Investigating the Potential of a Two-finger Chord Button in Multi-touch Applications

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Abstract

With the increasing use of multi-touch (MT) capable devices, MT interaction has become a commodity during the last years. From personal devices to larger multi-user screens, MT functionality is nowadays considered as a standard way of performing rich interactions. However, moving from a single-touch interaction to a dual-touch and consequently to MT is not always without challenges for the average user. Although, the use of single-touch is very common, interaction design have yet to be examined thoroughly by taking into account potential differences of single and multi-touch functionality. In this work, we investigate the potential of a two-finger chord button in comparison to the traditional single touch buttons that we find in touchscreens. Based on the fact that users are familiar with single touch buttons (even before the MT screens) our hypotheses are: the use of a two finger chord button a) decreases users' efficiency, and b) delays users' responses. In order to investigate our hypotheses, we conducted a controlled experiment with 12 users working on an appropriately designed MT application. The empirical results have indicated that the use of two-finger button significantly delays users' response-time while it does not affect users' efficiency on the performed task.

Author Keywords
Multi-touch; chords; two-finger button; buttons; menu; chord interaction

ACM Classification Keywords
H.5.2. Information interfaces and presentation

Introduction

With the advent of multi-touch (MT) surfaces, a large number of onscreen touch manipulations and interaction patterns have been enabled. The way users' working on many onscreen tasks has changed significantly. Instead of moving the mouse and/or typing on the keyboard of a desktop pc, users apply gestures or chords or even work collaboratively on an onscreen task, taking advantages of the new affordances the MT surfaces offer. In addition, programs and their interfaces need to be shifted from the traditional window icon menu pointer (WIMP) environment to a more appropriate one for supporting MT affordances [6].

In this work, we are focused on the most basic interaction of a touch screen, the operation of soft buttons. Most studies investigated the use of touch screen soft buttons in comparison to traditional keyboard buttons (e.g. [4]). It seems that the lack of tactile feedback in soft buttons is associated with lower performance [4]. However, it is widely accepted by the vibrant MT community that MT surfaces have more to offer than simply replicating the traditional way of interacting (e.g. single touch soft buttons). According to studies that investigated the emulation of the mouse in a MT environment (e.g. [7]) tapping with placing *one or two fingers* on the screen is intuitive and often fast. Based on such studies we were motivated to investigate practical differences on a button that could be pressed with a two-finger chord interaction.

Most studies are focused on examining the size or the type of a MT button, or even investigate alternative selection techniques like interactive moving buttons (e.g. [6]) or MT menus. Researchers have also tried to find methods that incorporate the number of the fingers touched on the screen in order to select a function ([5], [1]). However, these "gestures" or chords were not associated with a functionality of a simple button. Besides, according to some studies [3] there is a strong users' preference for using one or two index fingers, even when given the opportunity to use more.

In this ongoing work we examine whether using one or two fingers to touch a button has significant effect on the response time and efficiency of the users. Hence, we conducted a controlled experiment in order to better understand whether the use of a two-finger chord button (experimental condition) has an effect on users' response-time and efficiency compared to a traditional single touch soft button (controlled condition).

Methodology

Research design

In order to be able to investigate our research hypotheses, we have developed a MT application supporting both single and dual finger buttons. In particular, our MT application was developed in Kivy MT framework [9] (next page, Figure 3). With the selection of a small number of plants that are found in our area, we created a taxonomic key with the help of a domain expert. Our MT application allows the user to enlarge and rotate the main picture of the archive, which is positioned in the center (see Figure 3). Users were also

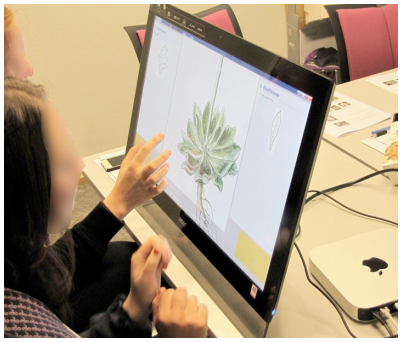

Figure 1. Photo taken during the experimental task: Users interacting with the MT application on the 27" MT screen.

