Usability of Back of Device Virtual Buttons

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ABSTRACT

Back of device touch screen capable game systems have been commercially available since the release of the Playstation Vita in 2012, however the use of these touch screens in games has been limited. With the release of the touch screen lacking Playstation Vita TV, it seemed as though the use of the second touch screen would become even less common as developers produce games with features common to both platforms. Back of device touch was revived with the release of the Playstation 4 with the purpose of mapping DualShock 4 inputs unavailable on the Vita to sections on the back of the device during remote play. This paper seeks to understand the limitations of using back of device touch screens for game input. Four selection tasks involving a total of 30 participants compared the reaction times and accuracy for 13 different back of device touch region layouts. The results found that the usability of the back touch screen on a Playstation Vita was in line with standard game controllers and the performance significantly decreased when 12 or more virtual buttons were present.

Categories and Subject Descriptors

H.5.m [**Human Centered Computing**]: Graphics Input Devices; Pointing Devices; Touch Screens

Keywords

Playstation;Vita;Fitts;Back;Touch;Interactions;Usability

1. INTRODUCTION

When the Playstation Vita (Figure 1) was released in early 2012, it offered unique input control mechanisms. In addition to containing standard mobile input mechanisms such as a touch screen, microphone, and accelerometers, it also included standard dedicated mobile gaming device controls such as thumbsticks and dpads. The combination of these two standard device controls was enhanced by also offering a touch screen on the back of the device.

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Figure 1: Playstation Vita and its Back of Device Touch Screen

Playstation Vita games offered different control options which typically included options to either use or not use the touch screen on the back of the device. Although all games released for the hardware platform could take advantage of the second touch screen, very few relied on it as the only control mechanism.

Sony announced the release of the Playstation Vita TV [14] in 2013. This device would be compatible with games released for Vita, however it displays on a TV and uses a DualShock 3 as a controller. Developers wishing to release a game to the highest population of consumers would release a game that functioned properly on both a Vita and on a Vita TV. This could mean future games would not contain control features specific to the Playstation Vita as it would be difficult to maintain both methods of control. Developing a game that required Vita second screen touch would alienate the population who only owned a Vita TV from potential purchasers.

The release of the Playstation 4 found a new use for the back of device touch screen on the Playstation Vita. Playstation 4 features Remote Play [13], the ability to mirror the contents of the Playstation 4's display on the Vita display. In addition to mirroring the video feed, Remote Play also allows players to use the Vita as a controller. This feature makes it possible for a gamer to play Playstation 4 games in the living room using the Vita, while the main TV is used for viewing other

content. The games played on the Vita are the same as the Playstation 4 version, there is no mobile specific content, or any major change in game play. However, the DualShock 4 controller included with the Playstation 4 contains more input options than are available on the Playstation Vita. Thus, the back of device touch screen has been used to mimic these missing inputs to provide players the same gaming experience regardless of when playing on the Vita or on an actual Playstation 4 using the DualShock 4 controller.

Commercial games utilizing the back of device for touch input offer from one to eight virtual buttons on the back touch screen. This paper seeks to find limitations of utilizing the back of device touch screen for gaming purposes. The commercial uses of the back touch screen is analyzed in current Playstation Vita Games and Playstation 4 Games using Remote Play. A piece of software was developed to mimic the current uses of the second touch screen as well as to measure the possibilities of expanding its use. A user study evaluated the software and the results are analyzed.

2. PREVIOUS WORK

One of the reasons why back of device touch might be necessary is that users may cover up important portions of the screen with their finger as they attempt to navigate the interface. Commonly known as the Fat Finger [11] issue, other approaches besides back of device touch have been attempted, such as Shift [12], which enlarges the portion of the screen underneath the user's finger and moves it away from the finger to allow the user to see what is beneath.

Back of device touch is a fairly new concept in commercial products, however its use has been evaluated in previous research. One research project, Double-side Multi-touch Input for Mobile Devices [10], investigated the use of touch gestures on both the front and rear touch screens for new interactive techniques to manipulate 3D objects. Their work displayed circles representing the active touch points on the back of the device overlaid on the top video display in order to show users where their fingers were during gesturing. HybridTouch [15] uses back of device touch input to scroll a map, while using the front touch screen for target selection.

