

COLORING-IN PIANO: A PIANO THAT ALLOWS A PERFORMER TO CONCENTRATE ON MUSICAL EXPRESSION

Chika Oshima⁺, Yohei Miyagawa⁺ and Kazushi Nishimoto^{+}*

+ Japan Advanced Institute of Science and Technology

*PRESTO, JST

ABSTRACT

In a piano lesson, a teacher teaches a way of performance by providing indirect cues, e.g., metaphors and singing. A model performance is one of the important cues. Meanwhile, it is difficult even for the teacher to perform a very technical piece without enough practice, even if he/she had formerly performed it. However, the teacher still retains his/her knowledge for performing the piece. Accordingly, we propose "Coloring-in Piano (CiP)" to support a piano lesson. CiP frees the performers from heavy labor of accurate reproduction of described melody and miss-touches. Therefore, CiP allows them to immediately concentrate on musical expression that is essential for the performers, which facilitates the teacher to show his/her musical knowledge to the pupil. We conducted experiments to subjectively evaluate the performances with Coloring-in Piano and with a conventional piano. These results demonstrate that the performer can perform music with CiP as felicitously as with the conventional piano. Moreover, we could find that CiP can facilitate the teacher to perform even an unpracticed piece to his/her own satisfaction. Considering the experimental results, we discuss what is necessary and essential for the performers to express "indiscrete elements," e.g., "articulation," "agogik," "dynamik," and so on based on her/his individual interpretation and impressions of an opus, than the correct reproduction of the sequence of notes.

1. BACKGROUND

This paper proposes "Coloring-in Piano (CiP)," which can support a teacher's model performances in a piano lesson. The teacher has "musical knowledge" that is required to execute the series of intellectual processes involved in musical performance. Musical knowledge consists of the various elemental pieces of knowledge used to express desired timbre, dynamics, agogics, articulation, and so on. Most musical knowledge consists of so-called "tacit knowledge" ^[1] that a performer cannot describe or explain, although she/he is aware of having such knowledge. Therefore, a teacher cannot help but show her/his musical knowledge through indirect cues, e.g., model performances, singing, and metaphors ^[2]. By applying induction or abduction based on such indirect cues, a pupil, in the beginning, attempts to imitate the teacher's way of performance ^[3] and to reconstruct the teacher's musical knowledge in her/his mind. The model performances can show the teacher's performance expression

directly. However, if a pupil studies a highly technical piece that the teacher has seldom performed or never performed, the teacher may not be able to perform it perfectly without any practice. Even in that case, the teacher has "musical knowledge" to perform it.

2. AIMS

To solve these problems, we propose CiP. CiP frees a performer from accurate reproduction of melodies described in a score. Therefore, CiP allows the teacher to perform the highly technical piece without paying too much attention to making mistakes. Accordingly, the teacher becomes able to concentrate on musical expression e.g., agogics, dynamics, articulation, and so on, with CiP in the pupil's presence. Thus, CiP is expected to facilitate the transmission of the teacher's musical knowledge to the pupil.

This paper reports a comparison between performances with CiP and performances with a conventional piano by subjective evaluation from the perspectives of felicity and similarity. Additionally, we discuss the importance of conveying musical knowledge from the teacher to the pupil and the necessity of supporting the piano lesson at a section of topic areas.

3. METHOD

3.1. Coloring-in Piano (CiP)

Figure 1 shows the structure of CiP. We used a YAMAHA Silent Grand Piano C5 that outputs MIDI (Musical Instrument Digital Interface) note-on/off and pedal control messages. The piano is connected to an SGI Indy workstation that records this output data. Before performing, it is necessary to feed the sequence of pitches of a piece to be performed into the computer. The pitches are actually specified by MIDI note numbers. While performing, the computer replaces the fed note numbers with the played note numbers in order. Finally, the computer outputs the replaced note numbers and inputs them into the tone generator. Accordingly, CiP can always output correct pitch sound, even if a performer touches incorrect keys. At present, CiP can handle monophony. To compensate for miss-touches, CiP does not react to the key-down events that occur within 50 msec after the previous key-down event. On the other hand, note-on (key down) velocity, note-off (key up) velocity, and pedal messages are output as the performer plays. Therefore, it follows that the various elemental pieces of the teacher's musical knowledge are expressed as the teacher expresses them.

