Improvements To A Digital Music Stand

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Abstract

After more than 10 years since the concept of digital music stand was first seriously designed, the research area in the field of digital music stand have somewhat matured. However, there are still improvements that can be done. One of the most useful aspects of a digital music stand is its ability to perform page turns silently to aid musicians in reading music during music performance. We found out, in this investigation, that using animation for page turning is more efficient in aiding musicians than the current page turning techniques: the half-page preview technique. We also present three multi-paged view page turning animations: OneStep, SimultaneousStep and MultiStep animations which further expand the capability of digital music stand to meets musicians' needs in having multiple page view during performance. We found out that test participants prefer SimultaneousStep the most.

Finally, we discuss on how our evaluation needs can be improved and what kind of other improvements that can be done on digital music stands.

Acknowledgments

I would like to take this opportunity to thank Tim Bell for his guidance, confidence and encouragement throughout the year. I would also like to all my family and friends, who have supported me every step of the way, and to my fellow honours and postraduates who have made this year a memorable one. Last but not least, to the test participants for their invaluable feedbacks.

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Chapter 1

Introduction

Since the 16th century, the time whe, music publishing has been always written on paper. Even until these days, it still relatively remain unchanged. Musicians compose, transpose and perform directly from the printed paper of sheet music. In this age of digital information, however, it is normal to start thinking how to come up with some kind of software and/or hardware systems that will help musicians in their daily tasks.

A digital music stand [11] is a design concept that was brought about by a team from Carnegie Mellon University (CMU) during the 1995 Apple Design Project. The team aims that this digital music stand would replace the current paper-based sheet music stand system that is still being employed by most musicians. It contains a metronome with audio and visual feedback, a pitch-generating tuner, stylus-based-on-screen annotation, inter-symphony communication capabilities, a music library, and manual or automatic page turning with indexing. However, the design was not implemented by the team.

At the other side of the world, in Japan, Juichi Kosakaya and his team [12] studied the prospect of having the next generation sheet music that will not only revolutionalise the way in which musical performances are performed, but also should have a large effect on the old traditions of producing and editing sheet music.

The authors identified that the problems of the conventional paper-based sheet music involve two things: the inconvenience for performers and the inconvenience in the production/editing of sheet music. Inconvenience for performers includes:

- Performers have to stop playing when turning pages
- The act of turning pages diverts the player's attention
- Sheet music becomes worn out the years
- Pages make an annoying noise when they are turned
- Sheet music is difficult to keep organized

- It cannot be used in the dark

The team also found out that the inconvenience in production of sheet music usually have something to do with trying to arrange the musical bars on the music score such that it helps musicians to turn their page (ie. having a rest bar at the very end of the page) during their performance.

It's been more than 10 years since the first concept of digital music stand was brought about, and now, digital music stands somewhat have matured. However, there are still many improvements that can be done. This report investigates in what ways a digital music stand can be improved, especially to help musicians in performing. Before we can find what exactly are the improvements that we can make on a digital music stand, we must first look at what a digital music stand is, who and what it is designed for and what features have been implemented.

Chapter 2

Background Information and Related Work

In this chapter, we shall discuss more about what a digital music stand is, and how far have the current state of technology for this application.

2.1 What is a digital music stand?

In 1995, as a part of Apple Design Project, Christopher Graefe *et al* at the Carnegie Mellon University designed and prototyped the *muse* [11], a digital music stand for the symphony musician. The authors gathered requirements from over 100 musicians based on music practice and rehearsal habits, preferences and habits of each musician. They also ran an observation on the Pittsburgh Symphony Orchestra for a certain period of time and took note on how they handled their daily tasks. After gathering some data, they found out that there are three situations in which the use of the *muse* will be useful: practice session, rehearsal session and the actual performing session. They found out that symphony musicians have problems dealing with the communication on the stage, music sheet annotation, page turning, instrument tuning and music library management.

From the requirements that they gathered, the authors conceptualised a final product of the *muse*. As a final design concept, the *muse* would comprise of a portable digital music display and a stand. The display would be foldable with two 9" x 12" high resolution flat panel touch-sensitive displays, a built-in microphone and two speakers. It would feature automatic silent page turning, an ability to annotate digital sheet music, an in-built metronome and in-built instrument tuner and a digital music sheet library. The digital music stand would also be able to be connected to other digital music stands, and thus musicians would be able to view the parts of other instruments for a given piece of music. This feature would be especially useful for a conductor. Finally, it also could be customized to each user's preferences and be able to accomodate

a personal note system. The team did not realise the design concept of *muse* into a real product but the team provided a very solid first step into digitalising traditional music stands.

2.2 Existing digital music stand system

Since then, the lessons learnt from the *muse* project [11] have been further implemented and evaluated. As a results of this, there are a number of emerging digital music systems and also other similar system both for commercial and experimental purposes.

2.2.1 Commercial systems

MusicReader

MusicReader[1] is a digital music stand system that is developed privately by a company in Borne, Netherlands. Music Reader was under development since 2002 and launched its first release in early 2008. Since it is sold as a software system, it can run on many Windows-based platform such as the usual desktop PC or laptop, but is designed especially for the use with pen or touch screen, such as Tablet PCs.

The software features a digital library for storing music, a hands-free silent page turning, annotation making, conversion of sheet music to a digital format, integrated recorder/player, metronome and tuner. For its page turning mechanism, it offers a 'half page preview' pageturning (which we will describe in the next section) and can be used in conjuction with a foot pedal to initiate a hands-free page turning.

