TECHNICAL PAPER

FRAUNHOFER IIS: DELIVERING A COMPLETE SUITE OF SOLUTIONS FOR THE NEXT GENERATION OF VIRTUAL REALITY AUDIO

The Audio and Media Technologies Division of Fraunhofer IIS remains at the forefront of global innovation in sound technology. The division has been active in evolving audio coding techniques and multimedia technology for more than 25 years, and is widely recognised for its integral contributions to the development of the MP3 and MPEG AAC standards. To date more than 1,000 companies have taken out licenses for Fraunhofer's audio codecs, which are installed on well over ten billion devices worldwide.

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VR REQUIREMENTS

While Fraunhofer IIS technologies continue to enable the services of today, its multichannel and immersive audio capabilities are also being implemented in the services of tomorrow. In fact, it is already facilitating audio for virtual reality (VR) and has been doing so for some time. For example, the first generation of Samsung Gear VR, the LG 360 VR headsets and the Hulu VR app are shipping with Fraunhofer's HE-AAC audio codec and Fraunhofer Cingo, its acclaimed binaural headphone rendering product, today.

The stakes for VR audio are arguably as high as they are for any other current platform. Audio is an integral element of VR delivery, but if it is produced or rendered insufficiently the illusion for the participant is 'broken' and the overall experience gravely compromised. But if it is delivered correctly – in other words with core requirements such as accurate binaural rendering and astute deployment of head-tracking – it can make for a truly immersive and enriching experience.

On many fronts, Fraunhofer IIS technologies are showing the way ahead for VR audio. This involvement starts at the point of capture and runs all the way through delivery and distribution to the consumer.

Immersive audio is crucial for virtual reality experiences to create a full sense of presence. The VR audio technologies by Fraunhofer deliver natural and clear sound that gives users the feeling of "being there".

PRODUCING STUNNING IMMERSIVE SOUND

While the availability and cost-efficiency of 360° cameras are improving all the time, it is generally the case that their onboard internal microphones are often unable to capture true 3D audio. Meanwhile, existing external 3D audio microphones generate extra costs for the user, are difficult to hide in a 360° video shooting, and usually require specialized knowledge for operation.

The Fraunhofer upHear Spatial Audio Microphone Processing technology has been designed to significantly improve the sound capture capabilities of professional and consumer 360° cameras and mobile devices using built-in microphones. The algorithm automatically transforms the captured sound in real-time to any popular surround or immersive audio reproduction format, such as FOA, HOA, 5.1 channels, and 7.1+4 height channels, while preserving the authenticity of the audio scene. The technology adapts to the unique body and microphone configuration of the device, which enables flexibility in the product design, and ensures optimal audio recording. This way, Fraunhofer upHear Spatial Audio Microphone Processing makes it possible for anyone capable of operating a camera to enhance video content with spatial audio in a simple and robust way.

But 3D audio recordings are just the starting point for the production of a compelling immersive sound experience for VR. Content producers also need tools that enable an easy and intuitive way to mix and audition what consumers will hear on VR. Therefore, Fraunhofer IIS provides VR audio plugins for Digital Audio Workstations, such as ProTools or Nuendo

The production of authentic 3D immersive sound starts with sound capturing and continues with mixing and mastering of VR sound. Fraunhofer IIS offers straightforward, cost-efficient solutions for both phases.

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(AAX and VST), which allow the creatives to mix 3D sound for VR in a familiar environment without the need to adapt to completely new ways of content creation. The plugins support audio channels and objects as well as ambisonics, scene-based audio elements. These post-production plugins are tailored for professional mixers in the cinematic, post-production and other VR communities.

DELIVERY TODAY WITH HE-AAC AUDIO CODEC

The efficient delivery of audio content to mobile devices has always been one of the biggest strengths of the technologies developed at Fraunhofer IIS. In fact, the pre-dominant audio codec for the delivery of stereo and surround audio content today to mobile devices and VR is the AAC family of codecs. Primarily developed by Fraunhofer IIS, it can now be found in more than eight billion devices worldwide. VR platforms such as Hulu VR, Samsung Milk VR or YouTube 360 use this codec to deliver high quality surround sound even at low bit-rates. However, for the delivery of truly immersive sound for VR, a next generation audio codec is needed: MPEG-H Audio.

The AAC family of audio codecs, co-developed by Fraunhofer IIS, is implemented in more than eight billion devices worldwide and used by the latest VR platforms.

MPEG-H AUDIO: A MAJOR TOOL FOR THE NEW ERA OF IMMERSIVE AUDIO

MPEG-H Audio became an international standard in 2015, and now provides the basis for an audio system that is a candidate for inclusion in the new ATSC 3.0 and DVB-TV broadcast standards. The versatility of MPEG-H Audio makes it ideal for immersive and interactive productions. With this coding technology, next generation audio services can be delivered easily and cost-effectively to mainstream consumers and enthusiasts alike.

