Evolution of the VMS

Virtual Microphone System

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The VMS System (Virtual Microphone System), based on the Ambisonic theory, was created and patented by the Rai Research Centre and the University of Parma to enable multi-microphone audio shootings using a single probe, through the synthesis of numerous virtual microphones. The first set-up, based on an array of 32 microphone capsules positioned over a spherical probe, has been widely used since 2010, with extremely positive results. Subsequently, a number of prototypes have been set up with probes characterised by different geometries, using the same user interface and enabling the synthesis of
the same number of virtual microphones. Such configurations are aimed at specific targets. Configurations based on a planar array are particularly suitable to audio shootings in TV studios or theatres, in order to avoid the use of lavalier microphones. The latest configuration is the cylindrical array, which is considered very suitable for musical shootings, when instruments are positioned very close to one another, since it allows for a higher directivity with respect to the spherical configuration, thus enabling a more detailed audio shooting. The prototypes based on planar and cylindrical arrays will soon be tested both in the anechoic chamber and in real operating conditions.

1. Virtual Microphone System

In September 2011, a selection of six articles was published within the LeMiniSerie [1] programme, concerning the design and testing of new audio shooting systems based on the holophonic and ambisonic technologies.

Three of those articles, published in 2010 and 2011, describe a system based on the Ambisonic (HOA) theory, relying on a multi-capsule probe to carry out a multi-microphone shooting, which enables the positioning of numerous recording spots on the azimuth and median plane (up to 7 virtual microphones).

The system is based on research and development programmes carried out in close collaboration by the Rai Research Centre and AIDA and, in particular, by Prof. Angelo Farina and Ing. Andrea Capra of the Industrial Engineering Department of the University of Parma. The system is patented [2].

The VMS system has been used for Rai and Vatican Radio productions, for the audio shooting of operas, symphonic orchestras, choirs...

The results obtained are considered extremely positive.

2. Spherical array

The set-up is called 3D-VMS and is based on a spherical probe with a diameter of 8.5 cm, on which 32 microphone capsules are installed (figure 1).

Fig. 1 - Eigenmike spherical microphone probe.

The signals, acquired and transferred thanks to the proprietary EMIB interface, are analysed and synthetized by the patented system.

The VMS system enables to position each virtual microphone on the scene and to display the microphones on the user monitor through the reproduction of a photograph or a video image.

The system is highly innovative, in fact, besides facilitating the positioning of the virtual microphones, it enables the definition of the zoom (directivity) up to the 6th order Ambisonic: the two settings, spatial positioning and directivity, can be carried out in real time and seamlessly.

Besides the possibility of modifying the parameters previously indicated during the shooting, the 32 individual "raw" signals can be recorded, and it thus possible to re-elaborate them and to develop other *ex-novo* sound scenes.

Fig. 2 – Planar array of microphone capsules.

3. Planar array

Parallel with the steady improvements of the software/hardware environments and the user interface of the 3D-VMS application, the evolution of the VMS system has enabled the identification of a number of configurations aimed at widening the range of applications.

Thanks to the spherical probe, the 3D-VMS system is particularly suitable to reproduce the spatiality of the sound scene, while coding it in the 5.1 format.

In many cases, such as audio shootings in TV studios or theatres, it is essential to increase the directivity of virtual microphones, in order to avoid the use of lavalier radio microphones worn by the actors, which tend to cause numerous

technical problems such as cracklings and switch offs due to battery exhaustion, besides the possible timbre distortion.

The answer was the development of a microphone model based on an array of capsules arranged on a plane, currently known as 2D-VMS, or Planar *Array,* or Microphone Panel (figure 2).

The device consists in an optimal sized panel (30 x 50 cm), over which 32 microphone capsules and a central video camera are arranged.

The arrangement of the capsules (figure 3), only apparently pseudo-randomized, has been optimized through software modelling in order to achieve the minimum spatial aliasing effect and the best "signal-noise" ratio, i.e. the ratio between the maximum level, when the array is focused in the exact wave incidence direction, and values close to zero when the array is focused in all the other directions (figure 4).

The planar configuration of the array does not allow to point a virtual microphone rearward, in order to obtain a surround effect. On the other hand, such a configuration facilitates forward focusing, thus increasing the directivity of the virtual microphones. In fact, it is possible to pass from the 6th order Ambisonic, obtainable with the spherical configuration, to the 10th order, thus increasing the "microphone zoom" capacity.

The Microphone Panel is currently in its prototype stage, and is awaiting the anechoic chamber tests, aimed at confirming or further refine the results of the improvements, using the processing software. Subsequently, it will be field-tested for television applications such as sound recordings in TV studios, or positioned in the orchestra "pit" in opera theatres.