MusicPadPro

MusicPadPro[2], developed by FreeHand System Inc., is another commercially sold digital music system. Unlike MusicReader, MusicPadPro is sold with a 12.1" TFT LCD back-lit touchscreen tablet. It has similar functionalities to MusicReader: it contains a digital music score library and it is able to annotation marking. MusicPadPro provides Optical Music Recognition system software to convert a digital format (such as png, pdf, etc) from the users' computer into the native MusicPadPro digital format.

In terms of its display and page turning ability, MusicPadPro has a two-page display in landscape mode, and also a half-page preview turn. It also has a built-in jack for foot pedal for easy, hands-free page turning.

[1] http://www.musicreader.net/
[2] http://www.freehandsystems.com/index.html

eStand

eStand[3], is developed by e-Stand Inc, is yet another commercially sold digital music system that is sold as a software system that can be installed on PC or laptop. It can be networked with other eStands. Similar to what MusicReader and MusicPadPro offer, eStand has a static page turn and half-page preview as its method of page turning.

2.2.2 Research-based systems

MICON system

MICON [6], or Music Stand for Interactive Conduction is an experimental digital music stand used for conducting. It lets the conductor to play around and control the speed of a recorded piece of music using conducting gestures. The page turning system that the designers used is a static page turning, where the new page completely replaces the old page without use of page turning animation.

MOODS

MOODS [3], which stands for Music Object-Oriented Distributed System, was designed by Bellini *et all*, is designed to be used for the whole orchestra (conductor and the orchestra members). As the name suggests, it is a distributed system of digital music stands. The designers used a half-page preview page turning, where half of the new page replaces half of the old page without use of page turning animation.

Hitachi Engineering Co Ltd system

Juichi Kosakaya and his team, from the Hitatchi Engineering Co Ltd in Japan, have researched, developed and evaluated a performer-friendly electronic music stand [12]. It features a page turning scheme based on time delays and variable page refresh ratios. The system employs an estimation method based on an analysis of musicians glance conducted during their preliminary study of the reseach project. They also looked into the cognitive load on the performers to time the page turning.

The authors chose three distinct classes of musicians ranging from their abilities (from professional musicians to beginners. Two turning methods that they use were fully-static and semi-static page turning ranging from 0 to 100% refresh rate. They found out that, performers with greater ability are able to operate with a larger page refresh ration and require a correspondingly smaller refresh delay time. Performers with less ability preferred smaller page refresh rations and tended to prefer longer refresh delay times. This means that as musicians become more professional their sight reading ability improves, and they can read further ahead in the sheet music.

[3] http://www.estandmusic.com/

MusicNotepad

MusicNotepad [10] is a an interactive electronic sheet of music paper developed by Andrew Forsberg and his team at Brown University. MusicNotepad attempts to mimic and emulate the look-and-feel of writing music notations using pencil-and-paper interface. Users would directly interact with MusicNotepad by a mean of a portable display surface (Wacom[4] tablet and stylus) and marking menus [13] for a more natural feel to access MusicNotepad menus.

The team also developed a list of unique pen gestures to enter, remove, and modify different types of musical notations and markings, and used Rubine's gesture recognition system [16] to identify users inputted gestures. One major issue they faced was the fact that the gestures might not initially interpreted correctly and thus users would learn a wrong gesture. They also found out that users' hand sometimes block the menu items of the marking menus. Although their aim for the MusicNotepad was to have MusicNotepad as a system that will replace paper, they did not launch any investigation on page turning.

LatteExpresso

Espresso [1] is a digital music stand developed here at University of Canterbury, while Latte [5] is an extension to Espresso that features a single-paged view page turning animations.

2.2.3 Other related systems

Sibelius

Sibelius[5], developed by Avid Technology Inc, is a music notation software for composing, arranging, publishing, teach and learning music. And thus, most of the tasks that are being performed on Sibelius is entering and typesetting music, rather than using it for music performance. Music data is entered through a series of mouse clicks directly onto the provided staves, or through a MIDI-enabled keyboard. Users then can hear a MIDI playback of it to receive feedback on the entered music notes. If satisfied, users then can arrange and decorate the look-and-feel of the music score before it would then be printed for performance.

There is no actual page turning technology in Sibeliusm but it implements two complementary techniques called Panorama & Magic Margin technology. Panorama transforms the sheet music into one single, infinitely-wide strio instead of having the scores being chopped into systems and pages; while Magic Margin is sort of a highlighter that follows which staves the users are in and also reflect changes made into the scores. This can be seen from Figure 2.1.

[4]http://www.wacom.com/
[5]http://www.sibelius.com/

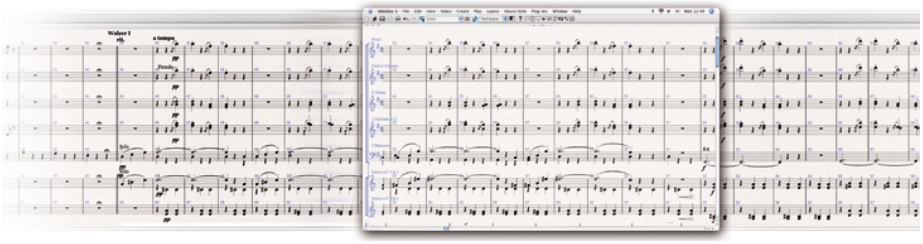

Figure 2.1: Sibelius' Panorama with Magic Margin technology

Yamaha Digital Music Notebook

Yamaha Digital Music Notebook[6] is a free software provided by Yamaha Corporation for learning and practicing music. It contains a gateway to digital music book library online where users can download these books, make changes to them (transposing, or change the tempo), and then played with a MIDI-enabled keyboard. The Yamaha Music Notebook's score navigation is somewhat similar to that of Sibelius, where a vertical blue bar will follow and jump to any section of the piece in which the current notes are being played.

