The regular Spatially Extended Sound Sources (SESS) fast synthesis algorithm simulates the sound impression of a diffuse field in certain specified target spatial regions. This is achieved by (virtual) summation of many closely spaced sound sources that are driven by uncorrelated versions of the audio signal. Sometimes, a part of the SESS is occluded by partially transmissive material (e.g. bushes), leading to a frequency-selective attenuation of the SESS in the occluded spatial region. This effect can be elegantly and efficiently incorporated into the efficient SESS algorithm by introducing a weighting step into the calculation between the table look-up operation and the further calculation of desired binaural cues. The lookup table stores precalculated partial sums of terms for each spatial sector around the listener. The extension comes at virtually no additional computational cost. Embodiments are related to an apparatus and method or computer program for reproducing or synthesizing a Spatially Extended Sound Source (SESS) with selective spatial weighting.

It is an advantage of the present invention that the present invention allows the processing of a spatially extended sound source with a possibly complex geometric shape.

It is a further advantage of the present invention that embodiments allow an improved concept of reproducing a spatially extended sound source and enable possibilities for spatially selective modification of the SESS rendering.

In accordance with a first aspect of the invention, there is provided an apparatus for synthesizing a spatially extended sound source (SESS), comprising: a storage for storing one or more rendering data items for different limited spatial sectors, wherein the different limited spatial sectors are located in a rendering range for a listener, wherein the one or more rendering data items for a limited spatial sector comprises at least one of a left variance data item, a right variance data item, and a left-right covariance data item related to the left head related function data and the right head related function data; a sector identification processor for identifying one or more limited spatial sectors for the spatially extended sound source within the rendering range for the listener based on spatially extended sound source data; a target data calculator (5000) for calculating target rendering data from the stored left variance data, the stored right variance data, or the stored covariance data; and an audio processor for processing an audio signal representing the spatially extended sound source using the target rendering data.

In accordance with a second aspect of the invention, there is provided a method of synthesizing a spatially extended sound source (SESS), comprising: storing one or more rendering data items for different limited spatial sectors, wherein the different limited spatial sectors are located in a rendering range for a listener, wherein the one or more rendering data items for a limited spatial sector comprises at least one of a left variance data item related to left head related function data, a right variance data item related to right head related function data, and a covariance data item related to the left head related function data and the right head related function data; identifying one or more limited spatial sectors for the spatially extended sound source within the rendering range for the listener based on spatially extended sound source data; calculating target rendering data from the stored left variance data, the stored right variance data, or the stored covariance data; and processing an audio signal representing the spatially extended sound source using the target rendering data.

A first embodiment relates to the usage of elementary spatial sectors. This first embodiment relates to the storing of data for elementary spatial sectors in the look-up table, where the elementary spatial sectors are distributed over the sphere. The data for the elementary spatial sectors are preferably tied to the user head forming a user-centric audio scene and are the same for each inclination of the head at the same position and also for each position of the listener head, i.e., for each degree of freedom of the 6-DOF. However, each movement or inclination of the head results in a situation that the sound from the SESS “enters” at another one or more elementary spatial sectors into the user head. The renderer determines the elementary spatial sectors covered by the SESS, retrieves the stored data for these specific sectors, optionally performs a weighting of the stored data due to occluding objects or certain distances, and then combines the stored data (or in case of weighting the weighted stored data), and, then uses the result of the combination operation for rendering (e.g. rendering cues are calculated from combined (co)-variance data, but other steps and parameters can be used here as well. Hence, this embodiment may or may not use a reference to occluding objects and may or may not use a reference to the specific stored variance data, since the combination (and optionally also the weighting) can also be done when other data are stored such as the (mean) HRTFs (for an elementary spatial sector or for a whole spatial extent) or even the frequency dependent cues themselves.

A second embodiment relates to modifying objects that can be occluding objects or other objects resulting in a modification of the sound of the SESS on its way from the SESS position to the user having a certain location and/or inclination. This

second embodiment relates to the treatment of e.g. occluding objects. The influence of the occluding object is a frequency-dependent attenuation having a low-pass characteristic. The frequency dependent weighting can also be applied to the prior art procedure, where one does not have any elementary spatial sectors. Based on transmitted data describing occluding objects, one would have to decide, whether a SESS is occluded or not and then apply the occluding function to the e.g. frequency dependent stored cues, that are already given for different frequencies in the prior art. Hence, this is a useful application of the occluding effect in the prior art without the usage of elementary spatial sectors or without the usage of stored variance data.

A third embodiment relates to the storage of variance data and covariance data for e.g. HRTFs for different spatial extents or elementary spatial sectors. This third embodiment relates to the storage, e.g. in a look-up table, of variance data and covariance data for e.g. HRTFs in a storage position. It is not relevant, whether one stores this data for a certain spatial extent as in the prior art or for an elementary spatial sector. The renderer then calculates all rendering cues from the stored variance data on the fly. In contrast to the prior art application, where at least the IACC is stored and probably other cues or HRFT data, his is not done in this embodiment. Covariance data is stored and the cues are calculated on the fly. Hence, this embodiment may or may not use the elementary spatial sectors and may or may not use any modifying or occluding objects.

All aspects can be used separate from each other or together with each other or only arbitrarily selected two aspects can be combined as well.

Preferred embodiments of the present invention are subsequently described with respect to the accompanying drawings, in which: