Claims

1. Apparatus for determining an early reflection pattern for sound rendition, configured to

receive at least one room acoustical parameter which is representative of an acoustical characteristic of an acoustic environment;

determine an early reflection pattern
which is indicative of a constellation of early reflection positions,
in a manner so that a number of the early reflection positions depend on the at least one room acoustical parameter.

2. Apparatus of claim 1, wherein the early reflection pattern is for being positioned at the listener position in a manner so that the early reflection positions are located around the listener position and at angular directions from the listener position which are invariant with respect to changes in listener head orientation.

3. Apparatus of claim 1 or claim 2, wherein the at least one room acoustical parameter comprises one or more of
room dimensions,
room volume, and
predelay time to the late reverberation.

4. Apparatus of any previous claims 1-3, wherein the at least one room acoustical parameter comprises merely one parameter selected out of
room dimensions,
room volume, and
predelay time to the late reverberation.

5. Apparatus of any previous claims 1-4, configured to, depending on the at least one room acoustical parameter, vary a mutual spacing of the early reflection positions and the number of early reflection positions.

6. Apparatus of any previous claims 1-5, configured to, depending on the at least one room acoustical parameter, parameterize one or more spiral functions centered at the

listener position, and place the early reflection positions using the one or more spiral functions.

7. Apparatus of any previous claims 1-6, configured to read the at least one room acoustical parameter, from a bitstream comprising a representation of an audio signal to be rendered using the early reflection pattern.

8. Apparatus of any previous claims 1-7, configured to

support a first determination of the early reflection pattern and a second determination of the early reflection pattern, wherein the first determination is different from the second determination and involves the determination of the early reflection pattern in a manner so that the number of the early reflection positions depends on the at least one room acoustical parameter, and

select the first determination in case of the acoustic environment being an indoor environment or in case of a pattern type index in a bitstream comprising a representation of an audio signal to be rendered assuming a predetermined state.

9. Apparatus of any previous claims 1-8, configured to determine the number of early reflection positions so that

the number is larger the larger the room dimensions are, or
the number is larger the larger the room volume is, or
the number is larger the larger the predelay time to the late reverberation is.

10. Apparatus of any previous claims 1-9, configured to determine the number of early reflection positions so that

a farthest early reflection position from the listener position is larger the larger the room dimensions are or
a farthest early reflection position from the listener position is larger the larger the room volume is, or
a farthest early reflection position from the listener position is larger the larger the predelay time to the late reverberation is.

11. Apparatus of any previous claims 1-10, configured to determine the early reflection positions so that same are in a substantially uniform manner angularly distributed around the listener position.

12. Apparatus of any previous claims 1-11, configured to determine the early reflection positions so that connection lines between same and the listener position do mutually not overlap.

13. Apparatus of any previous claims 1-12, configured to determine the early reflection positions so that same lie in a horizontal plane along with the listener position.

14. Apparatus of any previous claims 1-13, configured to determine the early reflection positions with adjusting a azimuthal rotation of the constellation according to a pattern azimuth parameter in a bitstream comprising a representation of an audio signal to be rendered.

15. Apparatus of any previous claims 1-14, configured to determine the early reflection pattern by

parameterizing one or more spiral functions centered at the listener position, and

placing the early reflection positions using the one or more spiral functions.

16. Apparatus of claim 15, wherein the one or more spiral functions comprise a first spiral function and a second spiral function wherein the apparatus is configured to place a first set of early reflection positions using the first spiral function and a second set of early reflection positions using the second spiral function so that each of the first set of early reflection positions is associated with a corresponding early reflection position of the second set of early reflection and is positioned on an opposite side of a line perpendicularly crossing a connecting line between the respective early reflection position and the corresponding early reflection position.

17. Apparatus of claim 16, wherein, for each of first set of early reflection positions, the corresponding early reflection position of the second set of early reflection is angularly offset relative to the connecting line into an angular direction which is common for all early reflection positions of the first set of early reflection positions.

18. Apparatus of claim 16 or claim 17, wherein the one or more spiral functions comprise a first spiral function and a second spiral function wherein the apparatus is configured to place a first set of early reflection positions using the first spiral function and a second set of early reflection positions using the second spiral function so that the first set of

early reflection positions is determined in polar coordinates as and the second set of early reflection positions is determined in polar coordinates as with

$\beta 1 = n \cdot \frac{\pi}{3}$, $\beta 2 = \frac{\pi}{8} + n \cdot \frac{\pi}{3}$, n = [1:nER/2]

$base = 1.85$

$r1 = distfactor * base^{2*\beta 1/\pi}$

$r2 = -distfactor * base^{2*\beta 2/\pi}$

wherein nER is the number of early reflection positions and distfactor is a constant.

19. Apparatus for sound rendering, configured to

receive information on a listener position, a first sound source position and a second sound source position;

render an audio signal of the two sound sources using a room impulse response whose early reflection portion is determined by an early reflection pattern

which is indicative of a constellation of early reflection positions, and

which is positioned at the listener position in a manner so that the early reflection positions are located around the listener position and at angular directions from the listener position which are invariant with respect to changes in listener head orientation,

by

forming a weighted sum of a first audio signal of a first sound source positioned at the first sound source position and a second audio signal of a second sound source positioned at the second sound source position wherein the weighted sum weights the first audio signal more than the second audio signal if a first distance between the first sound source position and the listener position is smaller than a second distance between the second sound source position and the listener position, and weights the second audio signal more than the first audio signal if the first distance is larger than the second distance, and

generating early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response by rendering the weighted sum from the early reflection positions.

20. Apparatus of claim 19, further configured to generate a diffuse late reverberation portion of the room impulse response.

