

Claims

1. Apparatus for generating a sound field description from an input signal comprising one or more channels, the apparatus comprising:

an input signal analyzer for obtaining diffuseness data from the input signal;

a sound component generator for generating, from the input signal, one or more sound field components of a first group of sound field components having for each sound field component a direct component and a diffuse component, and for generating, from the input signal, a second group of sound field components having only a direct component,

wherein the sound component generator is configured to perform an energy compensation when generating the first group of sound field components, the energy compensation depending on the diffuseness data and at least one of a number of sound field components in the second group, a number of diffuse components in the first group, a maximum order of sound field components of the first group and a maximum order of sound field components of the second group.

2. Apparatus of claim 1, wherein the sound component generator comprises a mid-order components generator comprising:

a reference signal provider for providing a reference signal for a sound field component of the first group of sound field components;

a decorrelator for generating a decorrelated signal from the reference signal,

wherein the direct component of the sound field component of the first group is derived from the reference signal, wherein the diffuse component of the sound field component of the first group is derived from the decorrelated signal, and

a mixer for mixing the direct component and the diffuse component using at least one of the direction of arrival data provided by the input signal analyzer and the diffuseness data.

5

3. Apparatus of claim 1 or 2,

wherein the input signal comprises only a single mono channel, and wherein the sound field components of the first group of sound field components are sound field components of a first order or a higher order, or wherein the input signal comprises two or more channels, and wherein the sound field components of the first group of sound field components are sound field components of a second order or a higher order.

10

15

4. Apparatus of one of the preceding claims, wherein the input signal comprises a mono signal or at least two channels, and wherein the sound component generator comprises a low order components generator for generating the low-order sound field components by copying, or taking the input signal, or performing a weighted combination of the channels of the input signal.

20

5. Apparatus of claim 4, wherein the input signal comprises the mono signal, and wherein the low order components generator is configured to generate a zero order Ambisonics signal by taking or copying the mono signal, or

25

wherein the input signal comprises at least two channels, and wherein the low-order components generator is configured to generate a zero order Ambisonics signal by adding the two channels and to generate a first order Ambisonics signal based on a difference of the two channels, or

30

wherein the input signal comprises a first order Ambisonics signal with three or four channels, and wherein the low order components generator is configured to generate a first order Ambisonics signal by taking or copying the three or four channels of the input signal, or

35

wherein the input signal comprises an A-format signal having four channels, and wherein the low-order components generator is configured to calculate a first order Ambisonics signal by performing a weighted linear combination of the four channels.

5

6. Apparatus of one of the preceding claims, wherein the sound component generator comprises a high-order components generator for generating the sound field components of the second group, the sound field components of the second group having an order being higher than a truncation order used for generating the sound field components of the first group of sound field components.

10

7. Apparatus in accordance with one of the preceding claims,

15

wherein the sound component generator comprises an energy compensator for performing the energy compensation of the sound field components of the first group, the energy compensator comprising a compensation gain calculator for calculating a compensation gain using the diffuseness data, a maximum order of the sound field components of the first group and a maximum order of the sound field components of the second group.

20

8. Apparatus of claim 7, wherein the compensation gain calculator is configured to calculate a gain factor based on the following equation

25

$$g = \sqrt{1 + \Psi\left(\frac{H+1}{L+1} - 1\right)},$$

or

30

$$g = \sqrt{1 + \Psi\left(\frac{H+1}{Lk+1+\frac{mk}{N}} - 1\right)}$$

wherein Ψ represents the diffuseness data, H represents a maximum order of the second group of sound field components, and L represents the maximum order of the first group, or

5 wherein the following holds:

$$\begin{cases} Lk = \lfloor \sqrt{K} - 1 \rfloor \\ mk = K - (Lk + 1)^2, \\ N = 2(Lk + 1) + 1 \end{cases}$$

wherein K represents the number of diffuse components in the first group.