Amazon Kindle & Sony PPS-700 Reader Digital Books

There has been also a sign of an emergence of e-book readers as we can start to see them to be sold in the market. We have looked briefly into them to see whether they have some kind of page turning technologies being implemented. There is no page turning as the reader comes with a scrolling wheel to scroll.

2.3 Page turning

Bell *et all* [2], McPherson [15] and Blinov [5] have looked deeper into page turning in a digital music stand. Here are some of the most important types of page turning they have designed, implemented and evaluated:

- **Realistic 3D book page turn**
  Page turning animation is implemented as realistic full 3D animation which closely resembles a real book than a scrolled or paginated electronic display [8].
- **Static page turn**
  This method of page turning is just simply replacing the old page with the new one right away. This method has a great deal of 'shock' factor.
- **Static+preview page turn/"'half-page preview"' page turn**
  This method of page turning is similar to the fully-static page turn, but

[6] http://www.digitalmusicnotebook.com/

instead of replacing the whole old page with the new one, it replaces it in parts. The most common implementation of this is to the half-way page turning where the top-half of the old pages is replaced with the new ones and once the musician initiates a second page turn, the digital music stand will replaces the lower half. This method is commonly used in many of digital music stand systems.

- **Animated page turn**
  This method use animation as an aid of a gradual page turning. Therefore, the very essential key ingredient is speed of the music.

  1. *Page fold technique* – This technique emulates a page peeling off a stack of pages. The animation can be done vertically, from the top to bottom, or horizontally form left to right.
  2. *Page roll technique* – This technique emulates a page rolling down towards the bottom of the screen, revealing the next page. The animation is done vertically, from the top to bottom of the page, or horizontally form left to right.
  3. *Simple line technique* –This technique simply draws a straight line between the parts of the old page and the new page. The animation is done vertically, from the top to bottom, or horizontally form left to right.

2.3.1 The benefits and shortcomings of animation

we have looked into some of the reseach repertoire in the benefits of animations in user interface design. There are some opposite forces, one saying that animation is beneficial, and the other saying that there are no proofs of it being beneficial at all:

- "'The benefits of applying techniques from cartoon animation to the user interface are both cognitive and affective. By making it easier for the user to track objects and understand what is changing on the screen, animation offloads some of the cognitive burden associated with deciphering what is going on in the interface from higher cognitive centers to the periphery of the nervous system."' [7]

- "'Animation has tremendous potential to improve of dynamic informations."' [4]

- "'However The absence of a statistically significant effect of animation neither validate nor disprove the initial hypothesis. Also, the data obtained in the study suggest that users may prefer animation even if it is not associated with any gains in efficiency."' [9]

- "'Animations must be used to direct or focus the users attention to key activities in the user interface of an application. However, inappropriate

use of animation will merely distract the user by drawing attention to the animation itself rather than the task at hand."' [17]

- "'Despite the plausibility of cognitively-based arguments for the benefits of animation, research to date has failed to provide unequivocal evidence that it is superior to static depiction. Interactivity may be the key to overcoming the drawbacks of animation as well as enhancing its advantages. If learners are in control of the speed of animation and can view and review, stop and start, zoom in and out, and change orientation of parts and wholes of the animation at will, then the problems of veridical perception can be alleviated."' [18]

- "'Despite the plausibility of cognitively-based arguments for the benefits of animation, research to date has failed to provide unequivocal evidence that it is superior to static depiction.(Tversky, Morrison, Betrancourt, 2002)"' [14]

2.3.2 The current implementation on Espresso Latte

We also looked into the current implementation on Espresso Latte and we found out currently it implements animation a single paged view with a page roll animation as its default page turning animation setting, as shown in Figure 2.2.

2.4 What improvements can we make?

Now that we have seen all the work that have been done on digital music stands, we ask ourselves: "So what kind of improvement can we make?". All the commercial based have done many effort into annotation, music score library management, or even page turning. However, we are convinced that there is a need to look into page turning animation especially after looking into what we currently have with the Espresso Latte.

Page turning animations are very useful in this case because during a performance, musicians would be able to preview the next page with less effort than any other page turning techniques. The half-page preview is good, but musicians have to initiate the page turning twice: one for previewing the upper half of the next page and another to see the rest of the new page.

Espresso Latte does exactly this, but with only single-paged view. This does not scale up to most musicians' needs where they usually want to have more than one page (usually two to three) to have some security and control over what they are playing. And thus, we think that Espresso needs to have this feature.

However, now we face another issue: "'How will we use animations in a multi-paged settings?" And during the research we have found three novel techniques that might solve this issue, which we will discuss in the next chapter.