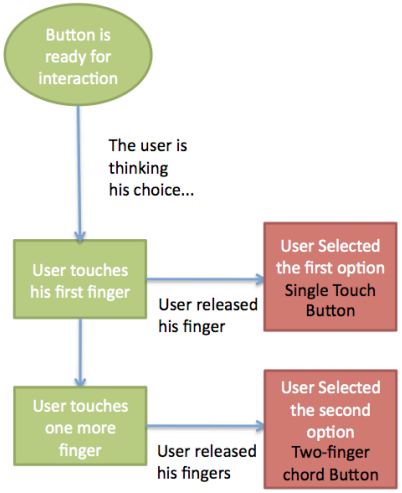

Figure 2. Interaction design of the one/two finger chord button.

able to see specific details of the plant (e.g. its sepals, blossoms). On the left/right side of the screen there is some text and the corresponding images of selection one (left) and two (right). Users have to carefully identify which of the two options corresponds to the plant they have in front of them by touching the button with one finger for the first option or with a two finger chord for the second option (as it is described just below the button). In Figure 2, the interaction design of the two-finger chord button is described. By making all the right selections in a number of steps, users are lead to the family of the plant and some interesting information concerning the plant.

Apparatus

Based on our experience with custom-based MT surfaces, we had to eliminate any factor that would influence the performance, accuracy and robustness of our installation since it would affect our results. Thus, our experimental setup was based on a robust 27" inch all-in projective capacitive monitor with 1920x1080 video analysis and 5ms response time, which was placed vertically in front of the two users (see Figure 1). The screen was connected via usb to a Windows 7 environment installed on a Mac mini hardware; our system was able to identify only 10 simultaneous touch points, but this number of touches was adequate for the purpose of our application. Users had to sit on their chairs in front of the screen and interact with the application. There was a camera just behind them capturing their interaction strategies and patterns.

Procedure

In the beginning there was an exploratory phase of the application. We wanted the students to understand what they have to do in order to reach the goal of identifying the plant species, and eliminate any potential learning effect from their experience with other applications; hence, we ended up with clear results concerning the interactions. During the warm-up phase they played as a team versus the computer and they had a team score. In order to complete the exploratory task there were 5 plants that were to be identified along with 25 questions.

Figure 3. The MT application – a step of the taxonomic key: Users have their own one/two finger chord buttons in the lower part of the screen where they make the appropriate selection (one finger for selecting the left option, two fingers for selecting the right option)

In the phase of the experiment (Figure 1), we explained to the users that there are two different territories/buttons (in dark yellow color) where they should apply one-finger touch in order to select the first alternative (left) or a two-finger touch so as to select the second alternative (right). Users had visual feedback when touching the buttons (a small circle on

the touch point) and audio plus visual feedback about their right or wrong selections.

Users were playing against each other and they were competing based on their personal total score along with their personal time that was displayed in the bottom of the screen. Since the procedure of identifying a plant is difficult, users had to carefully examine both options before making the appropriate selection.

Sampling

The sample of participants in this study consisted of 12 students. Of the 12 participants, 2 were boys and 10 girls. All of the students who participated in the experiment were 17-18 years old, enrolled in the third grade of high school, and were following the same syllabus. The experiment took place during an extracurricular activity in a museum/library in Trondheim, Norway.

Research findings

In our experiment we had 322 responses (258 correct); 218 responses (181 correct) of a single touch button and 104 responses (77 correct) of the two-finger chord button.

To examine our research hypotheses regarding the effect of a two-finger chord button (experimental condition) on users' efficiency and response time, compared to a traditional single touch soft button (control condition), we performed a t-test including users' score and response time as dependent variables and chord options as independent variables. All statistical analyses reported were conducted with a significant level of 0.05. As we can see from the outcome data in Table 1, chord selection has indicated a significant difference on users' response time while in users' efficiency we did not find any significant difference between the two alternative buttons.

	Mean (S.D.)		**T**	**p**
	Single touch (N=218)	Two finger chord button (N=104)		
Score (max 1)	0.83 (0.38)	0.74 (0.44)	1.81	0.075
Time (sec)	10.07 (7.58)	12.88 (9.06)	2.74**	0.007

*p < 0.05 **p < 0.01

Table 1. This table shows the results of a t-test with users' score and response time as dependent variables and single touch button or two-finger chord button as independent variables.

In Figure 4 (next page), the frequencies of the response time for the single touch button and the two-finger chord button are depicted. The frequency diagram is in accordance to the findings in Table 1; showing that the two-finger chord button demands significantly more time in order for the users to give their answer. In particular, we can see that we don't have any two-finger responses in the first 5 seconds after the question. In addition, in the "less than 10 second" responses, the single touch option dominates. On the contrary, in the "more than 10 second" responses, the two-finger chord button dominates.