10

9. Apparatus of claim 7 or 8, wherein the gain calculator is configured

to increase the compensation gain with an increasing number of sound field
15 components of the second group, or

to decrease the compensation gain with a increasing number of sound field
components of the first group, or

20

to increase the compensation gain with an increasing diffuseness value, or

to increase the compensation gain with an increasing number of sound field
components in the second group, or

25

to decrease the compensation gain with a increasing number of diffuse components
in the first group.

10. Apparatus of claim 8 or 9, wherein the gain calculator is configured for calculating
30 the compensation gain additionally using the first energy- or amplitude-related
measure for an omnidirectional component derived from the input signal and using
a second energy- or amplitude-related measure for a directional component derived
from the input signal, the diffuseness data, and direction data obtained from the input
signal.

11. Apparatus of one of claims 8 to 10, wherein the compensation gain calculator is configured to calculate a first gain factor depending on the diffuseness data and at least one of the number of sound field components in the second group, the number of diffuse components in the first group, the maximum order of sound field components of the first group, and the maximum number of sound field components of the second group, to calculate a second gain factor depending on a first amplitude or -related measure for an omnidirectional component derived from the input signal, a second energy- or amplitude-related measure for a directional component derived from the input signal, the direction data and the diffuseness data, and to calculate the compensation gain using the first gain factor and the second gain factor.
12. Apparatus of one of claims 7 to 11, wherein the compensation gain calculator is configured to perform a gain factor manipulation using a limitation with a fixed maximum threshold or a fixed minimum threshold or using a compression function for compressing low or high gain factors towards medium gain factors to obtain the compensation gain.
13. Apparatus of one of claims 7 to 12, wherein the energy compensator comprises a compensation gain applicator for applying the compensation gain to at least one sound field component of the first group.
14. Apparatus of claim 13, wherein the compensation gain applicator is configured to apply the claim compensation gain to each sound field component of the first group, or to only one or more sound field components of the first group with a diffuse portion, or to diffuse portions of the sound field components of the first group.
15. Apparatus of one of the preceding claims, wherein the input signal analyzer is configured to extract the diffuseness data from metadata associated with the input signal or to extract the diffuseness data from the input signal by a signal analysis of the input signal having two or more channels or components.

16. Apparatus of one of the preceding claims, wherein the input signal only comprises one or two sound field components up to an input order, wherein the sound component generator comprises a sound field components combiner for combining the sound field components of the first group and the sound field components of the second group to obtain a sound field description up to an output order being higher than the input order.
17. Apparatus of one of the preceding claims, further comprising:
- an analysis filter bank for generating the one or more sound field components of the first group and the second group for a plurality of different time-frequency tiles, wherein the input signal analyzer is configured to obtain a diffuseness data item for each time-frequency tile, and wherein the sound component generator is configured to perform the energy compensation separately for each time-frequency tile.
18. Apparatus of one of the preceding claims, further comprising:
- a high-order decoder for using the one or more sound field components of the first group and the one or more sound field components of the second group to generate a spectral domain or time domain representation of the sound field description generated from the input signal.
19. Apparatus of one of the preceding claims, wherein the first group of sound field components and the second group of sound field components are orthogonal to each other, or wherein the sound field components are at least one of coefficients of orthogonal basis functions, coefficients of spatial basis functions, coefficients of spherical or circular harmonics, and Ambisonics coefficients.
20. Method for generating a sound field description from an input signal comprising one or more channels, comprising:

obtaining diffuseness data from the input signal;

generating, from the input signal, one or more sound field components of a first group of sound field components having for each sound field component a direct component and a diffuse component, and for generating, from the input signal, a second group of sound field components having only a direct component,

wherein the generating comprises performing an energy compensation when generating the first group of sound field components, the energy compensation depending on the diffuseness data and at least one of a number of sound field components in the second group, a number of diffuse components in the first group, a maximum order of sound field components of the first group, and a maximum order of sound field components of the second group.

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