Claims

1. Apparatus for generating a plurality of audio channels ~~(12; 12-1; 12-2)~~ for a first speaker setup ~~(14; 14-1)~~, characterized by:

an imaginary speaker determiner ~~(18; 18-1)~~ for determining a position of an imaginary speaker ~~(22; 22a-d)~~ not contained in the first speaker setup ~~(14; 14-1)~~ to obtain a second speaker setup ~~(24; 24-1; 24-2; 24-3)~~ containing the imaginary speaker ~~(22; 22a-d);~~and at least partially speakers of the first speaker setup;

an energy distribution calculator ~~(26; 26-1)~~ for calculating an energy distribution from the imaginary speaker ~~(22; 22a-d)~~ to other speakers in the second speaker setup ~~(24; 24-1; 24-2; 24-3);~~, wherein the energy distribution represents an amount or a share of an energy of the imaginary speaker ~~(22; 22a-d)~~ being distributed to the other speakers in the second speaker setup ~~(24; 24-1; 24-2; 24-3);~~;

a processor ~~(28; 28-1)~~ for computing a power ~~(D^n)~~of the energy distribution to obtain a downmix information ~~(36)~~ for a downmix from the second speaker setup ~~(24; 24-1; 24-2; 24-3)~~ to the first speaker setup ~~(14; 14-1)~~;

wherein the processor ~~(28; 28-1)~~ is configured to generate an energy distribution matrix ~~(D)~~ based on the energy distribution, wherein the energy distribution matrix ~~(D)~~ comprises elements ~~(d_{xy})~~ representing the energy distribution of the imaginary speaker ~~(22; 22a-d)~~ to another speaker of the second speaker setup ~~(24; 24-1; 24-2; 24-3)~~, wherein the power ~~(D^n)~~ of the energy distribution leads the elements ~~(d_{xy})~~ representing the energy distribution of the imaginary speaker ~~(22; 22a-d)~~ to the other speaker of the second speaker setup ~~(24; 24-1; 24-2; 24-3)~~ to decrease; and

a renderer ~~(38; 38-1)~~ for generating the plurality of audio channels ~~(12; 12-1; 12-2)~~ using the downmix information ~~(36)~~.

2. Apparatus according to claim 1, wherein the processor ~~(28; 28-1)~~ is further configured to calculate a power ~~(D^n)~~of the energy distribution matrix ~~(D)~~, wherein an exponent ~~(n)~~ of the power ~~(D^n)~~ is a predefined value, and wherein the processor ~~(28; 28-1)~~ is configured to obtain the downmix information ~~(36)~~ based on the power of the energy distribution matrix ~~(D)~~.

3. Apparatus according to claim 1, wherein the processor (28; 28-1) is further configured to iteratively calculate a power (D^n) of the energy distribution matrix (D), wherein a number of iteration steps is based on a value of the power (D^n) of the energy distribution matrix (D).

4. Apparatus according to one of previous claims, wherein the energy distribution calculator (26; 26-1) comprises a neighborhood estimator for determining a neighborhood relation of the imaginary speaker (22; 22a-d) in the second speaker setup (24; 24-1; 24-2; 24-3) to at least one speaker of the second speaker setup (24; 24-1; 24-2; 24-3) that is a neighbor of the imaginary speaker (22; 22a-d), and wherein the energy distribution calculator (26; 26-1) is configured to calculate the energy distribution of the imaginary speaker (22; 22a-d) to the at least one neighbor of the imaginary speaker (22; 22a-d).

5. Apparatus according to claim 4, wherein the neighborhood estimator is configured to determine a neighborhood relation of the imaginary speaker (22; 22a-d) in the second speaker setup to at least two speakers in the second speaker setup (24; 24-1; 24-2; 24-3) that are neighbors of the imaginary speaker (22; 22a-d) and wherein the energy distribution calculator (26; 26-1) is configured to calculate the energy distribution such that the energy distribution among the at least two speakers that are neighbors of the imaginary speaker (22; 22a-d) is equal within a predefined tolerance.

6. Apparatus according to ~~one of~~ claim 5 ~~or 5~~, wherein the neighborhood estimator is configured to determine a neighborhood relation of the imaginary speaker (22; 22a-d) in the second speaker setup (24; 24-1; 24-2; 24-3) to at least two speakers that are neighbors of the imaginary speaker (22; 22a-d) and wherein at least one of the at least two speakers that are neighbors of the imaginary speaker (22; 22a-d) is a further imaginary speaker (22; 22a-d).

7. Apparatus according to one of previous claims wherein the imaginary speaker (22; 22a-d) is arranged at one side of a geometric plane (44) comprising speakers (16a-c) of the first speaker setup (14; 14-1) within a predefined tolerance (46a; 46b) and a predefined listener position (42).

