

Claims

1. A multi-channel decorrelator (140; 600; 1590; 1700) for providing a plurality of decorrelated signals (142, 144; 612a-612n'; 1592a-1592n; 1712a-1712n) on the basis of a plurality of decorrelator input signals (134, 136; 610a-610n; 1582a-1582n; 1710a-1710n),
 wherein the multi-channel decorrelator is configured to premix a first set (134, 136; 610a-610n; 1582a-1582n; 1710a-1710n; $\hat{\mathbf{Z}}$) of N decorrelator input signals into a second set (622a-622k; 1722a-1722k; $\hat{\mathbf{Z}}_{mix}$) of K decorrelator input signals, wherein $K < N$;
 wherein the multi-channel decorrelator is configured to provide a first set (632a-632k'; 1732a-1732k) of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and
 wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set (142, 144; 612a-612n'; 1592a-1592n; 1712a-1712n) of N' decorrelator output signals, wherein $N' > K'$.
2. The multi-channel decorrelator according to claim 1, wherein $K = K'$.
3. The multi-channel decorrelator according to claim 1 or claim 2, wherein $N = N'$.
4. The multi-channel decorrelator according to one of claims 1 to 3, wherein $N \geq 3$ and $N' \geq 3$.
5. The multi-channel decorrelator according to one of claims 1 to 4, wherein the multi-channel decorrelator is configured to premix the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

wherein the multi-channel decorrelator is configured to obtain the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

wherein the multi-channel decorrelator is configured to upmix the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec}.$$

6. The multi-channel decorrelator according to claim 5, wherein the multi-channel decorrelator is configured to select the premixing matrix $\mathbf{M}_{pre}$ in dependence on spatial positions to which the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals are associated.

7. The multi-channel decorrelator according to claim 5 or claim 6, wherein the multi-channel decorrelator is configured to select the premixing matrix $\mathbf{M}_{pre}$ in dependence on correlation characteristics or covariance characteristics of the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals.

8. The multi-channel decorrelator according to one of claims 5 to 7, wherein the multi-channel decorrelator is configured to determine the pre-mixing matrix such that a matrix-product

$$(\mathbf{M}_{pre} \mathbf{M}_{pre}^H)$$

is well-conditioned with respect to an inversion operation.

9. The multi-channel decorrelator according to one of claims 5 to 8,

wherein the multi-channel decorrelator is configured to obtain the postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{M}_{post} = \mathbf{M}_{pre}^H (\mathbf{M}_{pre} \mathbf{M}_{pre}^H)^{-1}.$$

10. The multi-channel decorrelator according to one of claims 1 to 9, wherein the multi-channel decorrelator is configured to receive an information about a rendering configuration associated with the channel signals of the first set ($\hat{Z}$) of N decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix (M_{pre}) in dependence on the information about the rendering configuration.
11. The multi-channel decorrelator according to one of claims 1 to 10, wherein the multi-channel decorrelator is configured to combine channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with spatially adjacent positions of an audio scene when performing the premixing.
12. The multi-channel decorrelator according to claim 11, wherein the multi-channel decorrelator is configured to combine channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions of the audio scene when performing the premixing.
13. The multi-channel decorrelator according to one of claims 1 to 12, wherein the multi-channel decorrelator is configured to combine channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with a horizontal pair of spatial positions comprising a left side position and a right side position.
14. The multi-channel decorrelator according to one of claims 1 to 13, wherein the multi-channel decorrelator is configured to combine at least four channel signals of the first set ($\hat{Z}$) of N decorrelator input signals, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of the audio scene.
15. The multi-channel decorrelator according claim 14, wherein the at least two left-sided channel signals to be combined are associated with spatial positions which are symmetrical, with respect to a center plane of the audio scene, to the spatial positions associated with the at least two right-sided channel signals to be combined.