Yang et al. [18] also utilized both sides of the touch screen in Dual-Surface Input research project. Their research compared acquisition times for front touch, back touch, and simultaneous dual surface touch when attempting to select different sized targets. Their study contained a total of 1296 data points and found the average selection time to be 4.38 seconds. The dual surface touch method performed better than the back of device only touch method and the back of device touch method outperformed the front of device shift selection method.

Baudisch et al. [1] looked into size constraints in small touch screen devices. Their research hoped to find a screen size where front touch input was worse than back touch input due to a user's finger covering most of the screen, and even using a technique such as shift would not be possible. Their results found that back of device interaction performed better for devices 0.6 inches across and smaller.

Back of device navigation was investigated in Back-of-Device Authentication on Smartphones [2]. In this study, a touch screen affixed to the back of a cell phone was used to enter a secure password by means of hidden gestures on the back of the device. A portion of the study showed users a four by two grid of eight targets and instructed the users to touch at location one and then drag to location two. The results showed combined first point and second point accuracy to be just over 70%. Other studies looked at back of device vs front of device touch gestures [17]. This paper is looking at touch interactions of virtual buttons contained within video games, not gestures.

Back of device touch has also been used in implementing new styles of keyboards. A mechanical version of the concept, RearType [9] physically attached a standard QWERTY keyboard to the back of a tablet screen. The keyboard was broken in half and each half was placed vertically along the sides of the tablet such that when it was held in landscape mode, the keys were easily accessible with the fingers. After a training session, it was found that RearType achieved an average of 15 words per minute. Sandwich Keyboard [8] investigated the use of a keyboard input method where the thumbs provide input on the top touch screen, and the eight remaining fingers type input from the back of device touch pad. Their method featured floating targets that adapted to a user's grasp style. They found users could accurately type using this method and after training could reach speeds up to and even exceeding traditional keyboard input methods.

Different types of back touch screen interactions were investigated by Hasah et al. [3]. Their study looked at performance differences between relative and absolute back of device cursor positioning. They found the relative positioning was significantly better performing than the absolute positioning. Another approach to including a reference pointer device on the visible screen includes LucidTouch [16], where the visible screen appears semitransparent allowing the full outline of the hand behind the screen to be visible. This approach has also been proposed in a commercial android based smart phone [5]. For games, however, this may not be desirable as the cursor or hand skeleton may be distracting to players.

3. BACK OF DEVICE TOUCH USE IN COMMERCIAL PRODUCTS

To better understand how back of device touch is being used commercially, its use in the Playstation Vita is investigated. The Vita can be used to play games designed for the Vita hardware, and it can also act as a controller for the Playstation 4 when running in remote play mode. Specific uses of each of these modes are analyzed and described below.

3.1 Back of Device Touch Use In Playstation 4 Remote Play

A very common scenario for mapping buttons in remote play while controlling PS4 games from a Vita is to split the back of device touch screen into two vertical halves. These halves represent the L1 and R1 buttons that are present on the DualShock 4 controller but not present on the Vita. Games such as *Assassin's Creed IV* use this control substitution method.

Level	Rows x Cols	Height x Width (mm)
1	2 x 1	25.8 x 90.3
2	1 x 2	51.6 x 45.1
3	1 x 3	51.6 x 30.1
4	3 x 1	17.2 x 90.3
5	2 x 2	25.8 x 45.1
6	2 x 3	25.8 x 30.1
7	3 x 2	17.2 x 45.1
8	2 x 4	25.8 x 22.5
9	4 x 2	12.9 x 45.1
10	3 x 3	17.2 x 30.1
11	4 x 3	12.9 x 30.1
12	3 x 4	17.2 x 22.6
13	4 x 4	12.9 x 22.6

Table 1: Grid Layout and Sizes

While playing *Angry Birds: Star Wars* in a Remote Play configuration, players can control the birds using the front and back touch screens. Instead of mapping missing DualShock 4 buttons to back touch areas, players can swipe and pull using the back of device touch screen just as they can while using a standard cell phone interface.

Games such as *Resogun* split the back touch screen into four quadrants. When any of the quadrants are touched, a semi-transparent small window pops up on top of the gameplay and shows an outline of the four quadrants, and also highlights the selected quadrant. This can give a player an indication if he is pressing in the desired quadrant, and if he is not he can adjust accordingly.

3.2 Back of Device Touch Use In Playstation Vita Games

The back of device control options vary based on the game. Some games do not utilize the back of device touch screen at all. Others offer the option to use it, but the back of device touch screen is not part of the default control mechanism. Several games do make use of it and some of them are listed below.

