Downward Compatibility Configurations when using a univalent 12 Channel 3D Microphone Array Design as a Master Recording Array.

Abstract

It can be shown that Microphone Array Design applied to a 12 Channel 3D Microphone Array can create a Master Recording Array design that will generate downward compatible signals that satisfy most of the present-day univalent lower order channel/loudspeaker configurations. The implementation of this compatibility oriented array design requires no matrixing or processing of the channel signals, whilst still maintaining the integrity of the overall sound field architecture. This compatibility approach to 3D array design produces a master recording system that can be adopted for an overall production, eventually to be distributed using several different media formats (stereo, DVD, Blu-ray, 3D, etc.). This approach can also be used as a consumer choice function within a global master recording.

Introduction

We have already been presented with a wide range of recording and reproduction formats for surround sound, and the inevitable dilemma of which would be the optimum system or systems to adopt for a specific recording, whether this be in the field of stand-alone audio recording, or where sound is part of the overall audio-visual product.

Upgrading of legacy recordings to the most recent surround sound or 3D reproduction formats is attracting considerable DSP expertize, whereas developing complete downwards compatibility in microphonr array systems seems to have attracted little attention.

Precis

The 12 channel 3D microphone array design is based on the isosceles triangle structure as developed in a paper presented at the recent Rome Convention (Preprint 8839). This type of array has proved capable of producing a realistic and robust 3D sound field. If we adopt a minimalistic approach to the number of channels needed in reproduction within lower order configurations, it is obvious that there is a certain amount of redundancy in the overall 12 channel array. However this is consistent with the aim of maintaining complete compatibility of the overall master recording array with most of the present-day lower-order/channel reproduction systems.

Standard reproduction systems usng 2 channels (Stereo), 4 channels (Quadraphony), 5 channels (so called multichannel), 7 channels (Blu-ray), 8 channels (Octophony) or the 3D reproduction formats, are directly compatible with the 12 channel 3D array, without any mixing or matrixing – only the selection of the specific channels is required.

The basic compatibility configurations for the 8 channel M.A.G.I.C. system were presented at the 122nd AES Convention in Vienna (Preprint 7057). This paper will concentrate on the new array configurations introduced by the 2nd layer of 4 microphones for height reproduction. An intriguing set of configurations, which combine both 3D reproduction and compatibility with 2D reproduction, have been presented to three different panels of listeners.

The 1st layer of the 8 microphone array (the M.A.G.I.C. array – preprint 7057) was coupled with the 2nd layer of 4 microphones in a spaced quad structure at 0°, 90°, 180° and 270°. It was found that the satellite microphones of the first layer were redundant, and for most listeners the only difference detected between the full 12 channel reproduction and an 8 channel reproduction (i.e. without the satellite microphones of the lower layer) was a slight decrease in the bass response of the system.

This is reduced considerably by the use of cardioid microphones as satellites, thereby decreasing the cylindrical wave front propagation of the lower 8 channel array in the bass frequencies. This meant that the difference between the full 12 channel reproduction and the 8 channel

(4 + 4) reproduction was negligible. This has considerable advantages in the design of a more compact 3D/2D array.

Another compatibility test was tried using an 8 channel 2D reproduction loudspeaker array, but routing the four 2nd layer (height) microphones to the center, left median, right median and back loudspeaker channels. This caused no degradation of the general sound field architecture, as long as the change from 3D to 2D reproduction is taken into account.

The comparison of all the different compatibility combinations has been presented in three different listening contexts and to three different sets of listeners.

1) A specialist listening panel at the University of Gothenberg, Sweden – the GOArt project (presented at the 27th Tonmeistertagung in Köln in 2012).
2) At a French Section meeting in Lyon, France
3) And at a course on 2D and 3D recording and reproduction for 2nd year students at the ITEMM in Le Mans, France

Listening Test Procedure

A special channel switching system, controlled by ProTools, allowed the listeners to compare, in real time, the various reproduction configurations that were being demonstrated

- Front sound stage reproduction in stereo or triphony
- Single layer surround sound reproduction compared with the two layer 3D reproduction
- Four channels in the lower layer + four 2nd layer channels reproduction, compared with the full 12 channel (2 layer) 3D reproduction
- Four (1st layer) + four (2nd layer) 3D reproduction compared with the surround sound system created by projecting the four by four reproduction height channels into the satellite channels of the eight channel horizontal system.

All the comparison pairs were generated by rapid cross-fading between two specific configurations, thereby allowing the listener to make a quality assessment in the crucial few seconds around the cross-over.

Recordings Presented

At the 1st venue only locally recorded organ music was presented
At the 2nd and 3rd venue, the recordings included an extract from the 'Jardin de Haikus' by Ramon Humet played by the London Sinfonietta and recorded at the Watford Colosseum in London, an extract from 'Ach wie nichtig,ach wie flüchtig' by George Böhm recorded at the 'Ôrgate Nya Kyrka' in Gothenberg, a clarinette trio recorded at the Montesquieu Church in Le Mans in France, some small ensemble classical recordings recorded in Barcelona, and a spectacular recording made at the RAF Airshow at Leuchars in Scotland, as well as recordings of some animal sounds. Recordings were also presented illustrating the first stage towards a new 'Integral 3D' approach to surround sound and height recording.

Analysis

It must be said initially that there is no intention to say or imply that the signals derived for, let us say, stereo reproduction will produce a surround sound impression, and that signals derived for surround sound reproduction will produce any form of height information.

The intention is that this microphone array system will produce signals that will be entirely satisfactory in, for instance, stereo reproduction in comparison with a traditional pair of microphones used to record stereo sound, and similarly for surround sound reproduction.

In the 1st group of listening tests in Gothenberg, the listeners were not even conscious that they were listening to either 12 channel 3D system or an 8 channel 3D system. This suggests total compatibility between the two reproduction systems.

In listening tests within group 2 and group 3 - the same excellent compatibility was experienced in the comparison between each of the 4 categories:

1) Front sound stage reproduction with 2 channel stereo and 3 channel triphony. The 3channel system did show a better geometric linearity compared to the 2 channel stereo due to the improvement in the geometric linearity coeficient with Triphony.
2) The different surround sound formats – 4 channel quadraphony, 5 channel multichannel, and 7 channel Bu-ray were deemed similar but with improving geometric linearity again with the increase in the number of channels
3) The addition of height information produced a realistic and robust sound field. The change from 4 + 4 reproduction to 8 + 4 reproduction was almost imperceptible.
4) The change from 4 + 4 3D reproduction to an 8 channel surround sound reproduction showed that the 3D reproduction could be successfully projected onto the surround sound reproduction field without modifying the overall sound field architecture.

In other words the objectives in developing this type of array were completely satisfied. This type of channel based reproduction is, of course, highly ‘sweet spot’ dependent, and only WFS virtual loudspeaker reproduction system can give a wider listening base.

For many people participating in these listening sessions, this was their first exposure to 3D sound recording and reproduction techniques, and gave rise to some very interesting discussion on the subject.