A Comparative User Study of Two Methods of Control on a Multi-Touch Surface for Musical Expression

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ABSTRACT

Mapping between musical interfaces, and sound engines, is integral to the nature of an interface [3]. Traditionally, musical applications for touch surfaces have directly mapped touch coordinates to control parameters. However, recent work [9] is looking at new methods of control that use relational multi-point analysis. Instead of directly using touch coordinates, which are related to a global screen space, an initial touch is used as an 'anchor' to create a local coordinate space in which subsequent touches can be located and compared. This local coordinate space frees touches from being locked to one single relationship, and allows for more complex interaction between touch events. So far, this method has only been implemented on Apple computer's small capacitive touch pads. Additionally, there has yet to be a user study that directly compares [9] against mappings of touch events within global coordinate spaces. With this in mind, we have developed and evaluated two interfaces with the aim of determining and quantifying some of these differences within the context of our custom large mutli-touch surfaces [1].

Keywords

Multi-Touch, User Study, Relational-point interface

1. INTRODUCTION

The use of mutli-touch surfaces for musical applications has a well-developed history, with work such as Toshi Iwia's "Composition on the Table" [4], and applications like the AudioPad [8], the reacTable [6, 5], and multiple applications on the Bricktable [1, 2]. Many of these instruments use fuducials, or objects that provide X-Y location, point acceleration, unique IDs, rotation, and rotational acceleration. While these objects provide more data than is available from a single touch event, and allow for more complex mapping schemes, it is possible to gain similar additional data from touch events by leveraging the relationships between an initial point and subsequent points [9]. The aim of this research is to determine if this type of relational control can afford musicians' greater creativity with respect to multi-touch interfaces.

This paper describes two software interfaces developed during the course of this research, and reports on the user study used to evaluate the interfaces. Following this, the experiments are described, including the process, participants, and results. These results are then discussed in a broader context, and will show that although the increased complexity of the relational interface was more challenging to learn, it allowed participants to be more creative while at the same time promoting greater exploration of the sonic space.

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2. XY AND ANCHOR POINT

The applications and user study were run using the Bricktable, a 50" rear diffuse illuminated (DI) custom-built multi-touch table. The first of the two interfaces is designed to allow for polyphonic control of a basic sine oscillator synthesizer using a global coordinate system. This interface provides similar control to existing single point X-Y surfaces, for which a touch event provides values for its X and Y position. The second interface is designed to control the same single oscillator synthesizer, however, control values are derived from the relationship between an anchor point (initial point), and the location of satellite points (subsequent points). This second interface creates a local coordinate space and provides an increased number of control data sources that can be used for expressive mappings to parameters. Furthermore, these control data streams are interdependent of one another, allowing for all parameters to be modified simultaneously in an organic manner.

2.1 Mapping

2.1.1 Mapping using global XY position

This first interface allows the user to control two parameters using the position of their fingers. Each finger placed on the table creates a note with the global X position controlling the pitch of the oscillator, and the global Y position controlling the volume of the oscillator. As the X position increases from left to right the pitch ascends, and as the Y position increases from top to bottom, the volume increases. The interface visually conveys this relationship by displaying a circle at the location of the touch event, and drawing rectangle between the top left corner of the screen (0,0 in the global coordinate space) and the location of the touch event (See figure 1)

2.1.2 Mapping using a local Anchor Point

The second interface also allows for the control of two parameters, however, this time local relationships between an anchor point and subsequent satellite points are used as control sources. The angle and distance between a satellite point and the anchor point control a note, with angles mapping to pitch, and distances mapping to volume. With respect to the anchor point, the pitch has a range of four octaves, with the lowest note directly underneath the anchor point, and the starting octave being determined by

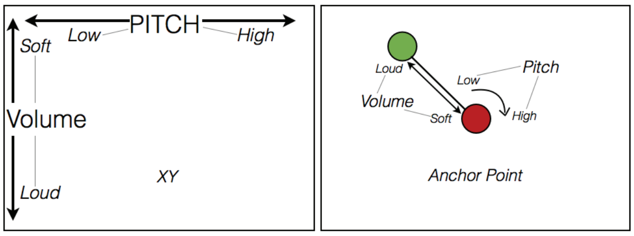

Figure 1: XY, and anchor point interfaces

the location of the anchor. The pitch ascends as the satellite point is rotated clockwise around the anchor point, and eighty percent of the volume range is controllable within the average span of a person's hand.