8. Apparatus according to one of previous claims, wherein the imaginary speaker (22; 22a-d) is arranged along a second side of a geometric plane (54) comprising a predefined listener position (42) opposing a first side of the geometric plane (54),

wherein a speaker of the first speaker setup (14; 14-1) is arranged at the first side of the geometric plane (54).

9. Apparatus according to one of previous claims, wherein the apparatus is comprised by a format conversion unit (1720), wherein the format conversion unit (1720) is configured to output the plurality of audio channels (12; 12-1; 12-2) based on input channels comprising a plurality of data channels (1205) and wherein a number of data channels (1205) is higher than a number of the plurality of audio channels (12; 12-1; 12-2).

10. Apparatus according to one of claims 1-8, wherein the apparatus comprises a panner (56) for generating panning coefficients for the second speaker setup (24; 24-1; 24-2), and wherein the render (38; 38-1) is configured to generate the plurality of audio channels (12; 12-1; 12-2) based on the downmix information (36) and the panning coefficients.

11. Apparatus according to claim 10 wherein the apparatus is comprised by an object renderer (1210), wherein the object renderer (1210) is configured to output the plurality of audio channels (12; 12-1; 12-2) based on position information of audio objects and wherein a number of panning coefficients is higher than a number of the plurality of audio channels (12; 12-1; 12-2 such that the audio object is rendered to the first speaker setup (14; 14-1).

12. Apparatus according to one of previous claims, wherein the imaginary speaker determiner (18; 18-1) is configured to calculate a convex hull (52) based on a position of speakers (16a-c) of the first speaker setup (14; 14-1) and to determine the position of the imaginary speaker (22; 22a-d) according to a QuickHull algorithm, wherein the position of the imaginary speaker (22; 22a-d) and the position of speakers (16a-c) of the first speaker setup (14; 14-1) is arranged at the convex hull (52) within a predefined threshold.

13. Apparatus according to claim 12, wherein the apparatus is configured to provide a validity information of the first speaker setup (14; 14-1) indicating that a position of every speaker (16a-c) in the first speaker setup (14; 14-1) is arranged at the convex hull (52) within a predefined threshold or indicating that a position of at least one speaker in the first speaker setup (14; 14-1) is arranged outside the convex hull (52) within a predefined threshold.

14. Audio system, comprising

an apparatus (10; 10-1; 10-2) according to one of claims 1-13; and

a plurality of speakers (16a-c) according to the plurality of audio channels (12; 12-1; 12-2);

wherein the plurality of speakers (16a-c) is configured to receive the plurality of audio channels (12; 12-1; 12-2) and to provide a plurality of acoustic signals based on the plurality of audio channels (12; 12-1; 12-2).

15. Method for generating a plurality of audio channels (12; 12-1; 12-2) for a first speaker setup (14; 14-1), comprising:

determining a position of an imaginary speaker (22; 22a-d) not contained in the first speaker setup (14; 14-1) and obtaining a second speaker setup (24; 24-1; 24-2; 24-3) containing the imaginary speaker (22; 22a-d);and at least partially speakers of the first speaker setup;

calculating an energy distribution from the imaginary speaker (22; 22a-d) to the other speakers in the second speaker setup (24; 24-1; 24-2; 24-3);, wherein the energy distribution represents an amount or a share of an energy of the imaginary speaker (22; 22a-d) being distributed to the other speakers in the second speaker setup (24; 24-1; 24-2; 24-3);

computing a power ($\tilde{D}^n$) of the energy distribution and obtain a downmix information (36) for a downmix from the second speaker setup (24; 24-1; 24-2; 24-3) to the first speaker setup (14; 14-1);, wherein the power of the energy distribution leads elements of the obtained energy distribution to decrease;

wherein computing of the power ($\tilde{D}^n$) of the energy distribution comprises generating an energy distribution matrix based ($\tilde{D}$) on the energy distribution, wherein the energy distribution matrix ($\tilde{D}$) comprises elements ($\tilde{d}_{xy}$) representing the energy distribution of the imaginary speaker (22; 22a-d) to another speaker of the second speaker setup (24; 24-1; 24-2; 24-3), wherein the power ($\tilde{D}^n$) of the energy distribution leads the elements ($\tilde{d}_{xy}$) representing the energy distribution of the imaginary speaker (22; 22a-d) to the other speaker of the second speaker setup (24; 24-1; 24-2; 24-3) to decrease; and

generating the plurality of audio channels ~~(12; 12-1; 12-2)~~ using the downmix information ~~(36)~~.

16. Computer program having a program code for performing, when running on a computer, a method for generating a plurality of audio channels ~~(12; 12-1; 12-2)~~ for a first speaker setup ~~(14; 14-1)~~ according to claim 15.