Suiview: A Web-based Application that Enables Users to Practice Wind Instrument Performance*

Misato Watanabe[1], Yosuke Onoue[1], Aiko Uemura[1], and Tetsuro Kitahara[1]

Nihon University, Tokyo, Japan
chmi19013@g.nihon-u.ac.jp, {onoue.yousuke, uemura.aiko, kitahara.tetsurou}@nihon-u.ac.jp

Abstract. This paper presents a web-based application that enables users to check the stability of the pitches, intensities, and timbres of the sounds they play. Amateur musicians have opportunities to play wind instruments, at a brass-band club at school. To make sounds with the *stable* pitches, intensities, and timbres, players have to carefully control the shapes of their mouth and lips, the strength of the breath, and their vibration. But this is difficult for most amateur musicians, who rely on expert players to check whether they are appropriate and advise them how to improve them. To solve this problem, we have been developing a web-based application to enable amateur musicians to check whether the pitches, intensities, and timbres of their sounds are stable without help from an expert player (https://suiview.vdslab.jp/). In this paper, we describe its basic system design, the current implementation, and preliminary results of its trial use.

Keywords: Wind instrument, Musical practice, Stability, Web application

1 Introduction

Wind instruments are popular among amateur musicians. They are indispensable in brass-band clubs at junior high school and/or high school, and many people enjoy playing a wind instrument as a hobby. However, playing a wind instrument is not easy. To produce sounds with *stable* pitches, intensities, and timbres, players have to carefully control the shapes of their mouth and lips, the strength of the breath, and their vibration.

One problem in learning a wind instrument is a lack of appropriate instructors. In the case of the above-mentioned brass-band clubs at school, the responsible teacher at the club might not be a wind instrument expert. At such clubs, it is often common for novice-level players to teach freshman players. Also, there are fewer music schools that teach wind instruments than the piano.

Wind instrument performances have been investigated from different points of view such as acoustic, psychological, and physiological ones. Brown [1] investigated acoustic features for automatic identification of woodwind instrument sounds. Hirano et al. [3] analyzed muscular activity and related skin movement during French horn performances. Micheal [5] examined the effects of self-listening and self-evaluation in the context of woodwind and/or brass practice by junior high school instrumentalists, and found that self-evaluation was important for improving the instrument.

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More recently, there have been attempts to develop systems that allow users to easily understand how their performances are good from visual feedback or computational assessment. Pati et al. [7] applied deep neural networks to automatic assessment of student musical performances. Giraldo et al. [2] developed a system that analyzes sound quality of violin performances and provides visual feedback to users in real time. Knight et al. [4] developed a visual feedback system of musical ensemble focusing on phrase articulation and dynamics. Morishita et al. [6] developed a system that gives novice practitioners (especially children) visual feedback of acoustic features in long-tone training of wind instruments. These systems have been aiming at a goal close to ours, but most of them are not designed to enable anyone to easily check his/her performances on his/her smartphone and/or tablet.

In this paper, we present a web-based application for practicing playing wind instruments by themselves. The important is to give users objective feedback. Because its target users are novice players, we consider that sounds should be stable, in other words, sounds should keep a close pitch, intensity, and timbre from the beginning to the end. Our app. analyzes the pitch, intensity, and timbre of sounds recorded on the app, evaluates their stability, and gives visual feedback to the user. It also provides a function that enables the user's teacher to give comments to the recorded sounds.

2 Basic Design and Functions

Our app aims to provide wind instrument practicers with useful information about the sounds performed by them. For novice-level players, as discussed in the Introduction, acquiring skills for sounding stably is important. Therefore, one of the important functions of our app. is therefore to visualize the stability of the acoustic characteristics (i.e., pitches, intensities, and timbres) of the sounds performed by the user.

Recognizing how well the user is incrementally improving such stability day by day is also important. Therefore, we implement a function for visualizing recording-by-recording variations in the stability of the pitches, intensities, and timbres as well as visualizing the acoustic characteristics of each recording.

Also, we implement a *teacher-to-student comment* function. Although objective visualization is useful for novice players, subjective evaluation and comments by their teacher is also important. By linking a teacher-mode user to student-mode users, the teacher-mode users can listen to the recordings of the linked student-mode users and give them his/her evaluations and comments.

2.1 Recording

Once the user opens and logs into our app., he/she can select what to play from a *long tone*, a *scale*, and an *arpeggio* (Fig. 1). The scores displayed are shown in Fig. 2. After selecting one from these three scores, the user starts recording his/her performance with a sampling rate of 48 kHz (Fig. 3). Recorded sounds are automatically stored on our web server with some metadata such as the user ID, and the recording date.

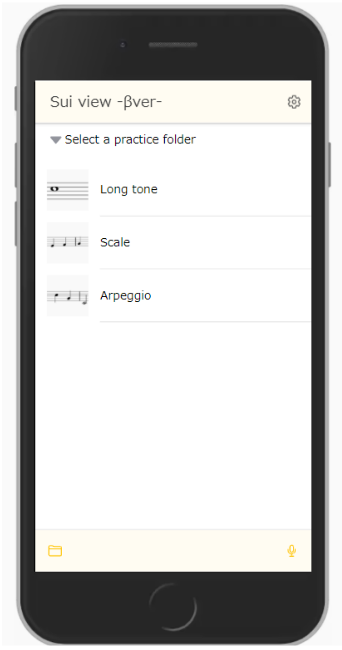
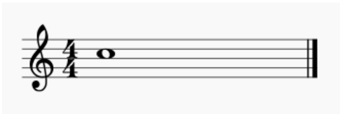


Fig. 1. Screen for selecting what to play



(a) Score for a long tone

(b) Score for a scale

(c) Score for an arpeggio

Fig. 2. Three scores currently supported by our app.

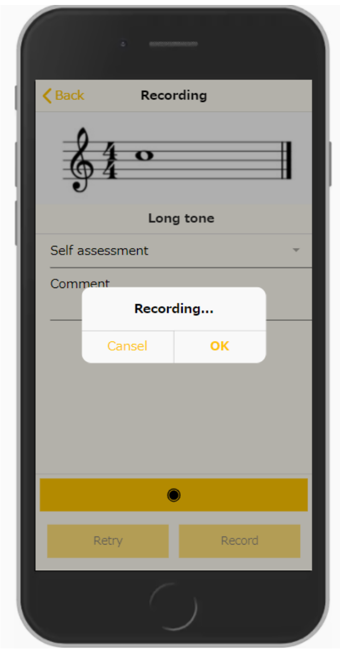


Fig. 3. Screen for recording a sound

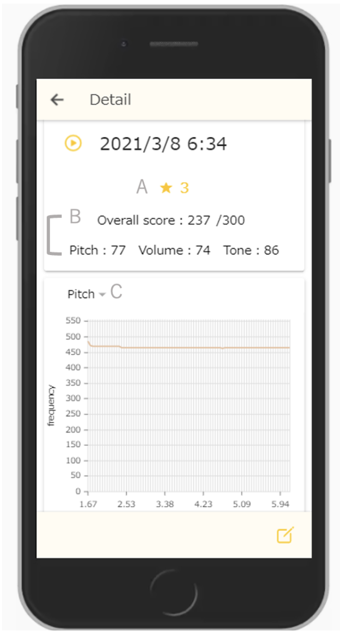
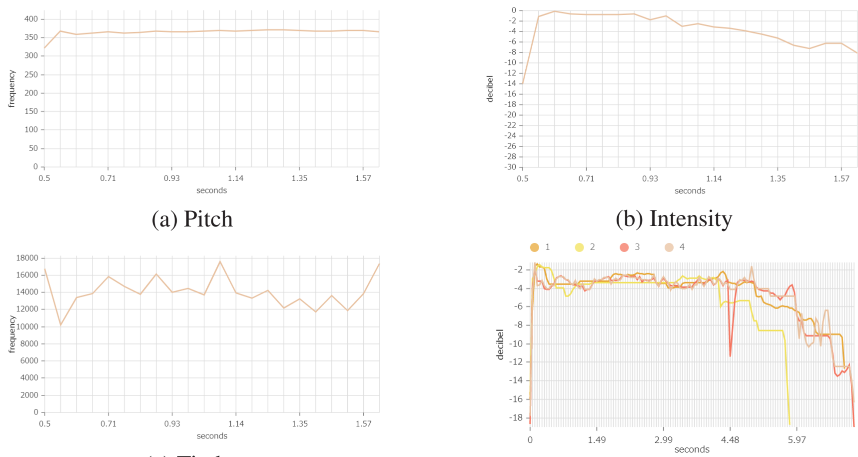


Fig. 4. Example of analysis results (A: self assessment, B: stability scores, C: chart)



(a) Pitch (b) Intensity

(c) Timbre (d) Intensities for multiple sounds

Fig. 5. Examples of visualization of acoustic features of recorded sounds

2.2 Visualizing the acoustic characteristics

Once a recording is stored on the webserver, its acoustic analysis starts. The fundamental frequency (F0), amplitude, and spectral roll-off are extracted with a 512-point shift from the recorded sound. We use Librosa (https://librosa.org/) for extracting these features. Next, these features are plotted on the screen, as shown in Fig. 5 (a) to (c). Features for multiple sounds can be plotted on the same screen, as shown in Fig. 5 (d).