Wipeout 2048 contains a basic use of the 2nd touch screen. Players can add thrust (acceleration) to their vehicle by pressing anywhere on the back of the device. This binary pressed or released state input will either accelerate the vehicle, or not.

Asphalt Injection is a racing game that splits the back of device touch area into two vertical halves. Pressing in the left area will down shift, and pressing in the right area will shift into higher gears. Similarly F1 2011, also a racing game, splits the rear touch into two vertical halves, but the right side acts as a binary gas pedal and the left side acts as a binary brake pedal.

Back of device touch is also used in special environments. For example. in *Uncharted: Golden Abyss* the back touch screen is used for climbing ropes. In *Dynasty Warriors Next*, players can use the back touch screen to throw bombs and trigger explosions.

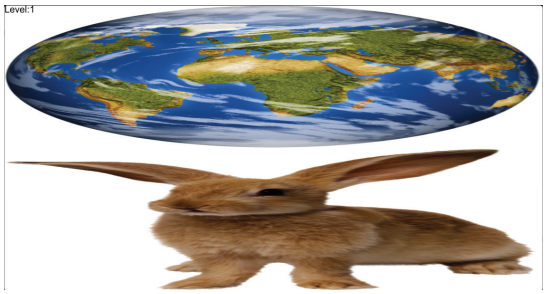

Figure 2: Level 1 Splash Showing Stretching of Target Icons

The most interactions on the rear touch screen can be found in the 2D fighting game *BlazBlue: Continuum Shift Extend*. This game allows players the option to configure the back of device touch screen in a variety of configurations. One configuration allows the player to set up to eight buttons arranged in four rows and two columns and map these touch buttons to physical buttons. Another configuration option allows players to make combo buttons using the back touch screen. For example, touching anywhere on the right side of the rear touchscreen will execute the combo of pressing the buttons A + B + C + D with one touch.

4. BACK OF DEVICE TOUCH RESOLUTION EVALUATION (IPODS)

Two types of software were created to analyze how players access the back of device touch screen. The first set of applications were developed and analyzed by attaching two iPod touches together, and the second set of applications were developed and analyzed by running on a Playstation Vita. Specifically they were designed to analyze the touch resolution of how players interacted with different regions on the screen. This section analyzes the usability of two iPods attached to each other, and the next section analyzes the usability of tests performed on the Playstation Vita.

4.1 Software

As performed in a previous study [2], two iPod touches were attached back to back in order to simulate a device containing two touch interfaces. The two devices communicated over bluetooth using the iOS GameKit framework. There were two pieces of software created for this experiment, one for the back of device touch, and one for the front screen graphics presentation. The back of device program simply relayed all touch events to the application running the front screen display over bluetooth.

The main application displayed graphics and handled touch events. Outside of the initial setup, all touch events on the front touch screen were ignored and the system relied only on the touches occurring on the back of the device.

4.2 Direct Press

The first application, Direct Press, highlighted different regions on the screen, and the user was required to touch that region by touching on the back touch screen. Quick play was encouraged by rewarding players more points the quicker

Figure 3: Level 13 Splash Showing All Icons in 4x4 Grid

Figure 4: Level 5 Gameplay Showing Missed Targets

they pressed in the correct location. Accuracy was encouraged by subtracting points from the player's score if a press was detected in a non highlighted location. The game contained 13 levels, each increasing in difficulty by highlighting smaller and smaller areas to touch on the screen. The timing for all touch events both correct, and incorrect were logged for later analysis. Player were awarded points based on how quickly they were able to correctly react to the highlighted space. Points started at 10000 for each target and were decremented one point for each millisecond it took the user to complete the task. Selections taking longer than 10 seconds were awarded zero points. Incorrect selections resulted in players losing 5000 points. The player display contained a current level indicator.

The first level highlighted one of two regions within the screen. The screen was split horizontally down the center, and the user was presented with one side colored in red, while the other side remained white. Once the player touched in the red zone by using the back of device touch screen, he was presented with the next target located on a random side. The user was required to touch ten targets correctly while playing levels 1-4, and twenty targets correctly in levels 5+ in order to move to the next level. Later levels containing a finer grid and more selectable areas required the successful acquisition of more targets. It was desired for the the player to have a good chance to select targets in all locations represented by the level grid and still maintain displaying the targets in a random sequence.

