoded low-frequency range signal corresponding to the audio signal and decode the encoded signal to produce a decoded signal having an energy spectrum of a

shape including an energy depression;

a filter processor configured to perform filter processing on the decoded signal, the filter processing separating the decoded signal into low-frequency range band signals;

a high-frequency range generating circuit configured to:

perform a smoothing process on the decoded signal, the smoothing process smoothing the energy depression; and

perform a frequency shift on the smoothed decoded signal, the frequency shift generating high-frequency range band signals from the low-frequency range band signals; and

a combinatorial circuit configured to combine the low-frequency range band signals and the high-frequency range band signals to generate an output signal, and output the output signal,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.

~~[Claim 17]~~

16. A tangibly embodied computer-readable storage medium including instructions that, when executed by a processor, perform a method for processing an audio signal, the method comprising:

receiving an encoded low-frequency range signal corresponding to the audio signal;

decoding the encoded signal to produce a decoded signal having an energy spectrum of a shape including an energy depression;

performing filter processing on the decoded signal, the filter processing separating the decoded signal into low-frequency range band signals;

performing a smoothing process on the decoded signal, the smoothing process smoothing the energy depression of the decoded signal;

performing a frequency shift on the smoothed decoded signal, the

frequency shift generating high-frequency range band signals from the low-frequency range band signals;

combining the low-frequency range band signals and the high-frequency range band signals to generate an output signal; and

outputting the output signal,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.

~~[Claim 18]~~

17. A computer-implemented method for processing a signal, the method comprising:

receiving an input signal;

extracting a low-frequency range signal from the input signal;

performing filter processing on the low-frequency range signal, the filter processing separating the signal into low-frequency range band signals;

calculating energy information for the low-frequency range band signals;

encoding the low-frequency range signal and the energy information; and

outputting the encoded low-frequency range signal and the encoded energy information,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.

~~[Claim 19]~~

18. A device for processing a signal, the device comprising:

a downsampler configured to receive an input signal and extract a low-frequency range signal from the input signal;

a high-frequency range coding circuit configured to:

perform filter processing on the low-frequency range signal, the filter processing separating the signal into low-frequency range band signals;

calculate energy information for the low-frequency range band

signals; and

encode the energy information;

a low-frequency range coding circuit configured to encode the low-frequency range signal; and

a multiplexing circuit configured to output the encoded low-frequency range signal and the encoded energy information,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.

~~[Claim 20]~~

19. A tangibly embodied computer-readable storage medium including instructions that, when executed by a processor, perform a method for processing a signal, the method comprising:

receiving an input signal;

extracting a low-frequency range signal from the input signal;

performing filter processing on the low-frequency range signal, the filter processing separating the signal into low-frequency range band signals;

calculating energy information for the low-frequency range band signals;

encoding the low-frequency range signal and the energy information; and

outputting the encoded low-frequency range signal and the encoded energy information,

wherein the encoded signal comprises smoothing position information for the low-frequency range band signals.