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,
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.

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 to 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 to 4, 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.

6. Apparatus of claim 5, 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.

7. Apparatus of any previous claims 1 to 6, 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 (r1; $\beta 1$) and the second set of early reflection positions is determined in polar coordinates as (r2; $\beta 2$) 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.

8. Apparatus of claim 7, configured to determine distfactor based on the at least on room acoustical parameter.

9. Apparatus of claim 7, configured to determine distfactor such that same is the larger the larger the predelay time to the late reverberation is.

10. Apparatus of claim 7, configured to determine nER based on the at least on room acoustical parameter.

11. Apparatus of any previous claims 1 to 10, 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.

12. Apparatus of any previous claims 1 to 11, configured to determine a 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.

13. Apparatus of any previous claims 1 to 12, configured to parametrize the one or more spiral functions and determine a number of early reflection positions so that a distance of a maximally distanced position among the early reflection positions to the listener position is larger

the larger the room dimensions are, or

the larger the room volume is, or

the larger the predelay time to the late reverberation is with the distance being smaller than the predelay time.

14. Apparatus of any previous claims 1 to 13, 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 parameterizing the one or more spiral functions centered at the listener position, and the placement of the early reflection positions using the one or more spiral functions, 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.

15. Apparatus of any previous claims 1 to 14, configured to determine the early reflection positions so that same lie in a horizontal plane along with the listener position.

16. Apparatus of any previous claims 1 to 15, 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.

17. 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 to 16.

18. Apparatus of claim 17, further configured to generate a diffuse late reverberation portion of the room impulse response.

19. Apparatus of claim 17 or claim 18, 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.

20. Apparatus of any of claims 17 to 19, 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.

21. Apparatus of claim 20, 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.

22. Apparatus of claim 21, 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.

23. Apparatus of claim 21 or claim 22, 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.

24. Apparatus of any of claims 20 to 23, 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.

25. Apparatus of any of claims 17 to 24, 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.

26. Bitstream for being subject to sound rendition according to any of the previous claims 17 to 25.

27. Digital storage medium storing a bitstream for being subject to sound rendition according to claim 26.

28. 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,
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.

29. 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 28.

30. Computer program for causing a computer, when executing the computer program, to perform the method of claim 28 or claim 29.