An Intelligent Piano Teaching System and Method Based on a Cloud Platform

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Abstract. With the progressive development of the 'Internet+' trend and the elevation of artificial intelligence to a national strategy, the use of new Internet cloud technologies and hardware and software technologies such as computers to serve music dissemination and music education has become an inevitable trend. In this wave, a large number of software and hardware systems and new teaching platforms have emerged over the years for piano education, which is an important area of popular music education. In the whole platform of intelligent piano teaching, the main aspects include hardware construction methods, software design methods, music presentation forms, teaching methods, etc. Based on the currently available technologies and theories, different methods have different characteristics in the whole teaching. This paper is based on a study of intelligent piano teaching systems on a cloud platform, and in this regard hopes to make such approaches better for new models of music education and to provide references for the transformation of other music disciplines on the Internet.

Keywords: Intelligent piano · Teaching software · Implementation methods

1 Introduction

Today, as the East meets the West, the piano has found its way into millions of homes. Its beautiful tone and rich expressiveness are loved by the Chinese public. The art of performing the piano has developed to a relatively high level and the playing method has become more scientific. In recent years, there has been a proliferation of smart piano concepts and products, a form that has brought about some influence and changes in piano teaching, especially in this wave of new computer software, internet and electronic circuitry as the main means of implementation of the system, which has brought about changes in all aspects of piano teaching, from the structure of the instrument, to the content, to the teaching methods and practice methods. Regardless of the current results, at least this change represents an exploration of traditional music teaching models in a new way of thinking, and we have reason to believe that this exploration is bound to provide some basis for future musical development [1].

The research and development process of this new approach requires the participation of researchers from several fields, such as piano repair, piano performance, piano

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pedagogy, digital audio production, multimedia production and internet software development, so the current design of this type of approach is relatively complex and there is much room for improvement in the currently available implementations. This paper is based on a study of an intelligent piano teaching system on a cloud platform, and in this regard hopes to make this type of approach better for the new music education model, so that this new approach can be better and more appropriately applied to piano teaching.

2 The Current Situation of Piano Teaching

2.1 Students are Passive Learners and Rely Heavily on the Teacher to Teach Them

The piano teaching has not yet left the track of the teacher-apprentice system, one-to-one, hand-to-hand teaching, where knowledge is transmitted orally by the teacher, and the students' knowledge is largely limited by the teacher's level. Foreign education emphasises active learning on the basis of the student's own initiative. The professor plays a guiding role. Students seek advice from the teacher, who is not responsible for their learning. In our case, teachers have a high degree of responsibility and always want to make every student a qualified person.

2.2 The Emphasis is on the Transmission of Knowledge from the Teacher to the Neglect of Cultivated Knowledge

There are two sources of knowledge: one is the direct transmission from the teacher and the other is indirect learning through books. As the piano is a highly technical instrument, students have to spend a lot of time practising technique and mastering literature, which makes it particularly easy to neglect cultivated knowledge. It is therefore important to note that in our teaching we also focus on direct teaching and neglect to direct students to the books. It is very important to ask for advice from books, because they contain the experiences and lessons of those who have gone before us and can prevent us from taking a wrong turn. It is said that Cortol taught his students to hand in a piece of background material on the author and the work before learning a new piece, forcing them to do their studies. In foreign countries, the library is the base of study for students, but in our case, how much material of academic value lies asleep on the shelves for a long time and is rarely asked for, how much audio material is underused, and some students rarely even listen to concerts other than piano [2]. The Japanese have progressed rapidly because they have done a lot of translation and research, and information flows. Now Taiwan and Hong Kong are also ahead of us in academic research. Our students' weaknesses in musical performance are inseparable from their poor knowledge and poor musicianship.

