PIANO4PLAY: AN AUTOMATED PIANO TRANSCRIPTION AND KEYBOARD VISUALIZATION SYSTEM USING AI AND DEEP LEARNING TECHNIQUES

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ABSTRACT

Piano keyboard visualization was very popular right now, but there are very few virtual piano keyboard visualizations right now [1]. I was using unity to show the virtual piano keyboard and then they can play piano pieces by themselves or play a recording online [2]. After that you can listen and see how the recording pieces play it on the visual keyboard to give them a clear idea about how the songs played on a keyboard2 [3]. For those who played by themselves it can let them heard and know also when the visual piano play for them, they can tell if they have offbeat playing or they missing not.

Piano4Play is an automated piano transcription and keyboard visualization system using AI and deep learning techniques. The user could upload a recorded piece of music, and our app would visualize the music on a digital piano keyboard. The user could see how the music is played visually in order to help piano beginners to see how the music will be played on piano in order to help them learn more quickly and easier, and advanced players could use the app to see whether they made any mistake when they are playing so they can get some improvement. Our app uses wav and MIDI files, repl, real-time database, google Collab and Unity.

KEYWORDS

3D Modeling, Machine Learning, Data Science.

1. INTRODUCTION

As we know that piano visualize was the visualize playing the piano, it must be the most vivid detail possible with the calm state of your mind and also can see the keyboard with the absolute clarity. The reason of making piano4play app was want to help the piano learner, people who already know how to play piano or the people who don't know how to play piano, etc. For the piano learners, you can just record a piece and then you will see how to play this and how hard is this piece. For people who already know how to play the piano is the way that when you practice by yourself, sometimes you don't know what you got wrong, what you need to improve more. When you record on this app you can see are you playing fast on someplace, did you miss a note that you didn't realize, did you forget the sharp or flat when you check your recording between your play and you're recording, etc. When the teacher is next to you they can tell you what you got wrong but when the teacher is not with you, you need to figure by yourself and need to improve when you practice, so come try this app. I want to make this app different from the other products intended to solve the same challenges. I also know that technology is advanced now,

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and there are many products similar to mine. However, my product is from my experience of playing the piano since I was a child, to decide how to help people who have just learned piano to understand some piano music, and how to help those students who are taking the exam to choose the correct music they want/suitable for. How to help those who don't know how to play piano music; what the difficulty is, help those who don't know where they are wrong when they practice piano, where they are listening fast and full, so that they can better understand how to play the piano. The later practice plays even better.

Due to the research of Piano keyboard Visualization I found one person who called Xiaoxiao made things about piano keyboard visualization called << Andante: Walking Figures on the Piano Keyboard to Visualize Musical Motion>> [5]. I knew that they chose to make Andante, which is the animated character walking on the piano keyboards to walking step by the physical key or rhythm [4]. They use step by human which is the most fundamental human rhymes to show the understanding of the human step by beat.This can help them more visualizations on the preliminary prototype when pianists practice, improvisation and when they make their own song. Another research I did due to the Piano keyboard visualization was called <<Real-time music visualization using responsive imagery>> by Robyn Taylor, this work was they turned the music into a visualization system. When performing live, according to the music played by the performer, different images corresponding to the played music are mapped out. Therefore, it can make people enjoy music more and let more people know that these two points can actually be combined. Due to those two research I knew there was no one using Unity to make the project. I want to use unity to show the different style and different types of the piano keyboard visualization, different experiences of anyone.

I'm using unity and python for the back serve. How it worked was that it was an app at first and the other app was the (). Then go to the unity front-end game module and then go to the python back-end server, after this there are two things one is ML algorithm another was all the storage.