16. The multi-channel decorrelator according to one of claims 1 to 15, wherein the multi-channel decorrelator is configured to receive a complexity information describing a number K of decorrelator input signals of the second set of decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix (M_{pre}) in dependence on the complexity information.
17. The multi-channel decorrelator according to claim 16, wherein the multi-channel decorrelator is configured to step-wisely increase a number of decorrelator input signals of the first set ($\hat{Z}$) of decorrelator input signals which are combined to obtain the decorrelator input signals of the second set of decorrelator input signals with a decreasing value of the complexity information.
18. The multi-channel decorrelator according to claim 16 or 17, wherein the multi-channel decorrelator is configured to combine only channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions of an audio scene when performing the premixing for a first value of the complexity information, and
- wherein the multi-channel decorrelator is configured to combine at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions on a left side of the audio scene and at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions on a right side of the audio scene in order to obtain a given signal of the second set of decorrelator input signals when performing the premixing for a second value of the complexity information.
19. The multi-channel decorrelator according to one of claims 16 to 18, wherein the multi-channel decorrelator is configured to combine at least four channel signals of the first set ($\hat{Z}$) of N decorrelator input signals, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of an audio scene, in order to obtain a given signal of the second set of decorrelator input signals when performing the premixing for a second value of the complexity information.

20. The multi-channel decorrelator according to one of claims 16 to 19, wherein the multi-channel decorrelator is configured to combine at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions on a left side of the audio scene, in order to obtain a first decorrelator input signal of the second set of decorrelator input signals, and to combine at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions on a right side of the audio scene, in order to obtain a second decorrelator input signal of the second set of decorrelator input signals for a first value of the complexity information, and

wherein the multi-channel decorrelator is configured to combine the at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions of the left side of the audio scene and the at least two channel signals of the first set ($\hat{Z}$) of N decorrelator input signals which are associated with vertically spatially adjacent positions on the right side of the audio scene, in order to obtain a decorrelator input signal of the second set of decorrelator input signals for a second value of the complexity information,

wherein a number of decorrelator input signals of the second set of decorrelator input signals is larger for the first value of the complexity information than for the second value of the complexity information.

21. A multi-channel audio decoder (100;1550) for providing at least two output audio signals (112,114;1552a-1552n) on the basis of an encoded representation (110; 1516a, 1516b,1518),

wherein the multi-channel audio decoder comprises a multi-channel decorrelator (140; 600; 1590; 1700) according to one of claims 1 to 20.

22. The multi-channel audio decoder according to claim 21,

wherein the multi-channel audio decoder is configured to render a plurality of decoded audio signals (122; 1562a-1562n), which are obtained on the basis of the encoded representation, in dependence on one or more rendering parameters (132), to obtain a plurality of rendered audio signals (134,136; 1582a-1582n), and

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wherein the multi-channel audio decoder is configured to derive one or more decorrelated audio signals (142,144; 1592a-1592n) from the rendered audio signals using the multi-channel decorrelator, wherein the rendered audio signals constitute the first set of decorrelator input signals, and wherein the second set of decorrelator output signals constitute the decorrelated audio signals, and

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wherein the multi-channel audio decoder is configured to combine (150;1598) the rendered audio signals, or a scaled version thereof, with the one or more decorrelated audio signals, to obtain the output audio signals.

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23. The multi-channel audio decoder according to claim 21 or claim 22, wherein the multi-channel audio decoder is configured to select a premixing matrix (M_{pre}) for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation.

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24. The multi-channel audio decoder according to one of claims 21 to 23, wherein the multi-channel audio decoder is configured to select a premixing matrix (M_{pre}) for usage by the multi-channel decorrelator in dependence on an output configuration describing an allocation of the output audio signals with spatial positions of an audio scene.

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25. The multi-channel audio decoder according to one of claims 21 to 24, wherein the multi-channel audio decoder is configured to select between three or more different premixing matrices (M_{pre}) for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation for a given output configuration, wherein each of the three or more different premixing matrices is associated with a different number of signals of the second set of K decorrelator input signals.

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35 26. The multi-channel audio decoder according to one of claims 21 to 25, wherein the multi-channel audio decoder is configured to select a premixing matrix (M_{pre}) for

usage by the multi-channel decorrelator in dependence on a mixing matrix (D_{conv} , D_{render}) which is used by an format converter or renderer which receives the at least two output audio signals.

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27. The multi-channel audio decoder according to claim 26, wherein the multi-channel audio decoder is configured to select the premixing matrix (M_{pre}) for usage by the multi-channel decorrelator to be equal to a mixing matrix (D_{conv} , D_{render}) which is used by a format converter or renderer which receives the at least two output audio signals.

