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Development of a Learning Support System for playing Ryuteki in Gagaku for Beginners

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Abstract: Ryuteki is one of the wind instruments in gagaku, a traditional music of Japan since ancient times. This instrument is difficult for beginners to acquire playing skills. The best way to learn how to play ryuteki is to learn from an expert, but the opportunity is limited due to time or cost constraints in gagaku. Therefore, in this study, we developed a system that automatically judges whether the pitch and timing of the sound are correct when a beginner plays ryuteki using sound processing technology, and presents feedback on the results.

Keywords: Learning support, Ryuteki, Gagaku, Skill, Sound processing

1. Introduction

Gagaku is a traditional Japanese music that is also called “the world’s oldest orchestra”. It was introduced from Asian countries such as China and Korea around the 5th century, and it fused with Japan’s ancient songs and dances. It was completed as a unique musical form of Japan in the middle of the Heian period, 9th century, and it has been continuing.

One of the wind instruments used in gagaku is “Ryuteki”, which is the subject of this research. It is a transverse flute made of bamboo, and it has a similar structure to the flute in Western music (Left in Figure 1). Because it has a wide range of tones among the instruments used in gagaku, it has a role of decorating the main melody played by Hichiriki (oboe in Gagaku), as well as a role of playing “Ondo”, which is a solo performance by a Ryuteki player at the beginning of a piece.

There are various skills required to play Ryuteki, and some of them are common with the skills for playing flute, but there are many techniques and practice methods that are unique to gagaku, so it is difficult to learn gagaku performance skills even for those who are familiar with music. Especially, the differences from Western music can be seen in the notation of Ryuteki and “shoka”, which is one of the practice methods of gagaku. The notation of Ryuteki is very different from the staff notation that is often used in Western music. It has shoka written in katakana vertically in the center, and fingering written in kanji vertically on the left side (Right in Figure 1).

Shoka is a practice method of singing the melody of a piece out loud while tapping the beat with hands and knees, without using a score. By doing this, one can grasp the flow of the piece and learn how to breathe and play in that piece. Gagaku pieces are difficult to understand the flow by just looking at the score, and to be able to play them, one has to not only read the score, but also understand the flow and playing style that are not written in the score by singing shoka.

One can only practice playing with an instrument after being able to sing shoka, so there are many things that are necessary to be able to play a piece, and it can be said that it is difficult for beginners to learn how to play.

In order to learn the music of gagaku, one must grasp the flow of the music using singing and other methods, and therefore it is essential to practice under the guidance of an expert. However, currently, beginners have limited opportunities to receive guidance from instructors,

and even if they can receive guidance once, there is often a long period of time before they can receive guidance again. Even if they practice on their own during that time, it is difficult for beginners to judge whether they are playing well or not due to the characteristics of gagaku music, and therefore it is difficult for them to practice satisfactorily and efficiently improve their performance skills.

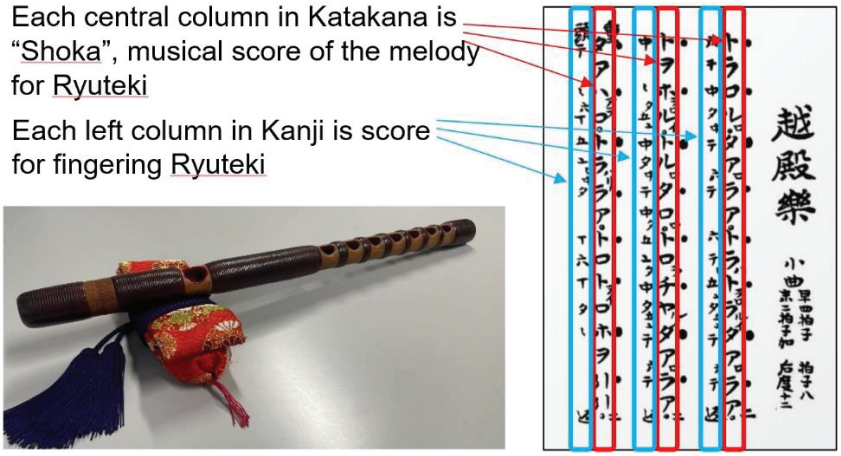

Figure 1. Ryuteki.and score (Ryuteki (left) and score for Ryuteki (right))

2. Research objective

It is very difficult for beginners to practice on their own and acquire gagaku performance skills. Therefore, in this research, the learners are beginners who have acquired some knowledge about Ryuteki (a type of flute used in gagaku) and the music they want to practice, however, have difficulty performing the music with Ryuteki. The purpose of this research is to design and develop a learning support system that can help beginners judge whether they are playing correctly or not and acquire performance skills even when they practice on their own without the help of a teacher.

