Evaluation of Multi-Angle System for Reflecting Piano Lessons

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***Abstract*—The author aims to pass on the tradition of classical music to the next generation by significantly reforming and evolving the traditional pedagogy of piano education. Recording and reflecting on one's performance through video can be a helpful tool in the learning process. However, current video platforms lack the functionality to quickly cue specific scenes. Moreover, video recording is generally limited to a single angle. Reflecting on not just the hands but also the use of the upper body and feet is crucial in piano performance. We have developed a system that enables multi-angle recording using multiple smartphones, allowing for the review of video linked to the musical score. This paper will discuss the system's development, focusing on the synchronization between audio and every video angle, and user reviews. Utilizing this system for objective evaluation of actual performances is expected to reveal gaps between the ideal and reality and to discover new challenges.**

Keywords-Piano Lesson; support; Multi-Angle recording system; visualization.

I. INTRODUCTION

This paper is part of a research project conducted at a music university in Japan, aimed at passing down the tradition of classical piano to the next generation. Previous piano studies [1] - [4] have primarily focused on beginners, aiming to record and analyze performance techniques, such as pointing out errors and playing habits. While multi-angle video recording can be achieved using multiple cameras, reviewing these recordings simultaneously requires aggregating data and editing with specialized software, making instant post-performance review challenging. Our study targets music university students, with a focus on lessons for acquiring musical expression. To master musical expression, repeated practice is necessary to understand the nuances in sound created by different playing styles. Therefore, it's crucial to instantly review one's playing technique and the resulting sound. We are developing a system that utilizes smartphones and tablets for recording performances from multiple angles. This system allows for immediate playback from specific annotated points [5], enabling performers to promptly reflect on their technique.

The remainder of this paper is organized as follows. Section II describes the multi-angle recording system being developed in this study, and Section III describes the results of two experiments. Finally, Section IV presents the conclusions and future challenges of this research.

II. SYNCHRONIZED RECORDING SYSTEM USING MULTIPLE SMARTPHONES

The architecture of our system is composed of a server-client model. On the server side, the system is implemented using the Laravel framework, while on the client side, it is developed using Vue.js. This system has been tested for operation using Chrome browsers on PCs, iOS, and Android.

A. Recording

This section describes a multi-angle recording method using three perspectives: upper body, hands, and feet, utilizing four smartphones. One smartphone is logged into the system and serves as the controller for starting and stopping recordings and capturing audio. The other smartphones are used as video cameras. Recording is synchronized with the start/stop signal from the controller device, and automatically uploaded to the server upon completion. Adding camera angles is streamlined by scanning a QR code displayed by the controller machine, which transfers user information and automatically directs to the recording standby page. The system's design allows for the addition of angles corresponding to the number of smartphones prepared. If only one smartphone is available, it can be utilized by turning on the video function on the controller device.

B. Reflection

When the user clicks on an index (score name and practice time) on the calendar, the score and the video are displayed. Figure 1 is the viewing page. One angle of the video is displayed prominently, while the remaining angles

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are displayed as thumbnails. Selecting a thumbnail switches between the enlarged display and the thumbnail display. During playback, the audio comes from the microphone recorded by the controller device, and the video displays all angles simultaneously. In the example in Figure 1, annotations are added at two different measures during the initial listening session. These annotations are also useful for reflecting simultaneously from the second time onward.

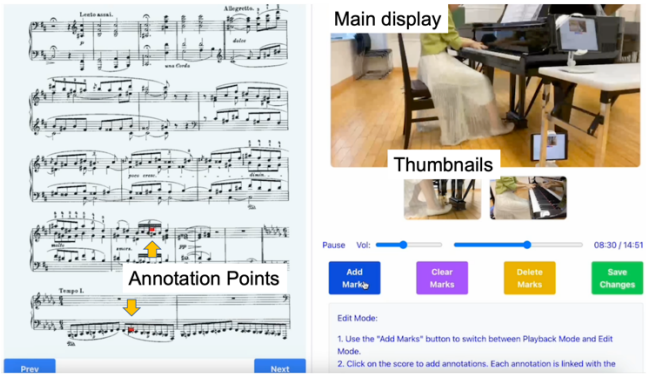

Figure 1. Example of score and video viewing page.

III. System Evaluation

A. Difference in video timestamps

The system compiles video from each device onto a server after recording ends, making it accessible to users instantly. The audio captured by the microphone was compared with the audio from three video recordings, which were not utilized during the reflection phase. The results revealed a discrepancy ranging from 0.03 to 0.29 seconds. This is the timing discrepancy between each device receiving the recording start signal from the controller and the actual commencement of recording.

B. User Reviews

Interviews were conducted with four students and one teacher to gather feedback on the system.

1) Audio Discrepancy: A notable discrepancy in audio timing, 0.29 seconds as reported by a student caused discomfort, though some students found it negligible. The teacher deemed a discrepancy as minimal as 0.03 seconds to be intolerable for educational use, emphasizing that precision within 0.01 seconds is fatal.

2) Multi-Angle Recording: Students noted its benefit for observing their full body and foot movements, which are typically not visible when only focusing on hand movements. Reviewing each angle's video separately is not practical. Having the capability to simultaneously reflect on multiple angles in a single view is highly convenient. However, the teacher highlighted the inadequacy of video for detailed foot technique analysis, noting that even with this system or standard iPhone recording, audio-video discrepancies can emerge. Specifically, the delayed auditory feedback from pedal use, as opposed to the immediate response from hand movements, underscores the necessity for improved visualization of pedal pressure and timing in such recordings.

3) Annotation Feedback: Users highly appreciated the feature for swiftly returning to annotated sections in lengthy pieces. Despite the initial effort to annotate these points, the ease of revisiting them was noted as a major benefit.

4) Suggestions for Improvement: The students suggested adding a 10-second rewind and fast-forward feature. They highlighted the need for easier navigation through small sections of the video, finding the current method of using the progress bar for minor adjustments to be less efficient and user-friendly.

IV. Conclusion And Future Work

In this study, we aimed to record piano performances in multi-angles to enable performers to check their body movements. A multi-angle recording system was developed, utilizing multiple smartphones working in tandem. The results showed that the system was effective for student self-review. However, for professional levels, like teachers, it was evident that the system requires further improvement.

Future tasks include addressing three main points: First, not only synchronizing the start of the recordings but also adjusting the playback timing of each file to eliminate discrepancies between audio and video. Second, beyond reviewing from annotated points, a feature for instant access to desired timestamps, like 10-second skips, is necessary. Third, for foot pedal usage, it was discovered that video of that angle alone is insufficient, and visualization of the force and extent of pedal engagement is required.

Acknowledgment

The present study was supported by the Japan Society for the Promotion of Science (JSPS) through KAKENHI Grant Number 21K18528.

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