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28. A multi-channel audio encoder (800) for providing an encoded representation (814) on the basis of at least two input audio signals (810;812),

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wherein the multi-channel audio encoder is configured to provide one or more downmix signals (822) on the basis of the at least two input audio signals, and

wherein the multi-channel audio encoder is configured to provide one or more parameters (832) describing a relationship between the at least two input audio signals, and

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wherein the multi-channel audio encoder is configured to provide a decorrelation complexity parameter (842) describing a complexity of a decorrelation to be used at the side of an audio decoder.

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29. A method (900) for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

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premixing (910) a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing (920) a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

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upmixing (930) the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$.

5 30. A method (1000) for providing at least two output audio signals on the basis of an encoded representation,

wherein the method comprises providing (1020) a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals according to claim 29.

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31. A method (1100) for providing an encoded representation on the basis of at least two input audio signals, the method comprising:

15 providing (1110) one or more downmix signals on the basis of the at least two input audio signals, and

providing (1120) one or more parameters describing a relationship between the at least two input audio signals, and

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providing (1130) a decorrelation complexity parameter describing a complexity of a decorrelation to be used at the side of an audio decoder.

25 32. A computer program for performing the method of claim 29, claim 30 or claim 31 when the computer program runs on a computer.

33. An encoded audio representation (1200), comprising:

30 an encoded representation (1210) of a downmix signal;

an encoded representation (1220) of one or more parameters describing a relationship between the at least two input audio signals, and

35 an encoded decorrelation complexity parameter describing a complexity of a decorrelation to be used at the side of an audio decoder.

Claims

1. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel decorrelator is configured to premix the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

wherein the multi-channel decorrelator is configured to obtain the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

wherein the multi-channel decorrelator is configured to upmix the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec},$$

wherein the multi-channel decorrelator is configured to select the premixing matrix $\mathbf{M}_{pre}$ in dependence on spatial positions to which the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals are associated.

2. The multi-channel decorrelator according to claim 1, wherein $K=K'$.
3. The multi-channel decorrelator according to claim 1 or claim 2, wherein $N=N'$.
4. The multi-channel decorrelator according to one of claims 1 to 3, wherein $N \geq 3$ and $N' \geq 3$.
5. The multi-channel decorrelator according to one of claims 1 to 4, wherein the multi-channel decorrelator is configured to select the premixing matrix $\mathbf{M}_{pre}$ in dependence on correlation characteristics or covariance characteristics of the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals.
6. The multi-channel decorrelator according to one of claims 1 to 5, wherein the multi-channel decorrelator is configured to determine the pre-mixing matrix such that a matrix-product

$$(\mathbf{M}_{pre} \mathbf{M}_{pre}^H)$$

is well-conditioned with respect to an inversion operation.

7. The multi-channel decorrelator according to one of claims 1 to 6,

wherein the multi-channel decorrelator is configured to obtain the postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{M}_{post} = \mathbf{M}_{pre}^H (\mathbf{M}_{pre} \mathbf{M}_{pre}^H)^{-1}.$$

8. The multi-channel decorrelator according to one of claims 1 to 7, wherein the multi-channel decorrelator is configured to receive an information about a rendering

configuration associated with the channel signals of the first set of N decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix in dependence on the information about the rendering configuration.

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9. The multi-channel decorrelator according to one of claims 1 to 8, wherein the multi-channel decorrelator is configured to combine channel signals of the first set of N decorrelator input signals which are associated with spatially adjacent positions of an audio scene when performing the premixing.

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10. The multi-channel decorrelator according to claim 9, wherein the multi-channel decorrelator is configured to combine channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions of the audio scene when performing the premixing.

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11. The multi-channel decorrelator according to one of claims 1 to 10, wherein the multi-channel decorrelator is configured to combine channel signals of the first set of N decorrelator input signals which are associated with a horizontal pair of spatial positions comprising a left side position and a right side position.

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12. The multi-channel decorrelator according to one of claims 1 to 11, wherein the multi-channel decorrelator is configured to combine at least four channel signals of the first set of N decorrelator input signals, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of the audio scene.

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13. The multi-channel decorrelator according claim 12, wherein the at least two left-sided channel signals to be combined are associated with spatial positions which are symmetrical, with respect to a center plane of the audio scene, to the spatial positions associated with the at least two right-sided channel signals to be combined.