Acronyms	
AIDA	Advanced Industrial Design in Acoustic
EMIB	Eigenmike® Microphone Interface Box
HOA	High Order Ambisonic
IP	Internet Protocol
VMS	Virtual Microphone System

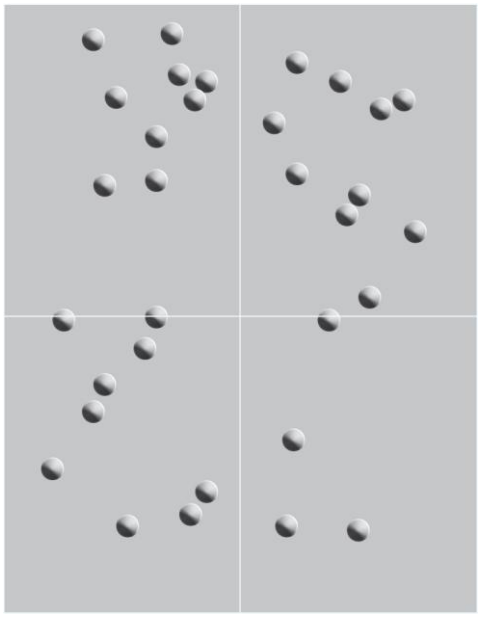


Figure 3 - Arrangement pseudo-random of the capsules

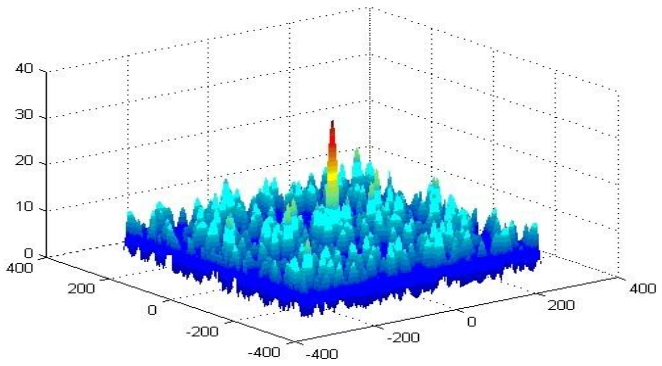


Figure 4 - Array pattern for evaluation the best "signal-noise" ratio

4. Cylindrical array

A further feasibility study, based on the VMS 32 microphone capsule system has a cylindrical configuration.

The microphone probe prototype (approx. height: 30 cm) is still in its finishing and testing stages (Figure 5a). The system is aimed at providing the synthesis of variable directivity virtual microphones (microphone zoom) capable of focusing at 360° and enabling an elevation of approx. 90° around the central axis.

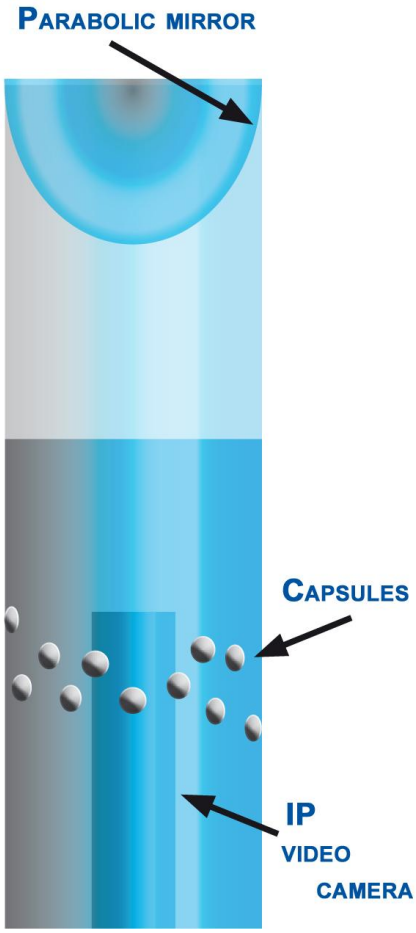
With respect to the previously described probes, this configuration should ensure a higher definition on the horizontal plane and a lower vertical definition, i.e. an elliptical recording diagram instead of a circular one, with a horizontal axis/vertical axis ratio equal to approx. 1/3.

Again, the enhanced arrangement of the 32 microphones over the surface of the cylinder along non-symmetrical trajectories (figure 5b) maximizes the signal/noise ratio.

This array model is expected to enable the recording of instruments positioned very close to each other in a more accurate and selective way, with an order Ambisonic equal to 10.

Fig. 5 – Example of an array of microphone capsules (a) and pseudo-randomized surface positioning (b).

(a)



(b)

Again, an IP video camera is present, together with a parabolic mirror positioned on top of the cylinder which enables a 360° image with an elevation of approx. 70°. The video image is circular (figure 6a).

Since the image cannot be directly used for positioning the virtual microphones, it is processed (unwrapping), turned into a two-dimensional image and is then used (figure 6b).

(a)

(b)

Fig. 6 – Image taken by the IP video camera before (a) and after (b) the unwrapping process.

Bibliography

1. *L. Scopece*: "Riprese Olofoniche e Ambisoniche - Il sistema 3D-VMS", LeMiniSerie 5, www.crit.rai.it/eletel/LeMiniSerie/indice.html.

2. *A. Farina, L.Scopece*: "Metodo per acquisire segnali audio e relativo sistema di acquisizione audio", patent IT 1395894 filed 18/9/2009.