Teaching elementary school students new method of music performance with Leap Motion

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I. Abstract

As the world continue to embrace motion recognition technology in recent years, it had also open up a new method for performing and learning music with motion recognition devices.

In 2013, Leap Motion was released. It is a programmable motion recognition device, ticking the requirement needed by the Author to design a new software and application for music education.

This research focus on the the process of creating a new software that will use the Leap Motion technology for music education class at elementary school. The research is meant to develop alternative ways in teaching music and performing for children, not to replace the traditional teaching method.

The paper will talk about the whole experience of designing, implementing, and testing the usage of Leap Motion for music education.

The research consist of two phase. The first phase is the music software design. It had 2 main program.

The first program is the performance application, students can use both of their hands to perform music through the software, limited only to monophonic melody. The right hand will be positioned to control the pitch, on a one octave diatonic scale. The left hand will be positioned to control the note on and note off. Through the combination of these hand position, the student will be able to play one note at a time, a mono sine wave sound.

The second program is the game application, student can practice their hand movement and carry out their music practice with this music application that's designed to mimic note scrolling music video games like the one found on commercial video games like Rock Band or Guitar Hero. A series of notes can be seen on the software user interface and they can practice to position their hand at the right moment to perform the right melody of the music piece.

This music software is aimed toward first and second grade of elementary school student as it can be devised as a tool to help the student to learn melody and rhythm in music.

The second phase of the research is a field study to measure the effectiveness of teaching this new method of music education through survey. The survey conclude that the there's still a long way to go to create an ideal motion recognition music based application. Through this survey we have collected data that consist of the the positives and negative opinion on the students experience with the software.

II. Background Study

In 1934, neuro-anatomist Andrew Arthur Abbie wrote "the pathways from the brain stem and cerebellum to the frontal lobes are capable of weaving all sensory experience and accurately coordinated muscular movements into homogenous fabric, and that when this occurs the result is man's highest powers as expressed, in art". His idea is that the neural pathway is closely related to motoric movement. When we remove the body from a children education, we limit the potential to learn, think and be more creative.

According to Fauth (1990), we retain:

- 10 percent of what we read.
- 20 percent of what we hear.
- 30 percent of what we see.
- 50 percent of what we hear, and see at the same time.

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- 70 percent of what we hear, see, and say at the same time.
- 90 percent of what we hear, see, say, and do (acting out, dramatizing, dancing, painting, moving).

By incorporating movement into music learning, the students will be able to retain more of what they have learned and fuel their creative side by expressing themselves through movement.

The research will experiment on using body movement to control music. A good music program that can detect body movement fluently will be able to provide better music education, especially for children.

Further idea of this research is to fully immerse the student to the learning process. Acting out a specific movement during the class can make it easier for the student to understand the topic and to enjoy the topic. It can motivate them to study more and be more creative in the future as every children have the potential for multimodal learning.

It is important to study more on the potential of multimodal learning to increase the effectiveness of any learning process. This research is a mean to develop one of the many possible methods to incorporate movement in to a multimodal learning process.

III. Research Objectives

For this research I have come up with three research objectives, they are:

a. To explore the use of Leap Motion for music education.

- What is the best way to use the device as a music education tool?
- How can we incorporate motion recognition technology on the device to the learning process?'
- Can we write a computer program which is effective for music education?

b. To do an experiment on the possible application of Leap Motion in an educational institution.

- How will the student and the teacher react to this technology?
- What are the difficulties that might rise behind this experiment?
- Is the technology easy enough to understand?
- Will the exam result be significant enough to warrant a revision from traditional teaching method to the a new integrated one with our software?

c. To analyze the recorded samples as a result of this experiment.

IV. Music Software

For this research, the Author come up with an idea to create two separate software. Each of the software serves its own particular purpose.

The first software will be focused on performance. Students will be able to perform music, strictly monophonic melody. The inspiration behind this software is one of the oldest motion recognition musical instrument which is Theremin.

The way we perform with the software is by using both of our hand. By positioning their hand on top of the Leap Motion, the student can play and perform a melody.

The right hand will control the pitch. By moving their hand vertically, the student can control which pitch that they want to perform. The display on the software will show the student which note they are playing at the time. On the image below, if the student put their hand on the position of the note Re then the software will show the note name on the display.

The left hand will control the note on and off situation. By clenching their fist, the student will send signal to the Leap Motion to start playing a musical melody based on the pitch information that's relayed from the right hand position. By unclenching their fist, the student will send signal to the Leap Motion to stop playing the note. The students can tell if the note is on or off by looking at the right bottom part of the software visual. If the note is on it will spell play, if the note is off it will spell stop.

The music education aspect comes in to play with the additional note information. This way, the student can learn, memorize, and understand more about the musical notes that they perform.

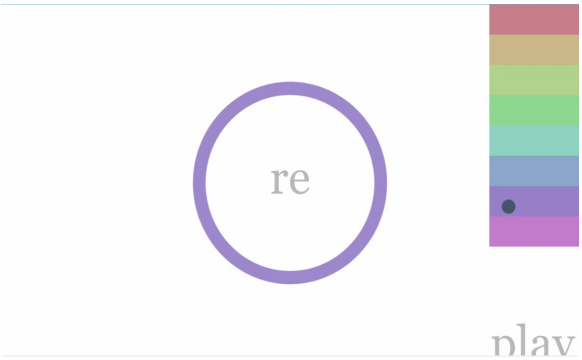

Figure 1: Performance Visual

Figure 2: Performance Application

The second software will be a music video game. Students will be able to practice their mastery of using the Leap Motion by playing a game. The inspiration behind this software is commercial music video game such as Rock Band and Guitar Hero.