This local relationship between the anchor point and satellite points can provide new control data streams. For example, the average angle and average distance of all satellite points to the anchor point, as well as the maximum angle and maximum distance of all satellite points to the anchor point. These additional control sources were not used during the user study in order to minimize the variables when comparing the two interfaces.

The interface visually represents this relationship by displaying a circle where a finger is placed. These circles differentiate the anchor/satellite relationship through colour, green representing a satellite point and red representing the anchor point. A circular diagram surrounds the anchor point to show the pitch increments in angle.

2.2 Software

The interfaces use the Java based language Processing, with TUIO [7], and OSC [10] providing the communication between various applications. TUIO communicates with the open source multi-touch tracker CCV, and OSC sends synthesis control data to Reaktor.

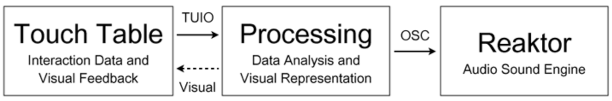

Figure 2: Data communication

3. EVALUATION

The study had participants freely exploring each interface for up to two minutes, and then completing four simple tasks designed to test specific aspects of each interface. After completing these tasks, participants were asked about their experiences with the two interfaces.

3.1 Participants

The user study consisted of twelve participants comprising a mix of students and lecturers from both music and computer science backgrounds. Eleven of the twelve participants played some form of musical instrument. Additionally, while nearly all participants had had at least some prior experience with multi-touch interfaces, only five participants had used them to make music. All participants were unpaid volunteers.

3.2 Method

3.2.1 *Pre-Survey Questionnaire*

The pre-interview questionnaire confirmed the participants consent to the experiment, as well as personal questions about their age, level of understanding, prior experience working with touch-table surfaces, and familiarity with musical concepts and instruments. These questions were designed to provide information about the participant's potential understanding of the interfaces.

3.2.2 *Interaction with Interfaces*

Firstly, each participant was asked to freely explore the interface without any specific task. After approximately two minutes, the interface interaction was explained to the participant with the experimenter demonstrating each parameter. The participant would then be asked to complete four tasks. The first task was to make a chord on the table. The second task was to create a chord on the table using both hands, and then remove both hands and attempt to make the same chord again. The third task was to hold a chord in the left hand while playing a melody in the right hand. The final task was to have a free improvisation on the table. The participant then discussed the two interfaces and completed the questionnaire. Additionally, the order of the interfaces was alternated between each participant in an effort to try and eliminate any bias this may have added to the results.

3.2.3 *Post-Interview Questionnaire*

The post-interview questionnaire asked the participant to critically compare the two interfaces. These questions examined eleven different aspects of the interfaces such as intuitiveness, learnability, control, mapping, creativity, visual reference, repeatability, exploration, applications and fun. Each participant was asked to rate the two interfaces on these aspects using a scale of 1 to 10, 1 being barely/not very and 10 being a lot/very. They were then asked to discuss any differences between the two interfaces and the reasons for their answers.

3.3 Results

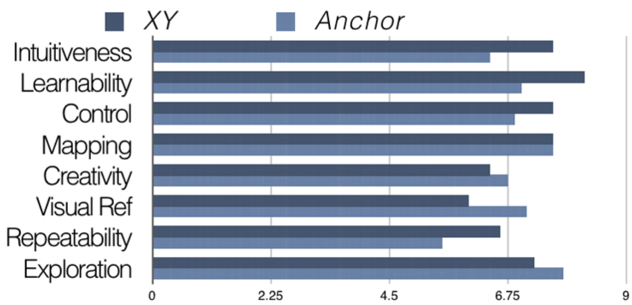

Figure 3: Overview of results

3.3.1 *Intuitiveness*

Participants were asked how natural and organic each interface felt, and to describe any differences they discerned between the two? Most participants found both interfaces to be quite intuitive, with the average response of 7.6 for the XY interface and 6.4 for the Anchor Point interface. Of the two, the XY interface was described as more familiar and transparent, with participants attributing this to simplicity of control and an easy learning curve. The Anchor Point interface was found to be slightly less intuitive as it took some time for most people to learn how to control the parameters. The relationship between an angle and a pitch was something that most participants hadn't encountered before. The requirement of placing an anchor point before sound could be made also required understanding of an extra parameter.