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14. The multi-channel decorrelator according to one of claims 1 to 13, wherein the multi-channel decorrelator is configured to receive a complexity information describing a number K of decorrelator input signals of the second set of

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decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix in dependence on the complexity information.

15. The multi-channel decorrelator according to claim 14, wherein the multi-channel decorrelator is configured to step-wisely increase a number of decorrelator input signals of the first set of decorrelator input signals which are combined to obtain the decorrelator input signals of the second set of decorrelator input signals with a decreasing value of the complexity information.

16. The multi-channel decorrelator according to claim 14 or 15, wherein the multi-channel decorrelator is configured to combine only channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions of an audio scene when performing the premixing for a first value of the complexity information, and

wherein the multi-channel decorrelator is configured to combine at least two channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions on a left side of the audio scene and at least two channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions on a right side of the audio scene in order to obtain a given signal of the second set of decorrelator input signals when performing the premixing for a second value of the complexity information.

17. The multi-channel decorrelator according to one of claims 14 to 16, wherein the multi-channel decorrelator is configured to combine at least four channel signals of the first set of N decorrelator input signals, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of an audio scene, in order to obtain a given signal of the second set of decorrelator input signals when performing the premixing for a second value of the complexity information.

18. The multi-channel decorrelator according to one of claims 14 to 17, wherein the multi-channel decorrelator is configured to combine at least two channel signals of the first set of N decorrelator input signals which are associated with vertically

spatially adjacent positions on a left side of the audio scene, in order to obtain a first decorrelator input signal of the second set of decorrelator input signals, and to combine at least two channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions on a right side of the audio scene, in order to obtain a second decorrelator input signal of the second set of decorrelator input signals for a first value of the complexity information, and

wherein the multi-channel decorrelator is configured to combine the at least two channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions of the left side of the audio scene and the at least two channel signals of the first set of N decorrelator input signals which are associated with vertically spatially adjacent positions on the right side of the audio scene, in order to obtain a decorrelator input signal of the second set of decorrelator input signals for a second value of the complexity information,

wherein a number of decorrelator input signals of the second set of decorrelator input signals is larger for the first value of the complexity information than for the second value of the complexity information.

19. A multi-channel audio decoder for providing at least two output audio signals on the basis of an encoded representation,

wherein the multi-channel audio decoder comprises a multi-channel decorrelator according to one of claims 1 to 18.

20. The multi-channel audio decoder according to claim 19,

wherein the multi-channel audio decoder is configured to render a plurality of decoded audio signals, which are obtained on the basis of the encoded representation, in dependence on one or more rendering parameters, to obtain a plurality of rendered audio signals, and

wherein the multi-channel audio decoder is configured to derive one or more decorrelated audio signals from the rendered audio signals using the multi-channel

decorrelator, wherein the rendered audio signals constitute the first set of decorrelator input signals, and wherein the second set of decorrelator output signals constitute the decorrelated audio signals, and

5 wherein the multi-channel audio decoder is configured to combine the rendered audio signals, or a scaled version thereof, with the one or more decorrelated audio signals, to obtain the output audio signals.

10 21. The multi-channel audio decoder according to claim 19 or claim 20, wherein the multi-channel audio decoder is configured to select a premixing matrix for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation.

15 22. The multi-channel audio decoder according to one of claims 19 to 21, wherein the multi-channel audio decoder is configured to select a premixing matrix for usage by the multi-channel decorrelator in dependence on an output configuration describing an allocation of the output audio signals with spatial positions of an audio scene.

20 23. The multi-channel audio decoder according to one of claims 19 to 22, wherein the multi-channel audio decoder is configured to select between three or more different premixing matrices for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation for a given output configuration, wherein each of the three or more different premixing matrices is associated with a different number of signals of the second set of K decorrelator input signals.

24. The multi-channel audio decoder according to one of claims 19 to 23, wherein the multi-channel audio decoder is configured to select a premixing matrix for usage by the multi-channel decorrelator in dependence on a mixing matrix which is used by an format converter or renderer which receives the at least two output audio signals.

