DOI: 10.61782/fa.2025.0327

FORUM ACUSTICUM EURONOISE 2025

Effects of audio-visual interactions on the soundscape in urban shopping streets

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ABSTRACT

This study examines effects of visual elements on urban soundscape in shopping streets across South Korea and Japan using Virtual Reality (VR) simulations. Participants assessed Sound Source Identification (SSI) and Perceived Affective Quality (PAQ) under audio-only and audio-visual conditions. Results revealed that visual stimuli significantly affected sound perception, creating distinct recognition patterns. This highlights context-specific soundscape characteristics, and the complexity visual components add to evaluations. The study underscores the importance of integrating audio-visual elements in urban planning to enhance sensory experiences in shopping environments.

Keywords: *Soundscape, Shopping Streets, VR, Audio-Visual, Acoustic Environment*

1. INTRODUCTION

In urban environments, the interaction of audio-visual elements significantly impacts soundscape perception. According to a previous study [1], soundscape encompasses not only acoustic aspects but also emotional responses influenced by personal experiences and the functional context of a region. Particularly in urbans shopping streets, where audio-visual elements are relatively diverse, it's crucial to consider their impact on the perception of soundscape Pleasantness and Eventfulness. This aligns with [2], which emphasizes the importance of integrating soundscape with visual satisfaction. However, existing research predominantly focuses on parks and other recreational spaces, leaving commercial environments less explored. This study aims to investigate how visual elements in urban shopping streets influence soundscape perception, using VR technology.

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2. METHOD

We selected six locations, which are shopping streets in South Korea and Japan based on types of shopping streets: indoor (CX, MU), outdoor (HD, SD), and arcade (AK, ES). To recreate the locations in VR, we captured 360-degree video using an Insta360 One X2 camera, alongside ambisonics and binaural audio recordings with a Sennheiser AMBEO ambisonics Mic and Head-acoustics BHS-II microphone. The A-weighted 1-minute equivalent sound pressure levels ($L_{Aeq,1\text{-}min}$) of each location was measured and is detailed in Table 1, to ensure that the VR environment reflected the true sound levels.

Table 1. A-weighted 1-minute equivalent sound pressure levels measured at the six locations.

Location	$L_{Aeq,1\text{-}min}$ [dB]
CXS	72.28
MUS	59.66
HDS	68.69
SDS	62.29
AKS	69.36
ESS	74.57

The experiment included two sessions: Audio Only (AO) and Audio-Visual (AV). Participants evaluated six locations based on Perceived Affective Quality (PAQ) using methods outlined in ISO/TS 12913-2, and Sound Source Identification (SSI) was assessed on a 5-point scale.

3. RESULT

3.1 PAQ of shopping streets

The evaluation showed that HDS, SDS, and MUS, despite being commercial environments, exhibited lower eventfulness scores compared to CXS, ESS, and AKS. Conversely, CXS, ESS, and AKS, which had higher eventfulness, showed lower pleasantness values. This contrasts with [3], which found positive scores for both Pleasantness and Eventfulness in shopping streets. The divergence in results underscores the unique soundscape dynamics of each urban setting, highlighting the need for context-specific approaches in soundscape design and urban planning.

3.2 SSI and Audio-visual interaction

Figure 1. illustrates the sound source proportions and session differences across six locations. It categorizes sound sources into Human, Machine, Music, Mature, and Traffic, comparing Audio Only (AO) and Audio-Visual (AV) conditions. Overall, "Human" sounds are prominent across most locations, while the introduction of visual stimuli (AV) generally leads to a shift in sound source perception, particularly reducing "Machine" sounds.

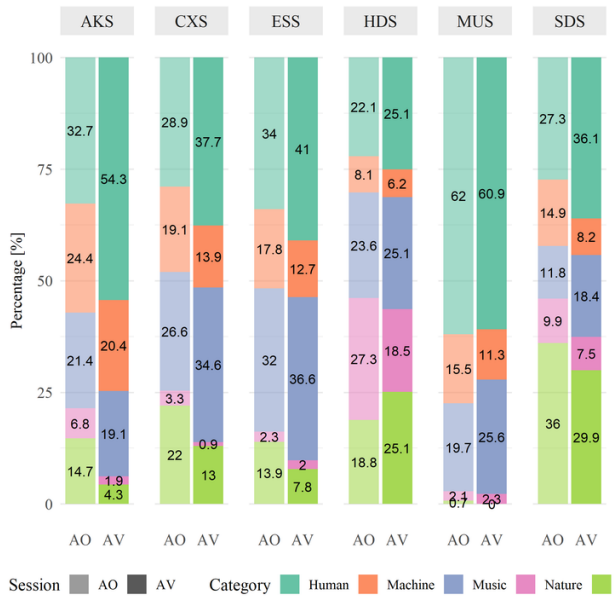

Figure 1. Sound Source Proportions and Session differences Across Locations

4. CONCLUSION

This study investigates the impact of visual elements on the sound environment of shopping streets. While the soundscape scores in the study locations exhibit slight differences from previous research, they offer meaningful insights into context-specific soundscape evaluations. The sound perception patterns indicate that visual stimuli create distinct differences in sound recognition. These findings suggest that visual components significantly influence how sounds are perceived, adding complexity to soundscape assessments. This research underscores the importance of integrating audio-visual elements in urban planning to create more engaging and perceptually balanced shopping environments.

5. ACKNOWLEDGEMENTS

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. RS- 2023-00220921 and NRF-2022R1C1C1008066).

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