The international standard MPEG-H Audio is ideal for immersive and interactive VR productions.

The MPEG-H Audio System is the perfect fit for VR Audio since it can carry audio channels, audio objects and ambisonics audio plus metadata within a single audio bitstream. Audio channels provide a great way to deliver immersive audio while dynamic audio objects enable directors to use audio cues to guide the audience through 360 stories. In this context, they also allow for a very precise placement of sound events around the listeners head and at a specific distance from the ear. Ambisonics audio on the other hand provides a convenient way to capture immersive audio scenes, for instance on set, plus they make it easier to realize point of view manipulation and head rotation at playback.

PLAYBACK OVER HEADPHONES WITH FRAUNHOFER CINGO

In tandem with the delivery of immersive sound to VR devices using MPEG-H Audio, Fraunhofer Cingo can be used for the authentic and realistic reproduction of the 3D sound scene over headphones. Cingo supports rendering of immersive audio content with formats that add a height dimension – including ambisonics audio and 3D channel configurations,

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such as 7.1+4 height – and allows the simultaneous placement of sound objects anywhere in the virtual space around the listener. This allows the listener to feel fully immersed and makes Cingo particularly suitable to the emerging VR segment.

Cingo has already made a global impact with the integration into the Google's Nexus and Pixel family of devices and is now making headway in the new world of VR thanks to its integration into the first generation of Samsung's Gear VR, LG's 360 VR headset, the Hulu VR app for mobile and tethered experience, as well as apps of all the major OTT providers in Korea: SK Broadband, LG U+ and KT.

First announced in September 2014, Gear VR was developed by Samsung in collaboration with Oculus VR. A compatible device, such as the Galaxy S7, acts as the headset's display and processor, while the Gear VR unit itself contains high field of view lenses as well as a custom IMU for tracking which connects to the smartphone via micro-USB.

LG introduced the LG 360 VR at Mobile World Congress 2016. Thanks to the combination of Cingo and HE-AAC, movies in LG 360 VR applications will immerse users and transport them in different virtual environments with perfectly matching audio properties for the success of the illusion.

Cingo helps to deliver an audio experience that is every bit as dramatic as the visual component. The specific features of Cingo that make it suitable for mobile VR include: the capability to render 3D immersive audio from all directions; the possibility to accurately place and track audio objects anywhere in the virtual space; and optimization for mobile platforms from the ground up, making it suitable for any VR platform, whether mobile or tethered to a PC or gaming console.

The combination of MPEG-H and Cingo will provide a suitable pathway for live streaming experiences on VR. Sports is one of the areas in which the most rapid adoption is to be expected.

As the transition from mono to stereo to 5.1 was protracted and hardly without its fair share of challenges, so it is reasonable to expect that the mass adoption of immersive and interactive audio services will take significant time and patience. But in HE-AAC, Cingo and MPEG-H Audio, among other developments, Fraunhofer IIS is showing itself to be at the very forefront of these next generation services. These technologies have already been implemented in a number of class-leading devices, and more significant announcements should be expected soon. A brave new world of audio awaits!

The post-processing technology Cingo allows rendering of surround and 3D sound over stereo headphones as well as the placement of audio objects, thus leading to a full immersion of the liste-ner.

Where to experience Cingo?

Mobile devices	Apps	Virtual reality glasses
Google Nexus family	Hulu VR app	Samsung Gear VR (1st gen)
Google Pixel family	SK Broadband Btv mobile	LG 360 VR
	LG U+ U-HDTV	
	KT olleh tv mobile	

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ABOUT FRAUNHOFER IIS

The Audio and Media Technologies division of Fraunhofer IIS has been an authority in its field for more than 25 years, starting with the creation of mp3 and co-development of AAC formats. Today, there are more than 10 billion licensed products worldwide with Fraunhofer's media technologies, and over one billion new products added every year. Besides the global successes mp3 and AAC, the Fraunhofer technologies that improve consumers' audio experiences include Cingo® (spatial VR audio), Symphoria® (automotive 3D audio), xHE-AAC (adaptive streaming and digital radio), the 3GPP EVS VoLTE codec (crystal clear telephone calls), and the interactive and immersive MPEG-H TV Audio System.

With the test plan for the Digital Cinema Initiative and the recognized software suite easyDCP, Fraunhofer IIS significantly pushed the digitization of cinema. The most recent technological achievement for moving pictures is Realception®, a tool for light-field data processing.

Fraunhofer IIS, based in Erlangen, Germany, is one of 69 divisions of Fraunhofer-Gesellschaft, Europe's largest application-oriented research organization.

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