The layouts of the rest of the levels were split into different grids (Table 1). Only one space on the grid at a time would be shown, and it would remain highlighted until the player correctly touched the highlighted region.

4.3 Associated Press

The direct press method allowed players to have a visual representation on the main screen and were required to press in the same region on the back touch screen without any type of physical guidelines. This can help deduce the resolution that players can touch, however it does not address the cognitive load involved with using different regions for different tasks. As shown in the current use in video games, players can map up to eight functions on the back of device touch screen, but it is not known if players can remember what actions are mapped and where they are physically located on the touch screen. To analyze this further, an application was created to test associated presses.

In the Associated Press game, players played through the exact same level progression as the Direct Press game, however the graphical display was modified. Instead of seeing a highlighted region on the screen and being required to press directly on the back of the device, players were presented with an icon and were required to press the location associated with that icon.

Prior to each level starting, players were shown a grid with a different icon located in each region available for that level. Target icons were stretched to fill up all space within the active touch region (Figure 2). The icons for the 4x4 grid in the final level are shown in Figure 3. The player could study the grid layout as long as he desired, and once confident of the layout, a press on the back of the screen would hide the layout and present the player with the target icon in the center of the screen. The player would then be required to press in the region containing that icon in order to be presented with the next icon. If a player pressed in the incorrect location (Figure 4), the icon contained within that grid space would be shown and would remain visible until the player choose the correct location. The grid locations of the icons was always in the same sequence with the new icons being added to the end of the list. This was done to mimic some of the learned behavior in video games. In video games it is common that controls start out simple and are built on as the player progresses throughout the game. In this study, players are first given a grid that contains only two icons, and then the number of icons is extended as the number of grid spaces is extended.

As with the Direct Press game, players were shown a score at the conclusion of 13 levels of play. The score was based on how quickly and accurately they chose the correct grid space. The score was not relevant to the study outside of the fact that it encouraged players to try their hardest to perform quick and accurate moves. At the conclusion of the game, players were shown their score as well as the highest score achieved so far.

4.4 iPod User Study

Two different user studies were performed. One for the Direct Press method and one for the Associated Press method. Although different users participated in each study, the execution of each study was the same. Graduate and undergraduate students were recruited at random to participate in the study. None of the users reported any types of impairments that might affect their ability to perform the tasks.

