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Mobile Games with Touch and Indirect Sensor Control

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Abstract

Controls for games on mobile devices, e.g. smartphones, are mostly based on touch interaction or physical gestures like tilting the device. Both approaches often interfere with the player's view of the game world, e.g. by occluding parts of the screen, enforcing a limited view angle or fast shaky movements of the whole device. We present a novel control concept for mobile games integrating tilt-interaction and touch-input with different mappings depending on the current orientation of the device and a corresponding view of the virtual world. The result is a cleaner user interface with no distracting objects but enhanced interaction possibilities. An evaluation against software buttons shows that while our control concept is comparable regarding objective performance it significantly increases the subjective user experience.

1 Introduction

Controls for mobile games on smartphones are mostly based on touch interaction, while some games of very specific genres like racing games make use of the additional sensors available in modern handhelds, e.g., accelerometers. On their own, both interfaces concepts can be problematic. Touch interaction is often restricted to a simple transfer of conventional hardware controls from mobile gaming handhelds to software buttons. Software buttons severely limit the field of view of the player. Tilt-based interaction can be very disturbing if the player turns the device to the side or shakes it while watching the screen. In order to tackle these challenges, we present a control concept based on a combination of a physical pitch gesture and touch areas. While the touch area technique provides a button less interface, the physical gesture is used as an indirect control mechanism. Pitching the device allows the player to switch between a top-down view and a third-person view as well as to switch between two touch input modes; one for translation and one for rotation. This results in a clean interface with no distracting objects on the screen while providing enhanced interaction possibilities.

2 Related Work

Rekimoto (1996) proposed using tilting for interaction with small screen devices already in 1996. General tilt interaction techniques are ubiquitous on today's mobile devices like smartphones and tablets. However, the application-specific impact is still not completely explored. Especially, in the area of games, where fun and the emotional experience are often more important than pure efficiency it is important to further investigate the trade-off between different input technologies. While some studies suggest that hardware buttons and keyboards are generally preferred by users compared to touch input (Wong et al. 2010; Chu & Wong 2011), the same studies also hint at the great potential of touch interaction. As hardware keyboards are no longer available on the majority of mobile devices today, this raises the question if the user experience for touch input can be improved by integrating additional input data, e.g., from accelerometers as in this work. Wenig and Malaka (2010) for example, extended touch interaction for map navigation by integrating tilting gestures. We build on this concept and investigate transferring it to the mobile gaming domain. While other studies investigated the use of tilt gestures for mobile gaming (Gilbertson et al. 2008; Chehimi & Coulton 2008) or compared tilting gestures to keypad (Tonder & Wesson 2011) or touch input (Browne & Anand 2012), our approach is unique in employing tilting gestures for switching between different view types with specific input mappings. Most closely related to our work is the research of Browne and Anand (2012), who found that players prefer accelerometer-based interaction to touch gestures and touch buttons but they also note that multiple user interfaces should be available. Our approach is consistent with their findings and also the design guidelines of Salo et al. (2012), who state that minimizing the number of on screen GUI elements is very important.

3 Control Concepts and Game

The proposed interaction concepts (introduced by Böhrs et al. (2012)) are based on the idea of different input modes depending on the current view in the virtual world. When a top-down view is shown, interaction with the smartphone results in rotation while in a third-person view interaction results in translation. We implemented three different ways of switching between both views: a physical gesture, a touch area and software buttons. Figure 1 shows the concept transferred to a ball-through-labyrinth game, which was employed as a testbed. The labyrinth is based on corridors which have to be passed by the user. The player's avatar moves forward continuously without the player's control and only stops when it hits a wall. The top-down view provides an overview but does not show objects in areas covered by tunnels. Only the third-person view allows the player to navigate effectively around these hidden objects. A simple casual game was used to reduce the influence of complex game mechanics. Each of the three different ways of switching between the top-down view and the third-person view described below was implemented for the game.

Figure 1: Top-down view (left) and third-person view (right)

Physical gesture and touch areas The first concept is based on a physical pitch gesture. When the player holds the device horizontally the top-down view is shown while he can switch to the third-person view by holding it in an upright position (figure 2, left). Furthermore, the screen is divided vertically into two areas (figure 2, right). Touching the left area triggers actions to the left while touching the right area triggers actions to the right. In the top-down view the action is a rotation. In the third-person view the action is a translation. The main advantage of this approach is a clean screen without any visible objects and an intuitive way of switching between the views. Additionally, the touch screen is only divided into two large areas, which reduces the chance of accidentally triggering a wrong action.