In the beginning, was thinking about a few points, unity app which can record the audio and upload a .wav file to the Firebase storage; Google collab notebook which will convert the .wav file to the MIDI format and it can be uploaded back to the Firebase storage; The Repl.it program will be download the MIDI file and convert it into a list with all the notes data and upload all the data to the Firebase real-time database; when the navigated to the piano playback menu in the Unity app, the notes data will be downloaded and the song will be played back based on the notes from the database [6][7]. But after making the step and thinking more about it having something I want to add on there and make it more perfect to what I really want to be, the unity app can record the audio and send the request to the server which is my google Colab. And when it selects a song, it needs to fetch and use the server Url that is stored in the Firebase real-time database; also for right now wants to send requests to the http://ip_address/midi "sone" as a key and can be value .wav file which is called record audio. At least, want to check what missing and want to improve on it make it more be perfect, more interesting, the last few things were: google collab notebook will be converted to the .wav file to be the MIDI format also can be converted into a list with all the notes data and will be upload all data to the Firebase real-time database; when the navigated to the piano playback menu in mine Unity app, the note data will be downloaded and the song will be played back based on the notes from the database.

- Problems:

-Piano learners often face the challenges that they do not have a both visually and hearing view of the tunes that they are going to play and learn.
-The lack of a visual piana keyboard in the market.

- Procedures:

-Users could use Piano4Play to show the virtual piano keyboard and then they can play piano pieces by themselves or play a recording online.
-Users can see how the recorded pieces are played online visually.
-Functions: give users the idea of how to play the recorded pieces or help users to check their playing.
-Using Firebase real-time database to save the final file [8].

- Conclusion:

-According to the data that we collected from a survey, most beginners and advanced piano players would like to use this kind of app. The most common reason is they like visualizing piano playing on our own mobile devices.

The rest of the paper is organized as follows: Section 2 gives the details on the challenges that we met during the experiment and designing the sample; Section 3 focuses on the details of our solutions corresponding to the challenges that we mentioned in Section 2; Section 4 presents the relevant details about the experiment we did, following by presenting the related work in Section 5. Finally, Section 6 gives the conclusion remarks, as well as pointing out the future work of this project.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Convert Piano Wav file to MIDI file and save it to Firebase Realtime database

First of all, I do not know how to convert the wav. file to the MIDI file. I was using the online tools that try to make those tools that I can not put into the server and also that I am not able to put in the code to run it. So that later on, I did the research and then found the python library, which I found very useful to help me improve my python programming skill [9]. Then I knew that this thing is capable of helping the project to convert the wav file to MIDI file. Although we have tried hard to use all resources we can find to solve the problem we have met, there is another problem right now. If we want to save the MIDI file as a database in our server, the size of this file requires a very heavy load of the server which is too big and expensive for us to afford and maintain. However, mongo and sql are not appropert, so last we decided to use Firebase real time database to save the final file.

2.2. How to make the file more fluently using the output and simulate the keyboards

I want to make the file more fluent by using the output and more simulating the keyboard. So first we tried to use 2d mode to demonstrate the data stream but none of them work well to what we think. So later we decided to use 3D unity software platform to simulate the virtual keyboard scenes the unity supported by c# programming language. Which I don't familiar with it, so I try to learned it by myself with the material that online, also found that C#, the programming language Community is very useful, I could find a lot of information there [10].

2.3. To choose a stable framework to build a web-service response data stream

To host the back-end, we need to choose a stable framework to build a web-service response data stream. Python flask and the Java spring are two options we have. I choose python flask since python is much easier to launch. For learning the python back-end, I have been learning for long time. Try to understand how I can do this to my app and how it can help for my app. Then we integrate all the code together into a main function in the python flask framework and run in a port to do the interaction with API calls. The API takes a Wav file as an input and returns a MIDI file as the output. Then after that, we launch the framework on the AWS server to stable response to all the API calls. But to use the AWS server we need to set up all the libraries and environments. The python version and dependence also matter.