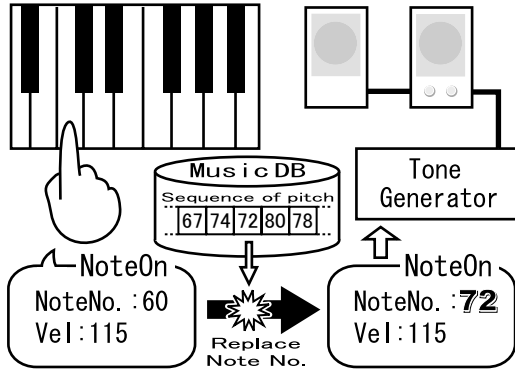


Figure 1: Structure of CiP

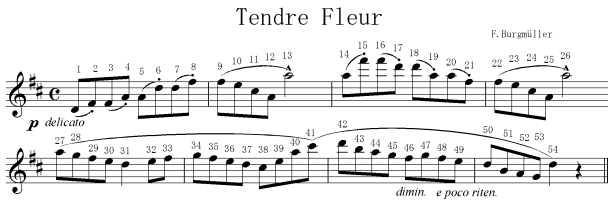


Figure 2: Bar 1st-8th of "Tendre Fleur", which is one of the 25 Leichte etuden Op. 100 by A. Burgmüller

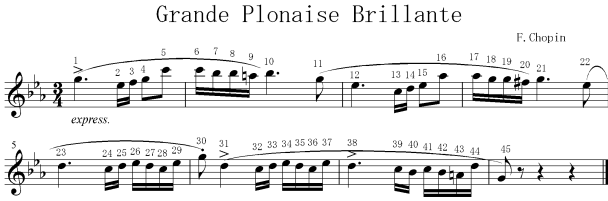


Figure 3: Bar 220-227th of "Grande Polonaise Brillante Op. 22" by F. Chopin.

3.2. Method of evaluations

Twenty experimental subjects who are student of our graduate school evaluated the performances played with the conventional piano and with CiP. They did not know this experimental condition. C. Oshima, who is one of the authors, performed parts of two pieces with the conventional piano and with CiP. She played only the melody without accompaniment. In the case of CiP, three ways of performance have been tried, e.g., using only one finger for one key performance (CiP-1), using only two fingers for two-key performance (CiP-2), and using five fingers for all-key performance (CiP-5). Here we should insist that fingering on CiP-5 is designedly changed from that on the conventional piano. One of the pieces is "Tendre Fleur," which is one of the 25 Leichte etuden Op. 100 by F. Burgmüller. We call this piece "Piece-A." The other piece is "Grande Polonaise Brillante Op. 22" by F. Chopin. We call this piece "Piece-B." Both of them are romanticism pieces and include various articulations. Figure 2 and 3 show eight bars selected from each piece. We asked the subjects to evaluate each of the performances

from the perspective felicity (1: poor performance 5: rich performance). Moreover, we asked them to evaluate the degree of resemblance between the CiP-1, 2, and 5 performances and the conventional piano performance (1: very different to 5: almost the same). We also asked them to evaluate that between the conventional piano performance and the same conventional piano performance. All of the evaluations were conducted in blind. Therefore, the subjects did not know that they compared which performances.