30 25. The multi-channel audio decoder according to claim 24, wherein the multi-channel audio decoder is configured to select the premixing matrix for usage by the multi-

channel decorrelator to be equal to a mixing matrix which is used by a format converter or renderer which receives the at least two output audio signals.

- 5 26. A multi-channel audio encoder for providing an encoded representation on the basis of at least two input audio signals,

wherein the multi-channel audio encoder is configured to provide one or more downmix signals on the basis of the at least two input audio signals, and

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wherein the multi-channel audio encoder is configured to provide one or more parameters describing a relationship between the at least two input audio signals, and

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wherein the multi-channel audio encoder is configured to provide a decorrelation complexity parameter describing a complexity of a decorrelation to be used at the side of an audio decoder.

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27. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

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providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

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upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$.

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wherein the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals is premixed into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is obtained on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

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wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is upmixed into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

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$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec},$$

wherein the premixing matrix $\mathbf{M}_{pre}$ is selected in dependence on spatial positions to which the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals are associated

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28. A method for providing at least two output audio signals on the basis of an encoded representation,

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wherein the method comprises providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals according to claim 27.

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29. A method for providing an encoded representation on the basis of at least two input audio signals, the method comprising:

providing one or more downmix signals on the basis of the at least two input audio signals, and

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providing one or more parameters describing a relationship between the at least two input audio signals, and

providing a decorrelation complexity parameter describing a complexity of a decorrelation to be used at the side of an audio decoder.

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30. A computer program for performing the method of claim 27, claim 28 or claim 29 when the computer program runs on a computer.

5 31. An encoded audio representation, comprising:

an encoded representation of a downmix signal;

10 an encoded representation of one or more parameters describing a relationship between the at least two input audio signals, and

an encoded decorrelation complexity parameter describing a complexity of a decorrelation to be used at the side of an audio decoder.

15 32. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

20 wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

25 wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

30 wherein the multi-channel decorrelator is configured to premix the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

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wherein the multi-channel decorrelator is configured to obtain the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

5 wherein the multi-channel decorrelator is configured to upmix the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec};$$

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wherein the multi-channel decorrelator is configured to select the premixing matrix $\mathbf{M}_{pre}$ in dependence on correlation characteristics or covariance characteristics of the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals.

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33. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

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wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

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wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

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wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel decorrelator is configured to premix the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

wherein the multi-channel decorrelator is configured to obtain the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

wherein the multi-channel decorrelator is configured to upmix the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec};$$

wherein the multi-channel decorrelator is configured to obtain the postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{M}_{post} = \mathbf{M}_{pre}^H (\mathbf{M}_{pre} \mathbf{M}_{pre}^H)^{-1}.$$

34. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel decorrelator is configured to receive an information about a rendering configuration associated with the channel signals of the first set of N decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix in dependence on the information about the rendering configuration.

35. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel decorrelator is configured to combine channel signals of the first set of N decorrelator input signals which are associated with spatially adjacent positions of an audio scene when performing the premixing.

36. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

5 wherein the multi-channel decorrelator is configured to combine channel signals of the first set of N decorrelator input signals which are associated with a horizontal pair of spatial positions comprising a left side position and a right side position.

37. 10 A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

15 wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

20 wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

25 wherein the multi-channel decorrelator is configured to combine at least four channel signals of the first set of N decorrelator input signals, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of the audio scene.

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38. A multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel decorrelator is configured to receive a complexity information describing a number K of decorrelator input signals of the second set of decorrelator input signals, and wherein the multi-channel decorrelator is configured to select a premixing matrix in dependence on the complexity information.

39. A multi-channel audio decoder for providing at least two output audio signals on the basis of an encoded representation,

wherein the multi-channel audio decoder comprises a multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

5 wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

10 wherein the multi-channel audio decoder is configured to select a premixing matrix for usage by the multi-channel decorrelator in dependence on an output configuration describing an allocation of the output audio signals with spatial positions of an audio scene.

40. 15 A multi-channel audio decoder for providing at least two output audio signals on the basis of an encoded representation,

wherein the multi-channel audio decoder comprises a multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

20 wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

25 wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

30 wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

35 wherein the multi-channel audio decoder is configured to select between three or more different premixing matrices for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation for a given output configuration, wherein each of the three or more different premixing

matrices is associated with a different number of signals of the second set of K decorrelator input signals.

