Design and Operation of Outdoor Performances Using Immersive Audio Systems

— Case Study on Spatial Expansion Performances Based on Yamaha AFC Image

Taebin Yoo 2025. 09. 03

1. Project Overview

This project is a case study of applying an immersive audio system in an outdoor athletic field environment. I oversaw the entire process, from the planning stage to system design, network configuration, tuning, and on-site operation. Based on the principles of the **Yamaha AFC Image** system, the goal was to implement a "spatial expansion performance" where the audience perceives the entire space as a stage rather than being fixed to a specific listening point.

2. Planning Background and Problem Identification

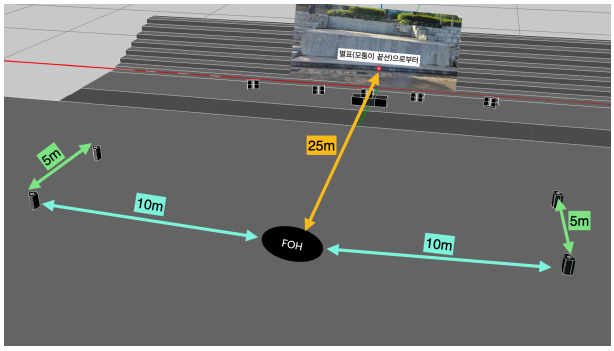
Traditional outdoor performances typically have a structure where acoustic energy is concentrated at the front of the stage, leading to significant limitations in spatiality and sound image perception depending on the listener's location. This project was conceived to verify whether immersive audio technology can function as a system that fundamentally transforms the audience's listening experience beyond simple sound effects.

3. Analysis of the Performance Environment

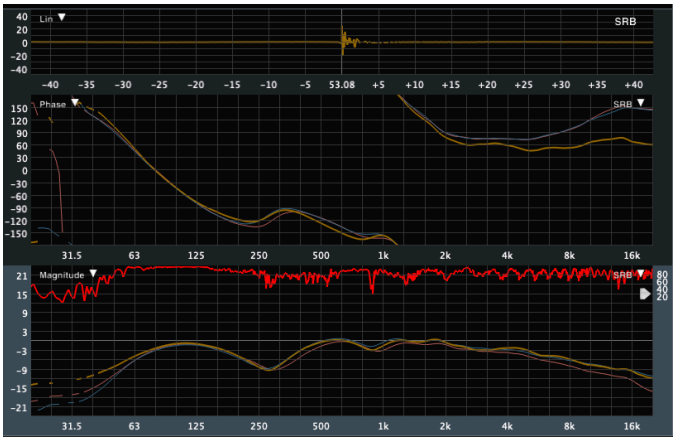
The performance took place on an outdoor field with a long, open structure, featuring a distance of approximately 25m between the front of the stage and the audience seating. Given the outdoor characteristics lacking natural reflections, creating a sense of space was challenging. Therefore, the sound system was approached from the perspective of **"virtual space design"** rather than simple amplification. The core objective was to ensure the sound image did not collapse abruptly as audience members moved, allowing the entire field to be perceived as a single integrated stage.

4. System Design Concept

The system was designed by applying the sound image control method of Yamaha AFC Image. The main system was based on **L-Acoustics KARA** line arrays, configured in a **9.1 channel structure** including L, C, R, LL, RR, SLC, SLB, SRC, SRB, and a Subwoofer (SUB).



All speakers were aligned based on the track boundary of the field using **Soundvision simulation**. The subwoofer was placed 1m behind the center speaker to ensure that spatial movement and diffusion effects were not physically distorted.



5. Signal Flow and Network Configuration

I directly designed and verified the entire signal flow and network topology. The performance was centered around a **Midas M32** house console, with all input channels received via **DL32**. Each channel was direct-outed post-fader and transmitted to the **DME7** via a **Dante network**, where the AFC Image processing occurred.

Signal Flow: *Stage Box (DL32) → Console (M32) → (Dante Network) → Immersive Processor (DME7) → Console (M32) → Amp (LA8 & LA4X)*

The network design utilized **VLANs** to separate the audio signal network (Dante) from the control network (OSC) to prevent traffic interference. It was configured with static IPs (192.168.101.x / 255.255.255.0), and **QoS and IGMP Snooping** settings were applied using managed switches. To ensure the stability of the digital audio system, I continuously monitored the clock synchronization between the console, Dante card, and DME7 to prevent potential issues.

6. Tuning and System Operation Process

During the tuning process, I used **Smaart** to measure the frequency response and phase characteristics of each speaker zone. Time alignment was performed between the rear/center speakers and the main systems. By comparing the response before and after applying AFC Image, parameters were adjusted to prevent excessive energy concentration or spatial distortion in specific bands. The AFC Image was operated not as a tool to excessively amplify spatial effects, but as a supplementary element to expand spatial perception while maintaining musical clarity.

7. Results and Limitations

The results showed that audience members experienced a relatively consistent sense of space without being fixed to a specific spot. Feedback confirmed that an immersive experience similar to that of the front row was possible even in the rear and side seating areas. However, some audience members reported a sense of "strangeness" regarding the unfamiliar virtual acoustic environment. This remains a task to be addressed through future research expansion into **Psychoacoustics-based HCI (Human-Computer Interaction)**.

8. Project Significance

This project is an engineering case study that integrates [Spatial Analysis – System Design – Network Construction – Tuning – Operation], going beyond the simple implementation of an immersive audio system. It established an engineering approach to performance sound, treating it as a measurable and designable system rather than just a sensory realm. This project holds significance as an experimental verification of how technical judgment and operational decisions based on field experience directly impact the audience experience.