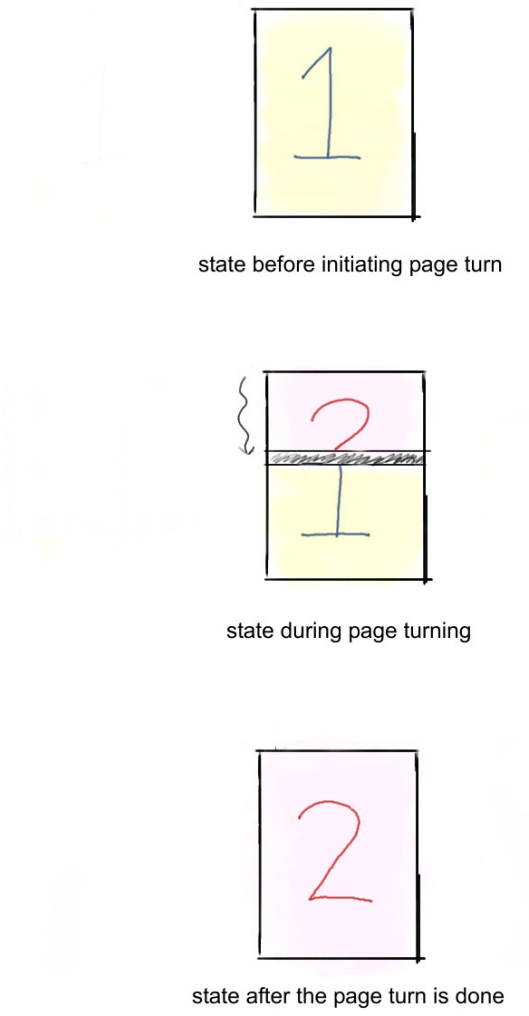

Figure 2.2: Illustration of single view, Page roll animation

Chapter 3

Design and Implementation

In this chapter, we will discuss in more detail the three proposed solutions to use page turning animations in a multiple-paged views. The three novel solutions are OneStep, SimultaneousStep and MultiStep.

3.1 Three proposed animation techniques for multipaged page turning

3.1.1 OneStep

OneStep is an animation where the page turn progress one page at a time. Since we have multiple page views, the original document is treated as a collection of multiple-paged stack or layers of pages. Users then initiate a page turn one page at a time on each stack. This results in a 'numPages - 1' page turning initiations. Our initial thoughts on this animation method that it would not be very efficient, however it would be intuitive. The illustration of this animation is shown in Figure 3.1.1.

3.1.2 SimultaneousStep

SimultaneousStep is an animation where the page turn progress simultaneously at one time. Just as OneStep, the original document is treated as a collection of layers of pages. We think of two versions of the SimultanenousStep animations: one is where the rate of page turning at each page is different and one is where the rate of the page turning for all the pages is the same throughout. Our initial thoughts on this would be more efficient as users will have to use less page initiations. This is perhaps slightly more intuitive than OneStep because they might be expecting to see the next set of pages instead of the next page when they initiate the page turn. The illustration of this animation is shown in Figure 3.2.

3.1.3 MultiStep

Multistep combines the previous animation methods. When users initiate page turning, all of the pages that are currently viewed will be turned but in an order. We believe this is animation is the best of both worlds, as it lowers the amount of page turning initiations and at the same time inherits the intuitiveness that we have assumed on OneStep animation.

3.2 Implementation on Espresso Latte Digital Music Stand

We tried to implement the system as an extension to what Blinov [5] had done with his single-paged view page turning animations, but it was not truly successful. We managed to implement a slightly less than functional multiple-page views, but in terms of the animations, we did not manage to successfully implement them.

However, we managed to come up with a Microsoft PowerPoint slides that simulates the behaviour of OneStep, SimultaneousStep and MultiStep animations almost perfectly, giving the same "'feel"' to what we had in mind in regards to how the animations actually work. This enabled us to convince ourselves to use this test system as a perfect candidate to evaluate the animations. We will discuss in the next section.