3. SOLUTION

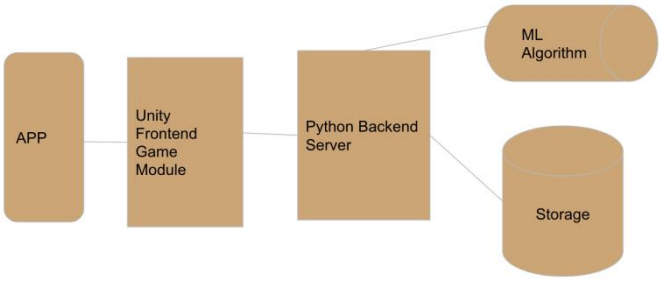


Figure 1. An overview of the project

Paino4Play is an automated piano transcription and keyboard visualization system using AI and deep learning techniques [11]. At the beginning, the unity app was used to record the audio, and then uploaded to the .wav file to Firebase for storage; google collab notebook will convert the .wav file into MIDI format, and upload it again to Firebase for storage; Repl [12]. It is a program to convert a MIDI file into a list with all the piano note data, and upload all the data to the Firebase real-time database; when these things are communicated to the piano in the unity app program it will play the menu, Compare the previously received note data with the notes in the existing database and then play the song. But at this time I wanted to add something here and make the whole thing more perfect and closer to the final look I had in mind. So it is intended that the unified application can record audio and send this request to the server which is my google collab. And when it wants to choose a song, it will need to get and can use those server URLs stored in the Firebase real-time database; also for right now wants to send requests to the http://ip_address/midi" sone" as a key and can be value .wav file which is called record audio. Finally, let google collab notebook be converted into .wav file into MIDI format or into a database list of all notes, etc., and all data can be uploaded to Firebase real-time database; when navigating to our Unity application The piano song play menu in the menu will automatically download the data about the notes and play the song according to the notes in the comparison database.

4. EXPERIMENT

4.1. Experiment 1

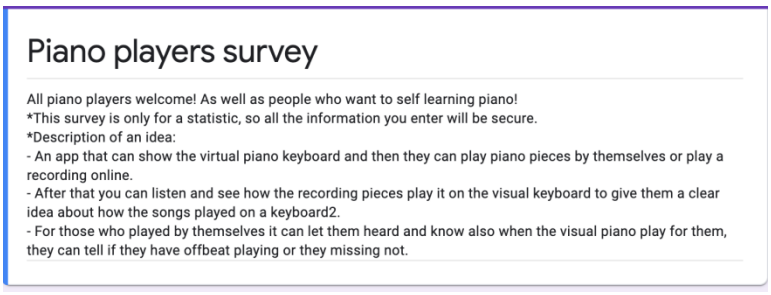


Figure 2. Survey result

First of all I made a survey called the piano players survey. In figure 2, it is what they will see when they open the survey. It says that there is an app that can show the virtual piano keyboards and then they can play piano pieces by themselves or play recording, after that they can listen and see how the recording pieces play it on the visual keyboard to give them a clear idea about how songs played on keyboard also. For those who played by themselves it can let them hear and know also when the virtual piano plays for them, they can tell if they have offbeat playing or missing out.

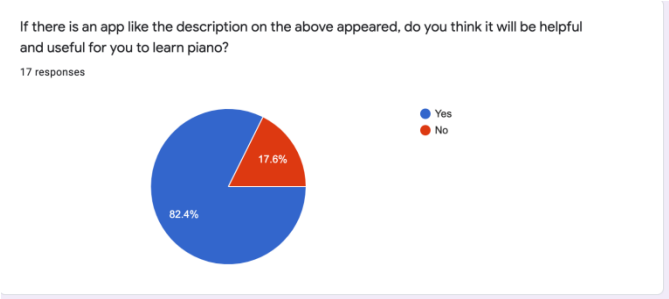
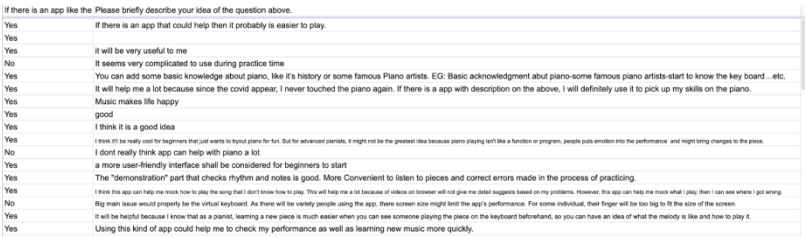