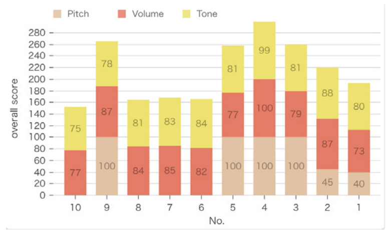
2.3 Visualizing the recording-by-recording variations in the stability

The stability of the pitch (F0), intensity (amplitude), and timbre (spectral roll-off) is calculated for each recording. The stability is defined based on the temporal standard deviation of each feature. Let $\sigma_{\mathrm{F0}}, \sigma_{\mathrm{Amp}}, \sigma_{\mathrm{Sp}}$ represent the temporal standard deviations for the F0, amplitude, and spectral roll-off, respectively. Then, their stability s_i ($i \in \{\mathrm{F0}, \mathrm{Amp}, \mathrm{Sp}\}$) is defined as $s_i = 100 \exp(-\sigma_i / a_i)$, where a_i are pre-defined constants ($a_{\mathrm{F0}} = 4, a_{\mathrm{Amp}} = 70, a_{\mathrm{Sp}} = 1500$). Thus s_i has a value between 0 to 100.

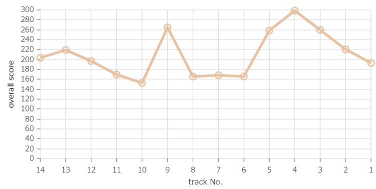
The stability is visualized in two ways to enable the user to check the stability for multiple recordings at a glance (Fig. 6). One is a stacked bar chart that represents the stability of each of the pitch, intensity, and timbre (Fig. 6 (a)). The other is a line chart that represents overall stability scores (Fig. 6 (b)).

2.4 Teacher-to-student comment

Logging in with the teacher mode, the user can listen to sounds recorded by the linked student-mode users and check the visualization of their acoustic features and stability scores. Also, using the teacher-mode, the user can write comments. The comments are automatically sent to the corresponding student-mode user.



(a) Stacked bar chart (for each stability)



(b) Line chart (for total stability score)

Fig. 6. Examples of visualization of Recording-by-recording stability variations

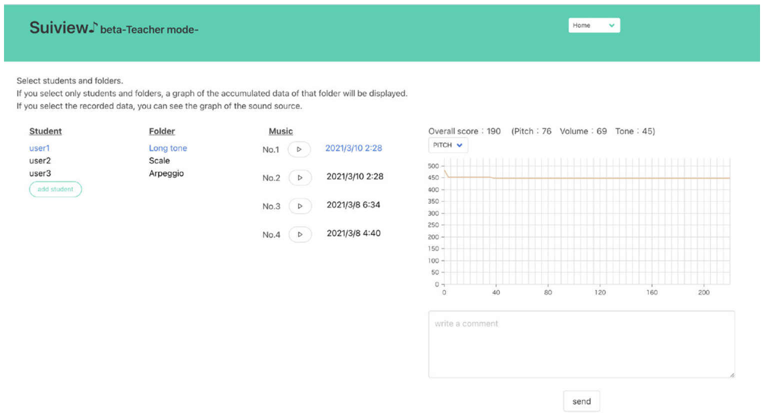


Fig. 7. Screen for the teacher mode

3 Trial Use

Three participants used our app for a preliminary evaluation of the effectiveness of the app. Out of the three participants, one (P 1) was an active player with an intermediate-to-advanced level while the other two (P 2 and P 3) were novices, though they had experience in playing instruments in the past.

Logging in with the student mode, the participants played a long tone, a scale, and an arpeggio on the clarinet several times and recorded them on our app. They saw the visualization of their sounds made by our app. and were asked to answer the following questions on a four-level scale (4: agree, 1: disagree):

Q1 Do you think this app helps you produce stable sounds?
Q2 Did you get useful information from the visualization?
Q3 Are the stability scores close enough to your own impression?

The results, listed in Table 1, imply that the participants comparatively highly evaluated our app. In fact, the two novice-level participants gave us comments such as:

– By listening alone, it was difficult to find what to improve to produce stable sounds.

Table 1. Results of the preliminary questionnaire (1 to 4)

	P 1	P 2	P 3
[Q1] Do you think this app helps you produce stable sounds?	3	4	3
[Q2] Did you get useful information from the visualization?	2	4	4
[Q3] Are the stability scores close enough to your own impression?	2	4	4

– With graphical visualization , novice-level players could find what to improve.
– Line charts were easy to grasp which were good and which were not.

On the other hand, one participant answered that he/she could not understand what each graph means. More intuitive visualization should be explored. We also received an opinion that they wanted to see the analysis for sounds given by professional players.

4 Conclusion

In this paper, we presented a web-based application that enables users to recognize the stability of wind instrument sounds played by them by visualizing their acoustic features and stability scores. Once the user records his/her wind instrument sounds on the app, their acoustic features including the pitches, intensities, and timbres are analyzed as well as their stability is evaluated. Three participants in a preliminary experiment gave us comments that the visualization was useful to produce stable sounds.

Although we focused on the stability of pitches, intensities, and timbres, more complex expressions such as detailed dynamics would be important for more advanced players. We will extend the app to support such advanced level players' practice as well as systematic evaluation of our app.

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