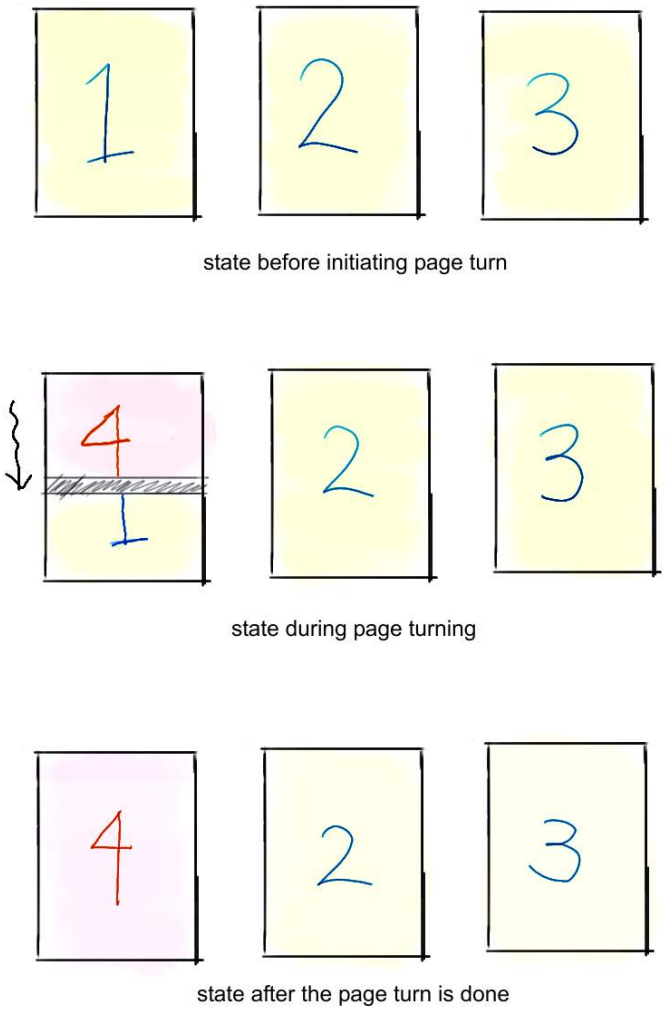

Figure 3.1: An illustration of OneStep animation

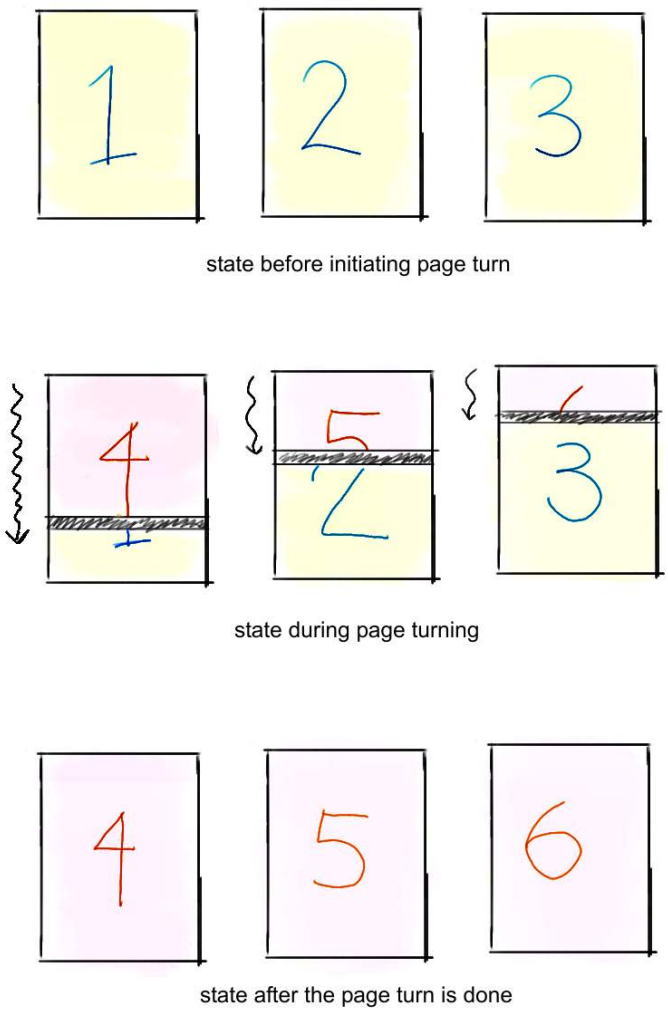

Figure 3.2: An illustration of SimulatenousStep animation, with different rate of turning on each page

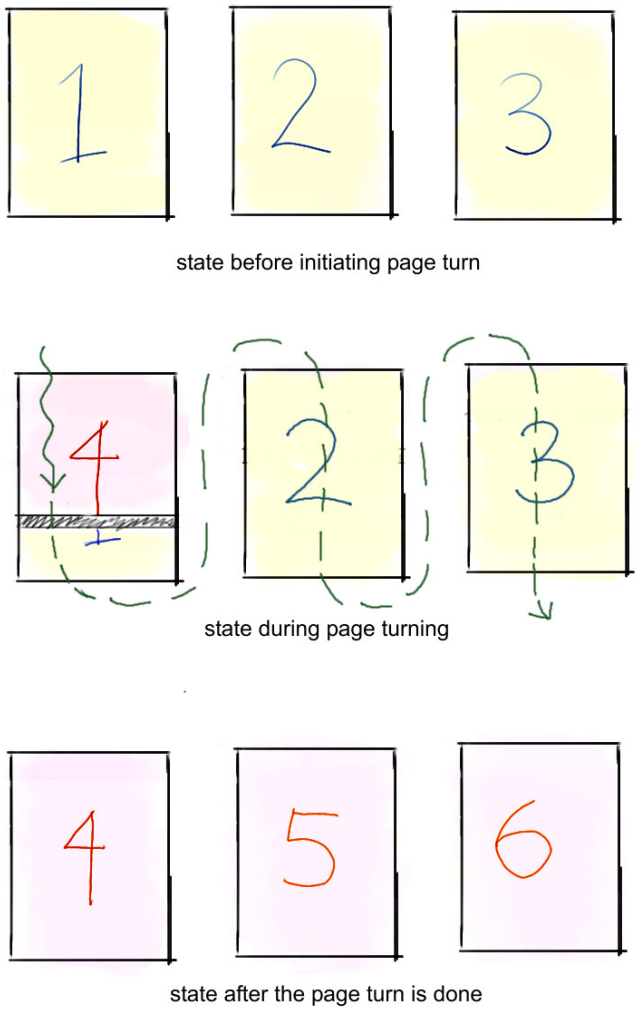

Figure 3.3: An illustration of MultiStep animation

Chapter 4

Evaluation

In this chapter we shall discuss how the evaluation process was conducted. We conducted a small evaluation of the three types of animation to find out which one out of the three proposed animations is the most efficient (that is, requires users to do the least amount of effort), the most intuitive (the one that feels very natural to users), the most distracting (leaves users annoyed or put them in the state of disarray).

4.1 Experimental design and procedures

The three animation systems were simulated on Microsoft PowerPoint. A test participant would casually read or skim an excerpt from *The Metamorphosis* by Franz Kafka. The digital e-book version of the novella is freely available from Project Gutenberg[1]. We used text so that the system could be tested with participants without requiring musical expertise.

