Claims

1. A decorrelator comprising:

a plurality of delay units ~~(12)~~ , wherein each delay unit ~~(12)~~ is configured for receiving a part ~~(14_1-14_n)~~ of a frequency representation being based on an audio signal ~~(22)~~; wherein each delay unit ~~(12)~~ is configured for delaying the received part ~~(14_1-14_n)~~ to provide a delayed part ~~($14'_1$-$14'_n$)~~; and

an envelope shaper ~~(16)~~ configured for receiving and combining signals being based on the delayed parts ~~($14'_1$-$14'_n$)~~ of the frequency representation; for receiving the frequency representation of the audio signal ~~(22)~~; for adjusting an energy of the delayed parts ~~($14'_1$-$14'_n$)~~ in respect of the frequency representation of the audio signal ~~(22)~~; and for providing a combined shaped frequency representation.

2. The decorrelator of claim 1, wherein different parts ~~(14_1-14_n)~~ of the frequency representation comprise a same or a different number of frequency bins.

3. The decorrelator of claim 1 or 2, further comprising a phase shifter ~~(26)~~ configured for phase shifting the frequency representation ~~(14)~~ of the audio signal ~~(22)~~; or for phase shifting the audio signal ~~(22)~~ in a time domain to obtain a phase shifted audio signal ~~(22)~~.

4. The decorrelator of claim 3, wherein the phase shifter ~~(26)~~ is configured for phase shifting the frequency representation of the audio signal ~~(22)~~ and comprises a plurality of allpass filters, wherein each allpass filter ~~(28)~~ is configured for phase shifting an associated part ~~(14_1-14_n)~~ of the frequency representation of the audio signal ~~(22)~~.

5. The decorrelator of claim 4, wherein an allpass filter ~~(28)~~ of the plurality of allpass filter comprises a set of allpass filter structures ~~(40; 50)~~ such as Schroeder IIR filters, being serially connected to each other; wherein the allpass filter structures ~~(40; 50)~~ are adapted for providing different time delays; or

wherein the allpass filter structures ~~(40; 50)~~ comprise a nested allpass filter structure.

6. The decorrelator of claim 5, wherein a number of allpass filter structures ~~(40; 50)~~ and/or a circuitry of the allpass filter structure is equal or different between different allpass filters ~~(28)~~.

7. The decorrelator of claim 5 or 6, wherein the different time delays are based on a prime number multiple of a local sampling rate used for obtaining the frequency representation of the audio signal ~~(22)~~.

8. The decorrelator of one of claims 5 to 7, wherein the set of allpass filter structures ~~(40; 50)~~ comprises a number of four allpass filter structures ~~(40; 50)~~ and are adapted for providing a delay of 1, 2, 3 and 5 or 1, 3, 5 and 7, respectively.

9. The decorrelator of one of claims 4 to 8, wherein a gain factor of the allpass filter ~~(28)~~ is adapted to a value with a magnitude of 0.7 within a tolerance range of e.g., 20 %.

10. The decorrelator of claim 3, wherein the phase shifter ~~(26)~~ is configured for phase shifting the audio signal ~~(22)~~ in a time domain; wherein the phase shifter ~~(26)~~ comprises a set of allpass filter structures ~~(40; 50)~~ such as Schroeder IIR filters, being serially connected to each other; wherein the allpass filter structures ~~(40; 50)~~ are adapted for providing different time delays; or

wherein the allpass filter structures ~~(40; 50)~~ comprise a nested allpass filter structure.

11. The decorrelator of claim 10, wherein the different allpass time delays are based on a prime number multiple of a reciprocal of a sampling rate used for obtaining the frequency representation of the audio signal ~~(22)~~.

12. The decorrelator of claim 10 or 11, wherein the different time delays are based on a prime number being obtained by multiplying each of a set of minimal prime numbers, e.g., 1, 2, 3 and 5; or 1, 3, 5 and 7, with a downsampling factor used for generating the parts ~~(14_1-14_n)~~ of the frequency representation of the audio signal ~~(22)~~ to obtain an intermediate result; and for using a next prime number with respect to the intermediate result, e.g., as 131, 257, 383, 641 or 131, 383, 641, 907.

13. The decorrelator of one of claims 10 to 12, comprising a first conversion unit ~~(24)~~ for obtaining the frequency representation of the audio signal ~~(22)~~ from the audio signal

(22) for the envelope shaper (16); and comprising a second conversion unit (34) for obtaining a frequency representation from the reverberated audio signal (22); wherein the parts (14_1-14_n) of the frequency representation form parts (14_1-14_n) of the frequency representation from the reverberated audio signal (22).

14. The decorrelator of one of previous claims, wherein the parts (14_1-14_n) of the frequency representation comprise an equal or different number of frequency bins.

15. The decorrelator of one of previous claims, being adapted for obtaining a number of 16 parts (14_1-14_n) of the frequency representation.

16. The decorrelator of one of previous claims, being adapted for obtaining the frequency representation with a number of 128 or 129 frequency bins.

17. The decorrelator of one of previous claims, wherein the decorrelator is adapted to additionally implement a same and predefined delay for a subset or all parts (14_1-14_n) of the frequency representation.

18. The decorrelator of one of previous claims, wherein the delay units (12) associated to a spectral part (14_1-14_n) of the plurality of delay units (12) are configured for delaying the associated part (14_1-14_n) of the frequency representation differently when compared to delay units (12) associated to other spectral parts (14_1-14_n).