3.3.2 Learnability

Participants were asked how challenging each interface was to learn, and to describe the main difference between the two? The average rating for XY was 8.2, while the Anchor Point interfaces averaged 7.0. Most people found the controls of the XY interface were very simple to learn whereas, the Anchor Point interface proved to be more complex, requiring an understanding of the relationships between satellite points and a relative anchor point. Even though the Anchor Point interface had a significantly lower average, this rating was still high and both interfaces proved to be relatively easy to learn.

3.3.3 Control

Participants were asked to rate the ease of control for each interface, and to describe the main difference between the two. The ease or difficulty of controlling the sound on each interface highlights pronounced differences between the two. The participants' scores were quite even with the average for the XY interface scoring 7.6 and the Anchor Point Interface scoring 6.9; however, the reason why the interface was easy to control was different for each. The XY interface was easy to control because it had simple parameters that were familiar and intuitive. However, most people found it hard to control the pitch precisely, with the degree for error being very high and each pitch only occupying a small, fixed space along the X-axis. In contrast the Anchor Point interface was found to be harder to control for some people as the physical action of rotating the hand "was useful but not easy to do." However, as people explored the interface more, they used the full range of the space, which allowed them to have much more control of the angle. As they moved the satellite points further away from the anchor, they were able to control the pitch a lot more precisely. This is because the distance between note increments becomes larger as a satellite point moves further away from an anchor point.

3.3.4 Mapping

The participants were asked if it felt as though the controls from each interface were mapped to the sounds being produced, and which mapping they preferred? Both interfaces scored similarly, with the preferred interface split equally and the XY and Anchor Point interfaces scoring 7.5 and 7.6 respectively. Most participants who preferred the XY interface's mapping liked it because of its simplicity. "It was a lot easier to know harmonically what it was going to do." Whereas, participants who preferred Anchor Point's mapping cited its freedom to move the anchor point, as well as it being interesting "because you could improvise and come up with things you didnâĂŹt expect." This parameter came down to personal choice and a clearer division might have been seen if the participants were given more time, as the ease of learning would not have impacted as much on the results.

3.3.5 Creativity

The participants were asked how much creative expression each interface allowed for, and to describe any difference between them? The XY interface had an average of 6.4 and the Anchor Point interface had a slightly higher average of 6.8. The reasons why participants found each interface to be creative were quite different. Participants found the XY interface to be easier to control, and because of this they could be immediately creative with the sounds they were making. In contrast, the Anchor Interface was found to be creative because it "offered a bigger range of things". It provided more freedom as the relational point was moveable and gave unexpected results. This freedom was felt to be essential for some people to be creative with one participant saying "I find that when your improvising its when something unexpected happens and you have to react is when your most creative."

3.3.6 Visual Reference

The participants were asked how effectively the visuals from each interface represented the relationship between interaction and sound, and if one interface provided a stronger visual references? The XY interface had an average of 6 and scored significantly below the Anchor Point interface, which had an average of 7.1. Most participants found the visual reference for the XY interface to be either confusing or unnecessary. The visual reference did not hinder their understanding of the interface but was deemed unnecessary due to the simplicity of the interaction. However, the visual reference for the Anchor Point interface was felt to help reinforce understanding of the interaction between touch events and sound.

3.3.7 Repeatability

The participants were asked how easy it was to reproduce a sound on each interface? Both interfaces scored quite low, with the XY interface having an average of 5.6 and the Anchor Point interface having an average of 5.5. Many people found that the placement of the anchor point made repeating a sound harder than the individual points of interface XY; however, some people did find the Anchor Point easier to repeat a sound due to the larger touchable area occupied by each pitch.

3.3.8 Exploration

The participants were asked how compelling each interface was, and if one interface prompted greater exploration? Both interfaces scored quite highly with the XY interface having an average of 7.3 and the Anchor Point interface having an average of 7.8. The simplicity of the XY interface seemed to make people lose interest quick; "Once I learnt it, it was fun to try and make some sounds, but because its limitations are so easily apparent it becomes a bit bland." On the other hand, the Anchor Point interface proved harder to control for most people, which made them want to explore and experiment with the interface more. Additionally, the method of control for most people was something with which they were unfamiliar, leading them to find that the anchor interface was "more interesting as you [could] create shapes and see how they relate."

