Claims

1. Audio processor for generating a frequency enhanced audio signal from a source audio signal, comprising:

an envelope determiner for determining a temporal envelope of at least a portion of the source audio signal;

an analyzer for analyzing the temporal envelope to determine temporal values of certain features of the temporal envelope;

a signal synthesizer for generating a synthesis signal, the generating comprising placing pulses in relation to the temporal values, wherein, in the synthesis signal, the pulses are weighted using weights derived from amplitudes of the temporal envelope related to the temporal values at which the pulses are placed; and

a combiner for combining at least one band of the synthesis signal that is not included in the source audio signal and the source audio signal to obtain the frequency enhanced audio signal.

2. Audio processor of claim 1, wherein the analyzer is configured for determining the temporal values of local maxima or local minima as the certain features.

3. Audio processor of claim 1 or 2, wherein the envelope determiner is configured

to decompose the source audio signal into a plurality of subband signals,

to calculate a selected temporal envelope of a selected subband signal of the plurality of subband signals, the selected temporal envelope being the temporal envelope, or

to calculate at least two temporal envelopes from at least two subband signals of the plurality of subband signals and to combine the at least two subband signals to obtain a combined temporal envelope as the temporal envelope.

4. Audio processor of claim 3,

wherein the envelope determiner is configured to normalize or filter the selected subband signals or the temporal envelopes before combining, or

wherein the combining comprises an averaging operation, or

wherein the envelope determiner is configured to calculate temporal envelopes from all subband signals of the plurality of subband signals, or

wherein the envelope determiner is configured to determine a single broadband temporal envelope of the source audio signal as the temporal envelope.

5. Audio processor of one of the preceding claims, wherein the envelope determiner is configured for determining the temporal envelope by

using an envelope follower configured for rectifying a waveform and low pass filtering the rectified waveform, or

calculating absolute values or powers of absolute values of a digital waveform and subsequently low pass filtering a result, or

using the calculation of an instantaneous root mean square value of the waveform through a sliding window with a defined window width, or

determining a piece-wise linear approximation of the waveform, wherein the temporal envelope is determined by finding and connecting peaks of the waveform in a sliding window moving through a result of the piece-wise linear approximation, or

using a Hilbert transform for generating an analytic signal for the waveform and calculating the envelope from the source audio signal and the analytic signal using squaring operations, adding operations and square root operations.

6. Audio processor of one of the preceding claims, wherein the analyzer is configured

to determine initial temporal values of the certain features, and

to derive, from the initial temporal values, the temporal values using an optimization function, or using side information associated with the source audio signal, or selecting or manipulating the temporal values in accordance with a processing rule.

7. Audio processor of claim 6, wherein the processing rule or the optimization function is implemented so that temporal values are placed in a raster with a raster spacing, wherein the raster spacing and a position of the raster within the temporal envelope is so that a deviation value between the temporal values and the initial temporal values has a predetermined characteristic.

8. Audio processor of claim 7, wherein the deviation value is a sum over squared differences and wherein the predetermined characteristic is a minimum characteristic.

9. Audio processor of one of the preceding claims, wherein the signal synthesizer is configured

to place only positive or only negative pulses to obtain a pulse train, and

to subsequently weight the pulses in the pulse train, or

to weight only negative or only positive pulses using the corresponding weightings associated with the temporal values of the pulses in a pulse train, and

to place the weighted pulses at the respective temporal values to obtain the pulse train.

10. Audio processor of one of the preceding claims,

wherein the signal synthesizer is configured to derive the weights from the amplitudes using a compression function, the compression function being a function from the group of functions comprising:

a power function with a power lower than 1, a log function, a square root function, and a non-linear function configured for reducing higher values and increasing lower values.

11. Audio processor of one of the preceding claims, wherein the signal synthesizer is configured to perform a post processing function, the post processing function comprising at least one of the group of functions consisting of noise addition, addition of a missing harmonic, inverse filtering, and envelope adjustment.

12. Audio processor of one of the preceding claims,

wherein the envelope determiner is configured to decompose the temporal envelope into a low frequency portion and a high frequency portion,

wherein the analyzer is configured to use the low frequency portion of the temporal envelope for analyzing.

13. Audio processor of claim 12, wherein the signal synthesizer is configured to generate energy adjusted noise, and to add the energy adjusted noise to a signal comprising weighted or non-weighted pulses to obtain the synthesis signal.

14. Audio processor of one of the preceding claims,

wherein the signal synthesizer is configured to high pass filter or to bandpass filter a signal comprising the placed and weighted pulses to obtain the at least one band of the synthesis signal that is not included in the source audio signal and to perform a spectral envelope adjustment with the band of the synthesis signal, or wherein the spectral envelope adjustment is performed using envelope adjustment values derived from side information associated with the source audio signal or using envelope adjustment values derived from the source audio signal or in accordance with a predetermined envelope adjustment function.

15. Audio processor of one of the preceding claims, wherein the source audio signal is a time domain audio signal,

wherein the at least one band of the synthesis signal is a time domain audio signal, and

wherein the combiner is configured to perform a time domain combination using a sample-by-sample addition of samples of the at least one band of the synthesis signal and corresponding samples of the source audio signal.

16. Audio processor of one of the preceding claims, wherein the source audio signal is an excitation signal in an LPC domain,

wherein the at least one band of the synthesis signal is an excitation signal in the LPC domain,

wherein the combiner is configured to combine the source audio signal and the at least one band by a sample-by-sample addition in the LPC domain,

wherein the combiner is configured to filter a result of the sample-by-sample addition using an LPC synthesis filter to obtain the frequency enhanced audio signal, and

wherein the LPC synthesis filter is controlled by LPC data associated with the source audio signal as side information, and wherein the LPC synthesis filter is additionally controlled by envelope information for the at least one band of the synthesis signal.

17. Audio processor of one of the preceding claims,

wherein the analyzer, the signal synthesizer and the combiner operate in a time domain or an LPC time domain.

18. Audio processor of one of claims 1 to 16, wherein the envelope determiner is configured to apply a spectral conversion to extract a plurality of bandpass signals for a sequence of frames,

wherein the signal synthesizer is configured to apply a spectral conversion, to extract the at least one band of the synthesis signal, and to perform an envelope adjustment to the at least one band of the synthesis signal, and

wherein the combiner is configured to combine in the spectral domain and to apply a conversion into a time domain to obtain the frequency-enhanced audio signal.

19. Method of generating a frequency enhanced audio signal from a source audio signal, comprising:

determining a temporal envelope of at least a portion of the source audio signal;

analyzing the temporal envelope to determine temporal values of certain features of the temporal envelope;

placing pulses in relation to the temporal values in a synthesis signal, wherein, in the synthesis signal, the placed pulses are weighted using weights derived from amplitudes of the temporal envelope related to the temporal values at which the pulses are placed; and

combining at least one band of the synthesis signal that is not included in the source audio signal and the source audio signal to obtain the frequency enhanced audio signal.

20. Computer program for performing, when running on a computer or a processor, the method of audio processing of claim 19.