Figure 3. Survey chart

In figure 3 it was asking if this will be an app due to the description (figure 2), do they think it will be helpful or not. In that picture, it has the pie chart of the 17 responses. It shows that 82.4% of people think it was helpful, 17.6% think it is unhelpful.



If there is an app like the	Please briefly describe your idea of the question above.
Yes	If there is an app that could help then it probably is easier to play.
Yes	
Yes	it will be very useful to me
No	It seems very complicated to use during practice time
Yes	You can add some basic knowledge about piano, like it's history or some famous Piano artists. EG: Basic acknowledgment abut piano-some famous piano artists-start to know the key board…etc.
Yes	It will help me a lot because since the covid appear, I never touched the piano again. If there is a app with description on the above, I will definitely use it to pick up my skills on the piano.
Yes	Music makes life happy
Yes	good
Yes	I think it is a good idea
Yes	I think it'll be really cool for beginners that just wants to tryout piano for fun. But for advanced pianists, it might not be the greatest idea because piano playing isn't like a function or program, people puts emotion into the performance and might bring changes to the piece.
No	I dont really think app can help with piano a lot
Yes	a more user-friendly interface shall be considered for beginners to start
Yes	The "demonstration" part that checks rhythm and notes is good. More Convenient to listen to pieces and correct errors made in the process of practicing.
Yes	I think this app can help me mock how to play the song that I don't know how to play. This will help me a lot because of videos on browser will not give me detail suggests based on my problems. However, this app can help me mock what I play, then I can see where I got wrong.
No	Big main issue would properly be the virtual keyboard. As there will be variety people using the app, there screen size might limit the app's performance. For some individual, their finger will be too big to fit the size of the screen.
Yes	It will be helpful because I know that as a pianist, learning a new piece is much easier when you can see someone playing the piece on the keyboard beforehand, so you can have an idea of what the melody is like and how to play it.
Yes	Using this kind of app could help me to check my performance as well as learning new music more quickly.

Figure 4. Survey result 2

Figure 4 shows why people think it is helpful or not due to their answer on the previous question(figure 3).

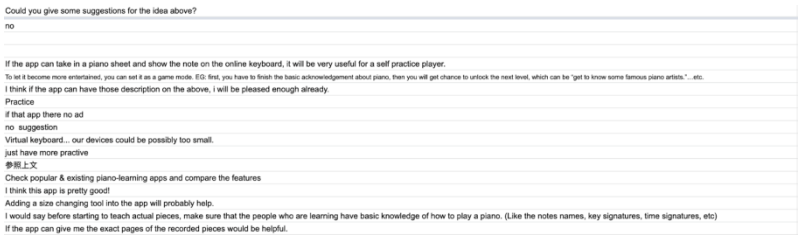


Figure 5. Survey result 3

Figure 5 shows that if this is an app, and if you think it is helpful or not, do you have any idea about it or do they want something specific due to the app description.