In each slide, there are three column placeholders, each representing a page view, as shown in Figure 4.1. Initially, we wanted to test our animation in a two-paged setting instead of three-paged setting. However, in the end, we chose to use a three-paged view because we felt that it is able to encapsulate how a multi-paged setting would behave, while a two-paged view does not quite capture the nature of general multi-paged situations. A Three-paged view also enforces an indirect semantic of '*previous*', '*current*' and '*next*' pages which we feel is a useful reading aid for readers.

The evaluation consists of three tasks, each task simulates one multiple-paged page turning animation. The first task simulating the OneStep page turning animation, the second simulates the SimultaneousStep animation and lastly, the third and final task simulates the MultiStep page turning animation.

To simulate OneStep animation in Microsoft PowerPoint, we use PowerPoint's *WipeDown* slide transition feature with its speed set to '*slow*'(the slowest possible transition speed setting on PowerPoint). We also use '*onMouseClick*'

[1] http://www.gutenberg.org/

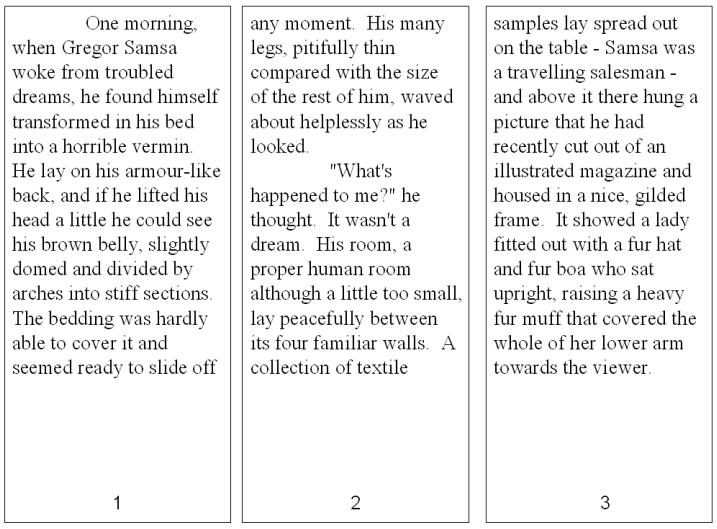

Figure 4.1: The test system on Microsoft PowerPoint

advance slide feature. This means that the slide will transition to the next one only with a mouse click. Then each new slide will contain one new placeholder with new page content, while the other two placeholders would carry the old page content from the current slide.

To simulate SimultaneousStep, we do exactly the same as how we implement OneStep animation. However in this case, all the placeholders in the new slide would carry a new page content.

To simulate MultiStep, we used PowerPoint's WipeDown slide animation for its slide transition with its speed set to '*slow*'. However this time, we also did not turn on the '*onMouseClick*' option, but rather ask PowerPoint to automatically do a slide transition at once until all the three placeholders have new page content.

At the end of the evaluation, we gave users a 14 question questionnaires. We ask a subjective opinion of each test participant regarding the three different page turning animation in each task (See the Appendix section for detailed questions). Each question is answerable through a Likert scale from 1 to 7, with 1 being '*strongly disagree*', 2 being '*disagree*', 3 being '*somewhat disagree*', 4 being '*neutral*', 5 being '*somewhat agree*', 6 being '*agree*', and 7 being '*strongly agree*'. We also asked them to rank the three animations based on their preference.

4.2 Participants

The participants of the evaluation are a group of eight people, 7 males and 1 female, which consisted of some postgraduates students and some former com-

puter science graduate students who are now in the workforce. All of them declared themselves as computer literate or at the very least, feel very comfortable working with computers through keyboard and mouse.

4.3 Results

We divided the results section into four sections: Efficiency, Intuitiveness, Degree of distraction and Preference. For the data gathered on efficiency, intuitiveness and degree of distraction we conducted a statistical analysis within-subject ANOVA with 3 levels of interface type. We also carried out a post-hoc Tukey's Test to find the Honest Significant Difference (HSD).

4.3.1 Efficiency

The Table 4.1 shows the participants' responses for efficiency, while Figure 4.2 shows the mean level of agreement on the efficiency of each animations.

	P1	P2	P3	P4	P5	P6	P7	P8	mean	sd
OneStep	3	1	2	2	5	4	1	3	2.625	1.4079
SimultaneousStep	5	7	6	6	6	7	6	6	6.125	0.6409
MultiStep	5	2	4	6	5	5	7	6	5	1.5119

Table 4.1: Results for efficiency: how efficient is each page turning animation?

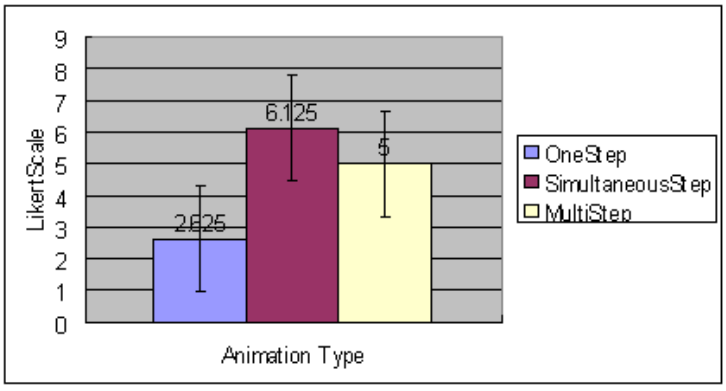

Figure 4.2: The means of the level of agreement on the efficiency of each animation

