

# Designing a Haptic Feedback System for Hearing-Impaired to Experience Tap Dance

Mina Shibasaki, Youichi Kamiyama, Kouta Minamizawa

Keio University Graduate School of Media Design  
4-1-1 Hiyoshi, Kohoku-ku, Yokohama, 223-8526 Japan  
{mina0415, kamiyama, kouta}@kmd.keio.ac.jp



Figure 1 The Karada tap performance and the audience

## ABSTRACT

In this study, we have designed a system to enable hearing-impaired to enjoy the performance of tap dancers. This system transfers the haptic sensation of tap dancing from the stage to the audience and helps hearing-impaired people enjoy the vibration of the taps even if they cannot hear the sound. We organized an event to verify the effectiveness of the system. To do this, we collaborated with a tap dance unit and science museum. We found that our system succeeded in helping the tap dancers share the fun and enjoyment of dance with the audience comprising people with hearing disabilities.

## Author Keywords

Tap Dance; Hearing-Impaired; Embodied Interaction; Haptics; TECHTILE

## ACM Classification Keywords

H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6): Haptic I/O and User-centered design.

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## INTRODUCTION

We enjoy performance art mainly through our visual and auditory senses. Specifically, tap dance is a performance medium that relies on hearing. However, hearing-impaired people cannot hear the rhythm of tap dance. Moreover, it is difficult to understand the sound component of tap dance through vision alone. Therefore, we developed a system that allows hearing-impaired people to realize the fun of tap dance through haptic sensation or the sensation of the skin.

Previous studies used haptic feedback technologies to enable hearing-impaired people to perceive sound via touch. Eberhardt et al. developed OMAR [1], a device that manipulates a hearing-impaired person's fingers in response to sound to enable them to perceive speech; Nanayakkara et al. developed the Haptics Chair [2], a system to assist hearing-impaired people with speech perception and enrich their experience of music. Honda et al. developed ONTENA [3], a wearable device to assist hearing-impaired people in perceiving sound in daily life. Watanabe et al.'s workshop, Heartbeat Picnic [4], used the vibrations of heartbeats as haptic information that enabled the experience of feeling one's own heartbeat. Their attempts aim at enabling a hearing-impaired person perceive sound using haptic technology. However, each of these systems was designed to be used by single person. Therefore, we attempted to create an experience of a dance performance for multiple people to appreciate. In this study, we have developed a system that transfers the haptic sensation of tap dance from the stage to the audience.

## EMBODIED APPRECIATION SYSTEM FOR TAP DANCE

Figure 2 illustrates the implementation of our system. This system is based on TECHTILE[5] technology. We set up haptic microphones in the stage in order to not restrict the dancers' movement. The stage was 1.8 m × 1.8 m and the haptic microphones were positioned at both ends of the front of the stage and at the rear center of the stage. The audience seating provided haptic information as the output using a power amplifier. To accommodate many people, we set up three types of output: chair, floor, and handheld. The audience did not have to wear any device to experience the performance. We called our system "Karada Tap."

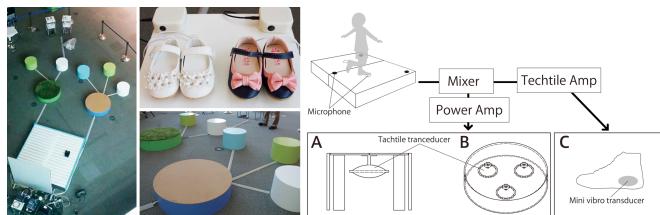


Figure 2 Implementation of the embodied appreciation system

## PUBLIC PERFORMANCE

We organized an event to verify the effectiveness of the Karada Tap system. We staged the performance six times over two days, with three performances per day. The performance was conducted once every half hour. The procedure for the performance was as follows: 1) Introduction to the event 2) Normal performance of tap dance without the Karada Tap system; 3) Introduction to the dancers and haptic technology; 4) Performance using Karada Tap; 5) Interview with the audience; and 6) On-stage experience (15 min). During the on-stage experience, it was possible for the audience to use the handheld output device to feel their own taps.

The number of visitors to this event was about 270 people (including about 20 hearing-impaired people). The audience included families, a professional dancer, hearing-impaired people, visual impaired people, and a UI designer who has a hearing handicap. Figure 1 shows the actual conditions of the event. Hearing-impaired audience members used sign language to understand tap. People sometimes laid a hand on their chairs. We observed children and a professional dancer lie down on the floor to feel the taps using their whole body. We also saw active participation during the on-stage experience. Hearing-impaired members appeared to be enjoying the feeling of their own steps. Comparing the normal performance and the performance using Karada Tap, we could confirm that a person with a hearing handicap was swaying their body to the rhythm when the performance used Karada Tap.

As result of a survey on the degree of audience satisfaction. All respondents answered that they were "very satisfied" or "satisfied" and 95% of hearing-impaired participants understood the rhythm of tap.

## DISCUSSION

### Karada tap created empathy between dancers and visitors

*"Thank you for making my wish come true...There are various types of people in the Hearing-impaired category of people. For example, a person does not know sound at all; they are interested in sound; a person who cannot sufficiently hear on the other day like me and gave up enjoying sound music, song and stage performance.... This system enabled me to enjoy the vibration, as if I could hear the sound." (Shuwapprin Kiyomi Hearing-Impaired People)*

*"I can't hear a low-pitched sound at all. I had given up on feeling the rhythms of Tap dance. I was surprised and impressed. This system helped me understand how to Tap dance." (Woman aged 40, Hearing-Impaired)*

*"I have never known that the rhythm of Tap dance is so fine because I have hearing difficulties. This system made me realize that tap was very fine." (Woman aged 20, Hearing-Impaired)*

It appears that visitors with hearing impairments were surprised. One of the visitors had her hand over her mouth because she had never known about sound before. In addition, we induced visitors with hearing disabilities to feel the rhythm and realize that the tap was very fine. We succeeded to tie vibration and the taps of tap dance. Through this experiment, we succeeded to combine the tap dancers' wish to introduce interest of tap dance to the hearing-impaired people who gave up enjoying the sound of tap by using haptic feedback. In addition, we can say less the distance between dancer and visitor because to make someone feel that visitor who is Normal-Hearing people attended to Karadatap and kids were concentrating at Karadatap. We got many suggestions from the Normal-Hearing and Hearing-Impaired people that they wanted to spread this system.

In addition, Karada tap created empathy between dancers and visitors. Many people could enjoy tap-dance at the same time.

## CONCLUSION

We developed the Karada Tap system to provide the rhythm of tap dance to hearing-impaired people. This system succeeded in helping tap dancers share the fun of dance with an audience comprising hearing-impaired People. This system also has the potential to be a tool for expression. The Karada Tap system can achieve our purpose to let hearing-impaired People realize the fun of tap dance through haptic feedback; it also helps dancers and visitors empathize with each other, satisfying the requirements of Kiyomi. In future research, Haptic feedback technology is expected that all people, with or without disabilities can enjoy tap dance.

## ACKNOWLEDGMENTS

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