Claims

1. Apparatus for generating a sound field description using an input signal comprising a mono-signal or a multi-channel signal, the apparatus comprising:

an input signal analyzer for analyzing the input signal to derive direction data and diffuseness data;

a low-order components generator for generating a low-order sound field description from the input signal up to a predetermined order and mode, wherein the low-order components generator is configured to derive the low-order sound field description by copying or taking the input signal or performing a weighted combination of the channels of the input signal;

a mid-order components generator for generating a mid-order sound field description above the predetermined order or at the predetermined order and above the predetermined mode and below or at a first truncation order using a synthesis of at least one direct portion and of at least one diffuse portion using the direction data and the diffuseness data so that the mid-order sound field description comprises a direct contribution and a diffuse contribution; and

a high-order components generator for generating a high-order sound field description having a component above the first truncation order using a synthesis of at least one direct portion, wherein the high order sound field description comprises a direct contribution only.

2. Apparatus of claim 1, 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.

3. Apparatus of claim 1 or 2,

wherein the low-order components generator is configured to generate K low-order sound field components, with K being 1 or greater than 1 and depending on the predetermined order and the predetermined mode,

wherein the mid-order components generator is configured to generate $(L + 1)^2 – K$ mid-order sound field components, L being greater than K and depending on the truncation order and,

wherein the high-order components generator is configured to generate $(H + 1)^2 - (L + 1)^2$ high order sound field components, wherein H is an integer greater than L and wherein H represents a maximum order of the generated sound field description.

4. Apparatus of one of the preceding claims, further comprising a sound field combiner for combining the low-order sound field components, the mid-order sound field components and the high-order sound field components to obtain a combined sound field having $(H + 1)^2$ sound field components, wherein H is a maximum order of the generated sound field description.

5. Apparatus of one of the preceding claims, further comprising a directional gains calculator for calculating directional gains for the mid-order and the high-order sound field components from the direction data and/or the diffuseness data and for feeding the directional gains for the mid-order sound field components to the mid-order components generator and for feeding the directional gains for the high-order sound field components to the high-order components generator.

6. Apparatus of claim 5, wherein the directional gains calculator is configured

to receive, for each time-frequency tile of a plurality of time-frequency tiles, the directional data and/or the diffuseness data, and

to evaluate a spatial basis function for a certain order and mode using the directional data to obtain the directional gain for the certain order and mode.

7. Apparatus of one of the preceding claims, wherein the mid-order components generator comprises:

a reference signal generator for providing a reference signal for a sound field component of the mid-order sound field description and for modifying the reference signal using the directional data;

a decorrelator for decorrelating the reference signal or a signal derived from the reference signal to obtain a decorrelated signal; and

a mixer for mixing the modified reference signal and the decorrelated signal using the diffuseness data.

8. Apparatus of one of the preceding claims,

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

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

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

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.

9. Apparatus from one of the preceding claims, wherein the high-order components generator is configured to only synthesize a direct portion for a component of the high-order sound field description using the direction data.

10. Apparatus of claim 9, further comprising a directional gain calculator for the sound field component of the high-order sound field description configured for evaluating a

spatial basis function for an order and a mode of the component of the high-order sound field description, and wherein the high-order components generator is configured to derive the sound field component from the reference signal and the directional gain.

11. Apparatus of claim 10, wherein the high-order components generator is configured to multiply the reference signal by the directional gain for the order and mode of the sound field component and to multiply by a factor derived from the diffuseness data to obtain the sound field component of the high-order sound field description.

12. Apparatus of claim 7,

wherein the decorrelator comprises a decorrelation filter for receiving the reference signal and for outputting a filtered reference signal, and

wherein the decorrelator is configured to weight the filtered signal or a signal input into the decorrelator filter by a weighting value derived from the diffuseness data and by a further weighting value derived from an order and mode of the sound field component under consideration to obtain the diffuse portion, and

wherein the mixer is configured to add the direct portion and the diffuse portion of the same order and mode to obtain the mid-order sound field component.

13. Apparatus of one of the preceding claims,

wherein the low-order components generator and/or the mid-order components generator is configured to perform an energy compensation to one or more sound field components of the low-order sound field description or the at least one diffuse portion of the mid-order sound field description or to a sound field component of the mid-order sound field description to compensate for an energy loss due to the high-order sound field description only having the direct component, or

wherein the sound component generator is configured to perform an energy compensation to one or more sound field components of the low-order sound field description or the at least one diffuse portion of the mid-order sound field description or to a sound field component of the mid-order sound field description the energy

compensation depending on the diffuseness data and at least one of a number of sound field components generated by the high-order components generator, a number of diffuse components generated by the low-order components generator and/or the mid-order components generator, a maximum order of sound field components generated by the low-order components generator and/or the mid-order components generator and a maximum order of sound field components generated by the high-order components generator.

14. Apparatus of one of the preceding claims, wherein the low-order components generator is configured to perform an energy compensation to a directional component included in the input signal or derived from the input signal by copying, taking or performing a weighted combination.

15. Apparatus of claim 14, wherein the low-order components generator comprises:

an estimator for estimating a first energy- or amplitude-related measure for an omnidirectional component derived from the input signal and for estimating a second energy- or amplitude-related measure for a directional component derived from the input signal; and wherein the low-order components generator is configured to perform an energy compensation of the directional component using the first energy- or amplitude-related measure, the second energy- or amplitude-related measure, the direction data and the diffuseness data.

16. Apparatus of one of claims 14 and 15,

wherein the low-order components generator comprises an energy compensator for performing the energy compensation, 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, wherein the maximum order of the sound field components of the second group depends of the number of sound field components in the second group.

17. Apparatus of claim 16, wherein the high-order components generator is configured to multiply the reference signal by the directional gain for the order and mode of the

sound field component and to multiply by a factor derived from the diffuseness data to obtain the sound field component of the high-order sound field description.

18. Apparatus of one of claims 16 and 17,

wherein the energy compensator comprises a compensation gain applicator for applying the compensation gain to at least one sound field component.

19. Apparatus of one of the preceding claims,

wherein a first group of sound field components and a 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. 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 direction data item and a diffuseness data item for each time-frequency tile, and

wherein the a low-order components generator, the a mid-order components generator, or the high-order components generator sound component generator are configured to operate separately for each time-frequency tile.

21. Method for generating a sound field description using an input signal comprising a mono-signal or a multi-channel signal, comprising:

analyzing the input signal to derive direction data and diffuseness data;

generating a low order sound field description from the input signal up to a predetermined order and mode, wherein the low order generator is configured to

derive the low order sound field description by copying the input signal or performing a weighted combination of the channels of the input signal;

generating a mid-order sound field description above the predetermined order or at the predetermined order and above the predetermined mode and below a high order using a synthesis of at least one direct portion and of at least one diffuse portion using the direction data and the diffuseness data so that the mid-order sound field description comprises a direct contribution and a diffuse contribution; and

generating a high order sound field description having a component at or above the high order using a synthesis of at least one direct portion without any diffuse component synthesis so that the high order sound field description comprises a direct contribution only.

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