

Interactive musical editing system for supporting human error and offering personal preferences for an automatic piano

- Preference database for crescendo and decrescendo -

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Abstract

We have developed an automatic piano that can accurately control the motion of both the keys and the pedal, based on performance information data that a user has elaborated for the piece of music. However, this system cannot perform a new piece of music by sight, as in a simulation of a human's expressive performance, because the user must first elaborate his or her desired interpretation of a new piece of music. Therefore, we have developed a program that can memorize and use knowledge databases and the user's preferences concerning an interpretation of a piece of music.

In this paper, we describe the interactive music editing system, the pianist's analysis of preferences regarding crescendos and decrescendos, and the resulting preference database that was developed.

Key words: automatic piano, knowledge database, music interface, user's preference, computer music

1. Introduction

In recent years, with the progress of electronic technology, electronic musical instruments are developing rapidly. However, when comparing the performance of a pianist and the performance of a player piano in the present situation, the timbre and interpretation by the electronic instrument are not a good representation of the live performer. When working with an electronic piano, the user must arrange the respective tones at a given tempo, dynamic, and so on. In the case of piano music, there can be over a thousand notes in even a simple score, which means a very large amount of time is needed for editing the input.

We are attempting to develop a performance information editing support system to edit music more efficiently^{[1]~[9]}. The system has the function to change performance information automatically and the function to provide the user music knowledge and so on (see Figure 1). We structured the database to store knowledge about the musical grammar, the score, and the user's preferences^[10]. Moreover, we have developed an automatic editing system based on musical rules.

In this research, we analyzed the data of some performances to investigate pianists' performance preferences. The main object of the analysis was data about crescendos and decrescendos. We considered the parameters that would express preferences. Also, we structure of the database which stored preferences to have taken out and developed the automatic editing system^[11].

In this paper, the preference database and a developed interactive editing system are described.



Figure 1. View of the automatic piano

2. Format of Performance Information

The performance information to be edited is shown in table 1 and table 2.

The automatic piano that we have developed uses a music data type structure that is similar to MIDI. We defined performance information, dividing it into two categories, the notes and the pedals.

There are six note information parameters: the key (note), velo(velocity), gate, step, bar, and timing involved in producing a tone. The velocity is dynamics, given by the value of 1~127. The gate is the duration of the note in milliseconds. The step is the interval of time

until the next note, and it also exhibits tempo. The bar is the vertical line placed on the staff to divide the music into measures.

There are four pedal information parameters: the key (indicating the kind of pedal, “Damper” or “Shifting”), velo (the pedaling quantity), time (the duration of applying the pedal), and bar.

Table 1. The parameters of note information

| Parameter | Key | Velo | Gate | Step | Time | Bar |
|-----------|--------|-------|-------|-------|-------|-----|
| Unit | - | - | m sec | m sec | m sec | - |
| Reference | 21~108 | 1~127 | - | - | - | - |

Table 2. The parameters of pedal information

| Parameter | Key | Velo | Time | Bar |
|-----------|-----------------|-------|-------|-----|
| Unit | - | - | m sec | |
| Reference | Damper or Shift | 0~127 | - | - |

3. Editing Process with Databases

3.1 System Architecture

The structure of the system is shown in Figure 2. The user edits music via the user’s interface on the computer display, which is shown in Figure 3. Also, the user can access a database that has musical grammar, the user’s preferences, and so on. As a result, editorial work is reduced and efficient editing becomes possible.

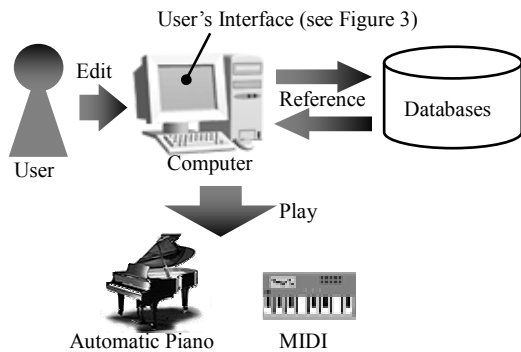


Figure 2. Structure of the editing system

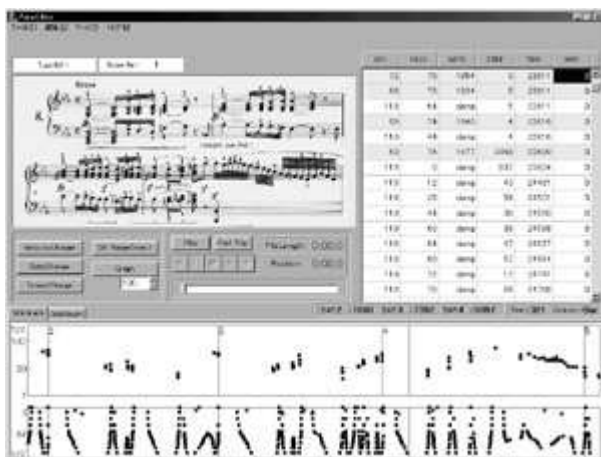


Figure 3. User’s interface on the computer display

3.2 Editing Support Process

The procedure of the editing by the system is shown in Figure 4.

Temporary music data (TMD) is the data of a piece of music without expression. For example, the TMD of a part of the first movement of Beethoven’s Sonata No. 8, which is shown in Figure 5, is shown in Figure 6. Because expression has not been added, the necessary editing of the TMD is extensive.

Therefore, the TMD is translated into original music data (OMD; This data may or may not be automatically translated using databases at the beginning of editing, and after that, the user can start to edit it. The data structure is similar to that of the TMD.) by the automatic translation of the system and is provided for the user (see Figure 7). The automatic translation program uses a Score Database, Musical Rules Database, and Preference Database (the details of the databases are described later). The user adds editing to the OMD and makes slight adjustments. When editing, the system watches over the data the user enters and music knowledge is provided. Concurrently, a phrase in the music is discovered. When the phrase with the same pattern exists in the music, it is automatically translated. After editing, the system extracts the expressions and the preferences which are peculiar to the user from the OMD. These expressions are stored in the Preference Database, which is then used when editing other music, which results in improved editorial efficiency.

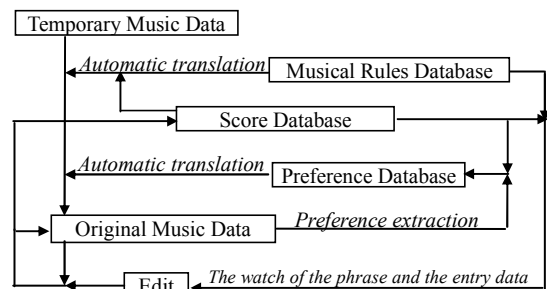


Figure 4. The editing procedure



Figure 5. Bars 1~2 of Sonata No. 8

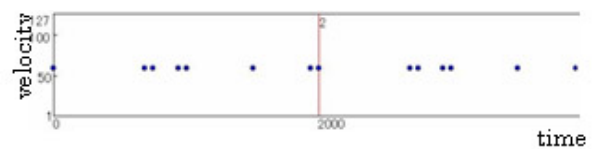


Figure 6. Temporary music data

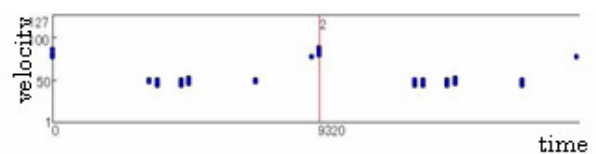


Figure 7. Original music data

3.3 Details of the Databases

3.3.1 Score Database

This database has symbols including notes and time signature rests and so on in standard musical notation. Symbols were pulled together in order of bar, and also in a bar symbol was arranged in time series.

This database is composed of three tables, the “Element table” (showing the position of the note and the composition of the chord), the “Symbol table” (showing the position of the music symbol) and the “Same table” (showing the position of the repetition of the phrase). Recently, we added “field of the note value” and “field of the pitch of melody” to the “Element table”. The overview of the Score Database is shown in Table 3.

3.3.2 Musical Rules Database

This database has the architecture of the musical grammar necessary to interpret symbols in musical notation. This database is composed of five tables containing “Dynamics marks”, “Articulation marks”, “Symbol of the Changing Dynamics or the Changing Tempo (Symbol that affects the speed of a note or the increase or decrease of the volume.)”, “Time signature” and “Tempo marks”.

Dividing a music symbol according to every usage allows efficient information processing by the system. The overview of the Musical Rules Database is shown in Table 4.

3.3.3 Preference Database

This database contains the expressions of the user's characteristic performance. The expressions show the relationship between tempo and dynamic. The basic data structures used in this database are shown in Table 5.

The “Edit” selection in the user’s interface of Figure 3 gives the user access to the parameters for expression. A user can edit his or her parameters, and the respective databases will automatically change at least one of their parameters.

The main theme of this paper is the development of that part of the Preference Database dealing with “Crescendo and Decrescendo”. We analyzed the performance data of the pianist to make it, to pick up the featuring and expressed parameter. Those analysis results are described in the following section.

3.4 Analysis of Crescendo and Decrescendo

We analyzed the pianist’s performance data in terms of crescendos and decrescendos to clarify the editorial tendency of the performance information. The graphs of the analysis results are shown in Figure 8-1 to 8-4. The horizontal axis of each graph is time (in milliseconds), and the vertical axis is velocity (1 to 127).

These graphs are a result of using the music of Beethoven's “Moonlight” piano sonata. The straight

line is the regression line of the notes with a crescendo or a decrescendo. Figure 8-1 is the result of drawing a regression line except for the note of the melody from the performance data. Figure 8-2 is the result including the note of the melody. The graph may appear confusing at first, but inspection will reveal that the graph in Figure 8-2 expresses a crescendo better than that in Figure 8-1.

The considering which was compared by presenting a sound to this actually in MIDI is included. Figures 8-3 and 8-4 can be more easily understood. The straight line with 3 colors in the graph is the notes played with the right hand, the notes played with the left hand, and the notes of the melody. Therefore, when we considered the right hand, the left hand, and the notes of melody and drew the regression line, we were able to show a linear crescendo (or decrescendo). Figure 8-4 shows that a crescendo (or decrescendo) is strongly influenced by the expression mark, the dynamics mark, and so on. In the range of our analysis, this rule applied to any case.

Based on these results, we developed a Preference Database that includes crescendos and decrescendos. An overview of the Preference Database is shown in Table 6.

Table 3. Structure of the Score Database

| Table | Summary |
|---------|---|
| Element | The position of the note, the role of the note and so on. |
| Symbol | The range where the position, the symbol of the symbol show an effect |
| Same | The position of the phrase with the same pattern |

Table 4. Structure of the Musical Rules Database

| Table | Summary | Example |
|-------------------|--|----------------------------------|
| Dynamics mark | This specifies the dynamics of the note. | <i>ff</i> , <i>mp</i> |
| Articulation mark | This changes the length and the strength of one note. | <i>staccato</i> , <i>fermata</i> |
| Changing mark | This changes the strength and the speed of the note in the specific range gradually. | rit., cresc. |
| Time signature | Defining both the number of beats in a measure and the type of note that fills one beat. | $\frac{3}{4}$ |
| Tempo mark | This specifies the tempo of the music. | Allegro. |

Table 5. Structure of the Preference Database

| Table | Summary |
|---------------|---|
| Phrase vector | The vector* of all notes of the phrase. |
| Symbol vector | The vector* of the note which had a symbol. |
| Gate rate | The ratio of Gate to Step.(Gate/Step) |

*The ingredient of the vector is Velo and Step.

Table 6. Preference Database for crescendo and decrescendo

| Record | Summary |
|-----------|--|
| ChangeNum | Kind of Symbol; Crescendo or Decrescendo |
| DyNum | Kind of the dynamics mark which is before and behind |
| PsNum | Kind of the articulation mark which is before and behind |
| Unit | Cresc and Decresc are connecting or no. |
| NoteValue | First note value of the Cresc or Decresc. |
| Slope | Slope of the regression line |
| Intercept | Intercept of the regression line |

4. Example of the Automatic Translating

4.1 Case by Musical Knowledge

The TMD of the first movement of Beethoven's Moonlight Sonata, which is shown in Figure 9, is shown in Figure 10.

Figure 11 is the OMD, which is derived from the TMD, changed automatically using the Musical Rules Database and Score Database. When observing Figures 10 and 11, OMD was changed from the TMD that Velocity was constant into the data which the expression which is certain degree of was added to.

4.2 Case by User's Preference

A result of applying the developed Preference Database for crescendo and decrescendo to the OMD (Figure 11) is shown in Figure 12, which can be seen to differ from Figure 11. With sufficient editing by such an automatic translation, the performance can eventually approach the performance of the user's preference. Eventually, the editorial efficiency, too, will improve.

5. Conclusion

We developed a Preference Database specific to a user. Specifically, it stored the preferences regarding crescendos and decrescendos. Also, we developed an interactive musical editing system that translates performance information automatically using the developed Preference Database. Then we input information about the music to the Score Database. The added information included the note value and note of melody. As a result of this improvement, the system became able to extract the user's preference regarding every melody or note value.

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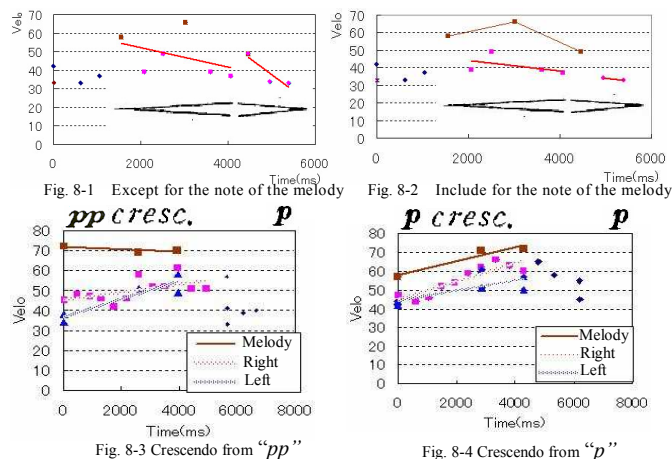


Figure 8. The results of analysis



Figure 9 Bars 16~18 of Moonlight Sonata



Figure 10. TMD



Figure 11. OMD



Figure 12. Result of applying the user's preferences