The way the student play with the game is almost the same with any other note scrolling music video game. A series of note will come from the right and left side of the screen as instruction for the student. The student will then have to position their hand at the right vertical position to trigger the right note. based on the game instruction. If the student hit the wrong note or didn't position their hand correctly, the melody for that note will not be played. If the student hit the right note, only then the melody for that note will be played.

By playing with this interactive music video game the student can learn the name of the notes that they are playing with through the information from the game visual. Every time the student hit the right note, the screen will show the name of the note that they are hitting. On the next screenshot, if the student hit the note F at the right time it is shown in the middle of the screen.

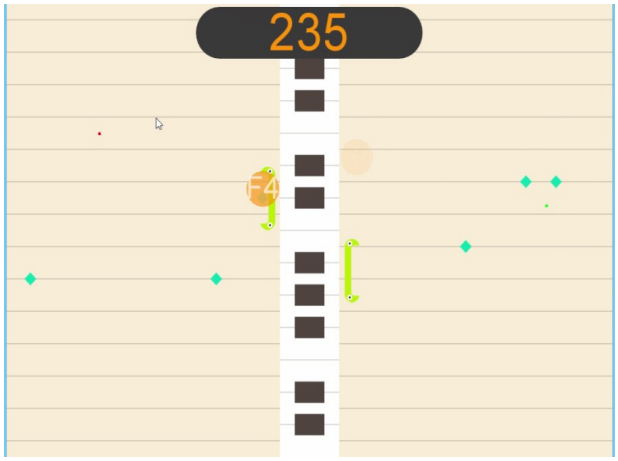

Figure 3. Music Game Visual

Figure 4. Music Game Application

V. Development

The development of the software is done by using Processing, which is a Java library for interactive multimedia application. This library allows us to quickly develop the software, because the code can be run instantly inside the IDE (Integrated Development Environment) without long compilation process, thus the road from prototype to end product were made shorter.

We also made use of the Leap Motion P5 library, which is the implementation of Leap Motion API (Application Programming Interface) for Processing. This library exposes custom events from Leap Motion, such as detecting hand and

certain gestures in practical ways that can be used during the development of the software.

Due to the fact that the software was targeted for general young audience, we then aimed for something visually colorful yet minimal. So that the visual aspects will not overshadow the sound, which is what the user should focus on. So, several basic shapes with different colors were generated using Processing to create the main user interface. Additional animations were also added to emphasize certain interaction, as a way to notify users that they've made a meaningful actions.

As for the audio element, it is also done inside Processing, using an audio library named Minim. We initially use it to trigger a piano sample, but after further research, we thought that basic sine wave should be better due to its simplicity. We then used one of Minim's audio generator to generate short sine wave every time the user touches the rectangles on the side. The circle on the center also reacts to the audio to further enhance the interactive experience by letting the user know that a sound is played.

We endured several difficulties during the making of the software, but two of the most crucial is how the hand grasping event was recognized and how Leap Motion differentiate left and right hand. The first problem was solved by using the hand closing event detector, but several custom programming were also need to be added because initially this causes the sine wave to be retriggered several time, creating sort of noisy delay effects which wouldn't be good. We also used threading to solve this, but this has caused the exported application to crash when no hands were recognized during startup.

In the end, the threading were removed and we can still detect the gestures. Also, differentiating the left and right hand had to be settled by comparing the position of both hands in respect to the original axis of the Leap Motion. This did the job, although it can be tricky once both hands are in the same position. The version 2 of the Leap Motion API, which came out after the software has been developed, resolves this issue and will be considered for further development.

V. Field Study And Survery

Despite our confidence on the software, a field study is still needed. We conducted a survey after allowing hands on experience of the software with several local elementary school students in Malaysia and the survey come up with this conclusion :

1. Motion recognition technology is pretty new and it is still too inefficient for daily use.
2. Based on our research, the software were proven to be pretty demanding. The fact that both hands need to be up all the time, is tiring for the children. Especially since our initial test were using standard duration song, around three to four minute. This resulted in discomfort on the students. We have to shorten the song duration to make it less demanding for the students.
3. The performance software is not easy to master. since the software uses both hands to control the melody, the coordination between both hands were proven to be difficult. Some student find it difficult to master the clench and unclench fist action to control the note on and off.
4. The students showed their interest more towards the game software. The game software is designed like the music video games that they are used to, making it easier to control than the performance software.
5. Accuracy is also an issue. Despite our best effort to ensure that the software can detect hand position correctly, in some cases the software can lose track of the hand. This usually occur when the student felt tired and they have to remove their hand from the Leap Motion sensor range. When they put their hand back in the sensor range, they have to readjust everything.

VI. Conclusion

There is still much to learn and study on the topic of designing motion recognition based music software that's easy to use. It is easy to treat the Leap Motion as a passive sensor, in which the user only have to put their hand on the right position based on the input from the Leap Motion software. But. it is much harder for the user to actively send instruction to the Leap Motion due to the unnatural feeling of not holding any physical control device that they are used to.

The Author will continue with the research on designing a more efficient and user friendly motion recognition software. With the release of version 2 of the Leap motion API, it also opens up new possibility for motion recognition technology. The prototype for the software is also available for public demo. Please contact the author for further information on demoing the software.

VII. References

B. Fauth, “Linking the visual arts with drama, movement, and dance for the young child”, Moving And Learning for the Young Child, Reston:National Association for Sport and Physical Education, 1990

D. Levitin, This is your brain on music, New York:Penguin, 2006

J. Klein, “Young children and learning”, Moving and learning for the young child, Reston:National Association for Sport and Physical Education, 1990

C. Hannaford, Smart moves: why learning is not all in your head, Salt Lake City:Great River Books, 2005