3.3. Analysis of performance data

Based on the performance data in MIDI format, we calculated inter-onset interval (IOI) and gap value. The IOI is obtained as follows:

$$IOI_i = t_{Non(i+1)} - t_{Non(i)}, \quad (1)$$

where IOI_i is the i -th IOI, $t_{Non(i)}$ is emitted time of the i -th note-on message $Non(i)$, and $t_{Non(i+1)}$ is emitted time of the $(i+1)$ -th note-on message $Non(i+1)$. The gap value is obtained as follows:

$$gap_i = t_{Non(i+1)} - t_{Noff(i)}, \quad (2)$$

where gap_i is the i -th gap time, $t_{Noff(i)}$ is emitted time of the i -th note-off message $Noff(i)$, and $t_{Non(i+1)}$ is emitted time of the $(i+1)$ -th note-on message $Non(i+1)$. Hence, if gap_i is positive, the performer shortened the i -th note. Additionally, we extracted the velocity values included in MIDI note-on message. The velocity of a note-on message shows the velocity of going down a key and almost corresponds to the sound level of the note.

3.4. Method of trial performances

C. Oshima tried to perform two other technical pieces on CiP-2, CiP-5 and the conventional piano. One was "Piano Concerto No.1" by F. Chopin, which she had not performed yet. We called this piece "Piece-C." The other was "Piano Concerto No.2" by F. Chopin, which she had not performed for long time. We call this piece "Piece-D."

4. RESULTS

4.1. Results of evaluation by the subjects

Table 1 shows the average evaluation values for the felicity by twenty experimental subjects. The results of a t-test indicate that the felicity of CiP-1 performance is significantly worse than that of the conventional piano performance for both of the pieces. On the other hand, the felicity of CiP-5 performance is significantly better than that of the conventional piano performance for Piece-B.

Table 2 shows the average values for resemblance between the CiP performances and the conventional piano performance or between the conventional piano performance and the same conventional piano performance. Additionally, it shows t-values that are obtained by comparing the average value of "CiP-n: conventional piano" pair to that of the "conventional piano: conventional piano" pair. The results of the t-test indicate that no significant difference in resemblance can be found between CiP-5 and the conventional piano performance for Piece-A. However, significant difference in resemblance can be found

Table 1: Average values of evaluations of felicity. Two asterisks (**) indicate a significant difference at 1%. An asterisk (*) indicates a significant difference at 5%.

Piece A			Piece B			
	conventional	CiP-1	t-value	conventional	CiP-1	t-value
1	3.30	2.20	4.82**	2.90	1.90	4.59**
	conventional	CiP-2	t-value	conventional	CiP-2	t-value
2	3.60	3.80	0.81	2.85	2.80	0.16
	conventional	CiP-5	t-value	conventional	CiP-5	t-value
3	3.55	3.65	0.49	3.20	3.65	2.65*
	conventional	conventional	t-value	conventional	conventional	t-value
4	3.55	3.50	0.37	3.65	3.75	1.00

Table 2: Average values of resemblances between CiP performances and conventional piano performance or between conventional piano performance and the conventional piano performance. Two asterisks (**) indicate a significant difference at 1%.

Piece	CiP-1:conventional	t-value
A	2.5	3.44**
	CiP-2:conventional	t-value
	2.85	4.97**
	CiP-5:conventional	t-value
	3.5	1.41
	conventional:conventional	3.90
Piece	CiP-1:conventional	t-value
B	1.85	7.44**
	CiP-2:conventional	t-value
	2.75	4.21**
	CiP-5:conventional	t-value
	2.85	6.00**
	conventional:conventional	4.05

between the other CiP performances and the conventional piano performance.

4.2. Results of performance data

The IOIs of the four ways of performances with CiP-1, CiP-2, CiP-5 and conventional piano, were almost similar for both pieces. Figure 4 shows the transition of the average gap values of the four ways of performance for Piece-B. The x-axis corresponds to the sequence number of notes of the piece indicated in Fig. 3. It is clear that the transition of the CiP-2 performance achieve positive values at the 8th and 19th notes, although CiP-5 and conventional piano performances have positive values at the 7th and 18th notes. Generally, a performer

