DEVELOPMENT OF TWO APPLICATIONS FOR ACOUSTIC EDUCATION FOR ARCHITECTURAL DESIGNERS

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ABSTRACT

According to architectural designers, although they are aware of the sound environment when designing spaces, in many cases visual (design) and cost (cost-effectiveness, etc.) were the predominant factors.
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KEYWORDS

Architectural Designers, Acoustic Education, Acoustic Environment, Reverberation Time

1. INTRODUCTION

According to architectural designers, although they are aware of the sound environment when designing spaces, in many cases visual (design) and cost (cost-effectiveness, etc.) were the predominant factors.

In many cases, the visual (design) and cost aspects (cost-effectiveness, etc.) were dominant. The tacit rule for evaluating the sound environment was that a quiet space with no noise was somehow better. However, recently, sound environment design focusing on indicators other than quietness, such as speech privacy-conscious sound environment design in hospitals and pharmacies, and sound environment design of commercial spaces to ensure liveliness, has also been conducted (Astolfi, 2004), (Joerg, 2016), (Kang, 2002). We have also conducted studies on sound environment design guidelines that take into account the anonymity of the sound environment (Maruyama, 2020). As described above, there is a need not only for quietness, but also for appropriate sound environment design for specific applications. Especially in multi-group conversation spaces such as restaurants, it is also important that the space is ‘comfortable for conversation’ in addition to visual elements.

On the other hand, when architectural designers have meetings with clients, they are consulted that although they can present photographs, it is difficult to explain comfort other than visual elements. Even if they have attended classes on sound environment at university, it seems to be difficult for architectural designers who are not specialised in sound to concretely verbalise and articulate the image of the sound environment in their own consciousness. Therefore, the authors considered that, in order for architectural designers to design spaces with consideration for sound, it is important for them to make it their own thing, such as their own senses, to absorb knowledge before learning the knowledge of acoustics, and to show it objectively and clearly. Therefore in this

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study, two applications were developed: an application to raise architectural designers' awareness of the sound environment and a reverberation sensation training application.

2. APPLICATION FOR EVALUATING THE SOUND ENVIRONMENT IN RESTAURANTS

2.1 Application Overview

In order to help architectural designers to optimise their design in consideration of sound, a sound environment assessment application for restaurants was developed to firstly trigger awareness of the sound environment. We developed a restaurant sound environment application for members of the design team of NOMURA Corporation, one of the leading architectural design firms in Japan. They are a design team that has designed spaces for many national and international restaurants (Ueda, 2024).

Figure 1 shows the screen where the user registers information on the sound environment.

The information to be registered is the situation at the time of the sound environment evaluation, the shop, the seating area and the user's (evaluator's) subjective opinion. Table 1 shows the details of each item.

Figure 1. Example of the sound environment assessment sheet input screen

Table 1. Evaluation items to be assessed in the application

Circumstances	Date, Noise level, Number of visitors
Shop	Shop name, Address, Business type, BGM, BGM genre
Seats	Capacity, Seat type, Seat distance, Seating area, Ceiling height, Open terrace availability, Open kitchen, Floor, wall, and ceiling materials, Table top and chair seat materials
Photo	Photos of the inside of the shop
Subjective evaluation	Ease of speaking, Liveliness, Difficulty in hearing, Reverberation

NOMURA Design Team architectural designers can reaffirm how they feel in any space by simultaneously evaluating physical data such as noise level, presence or absence of background music, seating size and distance between seats, as well as their own subjectivity. By collecting and sharing a large number of these evaluations, we believe that it is possible to clarify the relationship between physical characteristics and subjectivity.

The noise level is measured by other applications (for iPhone: Sound Level Analyzer Lite Decibel Meter, TOON, LLC/Android: SPL Meter, keuwlsoft) and is input by the user. We will also consider adding a measurement function to this application.

2.2 Brief Summary of the User Evaluation and Results

On subjective awareness: architectural designers' assessment of the sound environment of the restaurants and bars they visit on a daily basis led to the following statements. 'I used to focus on visuals such as wall materials and lighting, but the task of evaluating the sound environment using the app has made me more aware of the sound environment'. 'I had never been aware of noisy restaurants before, but using the app, I now realise that there are noisy environments and environments where it is difficult to have a conversation, and sound environments where it is easy to have a conversation.'

At the moment, the evaluation has only been carried out by about 30 architectural designers from NOMURA Corporation but it appears that awareness of the sound environment has been raised.

On evaluation tools: original applications seem to be more motivating for evaluation than evaluations using Google Forms or Excel. In Japan, there are several web applications for sharing restaurant evaluations.

Issues related to evaluation: Regarding the evaluation item 'reverberation', feedback such as 'I cannot get a sense of reverberation (echo)' and 'There are individual differences in the sense of reverberation' were reported.