3.3.9 Application

The participants were asked what sort of settings each interface might be used in. Many participants thought that both interfaces could be used in installation settings, or be quite effective as a teaching tool for both simple synthesis as well as melodic and chordal theory. Some participants also felt that both interfaces, especially the Anchor Point interface, could be used in live performance and studio work.

3.3.10 Fun

Lastly, the participants were asked which interface they found to be more fun, and why? The participants were divided regarding this question, and the reasons given were mostly ease of use and expressivity. Many people found the XY interface to be easier to use, and therefore spent more time exploring the controls. In contrast, while the Anchor Point was harder to learn, it afforded greater expression once the methods of interaction were understood.

4. DISCUSSION AND CONCLUSIONS

Before discussing these results further, it is necessary to consider the validity of these results in the context of the study that was performed. A shortcoming of this user survey is that there's a novelty factor that may influence the responses of the participants. In an attempt to minimize this, the interface that was to be used first by a participant was alternated throughout the survey. Another limitation of this survey may be the length of interaction with each interface. The Anchor Point interface requires some time to understand how it works, while the XY interface was understood almost immediately. This may adversely affect the user's interaction experience if they only allowed a short period of time to work with each interface. However, even with these limitations, the two interfaces have proven to be very similar. Both interfaces scored highly across all categories, and general conclusions can be made from the statistical results as well as the comments of the participants.

The XY interface has proven to be more intuitive and easier to learn. Most participants said that this was due to the simplicity of the parameters and their familiarity with an X-Y relationship. The Anchor Point interface is slightly harder to learn and slightly less intuitive. Most participants thought that the more complex relationship of rotation and relative position of the anchor point made the Anchor Point interface harder to learn and they were also less familiar with these relationships than the simplistic XY relationship. Both interfaces rated highly on ease of control, however, this question shows an important difference between the two interfaces. The XY interface's simplicity was the main reason given for why the interface was easy to control whereas, the Anchor Point interface has a unique feature that affords more precise control. As a satellite point is moved further away from the anchor point, the touchable area for each pitch division increases. This in turn leads to a smaller degree of error in pitch control for the user.

This feature also links into the creativity and exploration categories. Most people found that the Anchor Point interface allowed them to be more creative and encouraged greater exploration, with participants generally using more of the space during the free section. The Anchor Point interface also provided more organic control as many pitches could be played quietly to create a chord while a melody could simultaneously be played with accuracy by dragging a point away from the anchor point. In contrast, while people found the XY interface to be initially interesting, participants seemed to quickly become bored with its limitations. Once the user had worked out the limitations, they were quick to tire of interacting with the same relationship.

Interestingly, most people found it hard to repeat the same chord on both interfaces. This issue can be attributed partly to the lack of haptic feedback provided by multi-touch screens. This could be mitigated by stronger visual references for pitch divisions for these types of interface. The visual reference for the Anchor Point interface was found to be more essential to understanding its method of control, while the XY visual reference was felt to be distracting as the relationship quickly became self-evident when interacting with the interface.

With practice, the Anchor Point interface may allow more precise control as the user learns the angular relationships between the anchor point and subsequent satellite points. This would allow for greater control as well as more intuitive harmonic control as a chord shape could be inverted to create related chords. The shape of a triad can be played on the Anchor Point interface with one hand, and could be learnt and then transposed around the table. This provides an interesting alternative to the spacing of notes on the XY interface, especially when the range is large and requires multiple hands.

These results seem to indicate that although the Anchor Point interface is more complex and harder to learn, it affords more creative expression and prompts more exploration than the XY interface. The Anchor Point interface is closer than the XY interface in these aspects, to a traditional instrument, as instruments like the guitar or piano take some time to learn how to use but once learnt can be very expressive.

Both interfaces could be well suited for use on an iPad or similar surface, although the smaller screen would inhibit some of control afforded in the Anchor Point interface. The portability and popularity of these devices could promote many uses however, with use of both the XY and Anchor Point interfaces as musical pedagogical tools for aural training and recognition.

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