21. Apparatus of claim 19 or claim 20, further configured to, in rendering the audio signal, generate a set of loudspeaker signals by forming a summation over direct sound contribution loudspeaker signals relating to a direct sound source portion of the room impulse response and early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response(400).

22. Apparatus of any previous claims 19-21, further configured to, in generating the early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response, render the weighted sum from each early reflection position in a manner level adjusted according to a distance of the respective early reflection position to the listener position.

23. Apparatus of claim 22, further configured to, in rendering the weighted sum from each early reflection position in a manner level adjusted according to a distance of the respective early reflection position to the listener position,

offset a level at which the weighted sum is rendered from the respective early reflection position, using a level offset, or amplify same with a level factor, which offset or factor is common for all early reflection positions, and

set the level offset or level factor according to an amplitude correction factor.

24. Apparatus of claim 22 or 23, further configured to, in rendering the weighted sum from each early reflection position in a manner level adjusted according to the distance of the respective early reflection position to the listener position, modify the level adjustment according to the distance of the respective early reflection position to the listener position relative to a level adjustment used by the apparatus for rendering of the audio signal from the sound source positon according to a distance attenuation exponent.

25. Apparatus of any of claims 19-24, further configured to, in generating the early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response, render the weighted sum of the sound source from each early reflection position in a manner spectrally shaped according to one or more frequency response parameters.

26. Apparatus of any of claims 19-25, further configured to, in performing the rendition of the weighted sum of the sound source from the early reflection positions, use HRTFs specific for a listener head orientation.

27. Apparatus for sound rendering, configured to

receive first information on a listener position and a sound source position;

render an audio signal of the sound source using a room impulse response whose early reflection portion is determined by an early reflection pattern

which is indicative of a constellation of early reflection positions, and

which is positioned at the listener position in a manner so that the early reflection positions are located around the listener position and at angular directions from the listener position which are invariant with respect to changes in listener head orientation,

the apparatus comprising an apparatus for determining the early reflection pattern according to any of claims 1-18.

28. Apparatus of claim 27, further configured to generate a diffuse late reverberation portion of the room impulse response.

29. Apparatus of claim 27 or claim 28, further configured to, in rendering the audio signal, generate a set of loudspeaker signals by forming a summation over direct sound contribution loudspeaker signals relating to a direct sound source portion of the room impulse response and early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response.

30. Apparatus of any previous claims 27-29, further configured to generating early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response by performing a rendition of the audio signal of the sound source from the early reflection positions.

31. Apparatus of claim 30, further configured to, in generating the early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response by performing a rendition of the audio signal of the sound source from the early reflection positions, render the audio signal of the sound source from

each early reflection position in a manner level adjusted according to a distance of the respective early reflection position to the listener position.

32. Apparatus of claim 31, further configured to, in rendering the audio signal of the sound source from each early reflection position in a manner level adjusted according to a distance of the respective early reflection position to the listener position,

offset a level at which the audio signal of the sound source is rendered from the respective early reflection position, using a level offset, or amplify same with a level factor, which offset or factor is common for all early reflection positions, and

set the level offset or level factor according to an amplitude correction factor.

33. Apparatus of claim 31 or 32, further configured to, in rendering the audio signal of the sound source from each early reflection position in a manner level adjusted according to the distance of the respective early reflection position to the listener position, modify the level adjustment according to the distance of the respective early reflection position to the listener position relative to a level adjustment used by the apparatus for rendering of the audio signal from the sound source positon according to a distance attenuation exponent.

34. Apparatus of any of claims 30-33, further configured to, in generating the early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response by performing a rendition of the audio signal of the sound source from the early reflection positions, render the audio signal of the sound source from each early reflection position in a manner spectrally shaped according to one or more frequency response parameters.

35. Apparatus of any of claims 27-34, further configured to, in performing the rendition of an audio signal of the sound source from the early reflection positions, use HRTFs specific for a listener head orientation.

36. Bitstream for being subject to sound rendition according to any of the previous claims 19-26 or any of claims 27-35.

37. Digital storage medium storing a bitstream for being subject to sound rendition according to claim 36.

38. Method for determining an early reflection pattern for sound rendition, comprising

receiving at least one room acoustical parameter which is representative of an acoustical characteristic of an acoustic environment;

determining an early reflection pattern

which is indicative of a constellation of early reflection positions,

in a manner so that a number of the early reflection positions depend on the at least one room acoustical parameter.

39. Method for sound rendering, comprising

receiving information on a listener position, a first sound source position and a second sound source position;

rendering an audio signal of the two sound sources using a room impulse response whose early reflection portion is determined by an early reflection pattern

which is indicative of a constellation of early reflection positions, and

which is positioned at the listener position in a manner so that the early reflection positions are located around the listener position and at angular directions from the listener position which are invariant with respect to changes in listener head orientation,

by

forming a weighted sum of a first audio signal of a first sound source positioned at the first sound source position and a second audio signal of a second sound source positioned at the second sound source position wherein the weighted sum weights the first audio signal more than the second audio signal if a first distance between the first sound source position and the listener position is smaller than a second distance between the second sound source position and the listener position, and weights the second audio signal more than the first audio signal if the first distance is larger than the second distance, and

generating early reflection contribution loudspeaker signals relating to the early reflection portion of the room impulse response by rendering the weighted sum from the early reflection positions.

40. Method for sound rendering, comprising

receiving first information on a listener position and a sound source position;

rendering an audio signal of the sound source using a room impulse response whose early reflection portion is determined by an early reflection pattern

which is indicative of a constellation of early reflection positions, and

which is positioned at the listener position in a manner so that the early reflection positions are located around the listener position and at angular directions from the listener position which are invariant with respect to changes in listener head orientation,

the method comprising the method for determining the early reflection pattern according to claim 38.

41. Computer program for causing a computer, when executing the computer program, to perform the method of one of claims 38 to 40.