Dynamic Local Lag Control for Sound Synchronization in Joint Musical Performance
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Introduction

- A number of researchers have been directing their attention to joint musical performance in which multiple users play their respective same or different types of musical instruments together.
- In joint musical performance over a network, the synchronization quality of sound may seriously be deteriorated owing to the network delay.
- We can use local lag control over local information in order to be synchronized with received information. The control buffers local information for a constant time called local lag; thus, it degrades the interactivity.

Previous Work

- Irie et al., handle the case in which the network delay from the local terminal to the other terminal is equal to that in the opposite direction (called the symmetric delay case). They set the local lag to the same value as the network delay.

Problems

- They do not handle the case in which network delay from the local terminal to the other terminal is different from that in the opposite direction (called the asymmetric delay case).
- In the asymmetric delay case, high synchronization quality of sound may not be achieved.

- In our previous work, we deal with a networked haptic drum system for joint performance.

- There exists the optimum value of local lag for joint performance of the networked haptic drum system.
- The value is not always equal to the network delay. This is because the interactivity is severe in the joint performance.
- The optimum local lag can be calculated by using the network delay from the other terminal to the local terminal.

Configuration of Networked Haptic Drum System QoE Assessment Method

- For explanation, let us denote the constant delay from terminal 2 to terminal 1 (see the configuration of the networked haptic drum system) constant delay 1 and that in the opposite direction constant delay 2.
- We call the local lag at terminal 1 local lag 1 and that at terminal 2 local lag 2.
- Constant delays 1 and 2, the value of Δ, and the two types of control (i.e., the dynamic local lag control and the local lag control with fixed values of Δ) were selected in random order for each pair of subjects.
- In the dynamic local lag control, the value of Δ was dynamically changed according to Eq. (1).
- Each subject is asked to base his/her judgment about the synchronization quality of sound, interactivity, comprehensive quality (weighted sum of synchronization quality of sound and interactivity) based on the five-grade quality scale (5: Excellent, 4: Good, 3: Fair, 2: Poor, 1: Bad) to obtain Mean Opinion Score (MOS).
- Subjects are 16 persons whose ages are between 20 and 28.

This Work

- Based on our previous work, we propose dynamic local lag control which dynamically changes the local lag according to the network delay in joint musical performance.
- We make a comparison between the dynamic local lag control and the local lag control with fixed values of local lag in the symmetric and asymmetric delay cases by subjective QoE (Quality of Experience) assessment.
- In the assessment, we use the networked haptic drum system for joint musical performance.

Dynamic Local Lag Control

- The dynamic local lag control dynamically changes a buffering time (i.e., local lag, which is denoted by Δ (≥0) ms) of local information according to the network delay from the other terminal to the local terminal.
- The value of Δ is calculated by the following equation*:
  \[ Δ = 0.64D + 6.60 \]  \hspace{1cm} (1)
  \[ D: \] The time interval from the moment an MU is generated at the other terminal until the instant the MU is output at the local terminal


Assessment Results

Conclusions and Future Work

- We proposed dynamic local lag control for sound synchronization in joint performance.
- We found that the dynamic local lag control is effective in the joint performance of the networked haptic drum system.
- As the next step of our research, we will enhance the dynamic local lag control so that three or more users can perform joint musical performance.