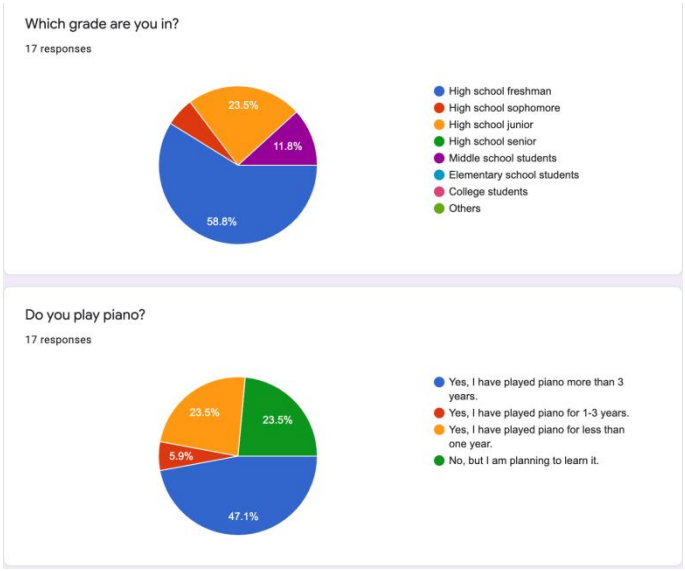


Figure 6. Survey result 4

For the figure 5, it shows which grade are the 17 respondents in, do they played piano before or not.

5. RELATED WORK

For their project, they use step by human which is the most fundamental human rhymes to show the understanding of the human step by beat [13].This can help them more visualizations on the preliminary prototype when pianists practice, improvisation and when they make their own song.

When performing live, according to the music played by the performer, different images, corresponding to the played music are mapped out.

When performing live, according to the music played by the performer, different images corresponding to the played music are mapped out [14]. Therefore, it can make people enjoy

music more and let more people know that these two points can actually be combined. Due to those two research I knew there was no one using Unity to make the project. I want to use unity to show the different style and different types of the piano keyboard visualization, different experiences of anyone.

Their spectrum analysis discovery uses an MDI file to do the piano visualization, which inspired me to use this skill in our projects.

In this article, they propose a new signal processing technique called spectrum analysis [15]. This can be visually demonstrated with a piano roll ten similar to chord music. Therefore Spectrum is defined here as the linear frequency transformation of the line segment of this number frequency. They experimented with multi-pitch signals containing sounds with different structural patterns, with varying degrees of parallel displacement superimposed on the more common spectral patterns in the logarithmic frequency domain or the overall shape of the multi-tone spectrum. They choose to convert to MIDI signals, which are crucial in the retrieval of music information.

Due to the research I knew that there is no such a project that uses Unity as a part. And unity can show the different style and different types of the piano keyboard visualization, different experiences of anyone.

6. CONCLUSIONS

This is an automated piano transcription and keyboard visualization system using AI and deep learning techniques. The user could upload a recorded piece of music, and the app would visualize the music on a digital piano keyboard. The user could see how the music is played visually in order to help piano beginners to see how the music will be played on piano in order to help them learn more quickly and easier, and advanced players could use the app to see whether they made any mistake when they are playing so they can get some improvement. Our app uses wav and MIDI files, repl, real-time database, google Collab and Unity. When doing this app, the main problem was: Can computers help piano players to visualize music, enable beginners to learn piano in a relatively easier way, and improve players' skills? For this problem I was trying to use the testing and the form to get the answer at the beginning, then I got the solution during the project time. Other problems about the project were: 1)How to Convert Piano Wav file to a MIDI file and save it to the Firebase Realtime database ? Solution for this was using the python library to convert wav and MIDI files. 2) How to save the MIDI file as a database in our server because the file is very big? Solution for this was using firebase real time database to save the final file. 3) How to make the file more fluently using the output and simulate the keyboards? Solution for this was 2D mode => cannot work well; 3D unity software: simulate the virtual keyboard scenes the unity supported by c# programming language. 4) The last question was How to host the backend using python or java? The solution was using python flask because it is so much easier to launch, API & AWS, also required for all the libraries and environments of the Python language. Due to all of that for future work I want to make the user interface and experience better like: slowing down playback for the beginner , scrubbing to certain parts of the playback, automatic recognition of errors, looping certain portions of playback. Also, due to the survey I mentioned before there are lots of people saying that adding the upload button for the music sheet when the 3D piano board is playing. Also, they want to add a metronome which can control the tempo or can make people more understand the beat.

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