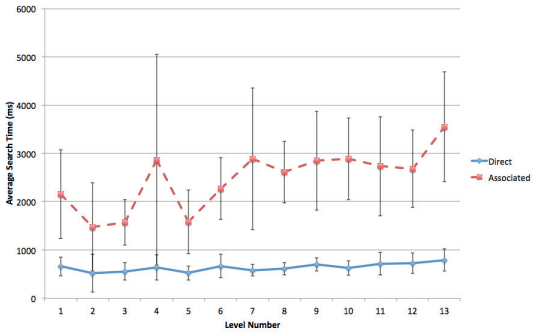

Figure 5: Average Search Time (ms) Per Level

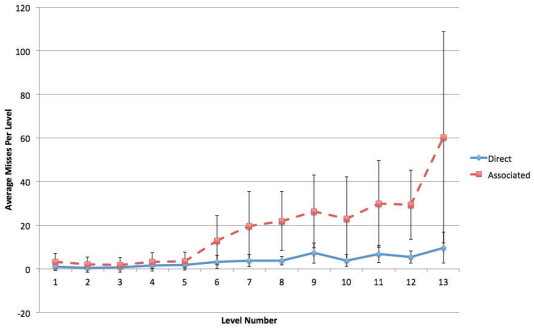

Figure 6: Average Misses Per Level

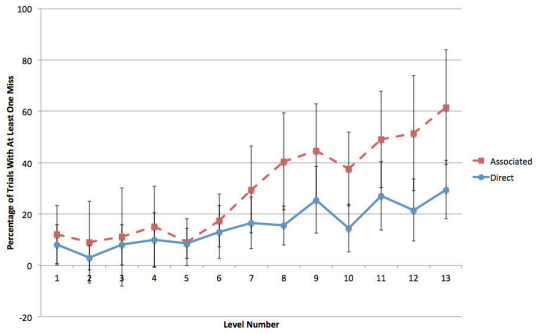

Figure 7: Percentage of Trials Per Level With At Least One Miss

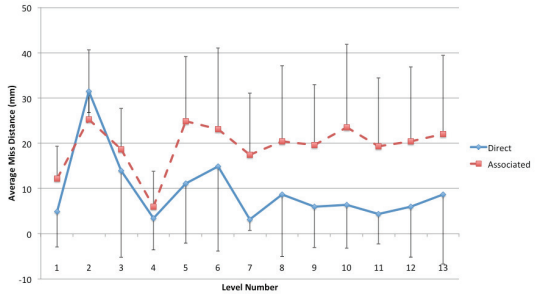

Figure 8: Average Distance (mm) From Target

Each participant performed their session in a one on one environment with only the study administrator present. Players were first explained the details of the version of the software they were using. Players were to hold the phone while the explanation was taking place, and when the requirements were understood, the user started the study by tapping on the back touch screen. The user then proceeded to complete all thirteen levels of difficulty and was presented with a game over message as well as a score once level 13 was completed. Players using the Associated Press version of the game were given a little more explanation as the concept was a little bit harder for players to initially grasp.

In total, each player played through 13 levels and correctly acquired ten targets in levels 1-4 and twenty targets in levels 5-13 for a total of 220 targets. Each study contained 10 participants for a total of 2200 targets successfully acquired in each study. The number of targets was more than the 1296 contained within the Yang [18] study.

4.5 iPod Results

The results of the study were broken down into several pieces. First, the search time for each level and each method is analyzed, then the number of misses for each level and each method is analyzed, and finally the distance from the target when a miss occurs is analyzed.

4.6 Average Search Time

For each level, the average search time for all targets for all users was calculated and shown in Figure 5. The average search time for all levels was higher for Associated Press when compared to Direct Press. Total average search time across all levels was 639.83 ms (SD=82.45) for Direct Press and was 2471.16 ms (SD=624.13) for Associated Press. On average for all levels, Associated Press was longer by a factor of 3.83 (SD=0.72).

4.7 Average Miss Rate

For each level, the total amount of misses for all targets for all users was calculated and shown in Figure 6. The calculation for a miss was based on the total number of incorrect attempts for each target, not the number of targets that were incorrectly chosen. For example, if a player selected the incorrect grid location 5 times for a single trial, the miss value would be 5, not the boolean 1. The average number of misses per level across all levels and all trials for Direct Press was 3.79 misses (SD=2.84). For Associated Press that average was 18.25 (SD=16.76). On average for all levels, Associated press had a higher miss rate than Direct press by a factor of 4.37 (SD=1.67). However level 13 had a higher Associated Press miss rate by a factor of 6.23. It was found that across all levels, 29.91% (SD=18.57) of the Associated Press trials contained a miss target, compared with 15.42% (SD=8.27) for Direct Press (Figure 7).

4.8 Average Miss Distance

When a miss occurred, the distance from the target region was measured and recorded (Figure 8). This distance is the shortest distance from the touch point to an edge of a region, not the center of the desired region. The highest average miss distance per level was 31.48 mm (SD=4.67) for Direct Press and 25.31 mm (SD=15.34) for Associated Pres. These both occurred during level 2 where the screen was split into vertical halves resulting in a large distance for

any incorrect response resulting from the user incorrectly choosing the wrong side of the screen. Some players may not have completely understood how to play the game until errors were made on the second level. Across all levels, Direct Press averaged 9.46 mm (SD=7.61) per miss, while Associated Press averaged 19.45 mm (SD=5.34) per miss.

4.9 Analysis

The large difference between Direct Press and Associated Press performance was expected. The cognitive load required for the Associated Press method contributed to the difference. Some participants would memorize the locations of the icons, and then prior to attempting a press would recite the sequence out loud while using their eyes to gaze at each grid location until the desired location was found causing a delay in selection response times.

Although the miss rates and the search times increased as the grids became more complicated, there were no outliers detected in the data sets. Both methods of control demonstrated the highest error rates on levels 9,11, and 13. These are the only levels that contain four rows in the possible grid. The average number of misses for just these levels was 38.89 (SD=18.73) misses per level and with these removed from the total, the remaining levels averaged just 12.07 (SD=10.61) misses per level. This suggests that 12.9mm may be too small of an dimension for a player to accurately touch.

Miss distances were consistently higher for Associated press after level 5. Levels 1-4 did not offer a 2 dimensional grid space. Once the grid was comprised of more than one column and more than one row, the average miss distance was higher. This could be attributed to the player's inability to correctly relate an image to its place on the grid.