2.3 Application Configuration

This application is implemented as a web application as shown in Figure 2. Firebas is a mobile and web application back-end service (BaaS: Backend as a Service) provided by Google, consisting of several product groups (Firebase). Firebase Authentication is used to implement authentication functions, Cloud Firestore is a document-oriented database for data storage and management, Firebase Hosting is used for web hosting, and Cloud Storage is used for image storage. The Google Maps Platform is also used for the implementation of the Google Maps Platform geo-targeting system. The geocoding service of the Google Maps Platform is used to convert latitude and longitude into addresses.

The implementation on the client side uses HTML, JavaScript and CSS, as in general web applications. In addition, the Firebase SDK for accessing Firebase services and UIKit, a front-end framework (CSS and JavaScript library) widely used in web production, are used. The Maps JavaScript API is used to access geocoding services.

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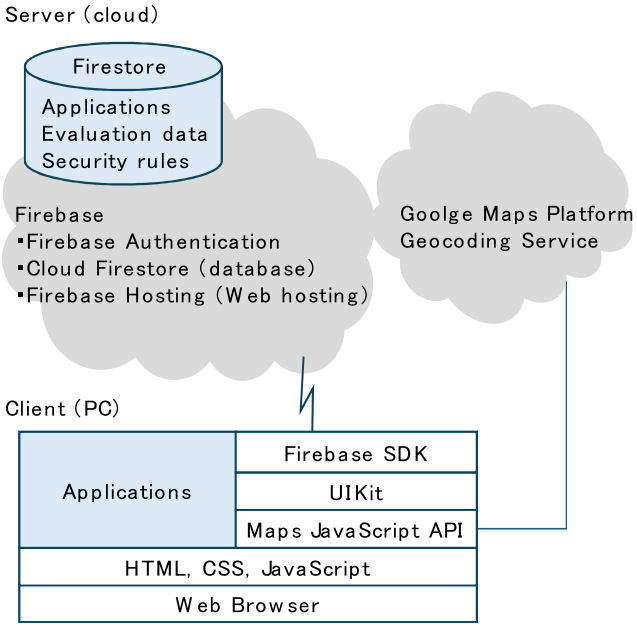

Figure 2. System configuration

3. DEVELOPMENT OF A REVERBERATION TIME TRAINING APPLICATION

In the previous chapter, we developed an application for evaluating the sound environment of restaurants and cafés so that architectural designers, who have given priority to visual design, can become aware of the sound environment when designing their spaces. As a result, opinions were heard that it was difficult to get a sense of 'reverberation (echo)' at the same time as the awareness-raising application, and that there were individual differences in the sense of reverberation. This led to the discussion that it is necessary to grasp the reverberation sensation sensitively at the same time as raising awareness of the sound environment. In this chapter, a reverberation training application for spatial designers was developed and tested on architectural designers, referring to the training for grasping the volume and frequency of ear training to foster sound perfection.

3.1 Application Overview

The application consists of a function for registering user profiles, a training function for listening to sounds and answering their reverberation time (1), a training function for listening to two sounds and answering the one with the longer reverberation time (2), and a history display function for these two types of training (Iwamiya, 2003), (Kawahara, 2016).

Figure 3 shows the screen of the training function (1), and Figure 4 shows its history screen. When the user clicks the start button on the training screen, a sound is played. The user selects the reverberation time with a button. This is repeated ten times, and the answer is registered by clicking the Register button. The history screen shows the training date and time, the correct answer, the answer, the correct answer and the difference between the correct answer and the answer for each session.

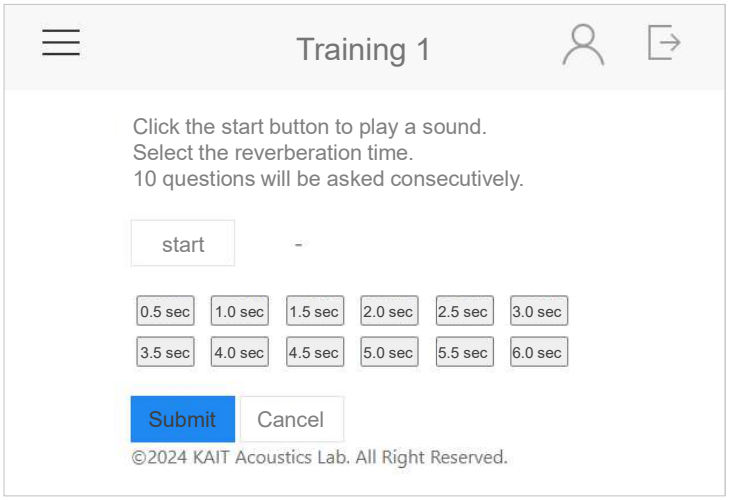

Figure 3. Example of training 1 screen

Figure 4. Example of training 1 history screen

Figure 5 shows an example of the screen of the training function (2). When the start button is clicked, the sound is played twice. The user clicks on the button with the longer reverberation. This is repeated ten times, and the answer is registered by clicking the Register button. The history screen shows the training date and time, the 10 correct answers, the answer, and the correct or incorrect answer.