41. A multi-channel audio decoder for providing at least two output audio signals on the basis of an encoded representation,

wherein the multi-channel audio decoder comprises a multi-channel decorrelator for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein the multi-channel decorrelator is configured to premix a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

wherein the multi-channel decorrelator is configured to provide a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

wherein the multi-channel decorrelator is configured to upmix the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the multi-channel audio decoder is configured to select a premixing matrix for usage by the multi-channel decorrelator in dependence on a mixing matrix which is used by an format converter or renderer which receives the at least two output audio signals.

42. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

5 wherein the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals is premixed into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

10 wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is obtained on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

15 wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is upmixed into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec};$$

20 wherein the premixing matrix $\mathbf{M}_{pre}$ is selected in dependence on correlation characteristics or covariance characteristics of the channel signals of the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals.

43. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

25 premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

30 providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

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wherein the first set $\hat{\mathbf{Z}}$ of N decorrelator input signals is premixed into the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals using a premixing matrix $\mathbf{M}_{pre}$ according to

$$\hat{\mathbf{Z}}_{mix} = \mathbf{M}_{pre} \hat{\mathbf{Z}}$$

wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is obtained on the basis of the second set $\hat{\mathbf{Z}}_{mix}$ of K decorrelator input signals, and

wherein the first set $\hat{\mathbf{Z}}_{mix}^{dec}$ of K' decorrelator output signals is upmixed into the second set $\mathbf{W}$ of N' decorrelator output signals using a postmixing matrix $\mathbf{M}_{post}$ according to

$$\mathbf{W} = \mathbf{M}_{post} \hat{\mathbf{Z}}_{mix}^{dec},$$

wherein the postmixing matrix $\mathbf{M}_{post}$ is obtained according to

$$\mathbf{M}_{post} = \mathbf{M}_{pre}^H (\mathbf{M}_{pre} \mathbf{M}_{pre}^H)^{-1}.$$

44. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the method comprises receiving an information about a rendering configuration associated with the channel signals of the first set of N decorrelator

input signals, and wherein a premixing matrix is selected in dependence on the information about the rendering configuration.

45. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein channel signals of the first set of N decorrelator input signals which are associated with spatially adjacent positions of an audio scene are combined when performing the premixing.

46. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein channel signals of the first set of N decorrelator input signals which are associated with a horizontal pair of spatial positions comprising a left side position and a right side position are combined.

47. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein at least four channel signals of the first set of N decorrelator input signals are combined, wherein at least two of said at least four channel signals are associated with spatial positions on a left side of an audio scene, and wherein at least two of said at least four channel signals are associated with spatial positions on a right side of the audio scene.

48. A method for providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals, the method comprising:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the method comprises receiving a complexity information describing a number K of decorrelator input signals of the second set of decorrelator input signals, and wherein a premixing matrix is selected in dependence on the complexity information.

49. A method for providing at least two output audio signals on the basis of an encoded representation,

wherein the method comprises providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals comprises:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein a premixing matrix for usage by the multi-channel decorrelator is selected in dependence on an output configuration describing an allocation of the output audio signals with spatial positions of an audio scene.

50. A method for providing at least two output audio signals on the basis of an encoded representation,

wherein the method comprises providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals comprises:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein the method comprises selecting between three or more different premixing matrices for usage by the multi-channel decorrelator in dependence on a control information included in the encoded representation for a given output configuration, wherein each of the three or more different premixing matrices is associated with a different number of signals of the second set of K decorrelator input signals.

51. A method for providing at least two output audio signals on the basis of an encoded representation,

wherein the method comprises providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals,

wherein providing a plurality of decorrelated signals on the basis of a plurality of decorrelator input signals comprises:

premixing a first set of N decorrelator input signals into a second set of K decorrelator input signals, wherein $K < N$;

providing a first set of K' decorrelator output signals on the basis of the second set of K decorrelator input signals; and

upmixing the first set of K' decorrelator output signals into a second set of N' decorrelator output signals, wherein $N' > K'$;

wherein a premixing matrix for usage by the multi-channel decorrelator is selected in dependence on a mixing matrix which is used by an format converter or renderer which receives the at least two output audio signals.

52. A computer program for performing the method of any one of claims 42 to 51 when the computer program runs on a computer.