Using Object-Based Audio Reproduction in Live Applications

Christoph Sladeczek[1], Bjorn van Munster[2]

[1] Fraunhofer Institute for Digital Media Technologie IDMT, 98693 Ilmenau, Germany, christoph.sladeczek@idmt.fhg.de

[2] Astro Spatial Audio, VanMunster BV, 5409 TN Odiliapeel, The Netherlands, b.vanmunster@astroaudio.eu

Introduction

Object-based audio is an approach for spatial sound reproduction which overcomes fundamental problems of traditional channel based applications. A spatial audio production consists out of audio objects. The audio objects are defined by an input signal and its associated metadata. The input signal represents the sound which should be perceived e.g a violin or a female voice, while the metadata describes the unique characteristics of that input signal such as its spatial position, movement or gain. Based on the audio-object information the loudspeaker signals will be generated by means of real-time audio rendering. For this the audio renderer need to know the loudspeaker setup. Especially in live applications, this new approach has major advantages for creative professionals. This paper describes the application and experiences of object-based audio installations in famous venues throughout Europe.

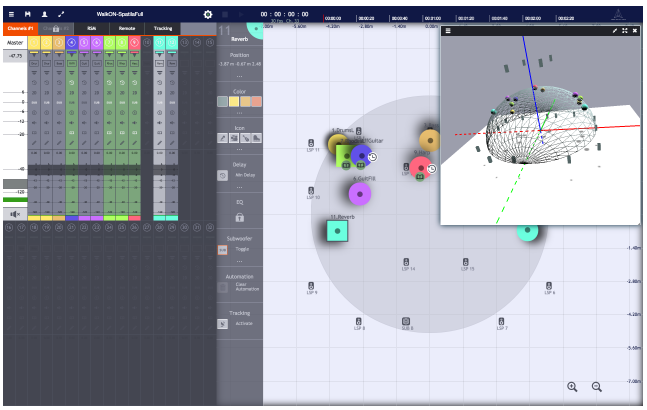


Figure 1: Example application for object-based audio authoring as provided by the Astro Spatial Audio technology. On the left side of the canvas the properties of each audio object can be changed, while the right allows for free three-dimensional positioning of the audio objects.

Object-Based Audio

Object-based audio is an approach for spatial sound reproduction initially coming from the computer games market [1]. In contrast to the channel-based approach where the audio engineer directly controls loudspeaker signal to create a spatial audio scene, the object-based audio approach utilizes a so called audio renderer. This renderer is a hard and software device which knows the current loudspeaker setup and calculates loudspeakers signals based on an scene description comprising of audio objects. An audio object can be interpreted as a virtual source, which is described by an input signal and associated meta data like position, gain, source type etc. . Depending on the reproduction algorithm the audio rendering allows a high-quality spatial reproduction when methods like wave field synthesis are used [2].

For the audio engineer, especially in live applications, the object-based approach gives much more freedom for creative design. Instead of needing complex and time consuming calibration procedures to pan sounds to certain direction by applying individual gains and delays to multiple loudspeakers, the object-based approach simplifies the interaction. Once the audio renderer is configured by getting only the positions of the loudspeakers, the audio engineer can create the spatial audio scene by using an authoring application as depicted in Figure 1.

Requirements of Live Applications

In order to be succesfull in the live audio segment different requirements need to be met in terms of hardware specifications as well as software structure and performance.

Live applications can vary from small spaces like a bar or sportschool up to large theatres or even arenas with thousands of people. With a processing unit at such a crucial position in the entire equipment setup, it is important that the system is very reliable. This requires a carefull selection of components that are being used, but one also needs to take redundancy features into consideration for the system or critical components. In case of emergency the system needs to be able to change free from artefacts in a redundant mode. Additionally, the latency of the system is important. To avoid confusion on stage as well as for the audience the overall system latency should not exceed 10ms. Considering the latency of other equipment, this puts stringent demands on the system performance. Finally the engine needs to support common standard audio interfaces, such as Madi and Dante, to easily integrate in large audio networks as well as provide comfortable amounts of channel counts.

Similar to the hardware, for the software stability and reliability is a need. There are a few more crucial requirements that the software needs to fulfill. First the software needs to be straight forward to use and implement. Each engineer should be able to understand and work with the software within ten minutes of training. Moreover, not knowing which audio equipment is being used, the software also needs to be able to provide full processing including input and output management.

(a) Zurich opera house, Foto: Thomas Wolf, www.foto-tw.de, https://commons.wikimedia.org/wiki/File::Opernhaus_Zürich_2013.jpg

(b) Zurich opera house from the inside. The audio engineer used a mobile device for three-dimensional positioning of audio objects.

Figure 2: Zurich Opera House, Switzerland.