Specifically, we developed a system that uses audio processing technology to judge whether the pitch and timing of the performance match the musical score, and provide feedback on the results. The goal of this system is to enable beginners to judge whether they are playing “Hyojo Etenraku”, a piece that beginners often encounter first as an example of gagaku music, correctly or not on their own, and to improve their own performance by using this system.

3. Related work

As previous research on learning support systems for musical instrument performance, Takekawa et al. developed a system that uses piano fingering recognition technology to check the performer’s fingering in real time, and provides intuitive information on fingering accuracy, performance accuracy, fingering information, and keystroke information. They are necessary for performance, to enhance keystroke position and fingering proficiency in the initial stage of performance (Yoshinari Takegawa et al. 2011).

Kikukawa et al. developed a learning support system that can measure the position and angle of the bow during the performance of bowed string instruments such as erhu using a magnetic position sensor, diagnose the movement of the bow in real time, and enable beginners to acquire performance skills for bowed string instruments (Fumitaka Kikukawa, Masato Soga et al. 2014).

These studies target instruments such as piano and erhu that are played by hand or arm movements, but Ryuteki is a wind instrument that produces sound by blowing air into it internally, so it is not possible to evaluate whether it is producing correct sound or not by measuring body movements as in previous studies. Therefore, in this study, we decided to

use audio processing technology as a means of evaluating performance for wind instruments by directly evaluating the sound produced.

4. Prototype system

This system is designed for learners who have learned about the music from an instructor and want to practice on their own, so it is desirable that learners have some prior knowledge of Ryuteki performance and how to read the musical score of “Hyojo Etenraku”. We will explain how to use the system as follows.

4.1 Selecting the score to play

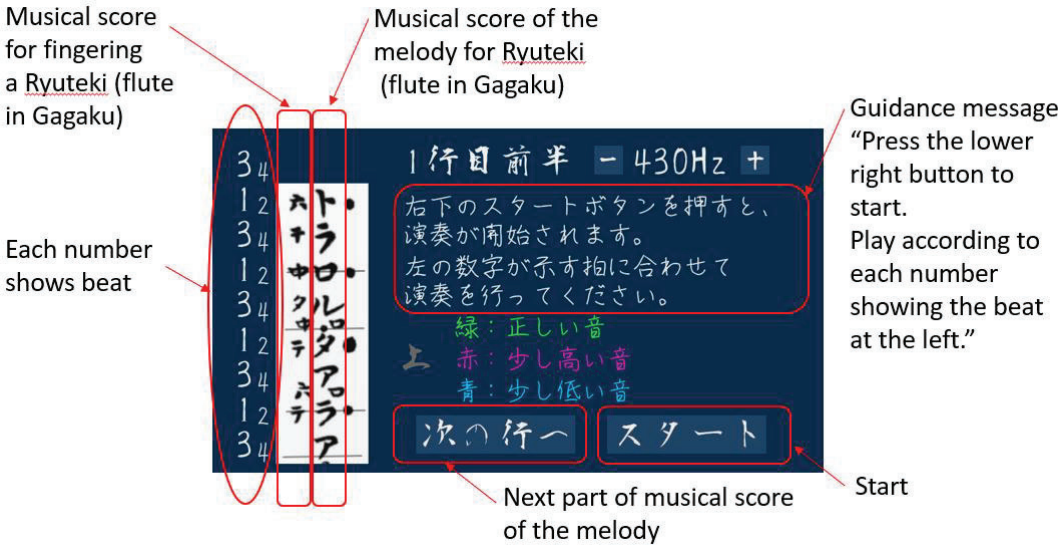

Figure 2. Score selection screen before performance.

When a learner starts the system, a screen like Figure 2 will appear. On the left side of the screen, part of the musical score of “Hyojo Etenraku” is displayed, and by clicking on “Next part of musical score” at the bottom of the screen, the learner can select the score he/she wants to evaluate by displaying it. The frequency in the upper right shows the frequency that is currently used as the standard for judging the sound, and the learner can change the standard frequency by 1Hz in the range of 400Hz to 460Hz by clicking on the “+” and “-” buttons on the left and right. The color indicates whether the sound is not sounding (gray), in tune (green), slightly high (red), or slightly low (blue) within that scale, so the learner can check his/her own sound and tune it before actually evaluating his/her performance.