19. The decorrelator of one of previous claims, wherein the plurality of delay units (12) is configured for delaying parts (14_1-14_n) of the frequency representation comprising lower frequencies with a higher time delay when compared to parts (14_1-14_n) of the frequency representation comprising higher frequencies.

20. The decorrelator of claim 19, wherein a relationship between different time delays is one of linear, logarithmic and/or based on a rounding on subband samples.

21. The decorrelator of one of previous claims, comprising a conversion unit (24) for receiving and converting the audio signal (22) or a reverberated version of the audio signal (22) into the parts (14_1-14_n) by performing a time-block-wise discrete Fourier transform, DFT, or Short-time Fourier transform, STFT; wherein the conversion unit

(24) is configured for converting blocks having an overlap of 50 % within a tolerance range.

22. The decorrelator of one of previous claims, comprising a conversion unit (24) for receiving and converting the audio signal (22) or a reverberated version of the audio signal (22) into the parts (14$_1$-14$_n$) by performing a time-block-wise discrete Fourier transform, DFT, or Short-time Fourier transform, STFT; wherein blocks comprise a block length of 256 samples.

23. The decorrelator of one of previous claims, comprising an inverse conversion unit (34) for receiving processed versions of the parts of the frequency representation (14) and for synthesizing an synthesized signal from the processed versions based on an overlap add procedure.

24. The decorrelator of one of previous claims, wherein the envelope shaper (16) is configured for operating in a subband domain and with a temporal resolution of less than 4 ms.

25. The decorrelator of one of previous claims comprising an interface (38) for providing a signal (36) based on the combined shaped frequency representation.

26. The decorrelator of one of previous claims, wherein the envelope shaper (16) is to shape spectral bins in time and/or in frequency individually or as a group, e.g., by implementing an interdependent or an at least groupwise common shaping processing.

27. The decorrelator of one of previous claims, comprising a signal processing stage (66) configured for receiving a signal based on the combined shaped frequency representation as a mono signal and for processing the mono signal at least to a stereo signal.

28. The decorrelator of one of previous claims, comprising a signal processing stage (66) configured for processing the combined shaped frequency representation at least to a stereo audio signal; and for source extend modelling based on the at least stereo signal, e.g., in the frequency domain.

29. Processing system comprising:

a decorrelator according to one of previous claims; and

a processing stage ~~(66)~~ for transforming a mid/side decomposed signal to a left/right decomposed signal.

30. The processing system of claim 29, wherein one portion ~~(74_1)~~ of the mid/side decomposed signal is provided by the decorrelator and the other portion ~~(74_2)~~ is provided by a delay compensation unit ~~(78)~~ being connected in parallel with the decorrelator and connected with the processing stage ~~(66)~~.

31. The processing system of claim 30, comprising a transient suppressor ~~(82)~~ configured for detecting a transient in the audio signal ~~(22)~~ or the frequency representation ~~(14)~~ thereof at an input of the decorrelator;

wherein the transient suppressor ~~(82)~~ is configured for temporarily muting the portion ~~(74_1)~~ provided by the decorrelator to suppress echoes at the processing stage.

32. The processing system of claim 31, wherein the transient suppressor ~~(82)~~ is configured for amplifying the portion of the delay compensation unit corresponding to muting the portion of the decorrelator.

33. The processing system of claim 32, wherein the transient suppressor ~~(82)~~ is configured for amplifying the portion of the delay compensation unit by a factor of

$$\frac{2}{\sqrt{2}}$$

when compared to an unmuted portion of the decorrelator.

34. The processing system of one of claims 31 to 33, wherein the transient suppressor ~~(82)~~ is configured for suppressing a detected transient and for suppressing a following transient not earlier than a predefined inhibition time.

35. The processing system of one of claims 31 to 34, wherein the inhibition time is a first inhibition time; wherein the transient suppressor ~~(82)~~ is configured for restarting the inhibition time as a second inhibition time being loner than the first inhibition time in case a transient occurs during the first inhibition time.

36. The processing system of one of claims 31 to 35, wherein the transient suppressor ~~(82)~~ is configured for operating in the frequency domain.

37. The processing system of one of claims 31 to 36, wherein the transient suppressor ~~(82)~~ is configured for muting the portion of the decorrelator for a longer time when compared to a pre-delay of the decorrelator.

38. The processing system of one of claims 29 to 37, wherein the decorrelator is to provide the combined shaped frequency representation as a part of the mid/side decomposed signal to the processing stage; and the processing stage is to transform the combined shaped frequency representation and a delayed version of the audio signal ~~(22)~~ to the left/right decomposed signal in the frequency domain.

39. A method comprising:

receiving ~~(1010)~~ a plurality of parts of a frequency representation being based on an audio signal;

delaying ~~(1020)~~ each of the received parts to provide a plurality of delayed parts; and

receiving ~~(1030)~~ and combining signals being based on the delayed parts of the frequency representation;

receiving ~~(1040)~~ the frequency representation of the audio signal;

adjusting ~~(1050)~~ an energy of the delayed parts in respect of the frequency representation of the audio signal; and

providing ~~(1060)~~ a combined shaped frequency representation.

40. The method of claim 39, further comprising:

detecting a transient in the audio signal ~~(22)~~ or the frequency representation ~~(14)~~ thereof;

temporarily muting a portion ~~(74_1)~~ provided by a decorrelator to suppress echoes at a processing stage.

41. Computer program for performing, when running on a computer or a processor, the method of claim 39 or 40.