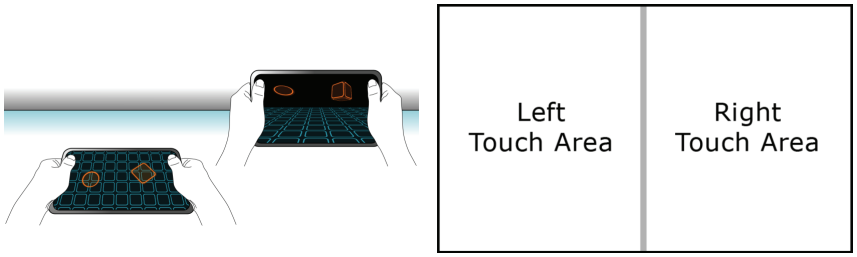

Figure 2: Concept of the pitch gesture (left) and touch areas (right)

Touch areas The second concept is based on the first one but without the need of physical interaction. Instead of switching the views by pitching, another touch area is added at the bottom of the screen (figure 3, left). This area is divided from the others by a viewable thin grey line. This concept reduces the required interaction to touch controls without limiting the field of view.

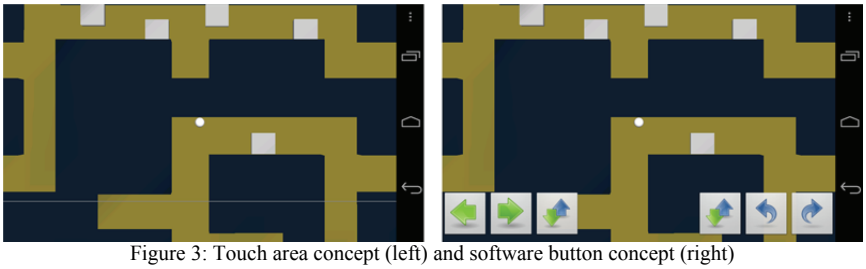

Figure 3: Touch area concept (left) and software button concept (right)

Software buttons The third concept is based on traditional software buttons located at the bottom of the screen (figure 3, right) for translation, rotation and switching the views (with both the left hand and the right hand). The interaction was restricted because pre-tests suggested that rotating the view in the third-person view irritates users. While players are allowed to translate in both views, rotation can only be triggered in the top-down view.

4 Evaluation

We conducted a user study to empirically compare the three different interaction concepts regarding subjective user experience and preference as well as objective user performance. We wanted to test the following assumptions: **(1)** Gesture-based interaction (even if restricted) is preferred to widget-based interaction (buttons). **(2)** Experience is more important than efficiency in the gaming context. **(3)** Users are able to understand and successfully employ the view-switching techniques and the different control mappings for each view.

The general setup of the study followed a within-subjects design, i.e., each participant tested all three interface conditions. The order of conditions was randomized between participants to avoid a possible learning bias. We chose a hybrid approach of on-site as well as online-based evaluation in order to increase the potential number of participants. The test application was made available through the Google Play Store. On-site participants could choose between bringing their own smartphone or using one of our phones for the evaluation. Participants were recruited through notices posted on our campus, a website that included a link to the Google Play Store and by spreading the information through social networks and mailing lists. Every interface condition was introduced by a short tutorial including images and screenshots that explained the goal of the game and the specific controls. The goal of the game was in all cases to reach the exit of the maze as quickly as possible. For each interface condition, completion times, input events and the number of view changes were logged directly by the application for later analysis. After each condition, the application presented a digital version of the QUESI (Naumann & Hurtienne 2010) questionnaire to collect subjective feedback concerning the usability. After they played all three conditions, we conducted an interview with all on-site participants. The online participants could choose to answer the same questions as a Google Docs questionnaire. The interview included questions regarding familiarity, specific problems and preference regarding the different input approaches.

Overall 22 users (19 m, 2 f) with an average age of 28 years (SD 8.2) participated in the evaluation. 10 users participated on-site and 12 users online. Only one of the online participants answered the optional interview questions. Eight of the on-site participants used the provided smart phone, two brought their own devices. Analysis of the application log data revealed that completion times were comparable across conditions. On average it took 121.28 sec (SD 84.67) to finish the maze for the tilt condition, 100.36 sec (SD 60.79) for the touch areas condition and 116.58 sec (SD 71.24) for the touch buttons condition. Usage of the view-switching and view-specific interaction counts were also very similar across all conditions. For all conditions, the top-down view dominated both in terms of overall time spent in this view (approx. 83% of the overall time) and in the number of interactions (approx. 86% of all touch input events) performed in this view compared to the third person view. While a non-parametric test for repeated measures (Friedman) of the subjective usabil-

ity ratings obtained by the QUESI questionnaire revealed statistically significant ($p = 0.02$) differences between all three conditions with touch areas rated highest (M 3.74, SD 0.88) followed by tilt-touch-interaction (M 3.53, SD 0.91) and soft buttons (M 3.28, SD 1.02), pair-wise analysis of variances did not show significances. Five of the eleven participants who answered the interview questions, rated the soft-buttons to be the most effective of the three conditions. The remaining participants in equal parts rated touch areas (three) and tilt-touch interaction (three), respectively, to be the most efficient. Regarding fun, the participants almost unanimously voted for the tilt-touch interaction condition (nine). Two participants found touch areas to be the best in terms of fun. No participant voted for the soft buttons in this category. When asked to choose the most limiting interface condition, most participants decided for the soft buttons condition (seven), four participants voted for the touch areas condition and none for tilt-touch interaction.