2.3 Theoretical Education About the Basic Concepts and Fundamentals of Piano Playing Should be Emphasized in Teaching

We have to repeat the same words in almost every lesson (e.g. relaxation, natural weight, tone, pedal, rhythm, etc.), and teachers are indeed very tired, but many students have been learning piano for years, but they still haven't figured out what playing piano is all about. The reason for this is that the specific instruction and perceptual understanding in teaching does not rise to a rational level and some basic concepts are not yet established in the student's head, so they often learn blindly and lack awareness, and their learning efficiency will not be high. Therefore, I wonder what kind of foundation we should give to our students in the process of learning the piano, just technical training and learning a lot of piano literature? No. Rather, it should be a study of various teaching materials to establish the basic concepts of the art of piano playing, to acquire some basic knowledge of the rules, to develop a scientific approach to learning and to train practical working skills. The foundation should be interpreted in a broad sense, including playing skills, learning methods and musical understanding. In the case of vocal issues, the concept of sound is closely linked to the method of playing and touching the keys. Compared with the best international players, there is still a considerable gap between our voicing, which is hard, does not travel far, does not have a large range of forces, does not have many variations in levels, and is not beautiful enough. The reason for this is that in our training we have placed more emphasis on the solidity of the sound and the granularity of the fingers, so that there is not enough variety in the touch of the keys and very little training in legato Jegeropp etc. The first thing to do is to have an imagination for the beauty of the sound in order to find the right way to play it. The theory of relaxation and control, the use of natural weight, is not new to us, but in practice there are still many problems that affect the penetration and softness of the sound. Music is an art of sound, and in order to play with charm, one must work hard on the sound, which is one of the major trends in the world. It is therefore important that students are given the correct concept of the beautiful voice and the playing methods associated with it. Many students never understand that, in the final analysis, the support and control of the fingertips is the most important thing in terms of relaxation.

3 Teaching Software Implementation of Intelligent Piano Based on Cloud Platform

3.1 About the Music Score

The first thing to be solved in a cloud-based intelligent piano teaching software system is the display of the score and the accompanying synchronous playback, etc. In this case we first need a digital score made by computer music edition technology, and then develop the corresponding analysis and reproduction technology based on such a score, in order to basically meet the teaching needs of intelligent pianos.

Since the 1980s, with the development of the personal computer, the traditional computer music notation was gradually replaced by computer music notation, especially with software such as Sibelius, MuseScore and Finale, which made it possible to enter complex scores into the software and to display and play them instantly, and to extract scores, etc. In addition, open-source libraries such as LilyPond, which follows the GNU protocol, support the input of scores as text. Other libraries such as Vexflow (Java Scrip library), Verovio (JavaScript and Python library), Guido Engine (C++ library) etc. also have their own unique features. This score system is also closely related to the related music evaluation systems, music reproduction, and score display systems, which have been a research challenge for a long time, especially for complex scores [3].

While all of the above-mentioned software and tools can be used as platforms for the production of digital scores, the most common and suitable common interchange format for scores is MusicXML, an open XML-based music notation file format for music interchange and music distribution.MusicXML aims to create a common general Western music notation format. Compared to MIDI, MusicXML allows for the recording of richer information such as music notation, as shown in Fig. 1. This is why MusicXML has been considered in recent years to be one of the most popular common formats for the exchange of content. Although other common file formats are being developed, standards and formats that allow musicians to easily exchange music on the Internet, MusicXML is still the most respected format.

Fig. 1. MusicXML score and message correspondence diagram

3.2 About Playback

Unlike traditional scores, digital scores have the advantage that they can be played back, synchronising the accompaniment of the piece or the sound of other voices while the score is being played. The playback speed can also be adjusted according to the teaching scenario. This makes it necessary to use the relevant technical means to play the score. There are also two ways of playing the score and the accompaniment, mainly through MIDI and audio playback.

This is due to the different operating systems and platforms (computers or mobile devices). There are also differences in performance. The MIDI playback method is firstly due to the size of the MIDI file, which allows for significant savings in storage space or data traffic. Secondly, because of the ease of editing MIDI files, it is possible to change their speed without compromising on sound quality. However, as we all know, MIDI files are not audible per se and we need to prepare the appropriate software sound source to work with them, but the methods and problems encountered in implementing audio playback vary from platform to platform, operating system to operating system and programming language to programming language, making it somewhat more difficult for the programmer.

The advantage of using audio for playback is that you don't have to provide a source, and you can also use real instrument recordings in the production of the music, which in theory gives a better reproduction and acoustic quality. Usually the audio will be in the usual wav, mp3 etc. formats and will take up much more space or traffic than a MIDI file. In addition, the sound quality is significantly reduced when the audio is subjected to some variable speed, and there is a delay in playback in some operating systems and programs, which does not facilitate synchronisation of display and playback.

3.3 On Error Correction and Scoring Mechanisms

The ultimate point of intelligent piano teaching system is the ability to automatically correct and score errors according to the input of real-time playing signals and digital music information.

The three elements of sound, including pitch, intensity and timbre, together with time, make up the four elements, which are synchronised to the position of the keys, the strength of the keys, the timing of their press and the timing of their lift. As the tone is mainly influenced by the material and construction of the piano itself, it is largely ignored in the evaluation process of intelligent pianos, and the core points become the above four. The start time, point and lift point of the keys are used to calculate the time value of each note, while the rhythm of the player is judged by the time point of the key presses, and the position of the buttons determines the pitch accuracy of the playing. In summary, the main points of judgement in an intelligent piano are accuracy, intensity, rhythm and timing. Accuracy can be judged in four categories: left-handed unison and left-handed chord, right-handed unison and right-handed chord, but in practice these can be combined into two categories, unison and polyphony, as the system does not distinguish between left- and right-handed presses [4].

At the same time, from another point of view the judging mechanism can be divided into three cases: missed notes, multiple notes and misplayed notes. In all three cases, it is theoretically necessary to first obtain the correct pitch and number of tones to be played at the current point in time from the digital score, and at the same time to obtain the pitch and number of tones being played through the hardware system of the intelligent piano, and to compare this information, firstly, according to the number, whether the current situation is one of missed tones or multiple tones or neither missed tones nor multiple tones, and then to compare again whether there are tones played incorrectly. The next step is to compare whether there is a misplay.

Rhythmic and temporal judgements are also useful in assisting with the accuracy of music playing. For example, a common algorithm for evaluating performance accuracy is as follows: if the current weight of the note is set to w, the current tempo is Tempo, and the current time value of the note is d, then the current tempo weight of the note = current tempo/current time value of the note, i.e. $w = 60/Tempo/d$;

We then set the note score to a, the actual time point in the performance of the note is T, and the standard note should be played at ST; then the score of the note = |actual time point - standard time point|*note current rhythm weighting.

The final score is the sum of the note scores divided by the total number of notes. If the total number of notes is S, then the formula for the final note accuracy C is as follows (the subscript of the symbol is the note number):

$$C = \frac{1}{S} \times \sum_{n=1}^{\infty} (|T_n - ST_n| * 60/Tempo/d_n) \tag{1}$$

In the overall assessment of the performance, the assessment of pitch accuracy is relatively logical and should be the most heavily weighted item in the overall assessment criteria, with rhythm and timing only being given a small weighting. Figure 2 is an example of the final display of data and markers such as correct errors:

Fig. 2. Example of a score judging page in an APP

4 Conclusion

In the midst of the global technological revolution of the Internet, the traditional musical instrument industry is moving towards intelligence. The result will be a further lowering of the barriers to learning musical instruments and the creation of new segments or completely new fields. Based on the technology currently available, there are limitations to the problems that intelligent pianos can solve, and we need to properly understand the impact that intelligent pianos can bring, neither ignoring their role nor exaggerating it. At this stage, we need to respect the laws of piano teaching and let this approach work together with teachers to improve teaching efficiency.

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