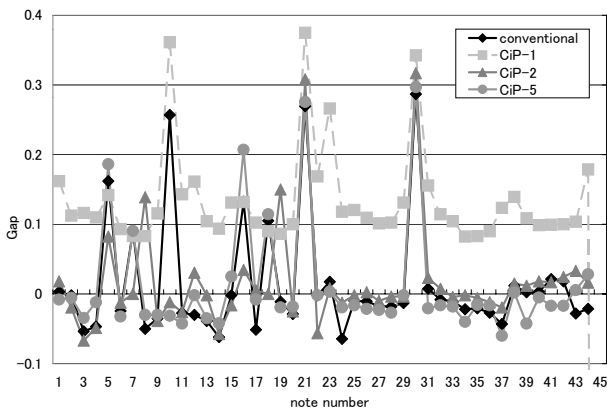


Figure 4: Transition of average gap values of the four ways of performances of Piece-B.

changes fingers when repeatedly performing the same note. However, this performer played the same notes with the same finger as with CiP-2.

Figure 5 shows the transition of the average note-on velocity values of the four ways of performances for Piece-A. The x-axis corresponds to the sequence number of notes of the piece indicated in Figs. 3. It is clear that the velocity of the CiP-2 performance decreases at the 14th note. This velocity value is 36 points smaller than that of the normal performance.

4.3. Results of trial performances

C. Oshima could perform Piece-C perfectly with CiP-5 in spite of her first trial. Concerning Piece-D, although she sometimes confused some fingering with CiP-5, she could perform it basically good enough. On the other hand, she made many mistakes with the conventional piano in playing both pieces. She felt that CiP-2 was very useful when she played technical passages, and she could perform them more smoothly. However, she could not express expression marks, e.g., staccato and articulation, as much as she would have liked with CiP-2.

5. DISCUSSION

These results demonstrate that CiP, except for CiP-1, allows the performer to felicitously perform music. Particularly, it is interesting that there is possibility that CiP-5 performance can become more felicitous than the conventional piano performance. We think this result derives from the flexibility of fingering on CiP-5. Namely, she played the technical passages with only two fingers to achieve smoothness, while she used all fingers for the other passages to achieve rich expression: using all fingers is the most natural way for her to perform the piano. Each way of playing, i.e., two-finger use or five-finger use, has both advantages and disadvantages. Therefore, we found that the pieces were expressed differently between most of the CiP performances and the conventional piano performances. Consequently, it is desirable that CiP provide all keys, as with CiP-5, and that it allows the teacher to select the ways of playing, e.g., CiP-2 or CiP-5.

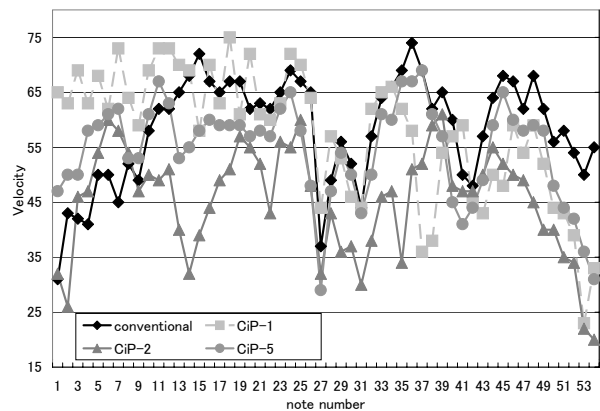


Figure 5: Transition of average note-on velocity values of the four ways of performance for Piece-A.

Conventional music consists of two kinds of elements, i.e., "discrete elements" and "indiscrete elements." The pitch of each note and the basic rhythm of the notes (i.e., time value of each note) described in the score are the discrete elements, while tempo, "articulation," "agogik," "dynamik," and so on are the indiscrete elements [4]. Although the composers had come to describe the expression marks minutely in the scores for the performers since about 1830 [5], G. Gould and N. Goodman pointed out that what is eventually described in the score are only the pitch and basic rhythm of each note [6]. Consequently, what is necessary and essential for the performers is to express indiscrete elements based on her/his individual interpretation and impressions of an opus than the correct reproduction of the sequence of notes. However, the performer is apt to concentrate on discrete elements (there are many systems that support a novice performer to operate correct keys [7][8]). CiP frees the performers from heavy labor of accurate reproduction of described melody and miss-touches. Therefore, CiP allows them to immediately concentrate on musical expression that is essential for the performers, which facilitates the teacher to show his/her musical knowledge to the pupil.