The results indicate that using back of device touch for time sensitive non-reaction based interactions may produce unacceptable results. Reaction based interactions are those that are represented by the Direct Press method. For example, a game where touching the back of the device acts as a gas pedal in a racing game. As the player plays the game more, it becomes a reaction to touch the back to go and release to slow down. In a fighting game that contains eight different locations for touch events, it may require too much time for a player to choose a desired move, associate a touch location, and press the touch location. Fighting games move fast, and this process may result in a weaker player. Items such as selecting items by showing a visual on the main screen while requiring a selective touch on the back of device screen should be acceptable forms of interaction. The results show the worst performing grid layouts are those that contain four rows. Commercial games do offer grid layouts containing four rows and two columns. Commercial games requiring eight virtual buttons should consider an eight button layout consisting of four columns and two rows as this study identified that layout to be more accurate.

5. USABILITY OF THE PLAYSTATION VITA

Initial testing on the sandwiched phone setup yielded results, however this type of interface analysis has specific implications to the success of the Playstation Vita as it is currently the only mainstream gaming device with a touch interface on

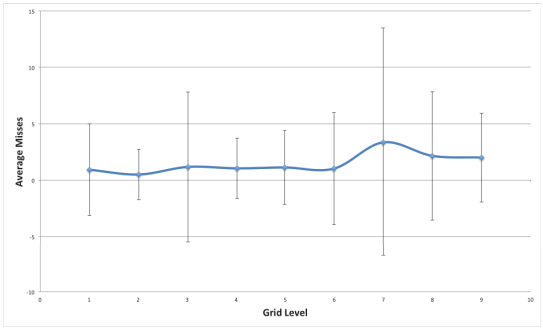

Figure 9: Average Number of Misses Per Grid Level

the back. Sony allows development on retail Vitas through the Playstation Mobile SDK. The early versions of this SDK did not allow developers access to the back touch screen. In 2014 this changed and developers without a full blown commercial SDK could access both touch screens when developing with a special build of Unity3D that was specific for PSM applications. Two applications were developed for the Playstation Vita with the specific purpose of identifying the usability of the back of device touch screen.

The first application developed sought to identify the usability of the touch screen by measuring throughput. Fitt's Law [6] explains throughput as the relationship between, selection time, distance to the target, and size of the target. ISO 9241-9 [4] provides standards to examine the usability of non-keyboard based input. This target selection application replicated an interface test described in ISO 9241-9. In this test, users were presented with a variety of targets and the time to select each target was recorded. Players playing through this game were presented with four levels of play in a random order. The levels consisted of large targets (10.5mm diameter) around a large (63mm) diameter circle, large targets around a small (38mm) diameter circle, small targets (5.5mm diameter) around a large diameter circle and small targets around a small diameter circle. The back touchscreen on the Vita is 11cm x 4.5cm, while the front display is 11cm x 6.3cm. Touch events were scaled to represent the full front display. For example, a touch at the bottom (4.5cm) of the back touch screen would be represented as a selection at the bottom (6.3cm) on the front display. The targets were presented to the users one at a time at opposite sides of the circle. For example, target 1 would be shown at the 12 o'clock position, and target 2 would be shown at the 6 o'clock position on a clock. Target 3 would then be at the 1 o'clock position and target 4 would be at 7 o'clock and so on. On the screen, players would see the diameter of the circle targets would be appearing on and the current target to select. All touches were recorded on the down press, not on a drag or release. When the player touched down on the back touch screen, a small icon was shown on screen to indicate the location of the touch. If the target was touched, it was removed from the screen and the next target was shown. Players continued selecting targets until all four levels had been completed.

The second application sought to identify the accuracy and time spent using virtual buttons on the back of the device. This is similar to the object matching task described ear-