4.2 Playing the score

To practice playing a score the learner wants to play, he/she selects the score and presses “Start” to switch to the mode where he/she can play and evaluate the score. In this mode, the numbers on the left side of the screen change color from gray to white in order from top to bottom. These numbers indicate the beats of the score, and the first 3/4 are set up to prepare for playing before entering the performance, and the learner is supposed to prepare for playing during these two beats and start playing according to the score from the next beat.

The gagaku score has a length of two beats per large character of katakana singing (the part that says “Toraro…” in this score), and the learner is supposed to play along with the numbers that light up in order at regular intervals. Figure 3 shows the screen display during performance, and in this figure, it is playing the first 4th beat after starting the performance. Also, if the learner feels that his/her performance is not going well, he/she can stop playing by pressing the stop button at the bottom right of the screen, go back to the scene where he/she selects the original score, and press start again to start playing from scratch.

While the learner is playing, the system internally processes information about the sound that is currently being played and stores it in an array. This array consists of three types of arrays: an array that stores information on the scale (array 1), an array that stores the frequency deviation between the correct sound and the sound being played for that scale (array 2), and an array that stores how many seconds after pressing the start button this sound was played (array 3), and information on sound is stored in an array.

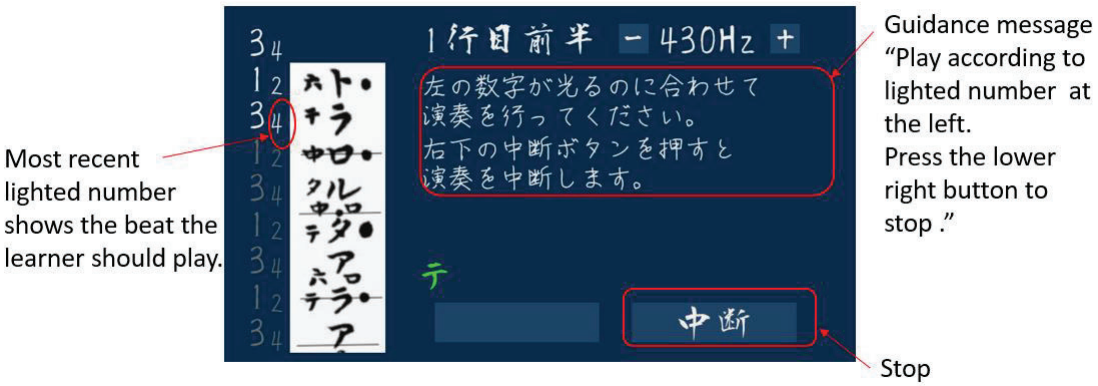

Figure 3. Screen during performance

4.3 Evaluation of performance

When the learner finishes playing until the last beat, the system compares the three arrays recorded during the performance with the score data and judges whether the scale matches for each beat on the score and whether there is any pitch deviation, and presents the results as feedback. Figure 4 shows an example of the screen display when giving feedback on the evaluation of performance. In this figure, it can be seen that the correct sound is produced during the first three beats, but the fourth beat is slightly high, and from there, either the sound is wrong for three beats, or the timing of switching or starting or ending the sound is off.