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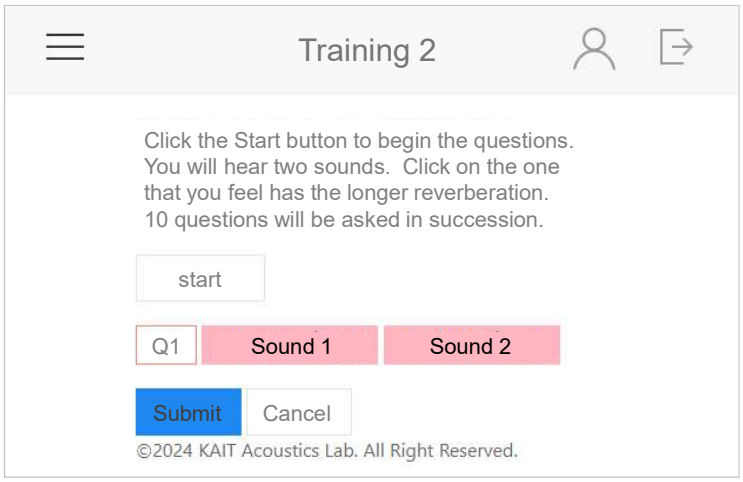

Figure 5. Example of training 2 screen

3.2 Feedback at the Moment from Architectural Designers

The reverberation training application is currently being used by spatial designers, who have given feedback such as 'the actual reverberation time is far different from what I had imagined in my head' and 'the sense of long reverberation was different for each person, but through training I expect that the team's sense of reverberation will be consistent to some extent'. The training is expected to make the team's sense of resonance more consistent to a certain extent.

3.3 Application Configuration

This application is implemented as a web application in the same way as Figure 2. Firebase is a mobile and web application back-end service (BaaS: Backend as a Service) provided by Google, consisting of several product groups. Firebase Authentication is used to implement authentication functions, Cloud Firestore is used for data storage and management, and Firebase Hosting is used for web hosting.

The client-side implementation uses HTML, JavaScript and CSS, as in general web applications. In addition, the Firebase SDK for accessing Firebase services and UIKit, a front-end framework (CSS and JavaScript library) widely used for web production, are used.

4. CONCLUSION

In this study, as a first step to enable spatial designers to concretely verbalise and clarify the image of the sound environment in their consciousness, we developed a sound environment evaluation application for restaurants to trigger their awareness of the sound environment. During the evaluation, many of the space designers stated that it was difficult to evaluate reverberation and resonance, and that the feeling seemed to differ from person to person even when talking (among designers). The reverberation training application is currently being used by spatial designers, and their impressions include: 'The actual reverberation time is far different from what I thought in my head' and 'The sense of long reverberation was different for each person, but I expect that the team's sense of reverberation will be consistent to some extent through training. The training is expected to make the team's sense of resonance more consistent to a certain extent.

Currently, the designers are actually using the application to evaluate the sound environment of various restaurants. In the future, it is planned to investigate whether there are any changes in awareness before and after the use of the application and how it is actually utilised. In addition, by combining this reverberation training

with the sound environment evaluation application described in the previous report, the awareness of space designers towards the sound environment will be broadly promoted.

REFERENCES

Astolfi. A., et al. (2004). "Good Acoustical Quality in Restaurants: A Compromise between Speech Intelligibility and Privacy." Proceedings of International Conference on Acoustics, ICA 2004, 1201-1204.

https://firebase.google.com/

Iwamiya, S., et al. (2003). "Technical Listening Training: Improvement of sound sensitivity for acoustic engineers and sound designers". Acoustical Science and Technology. 24. 27-31.

Joerg, B., et al. (2016). "Privacy-Aware Acoustic Assessments of Everyday Life," JAES Volume 64 Issue 6, pp. 395-404; June.

Kang, J. (2002). "Numerical modelling of speech intelligibility in dining spaces." Applied Acoustics 2002, 63, 1135-1333.

Kawahara, K., et al. (2016). "Training course for instructors of technical listening training," Acoust. Sci. & Tech., 37, 185–186.

Maruyama, N., et al. (2020). "Assessing the ease of conversation in multi-group conversation spaces: Effect of background music volume on acoustic comfort in a café," Building Acoustics 27(2), 137–153.

Rindel, J. H., et al. (2012). "Acoustical capacity as a means of noise control in eating establishments." Proceedings of BNAM 2012, Odense, Denmark.

Rindel, J. H., et al. (2010). "Verbal communication and noise in eating establishments, Applied Acoustics 71, 1156-1161.

Ueda, M. et al. (2024). "Development of a restaurant sound environment assessment application to provide acoustic education for space designers." Proceedings of The Acoustical Society of Japan Spring Meetings 2024(in Japanese).