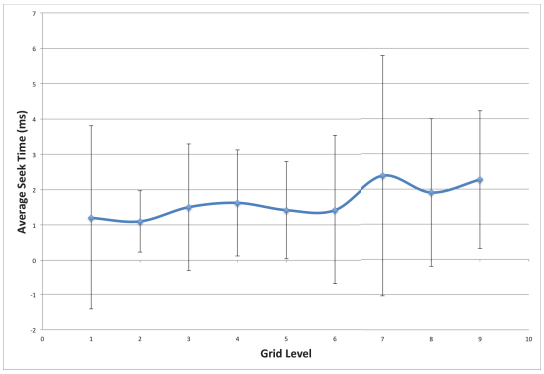

Figure 10: Average Seek Time Per Grid Level

lier, however this test removed the need to memorize where objects were on the virtual buttons, and instead presented the user with a numbered pattern. For example, in level 1 of the game, players were first shown a display on the screen that showed the numbers 1,2,3,4 located in quadrants. Once the player was familiar with the sequence of the numbers, he could begin the level. Each level would show a random number in the center of the screen, and the player was to touch in that region on the back of the device. The grid layout followed the same layout as the test described earlier, however this test had the buttons arranged in numerical sequence, which should have lowered the memorization component of the test. In addition to the numerical display, this application also started with a 2x2 grid of four numbers as opposed to the 1x2 grid. Missed targets were not shown on screen, however, an icon showing where the user touched was shown.

5.1 Vita Results

A user study was conducted with 10 participants (9 male, average age 26.2 years) who had never used a Playstation Vita. Participants were shown the Vita and explained that there was a touch screen on the back and their task was to select objects appearing on the display as quickly as possible by pressing on the region represented by the target on the back of the device. All participants performed the Fitt's law selection task first (the four levels were presented in a random order) followed by the region selection task where the nine levels were always presented in the same sequence following the description of the last nine levels in Table 1. Players selected a total of 52 targets in the Fitt's Law test, and 90 targets in the region selection test, for a total of 1420 targets selected throughout the study.

The ISO 9241-9 test yielded throughput values and miss rates for each of the four selection tasks. The average throughput for the selection tasks was 1.57 bps (SD=0.16). This is compared to a study of game controller throughput which resulted in a throughput of 1.48 bps and a mouse selection task analysis that yielded a throughput of 3.78 bps [7]. These results show that the usability of the Playstation Vita back touch screen is in line with normal game controller interactions.

The region selection task saw selection times (Figure 10) and errors (Figure 9) increase as the levels produced more selection areas. Breaking down the tasks into grid locations with less than 12 grid locations and tasks that have 12 or more grid locations shows a difference. The earlier levels contain an average seek time of 1.38 seconds and an average miss count of 0.96, while the later levels contain an average seek time of 2.18 seconds and an average miss count of 2.50. An analysis of variance shows both of these are significant (Seek Time - $F(1,7) = 28.86$, $p < 0.01$ and Miss Count - $F(1,7) = 23.93$, $p < 0.01$). These values become important when a player is attempting to play a game where quick reflexes are required to properly play the game. With a miss count of less than one, a player typically would hit the correct virtual on the first or second try, however with a miss count of 2.5, the player would typically hit the correct virtual button on the 3rd or 4th attempt. Not only can these missed attempts make it longer for the player to correctly perform the task, it can also result in the player performing incorrect tasks. These incorrect tasks could result in an incorrect virtual button being pressed and an unwanted action performed within the game. In this user study, players were not penalized by selecting the incorrect grid location outside of requiring more time to make an additional selection attempt.

It is also interesting to point out that the miss rate is much higher in the iPod version of the usability test when compared to the Playstation Vita version. This is likely because the interactions are slightly different. The Playstation Vita would respond to drag events. That is when a player would drag his finger across the back touch screen, an icon would follow. It was observed that players would tap down and drag to the section of the screen where the target was located, then lift and tap again to acquire the target. This was not possible in the iPod tests as the application would only respond to touch down events. Players going through the interactions with the iPods were observed repeatedly touching in order to get a reference of their current finger location in relation to the video display.

6. FUTURE WORK

One area of future work would be to introduce back of device touch regions in the use of a game that is played on a regular basis. This study gave participants a quick look at a grid of icons and then required a selection of items on that grid with no reference. Participants were given at most 20 trials on one grid layout. If more trials were given, locations of the items could become better known. In a gaming context, players may be able to associate common moves at a faster rate as in game elements could trigger reactionary responses.

7. CONCLUSION

This paper analyzed back of device touches for use in games. Four different interaction tests were performed, Direct - where the user always had a visual cue directly on top of the target touch location, Associated - where the user was given a grid containing icons to memorize and later had to recall the location of the icon, an ISO 9241-9 test, and a region selection task. Throughput of the touch interface on the Playstation Vita was in line with a standard video game controller, and there was a significant drop in performance on the Playstation Vita when virtual buttons on the back touch screen were placed in a grid of 12 or more. The results of these studies can be used to determine what types of back of device touch implementations are usable for different games requiring a variety of reaction times and target acquisition accuracy.

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