Installations

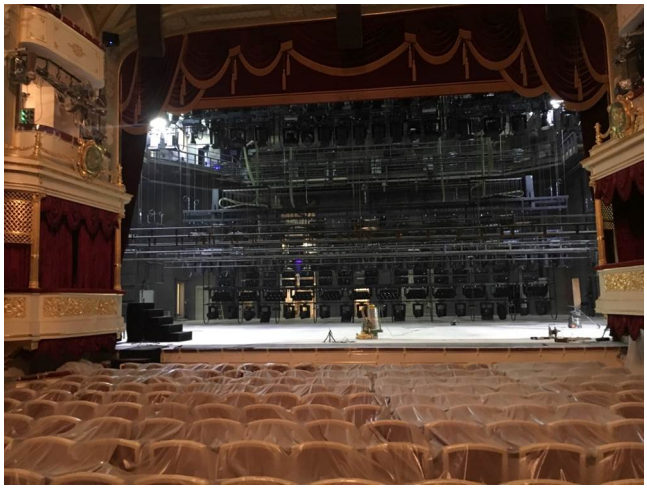
Opera houses worldwide

The system has been successfully applied for optimized localization on stage, immersive 3D sound effects or support of the acoustics (or a combination) in multiple opera houses worldwide. Newer installations include renowned venues such as the Zurich Opera House (Figure 2), Maly Theatre Moscow (Figure 3), the Presidential theatre in Ankara (Figure 4) as well as the Staatsoper Berlin (Figure 5). Each of the projects had its own distinct challenges such as a mixture of brands and types of speakers or integration with the main PA and stage system, but most of all a proper integration. Especially in such culturally important buildings care has to be taken to a respectful integration of the technology with the architecture, yet preserving an outstanding system performance. The WFS object based algorithms used in the system allowed for a flexible and quick setup in each of the project.

Musicals and shows on Broadway and Westend

Sound designers for musicals and shows on Broadway in New York and Westend in London are known to push technology to its limits. Each new show tries to raise the bar to a new level. The system has been used in multiple indoor and outdoor shows for optimized source localization on stage, 3D immersive audio experiences throughout the hall or room as well as for spatial sound effects.

(a) Maly theater.



(b) Inside of Maly theater during the installation of Astro Spatial Audio technology.

Figure 3: Maly theatre in Moscow, Russia.

Besides the performance of the algorithms here also the usability comes in the game. Proper interfaces that match flawlessly the existing workflow of the sound designers and is able to interact with third party equipment for show control, tracking or mixing consoles is of key importance for a successful application in musical or show applications.

Different shows with outstanding critics have used the Astro Spatial Audio system, such as Loreley in St. Gallen in 2017 (Figure 6), The Bands Visit (New York, since 2017; Figure 7), Tina the Musical (London, since 2018 Figure 8) as well as the newest installation The Who's Tommy (Denver, 2018).

References

[1] D. R. Begault. *3DD Sound for Virtual Reality and Multimedia*. Academic Press Professional, Inc., San Diego, CA, USA, 1994.

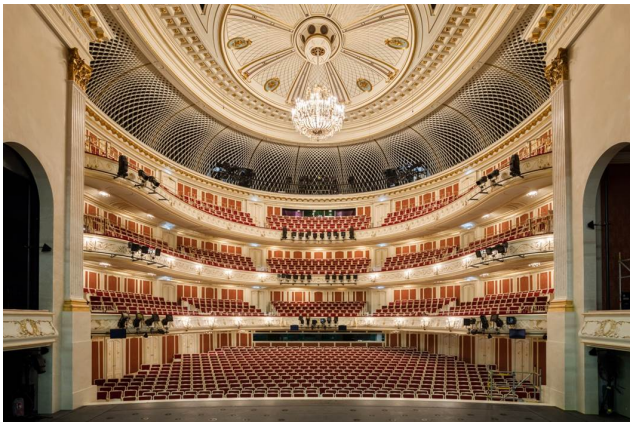
[2] E. N. G. Verheijen. *Sound Reproduction by Wave*

(a) Presidential palace in Ankara, Turkey. One of the buildings contains Turkey's most modern theater. Foto: Ex13, https://commons.wikimedia.org/wiki/File::Ak_Saray-_Presidential_Palace_Ankara_2014_002.jpg

(b) Theater of the presidential palace from the inside during installation of Astro Spatial Audio technology.

Figure 4: Presidential palace Ankara, Turkey.

(a) Deutsche Staatsoper Berlin during renovation, Courtesy Gordon Welters.



(b) Inside of the Deutsche Staatsoper Berlin where an Astro Spatial Audio system is installed, Courtesy Gordon Welters.

Figure 5: Deutsche Staatsoper Berlin.

Figure 6: Stage of the St. Galler Festspiele in 2017 used for the performance of the Loreley. For the loudspeakers on stage as well for the auditorium which was surround by a band of loudspeakers Astro Spatial Audio was used, Courtesy: D. Meyer.

Figure 7: Outdoor announcement in the Barrymore theater on Broadway New York.

Figure 8: Aldwych theater, West End London, where Tina the Musical uses ASA to its fullest extend.

Field Synthesis. PhD thesis, Technische Universiteit Delft, January 1998.