The means of the level of agreement on the efficiency of the animations are significantly different ($F_{2,14} = 15.604, p < 0.01$) with SimultaneousStep being perceived as the most efficient by the test participants ($mean = 6.1250, sd = 0.6409$). Test participants somewhat agree that MultiStep is efficient ($mean =$

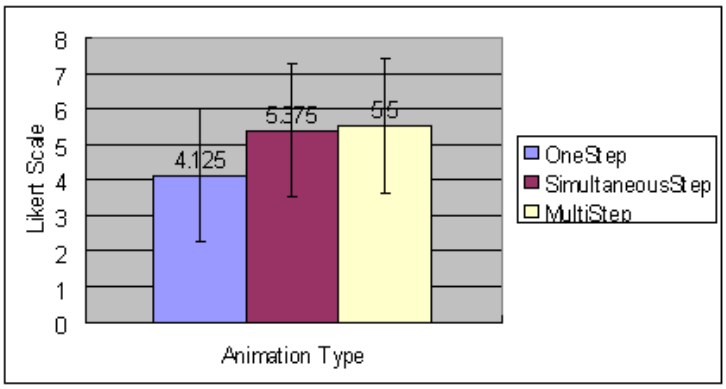

Figure 4.3: The means of the level of agreement on the intuitiveness of each animation

$5.000, sd = 1.5119$) while they disagree that the OneStep is efficient ($mean = 2.6250, sd = 1.4079$). We also conduct a Tukey's Test to find out the degree of the *Honest Significant Difference (HSD)*. We found out that the $HSD = 1.674$ at 95% confidence interval. This tells us that each of the means obtained are significantly different to each other as shown in Figure 4.2.

4.3.2 Intuitiveness

The Table 4.2 shows the participants' responses for intuitiveness, while Figure 4.3 shows the mean level of agreement on the intuitiveness of each animations.

	P1	P2	P3	P4	P5	P6	P7	P8	mean	sd
OneStep	5	7	2	3	4	2	4	6	4.125	1.808
SimultaneousStep	6	7	6	5	4	4	6	5	5.375	1.061
MultiStep	5	4	4	5	6	7	7	6	5.5	1.1953

Table 4.2: Results for intuitiveness: how intuitive is each page turning animation?

The means of the level of agreement on the intuitiveness of the animations are somewhat significantly different ($F_{2,14} = 2.252, p = 0.142$) with SimultaneousStep being perceived as the most intuitive by the test participants ($mean = 5.3750, sd = 1.0607$). Test participants somewhat agree that MultiStep is intuitive ($mean = 5.5000, sd = 1.1952$) while they somewhat disagree that the OneStep is efficient ($mean = 4.1250, sd = 1.8077$). We also conduct a Tukey's Test to find out the degree of the Honest Significant Difference (HSD). We found out that the $HSD = 1.875$ at 95% confidence interval. This tells us that each of the means obtained are not really significantly different to each other as shown in Figure 4.3.

4.3.3 Degree of distraction

The Table 4.3 shows the participants' responses for degree of distraction, while Figure 4.4 shows the mean level of agreement on the degree of distraction of each animations.

	P1	P2	P3	P4	P5	P6	P7	P8	mean	sd
OneStep	3	7	6	2	4	6	5	4	4.625	1.685
SimultaneousStep	2	2	2	2	2	2	2	5	2.375	1.0607
MultiStep	3	4	6	5	5	6	2	4	4.375	1.4079

Table 4.3: Results for degree of distraction: how distracting is each page turning animation?

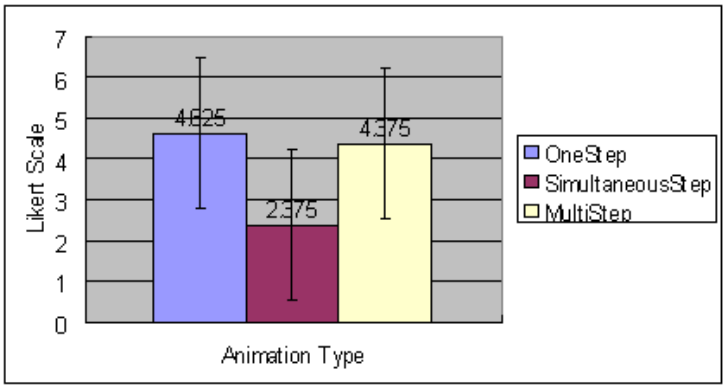

Figure 4.4: The means of the level of agreement on the degree of distraction of each animation

The means of the level of agreement on the degree of distraction factor for the animations are quite significantly different ($F_{2,14} = 6.157, p < 0.05, actualp = 0.012$) with SimultaneousStep being perceived as the least distracting by the test participants ($mean = 2.3750, sd = 1.0607$). Test participants somewhat disagree that MultiStep is distracting ($mean = 4.3750, sd = 1.4079$) while they somewhat agree that the OneStep is distracting ($mean = 4.6250, sd = 1.6850$). We also conduct a Tukey's Test to find out the degree of the Honest Significant Difference (HSD). We found out that the $HSD = 1.840$ at 95% confidence interval. This tells us that each of the means obtained are quite significantly different to each other as shown in Figure 4.4.

4.3.4 Participants' preferences

We found that 50% of the test participants prefer SimultaneousStep animations to aid page turning while reading, 37.5% of them prefer MultiStep animations, and 12.5% of them prefer the OneStep animations.

