Spatial Audio Interface for Desktop Applications

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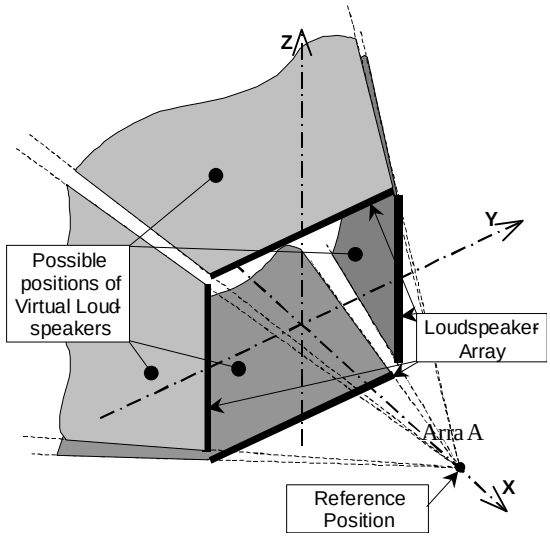
Abstract:
The aim of the proposed system is to create an immersive audio environment for desktop applications without using headphones. Loudspeaker driving signals are derived by combining the Holographic Approach (*WFS, Wave Field Synthesis*) with different panning laws. For optimization a simulation environment in MATLAB has been implemented and beside numerical results, the quality of the synthesized wave field can be evaluated graphically.



Revise:
Applying the concept of the Wave Field Synthesis approach shows that starting from the Kirchhoff-Helmholtz wave field representation, a synthesis operator can be derived that allows a spatial and temporal reconstruction of the original soundfield. Therefore it is possible to generate the sound field of virtual sources lying behind an array of loudspeakers. Beyond sound sources in front of the array can be synthesized as well by using a special manifestation of the synthesis operator. In the latter approach the array radiates convergent waves towards a focus point, from which divergent waves propagate into the listener area. The practical implementation of wave field synthesis requires continuous distributions of secondary sources to be replaced by discrete arrays of loudspeakers. This has influence on the frequency response and the spatial behaviour of the synthesized wave field, artifacts may occur. The aim of the proposed system is to develop an immersive audio environment for desktop applications without using headphones. For that purpose

a loudspeaker array is mounted around a 17” screen using equidistant spacing. Spatial sampling determines the maximum frequency component of the wave field that is synthesized correctly by the array. This effect can be reduced by applying special filter to the array. Loudspeaker signals are derived by combining the holographic approach (wave field synthesis) with various panning laws. Therefore it is possible to move a virtual sound source at the area of the screen as well. Furthermore to reproduce spatial sound sources using wave field synthesis does not suffer from small "sweet spots" like conventional stereo or surround setups. The duplex theory of sound source localization states that the main cues are the interaural time difference (ITD) and the interaural level difference (ILD). Localization of virtual sound sources occurs naturally by diffracting waves around the listeners head in combination with shadowing effects of the head. Because of reproducing the sound field it is possible for the listener to hear in a natural way. For loudspeaker based approaches artifacts using nonindividual head related transfer functions (HRTFs) don't have to be taken into account like using binaural sound reproduction techniques with headphones. A simulation environment in MATLAB has been implemented to obtain theoretical information that depends on the design of a prototype like spatial radiation and bandwidth of loudspeaker arrays. Beside numerical results, the quality of the synthesized wave field can be evaluated graphically plotting error surfaces. The loudspeaker feeds for the prototype are calculated using PD (Pure Data by Miller Puckette, an open source real time computer music software) to obtain realtime capability. Any state of the art PC running PD delivers enough performance for real time calculation of the speaker signals.

Simulation Results: