Digital Koto Music Scores

Craig Stuart Sapp*  Sachiko Deguchi†

1 Introduction

Koto music originated in the seventeenth century and was traditionally taught orally, although modern koto students usually use written scores. Over the past century, several notation systems have been developed for preserving music in the Ikuta and Yamada schools of koto playing.

This paper describes a digital representation for koto music and a printing system for typesetting scores for koto performance. The printing system was designed in particular for non-Japanese koto students, since string numbers can be displayed in Arabic numerals rather than with kanji numbers. The format of the musical data closely resembles modern koto scores[1] and can be converted into other types of data such as MIDI or standard Western musical notation.

2 Koto-Humdrum Representation

The newly designed koto data representation is based on the Humdrum Toolkit for music research[2]. The format is text-based, so the data is easy to read and edit with any text editor. The Humdrum data format is useful for representing non-standard music repertories and has been used to encode early Western music[3]. Figure 1 shows the first four measures of the traditional koto composition Rokudan no shirabe in the Koto-Humdrum format. The first column contains the koto score data, and the second column contains Kern-Humdrum data which is the standard format for representing Western music notation.

The koto representation consists of several types of symbols. The primary data components are the string numbers 1–9 plus the letters A–D used for strings 10–13. Rhythm is indicated by the symbols ’|’ and ‘.’ which closely map to the beams and augmentation dots of Western music notation. With no rhythm qualifier, the duration of a string note is a quarter note. Beam symbols (’|’) are added to indicate shorter durations, such as eighth-notes with one beam (e.g. ‘5|’), and sixteenth-notes with two beams (e.g. ‘5||’). Augmentation dots are added to lengthen string-notes, for example ‘5.’ is a dotted eighth-note duration. The rest is represented by the number 0.

Strings are usually plucked with the right hand, while the left hand changes the pitch of the string. Left-hand techniques are indicated as modifiers of the string numbers in koto scores. In the example music given in figure 1, the symbol ’o’ represents oshi tome (“push”) which is a glissando from the natural position of the string to a whole tone above the string’s natural pitch. The symbol ’s’ represents the right-hand technique sha which is similar to an arpeggio in Western music. A full specification of the Koto-Humdrum format and all ornament encoding symbols are available on the internet[4].

Since koto strings can be tuned in any arbitrary manner, a description of the tuning is necessary at the start of the data for conversion to MIDI or Western notation. The second text line in figure 1 indicates what pitch to tune each string, in this case using the Hira tuning, the primary tuning of koto music. Other symbols in the koto representation are borrowed from the Kern-Humdrum data format. For example, ’=’ is a barline, and *M4/4 is the 4/4 time signature.

The third column in the text of figure 1 represents the original orally transmitted score. Mnemonic words called kuchi-jamisen (“spoken-instrument”) were originally used to help remember the music, but today most students of the koto instead use written scores. Pitch information is not exactly specified by kuchi-jamisen, which cannot be used by itself to reproduce a complete composition.

3 Koto printing system

PostScript has been chosen to print scores from Koto-Humdrum data since graphic objects can be flexibly scaled and placed anywhere on the page with this printing language. The layout of musical elements on the page goes through three main stages as illustrated in figure 2. First, the music is spaced in an ideal manner (line A), and a break in the music is determined. The music is then justified to fit within the margins (line B), and finally objects which do not affect width are added to the music (line C).

Musical elements which influence the width of the music include string numbers, barlines, the sha ornament and rhythm augmentation dots. Musical elements which do not determine the width of the music include most ornaments

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*Stanford University, craig@ccrma.stanford.edu
†Kogyokusha College of Technology, deguchi@ccrma.stanford.edu

Figure 1: Sample music in Koto and Western notations.
Koto-Humdrum to Kern-Humdrum

Converting from Western-style notation into koto notation does not have a unique solution. Koto strings can be tuned in several ways by moving the bridges, however it is not acceptable for players to change the string tunings often. Therefore, we have defined the following two tunings for converting Western music in major keys into koto notation:

- C major: \[C_4 \ D_4 \ E_4 \ F_4 \ G_4 \ A_4 \ B_4 \ C_5 \ D_5 \ E_5 \ F_5 \ G_5 \ A_5\]
- G major: \[C_4 \ D_4 \ E_4 \ F_4 \ G_4 \ A_4 \ B_4 \ C_5 \ D_5 \ E_5 \ F_5 \ G_5 \ A_5\]

To convert music, the original key of the music must be transposed into either C or G major depending on the range of the pitches. The Krumhansl-Schmuckler pitch-profile algorithm is used to determine the original key[6]. The range of notes above and below the tonic pitch are then compared, and either C or G major is chosen as the transposed key. The Essen Folksong Collection[7] notated in the Kern-Humdrum format has been converted to the Koto-Humdrum format for performance with kotos.

5 Conclusions

Further issues are as follows: work is underway to develop a program which converts koto scores into a simulated performance in the MIDI format where the string sounding durations closely match a real koto performance. Also, we plan to convert Western classical music scores notated in Humdrum, MuseData[8], and MusicXML formats into koto performance scores. The koto pitch range is too small for Western instrumental music, therefore it will be necessary to arrange the original pieces for a more limited range.

The advantages of our system are as follows: (1) koto scores can be notated in an electronic format and can be used as a database. (2) koto scores can be easily edited and printed. (3) koto scores can be converted to the Western style and can be analyzed by using general analysis tools as well as played using MIDI. (4) Western music scores can be converted to koto scores. Many scores noted in Kern-Humdrum are available for printing as koto scores. Also, new pieces can be written in the Western style and can easily be converted into the koto score style. Some pieces converted by this system will be used in a class for introducing koto music at Stanford University.

References