PLACING SOUNDS IN THREE DIMENSIONS

We have seen how we can place multiple sound sources along a line in space so that they stay put when listeners move and turn in an extended target listening area. We needed an array of just two controlled directivity loudspeakers to do this. We have been able to place sound sources anywhere along a line from the acoustic horizon or vanishing point to well in front of the nearest loudspeaker.

The next question is whether we can extend this to placing sounds in space over an area.

Placing sound sources on a plane

One somewhat impractical approach would use multiple sets of loudspeaker pair arrays each able to place sound sources at fixed locations along its individual axial line. Each of these arrays could be aligned with the listening area and fanning out so as to cover the desired range of source locations. Figure 1 shows such a configuration. By this means many sources could be placed in space so that they remained correctly located when the listener moved and turned throughout the listening area. As before, the virtually placed sources being reproduced will appear correctly located over the whole of the defined listening area.

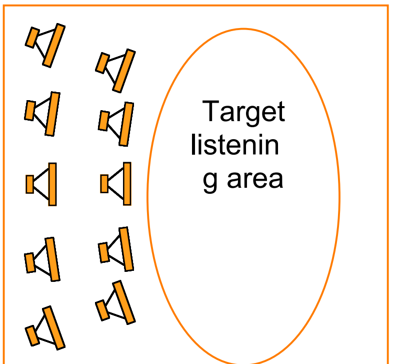

FIGURE 1

One interesting aspect of this approach is that if the reproduction reference is the vanishing point the loudspeaker arrays do not need to be accurately placed. The arrays are reproducing virtual source locations and so just need to align with each line from the vanishing point where sources are to be rendered and aimed to uniformly cover the target listening area.

An implication of this approach would be that the source images need to be allocated to their nearest render "lines" before being rendered along these lines.

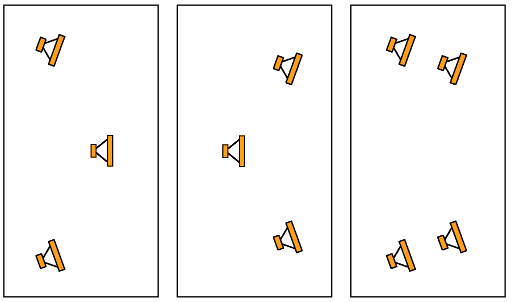

Figure 2 Three render configurations placing sounds anywhere on a plane

If it is recognised that the phase correction for wavefront curvature and hence render distance on each line can be the same, then it becomes possible to collapse one or other of the near or far loudspeaker sets to a single unit. Further, the remaining loudspeaker set can then be replaced with only two loudspeaker sources at the extremities and the directions for render derived using the phantom image creation techniques of stereo reproduction. All that is needed is to ensure that the coverage of the listener area remains uniform.

By feeding separate channel signals to the loudspeakers at the render area extremities it would thus be possible to place sounds at any distance in any direction on the plane between the two lines formed by the arrays, and feed the corresponding common loudspeaker source with a phase controlled derived signal. This means sounds could be placed at any point in space (at a distance and in a direction) between the two lines of the arrays and in the plane of the arrays.

Figure 2 shows three possible loudspeaker configurations that achieve source render over a two dimensional area from the vanishing point to well in front of the nearest array source. A restriction of the simplest approach of a common driver shared between the arrays is a limit to the available listening area size. The best compromise is to use two arrays to cover the two dimensional render area.

HuonLabs refers to these techniques and apparatus of controlled distance render with or without direction as Vector Wave-Front (VWF), to distinguish them from prior art including Wave Field Synthesis (WFS)[1].

Rendering sound sources in 3D

In a similar manner, sound sources can be placed in space in three dimensions by use of additional arrays covering the extent of the three dimensions where sources are to be rendered. Again the whole of the designated listening area provides consistent observation of the fixed location rendered sources.

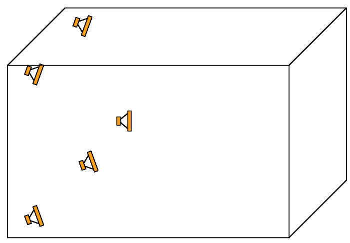

Figure 3 One possible 3D render configuration

Figure 3 shows one such configuration. Again there is a near and a far source but now the far images are virtual, having been panned in two dimensions. The third dimension of distance is then added by the near source and appropriate wave divergence control with the relative phase of the signals.

When the listener moves out of the target listening area, the source location will not necessarily remain consistent, and spatial and frequency dependent smearing of sources may appear.

Depth Render (DR) is a term used by HuonLabs to describe a special case of VWF where the time delay (frequency dependent phase shift) behaviours of all sources at capture are reproduced directly by appropriately spaced source arrays that match the time delays (phase shifts) associated with the capture delays. DR reproduction consequently needs no additional render correction for the arrays, but separate channels are required for each source to be fed to the array loudspeakers . This ensures that correct presentation of all the source location phase information occurs. DR thus creates a scaled 1, 2 or 3D image field dependent on the reproduction loudspeaker placement and spacing. DR was the first distance rendering format demonstrated by HuonLabs[2].

[1] WFS uses extended broad-fire arrays to holistically recreate the entire wave-field in a region. This can require hundreds of channels and loudspeakers for overage of a two dimensional area and more for three dimensional cverage.

[2] AES NY pre-print publication (Huon, Velican)

The next step is to consider any loudspeaker design issues for VWF. Later we will consider other aspects including distribution channel requirements.