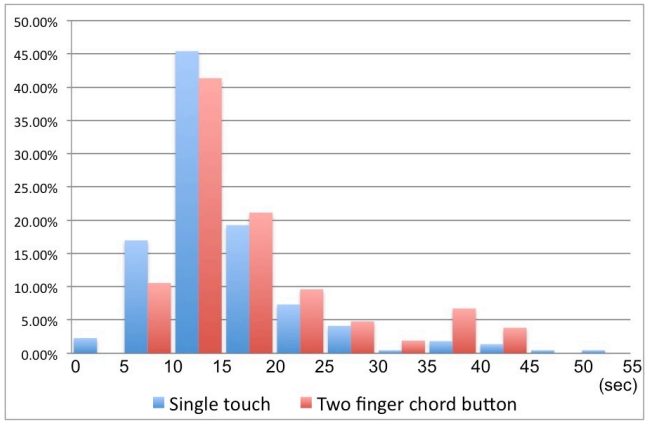

Figure 4. Frequency diagrams for single touch button and the two-finger chord button over the time (starting from questions' appearance).

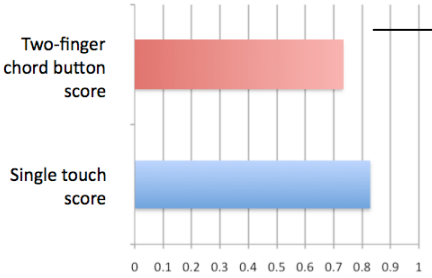

Figure 6. Single finger correct answers were 83% of the total single finger answers and two finger correct answers were 74% of the total two finger chord button answers.

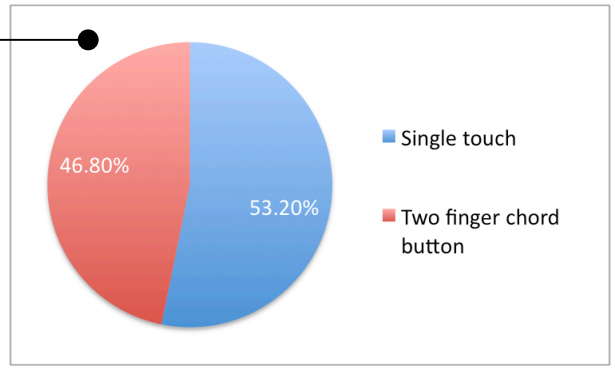

Figure 5. Right answer absolute percentage: This chart demonstrates the absolute percentage of the correct answers for the single touch button condition and the two-finger chord button condition respectively in relation to the total right answers.

On the other hand, Figure 5 shows that there is a difference in giving the right answer between the single touch button and the two-finger chord button, but this difference is small (Figure 5,6) and insignificant, as indicated from the t-test results (Table 1).

Conclusion

Trying to investigate potential challenges for casual users while moving from the traditional single-touch buttons, we decided to compare a two-finger chord button with the traditional single-touch one. Even though the two-finger chord touch has been commercially used a long time ago [2] and is widely used among users as a gesture for zoom-in or zoom-out (the pinch gesture) or as an emulation technique of the mouse right click (or usually as a context menu), it can be considered as a somewhat more complex interaction due to the slightly higher cognitive and movement load [8] compared to the single touch interaction. Thus, our initial hypothesis was that the use of a two-finger chord button might have a negative effect on users' response time and efficiency (in the case of our application that is the score of students' answers). Our preliminary findings demonstrate a difference in the number of right answers in favor of the single-touch button, however, the difference is not significantly important. The two-finger touch chord might not have been traditionally used as a button, but it is a widely used gesture for rotating or changing the size of objects on a MT surface.

Concerning our second hypothesis regarding the time needed in order to articulate the two finger chord, it seems that our initial hypothesis that the two finger chord button creates a small delay compared to the traditional single touch button was true, since we found

that the single touch button demands significantly less time from the users. Our subjects were generally more familiar with the single-touch button, especially compared with the two-finger chord one, however, they had experience with MT devices and by performing a warming-up (training) period we reduced any potential learning effect.

In this study, the subjects were told how the two-finger chord actually worked well and allowed them to have more options in a limited single button area. In our future studies we will examine further the use of a two-finger chord button in MT applications by investigating its ideal size and functionality, while trying to find ways so that the two-finger chord button interaction being intuitive and more effective for users that work on a MT screen. In addition, we will attempt to investigate users' time response and efficiency in more demanding interactions (e.g., more than two-finger buttons). By doing that, we will be able to find the design thresholds and apply them in more complicated chord actions and menus.

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