

CG Animation for Piano Performance

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1 Introduction

Technologies recreating piano performance in the form of CG animation are eagerly anticipated by people working in various fields, such as content production, music education, etc. Nonetheless, much of the past research has dealt with the mechanical finger movements in piano practice support systems and performance support GUIs, etc. and there has been little research recreating the reality of finger movements. We are promoting research into the analysis and CG expression of realistic and natural piano fingering. This paper describes the following aspects of this research program: (i) measurement of piano fingering using motion capture technology, (ii) generation of a CG animation of fingering using offline/real-time rendering, and (iii) automatic generation of fingering using optimized algorithms. And finally we will introduce examples in which the fingering data created in (i) is used in TV animation.

2 Measurement of piano fingering using motion capture and offline rendering

First, we obtain the finger movements during a piano performance using motion capture technology. We attach optical markers to the joints of the fingers and measure the 3-dimensional location coordinates. Next we apply the obtained motion capture data to the CG model of the hand with 16 joints and bones. The motion of the piano keyboard is created from performed music data. By linking the notes and numbers of the MIDI to the movements of the each key prior to the motion capture photography we are able to generate keyboard movements that correspond to the MIDI data. In the offline rendering stage we produced the model of the hand and the model of the piano using CG software (Figure 1).

3 Real-time rendering and its application to music performance interface

We implemented a real time rendering program using directX based on the obtained motion capture data. Furthermore, we achieved the synchronous processing of music performance interface iFP, which works by using motion capture data, interactively obtaining the tempo and the intensity (Figure 2).

4 Automatic Generation of Optimal Fingering from a Musical Score

Aside from the researches mentioned above, we are developing a system that automatically generates an animation of a pianist playing piano from a musical score. This system is mainly composed of the function determining an optimal piano fingering and the function determining the trajectories of all control points in the bony frameworks of hands based on the fingering. We designed efficient algorithms to realize these functions from the view of the discrete and the continuous optimization theory. As a result, our system generates plausible and reasonable CG animations for the musical scores of some famous piano works.

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5 Animation Production Using Motion Capture Data

Finally, we will present an example of the use of fingering data in the production of a TV animation. “Nodame Cantabile” is a Japanese comic book primarily about the success story of a young female pianist.

We asked a professional pianist to perform the music and carried out the measurements. We attached 29 markers to each arm of the performer, who performed in time with the performance sound we had recorded earlier. To increase the precision of the data, for the motion capture we used 13 cameras and we obtained the data at 60Hz. With respect to the measured data after making corrections, hand application of the animation was carried out in the animation studio (Figure 3).

Approximately 20 cuts of 20 songs were performed. Nothing sounded wrong even with the early phrases, and fingering synchronized with the music was recreated. In addition the mechanical impression that CG animation tends to give was absent, thus preserving the quality of hand-applied animation. We can conclude that this was an example of skillful maximization of the benefits of interactions between the two technologies.

6 Conclusion

We have discussed technologies for creating animations of piano fingering. Currently, we are studying technologies for expressing the texture of the skin using GPU programming, and advanced technologies related to the automatic generation of fingering. Finally, we are aiming to construct a music and images generating system that outputs natural and emotionally rich music performances and fingering when a musical score is input into it.



Figure 1: Process of making CG animation of piano performance, and an example scene.



Figure 2: Realtime rendering of obtained motion capture data. images



Figure 3: Examples of hand-applied animation based on the data. c Tomoko Ninomiya/Kodansha Ltd./Nodame Cantabile 2 Production Committee.

7 Reference

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