6. CONCLUSIONS

We proposed Coloring-in Piano (CiP) to support the teacher's model performance in a piano lesson. We examined the similarity between the performances with CiP and the performance with the conventional piano as well as the felicity by subjective evaluation. Moreover, the performance data were analyzed. These results indicated that CiP allows the performers to felicitously perform music. In addition, one of the authors played technically unfamiliar pieces with the CiP and the conventional piano. CiP could support performance of technical passages and the part of piece including difficult articulations by using only two fingers or/and five fingers, and the performer could expressively play pieces that she had seldom/never performed. Consequently, CiP is useful in conveying musical knowledge to the pupil.

We proposed CiP as a supporting system for piano teachers to convey the teacher's musical knowledge to pupils. CiP can be used as a supporting system (or a mere "Toy") for novices. However, if the novices desire to become able to perform the piano, we think it is the better way to practice with the conventional piano, not with CiP.

We will improve CiP so that it can be performed with both hands. In addition, we will examine the effectiveness of CiP in actual piano lessons.

7. TOPIC AREAS

A piano lesson is a process where a teacher cultivates an individual pupil's creativity in piano performance. However, it must start from an imitation of the teacher's performance.

Through observation of P. Casals's violoncello lesson, Schone [3] showed that there are two stages in a music lesson: an imitation stage and a creation stage. In the same way, Inoue [9] said that a pupil should learn various ways of performing, interpreting, and so on at first so that the pupil becomes able to contrive solutions to musical problems by her/himself. These observations suggest that a pupil should accept the ways of the teacher's performance before advancing to the next stage, where the pupil creates her/his own expression.

Many studies that examined a performer's way of playing the piano by using MIDI or equipment to record piano-key-hit have been conducted for long time. Seashore [10] showed that a performer can repeat to play a piece in the same way if he/she practiced the piece enough.

8. REFERENCES

1. Polanyi, M., *The Tacit Dimension*, Routledge & Kegan Paul Ltd., London, 1966.
2. Ikuta, K., "What is the Ability of Communication? --- beyond the language of school", *Journal of Japan Society for Fuzzy Theory and Systems*, Vol.12, No.4, pp.501-506, 2000.(in Japanese)
3. Schone, D. A., *A master class in musical performance, Educating the reflective practitioner*, Chapter eight, Jossey-bass publishers, pp.175-216, 1987.
4. Nishimoto, K., Oshima, C., Miyagawa, Y., and Shirotsuki, T., "A Musical Instrument for Facilitating Musical Expressions", *CHI2002*, Minneapolis, Minnesota, April 20-25, 2002. (to appear)
5. Kuniyasu, H., *A guide to a musical aesthetics*, Shunjusya Press, 1981. (In Japanese: This book does not have the English title. Therefore, we translated the title from Japanese.)
6. Bazzana, K., *Glenn Gould: The performer in the work*, Clarendon Press. Oxford, 1997. (In Japanese)
7. Silent ensemble grand piano EA1, YAMAHA, <http://www.yamaha.co.jp/product/pi/topics/topics.html>.
8. CASIO Web-page of Lighted Keyboards. Available at <http://www.casio.com/musicalinstruments/section.cfm?section=35>
9. Inoue, N., *A way of piano performance*, syunju publisher, 1999.(in Japanese: This book does not have the English title. Therefore, we translated the title from Japanese.)
10. Seashore, C. E., *The psychology of music*, New York: McGraw-Hill, 1938.