We also asked them to order the three animation systems in terms of efficiency, intuitiveness and degree of distraction.

For efficiency, we found out that 75% of the test participants rate SimultaneousStep as the most efficient, followed by MultiStep, with OneStep as the least efficient. 25% of them rate MultiStep as the most efficient, followed by SimultaneousStep, with OneStep as the least efficient.

For intuitiveness, we found out that 62.5% of the test participants rate MultiStep as the most intuitive, followed by SimultaneousStep, with OneStep as the least intuitive. 37.5% of them rate MultiStep as the most intuitive followed by SimultaneousStep, with OneStep as the least intuitive.

For the degree of distraction caused by the animations, we found out that there are high variations in the opinions within the group of test participants. 37.5% of the test participants rate MultiStep as the least distractive, followed by OneStep and SimultaneousStep as the most distractive. 12.5% of them rate SimultaneousStep as the least distractive, followed by MultiStep, with OneStep as the most distractive. Another 12.5% of them rate OneStep as the least distractive, followed by SimultaneousStep, with MultiStep as the most distractive. Another 12.5% of them rate SimultaneousStep as the least distractive, followed by OneStep, with MultiStep as the most distractive. And yet another 12.5% of them rate MultiStep as the least distractive, followed by SimultaneousStep, with OneStep as the most distractive. The final 12.5% thinks that SimultaneousStep is the least distractive, with MultiStep and OneStep are equally most distractive animations.

Chapter 5

Discussion, future work and conclusion

5.1 Discussion

Our evaluation results indicate that most of the test participants like the SimulatenousStep animation the most. Although the minimal number of the test participants might not represent a sample size of the whole population, we believe that this will give an initial insight into musicians' opinions regarding the three animations.

There are no any additional comments given by the test participants for OneStep and SimultaneousStep animations. However, interestingly, some of the test participants did comment on MultiStep. One participant praised MultiStep, saying that 'the intuitiveness of the animation method in Task 3 is really good'. One participant said that the 'animation method in Task 3 is prone to mistakes, but that might be a matter of getting used to it'. Another participant thinks that MultiStep would be better if it has slower turning speed.

Some of the also made a comment regarding whether there is any difference reading with using page turning animations or none at all. Some of the participants prefer reading with an aid of page turning animations. One participant commented that 'it is fine as long as the animations run quick and is not too flashy'. Another participant prefered reading using animations as 'the change does not seem so abrupt'. Some other participants commented that there is not so much difference and animation does not really gain any benefit other that giving a 'cool' image. They actually opted for reading with no aid of page turning animation at all when it comes to reading efficiency.

However, we need to keep in mind that the evaluation tasks are that of reading a text of a novel, not sight reading a music scores. So this should be look into further for our one of future work. Of course, with sight reading music scores, the performer may have a very limited window of time for triggering a page tirn, so the abrupt change in page turning would be unsuitable for a music

system.

5.2 Improvements and future work

Although we have learnt a lot of things from the evaluation and received a lot of great feedback from test participants, we still have things to do given the time. The first thing we need to do is to implement the animations onto Espresso Latte. And then the evaluation could be implement the animations with timers. We could further improved the evaluation process by evaluating the animations in a musician's sight reading tests.

It is also good to find a way to find an objective measurements because objective measurements although they are harder to obtain because task time does not really say much about the effectiveness of animations.

During the duration of the project, we have also identified many improvements that can be done on digital music stands, especially Espresso.We think that Espresso could be furthered improved by having it to handle an even more general animation. This means we have to look into how each page turning performs with respect to the screen resolutions of the digital music stand. There might be some applications where a digital music stand is used in a relatively large screen. This may especially benefit to the understanding on how a digital music stand work in orchestral type of scores for conducting, where the music scores are really big and a vertical page turning is not an option in this situation.

There might be also some applications where a digital music stand maybe useful in a situation where musicians needs to carry a relatively small screen, such as in a marching band. With the emergent era of portable systems like iPhone or iPhone Touch and many touchscreen music player. This may especially benefit to the understanding on how a digital music stand work on a small screen (in the likes of iPhone, iPodTouch and other emerging mobile devices) and how musicians would interact with.

Having to aim for a general page turning system will also mean we have to research and investigate the many different types of different kind of music notations, page formats in different genres, from a proper and formal orchestral format to the very casual "lyrical book" format, where the music scores is nothing but chord progressions and lyrics.

Different instruments also have different musical notation culture. For instance, a guitar has a proper music notation format but also it has a tablature format to help a more beginner to learn how to play guitar. Different genres also have different types of music scores and notations. For instance, in a jazz world, there are the existence of a 'real book' and 'fake book'. Also, it might be worth looking at the ridiculously written music sheet that do not follow the normal format (eg. with having many music systems).

5.3 Conclusions

In conclusion, We have learnt that there are still plenty of improvements that can be done to improve digital music stands. The improvements that we concentrate most on in this project is the multi-page view and its three proposed page turning animations: OneStep, SimultaneousStep and MultiStep. We found out, that using animation for page turning is more efficient in aiding musicians than the current page turning techniques: the half-page preview technique. We also found out that test participants prefer SimultaneousStep the most.

We felt that our evaluation of the animations is not perfect because we did not successfully carry out the implementation of the animations, and thus, we were not able to ask musicians to evaluate it. However, we are convinced that our evaluation provides the a solid starting point for further research in page turning animations and in the research field of digital music stand in general.

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