The obtained log data shows that all interface conditions were in principle understood and successfully employed by the participants. The objective performance measures were all similar across conditions. Within the bounds of this experiment no objective difference regarding efficiency of one of the conditions could be found. It is interesting that the top-down view dominated the interaction. This can be explained by the specific game setting (maze) and the familiarity some users might have with games like the well-known marble-maze type games, which are mostly played from a top-down perspective. That being said, the third-person view was also successfully used for almost 20% of the overall game time. Thus we deem the selection of interface conditions and the game mechanics and mapping overall as successful. With regard to our initial assumptions (assumption 3) in can be stated that users did indeed understand the view-switching mechanic and that they had no problems with changing the control mappings according to the view. The subjective usability rating shows that users preferred the gesture-based interaction to widget-based interaction as with the soft buttons (assumption 1). Even though the touch areas lack any visual feedback, the concept was well received and rated best of all three interface conditions. Even if no objective differences regarding efficiency could be found, most users rated the soft buttons interface condition to be the most effective. Still, the tilt-touch interaction was rated to be the most fun and the least limiting condition. This does not fully confirm assumption 2 but indicates that experience may be more important than efficiency to users in the context of this study.

5 Conclusion and Future Work

In this paper we presented a novel control concept for mobile games based on the integration of touch-input and tilt-interaction with different input mappings depending on the current view in the virtual world. In a user study, we compared our concept to standard software buttons and pure touch-interaction. The results of the experiment show that while all techniques are comparable regarding objective performance, i.e. game completion time, our concept increased the subjective user experience, which is an important factor for designing mobile games. As player preferences might depend on the specific game genre, further evaluations with different kind of games and larger samples sizes will be necessary in the future. Furthermore, more complex games might give insights on the transferability and the generalizability of the proposed control concepts.

References

Böhrs, D., Wenig, D. & Malaka, R. (2012). Mobile Gaming with Indirect Sensor Control. In Proceedings of the ICEC 2012, pages 441–444, Berlin, Heidelberg. Springer.

Browne, K. & Anand, C. (2012). An empirical evaluation of user interfaces for a mobile video game. Entertainment Computing, 3(1):1–10.

Chehimi, F. & Coulton, P. (2008). Motion Controlled Mobile 3D Multiplayer Gaming. In Proceedings of the ACE '08, pages 267–270, New York. ACM.

Chu, K. & Wong, C. Y. (2011). Mobile Input Devices for Gaming Experience. In Proceedings of the iUSEr 2011, pages 83–88. IEEE.

Gilbertson, P., Coulton, P., Chehimi, F., & Vajk, T. (2008). Using "Tilt" as an Interface to Control "No-Button" 3-D Mobile Games. Comput. Entertain., 6(3):1–13.

Naumann, A. & Hurtienne, J. (2010). Benchmarks for Intuitive Interaction with Mobile Devices. In Proceedings of the MobileHCI '10, pages 401–402, New York. ACM.

Rekimoto, J. (1996). Tilting Operations for Small Screen Interfaces. In Proceedings of the UIST '96, pages 167–168, New York. ACM.

Salo, K., Arhippainen, L. & Hickey, S. (2012). Design Guidelines for Hybrid 2D/3D User Interfaces on Tablet Devices - A User Experience Evaluation. In Proceedings of the AHCI 2012, pages 180–185. ThinkMind Digital Library.

Tonder, B. & Wesson, J. (2011). IntelliTilt: An Enhanced Tilt Interaction Technique for Mobile Map-Based Applications. In Proceedings of INTERACT 2011, pages 505–523, Berlin, Heidelberg. Springer.

Wenig, D. & Malaka, R. (2010). Interaction with Combinations of Maps and Images for Pedestrian Navigation and Virtual Exploration. In Proceedings of the MobileHCI '10, pages 377–378, New York. ACM.

Wong, C. Y., Chu, K., Khong, C. W. & Lim, T. Y. (2010). Evaluating Playability on Haptic User Interface for Mobile Gaming. In Proceedings of ITSim 2010, pages 1093–1098. IEEE.

Workshop

Methodische Zugänge zu Mensch-Maschine-Interaktion

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