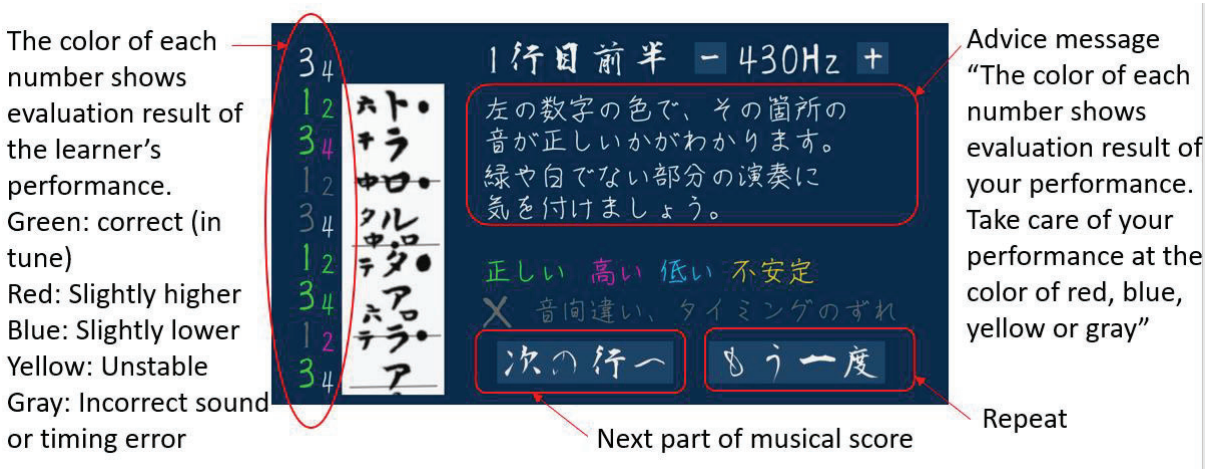

Figure 4. Screen for displaying results after performance

After checking the evaluation, if the learner is not satisfied with his/her performance, he/she can press the "Repeat" button to redo the performance of the same score, or if he/she feels that he/she has practiced enough, he/she can press the "Next part of musical score" button to practice the continuation of the score.

In this way, by checking from the evaluation of performance, he/she can find out which parts are easy to make mistakes or deviate in sound, and find out what he/she needs to improve in his/her performance, and by repeating practice, he/she can deepen his/her understanding of the music and practice to be able to play well. This is a system that allows him/her to practice to be able to play well.

5. Evaluation Experiment

The purpose of the experiment using this system was to investigate, using a questionnaire, whether beginners, who are the target of this study, can expect to improve their performance of “Hyojo Etenraku” by practicing with the proposed method, and whether the evaluation of Gagaku performance by the proposed method is useful for learning Gagaku. In addition, we also asked for answers on improvement points and functions that they want us to add to this system for future research.

The subjects who cooperated in the experiment were four people (two men and two women) who had experience playing Ryuteki. Of the four subjects, two were beginners, one was an expert who had performed in concerts and other events, and the remaining one was an instructor who taught Ryuteki.

In this experiment, we explained how to use the system and that it was a system built assuming that beginners would practice by themselves. We asked them to practice playing for about 10 minutes using the system. After that, we asked them to answer a questionnaire on whether they expected to improve their Ryuteki performance by using this system

5.1 Evaluation of usefulness of the system

To evaluate the performance and functionality of the system, we conducted a questionnaire with four questions using a five-point scale. The questions and the results are shown in Table 1. The results are indicated by average points of five-point scale.

Table 1. *Questions and results on usefulness of the system*

No.	Question sentence	Average point
(1)	I understood which parts I played well through the system.	3.75
(2)	I understood which parts I was weak at through the system.	4.25
(3)	I felt that I could expect to improve my performance by using the system.	4.25
(4)	I felt that the method of evaluating by pitch in this study was useful for learning Gagaku.	4.25

5.2 Free comments

In parallel with the multiple-choice questions, we asked for opinions on improvement points and other things that they wanted us to incorporate in a free-writing format. A summary of the answers is as follows.

- I want them to put in a sound at the timing when the beat changes.
- I want a little more time between pressing start and starting to play.
- I felt that the judgment of pitch and tempo was too strict.
- I want them to evaluate my performance not only by the color of the numbers but also by words.
- It would be interesting to show a message by the system with a chat bot.
- I don't know if I can match with others in an ensemble, so I felt it would be nice if what I played was recorded and I could play it back and get feedback later.
- I felt that if I eliminated the Gagaku-like quality from my performance, I could get a higher score.

5.3 Discussion

5.3.1 Discussion on the usefulness of the system

From the results of the questionnaire from question number (1) to (3), it was found that by using this system, they were able to evaluate their performance, which they could not judge

when they practiced alone before, and that they expected to improve their performance. Also, since we obtained a high evaluation for question number (4), we recognize that we have obtained agreement for the method of evaluating Ryuteki performance based on pitch and timing.

5.3.2 improvements of the system

In the free comments, some users expressed their wish to have a sound cue at the timing when the beat changes, and to have a little more time between pressing the start button and starting the performance, as they felt they could not perform well in the scenario of playing. In actual gagaku ensemble, there is no conductor who keeps the beat, so players have to catch the flow of the beat by themselves, and in this system, we did not play a sound at the beat timing to create a similar situation. However, considering the opinions of the experimental results, and also considering that this system was designed with the purpose of enabling self-practice, we realized that we need to design it with more user-friendliness and playability.

6. Conclusion

In this study, we developed a prototype system of learning support for playing Ryuteki for self-learning. We evaluated the system, and we got the results that the system can support for learning Ryuteki. However, we also got opinions which tell some points to be improved. We also think the number of participants of the evaluation is only a few. We would like to increase the number of participants in future.

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