POSTER

Woody: A Location-based Smartphone Game to Increase Children's Outdoor Activities in Urban Environments

Paul Spiesberger, Florian Jungwirth, Christoph Wöss, Stefan Bachl, Johannes Harms, Thomas Grechenig
Research Group for Industrial Software
Vienna University of Technology
Vienna, Austria
firstname.lastname@inso.tuwien.ac.at

MUM '15, November 30 - December 02, 2015, Linz, Austria

ACM ISBN 978-1-4503-3605-5/15/11.
DOI: http://dx.doi.org/10.1145/2836041.2841210

Abstract
This work describes the design of a smartphone-based game that aims to increase children's outdoor activity through location-based interactions. In the game, players have to physically go outside, find real trees, and interact with them using their smartphones in order to keep the game's character (a timber worm) alive. First evaluation results show that children enjoyed playing and increased their outdoor activity.

CCS Concepts
• Human-centered computing~Ubiquitous and mobile computing systems and tools;

Author Keywords
Mobile; Game; Location-based; Physical activity

Introduction
One key reason for childhood obesity is lack of physical activity [10]. Various mobile apps have consequently sought to motivate children for outdoor activity [2,4,5]. To extend prior works that also addressed this problem in a playful way, this work contributes the description of a novel, mobile, location-based, smartphone game called *Woody*. Our design rationale is to combine playful, "fun" experiences with outdoor activity and to raise awareness about trees in an urban environment.

Figure 1: Screenshot of the location-based smartphone game *Woody* presented in this paper. The figure shows the game's main character (a timber worm) and a nearby-located tree that players can interact with.

The game was evaluated with school children in a realistic setting with promising results.

Related Work

Prior work has introduced complementary physical activity to the normally sedentary activity of gaming [2]. This includes a growing number of mobile games that transferred virtual gaming experiences into the real world [3,5]. More akin to this work, further games aimed at motivating young audiences through location-based experiences – for example, *BunnyBolt* [4], an interactive, maps-driven exercise game, as well as *HeartBeat* [8], an adaption of Capture-the-Flag. Another example includes *Can You See Me Now* [1], a catch game involving online-players and players on the street. The (virtually present) former are chased by the latter across the city. In a similar way, *Catchbob* [6] allows players to form groups of three to find virtual objects and "catch" them by forming an enclosing triangle with their smartphones. Tiensyrjä et al. [9] designed and evaluated a location-based multiplayer game. Rogers et al. [7] and Yang et al. [11] used ubiquitous technologies to create a gameful outdoor learning environment. To continue and extend prior work, our approach investigates a location-based, mobile game within an educational context. Persuasive design elements are used to foster outdoor activity. Additional distinct characteristics are direct interactions with physical objects (i.e., trees) and the use of a virtual companion to motivate long-term, sustained gameplay and corresponding physical activity.

Design of *Woody*

A novel game for Android smartphones called *Woody* was designed and developed to increase outdoor activity and boost awareness and knowledge about trees and nature in urban areas amongst children aged between six to thirteen years. Location-based interactions with trees are combined with educational information about them. In the game, players take care of a virtual companion, a timber worm called *Woody* (see Figure 1). They have to find and frequent real trees in the cities of Vienna and Linz (Austria) in order to replenish the timber worm's food supply and energy. The current GPS position of a player's smartphone is compared to the locations of trees (based on data from an open data catalog). If a tree is present within a close range, the player can interact by executing one of three distinct gestures (see Figure 2). The Send gesture is performed by pushing the smartphone diagonally upwards to send *Woody* to a tree to replenish his energy instantly. This does not harm the tree. Players get the chance to gain new seeds for replanting trees. To perform the Chop gesture, players swing their smartphone like an axe to cut down a tree. This harms the tree, but yields food for storage. Lastly, players can perform the plant gesture by turning the smartphone upside down to drop seeds to replant a tree.

The above actions allow for different game strategies. Players can feed Woody by sending him to a tree to eat some wood without doing any further harm, but only by cutting down a tree they can replenish a food storage, allowing Woody to survive for up to four days without any further user actions. When Woody runs out of wood, a notification is sent to the player. Depending on a player's chosen strategy, Woody will either turn into a good or evil game character. The visual appearance of *Woody* reflects his attitude, as shown in Figure 3. Gameplay mechanics are also adapted. For instance, developing a good attitude increases the probability of getting new seeds when sending *Woody* to a tree.

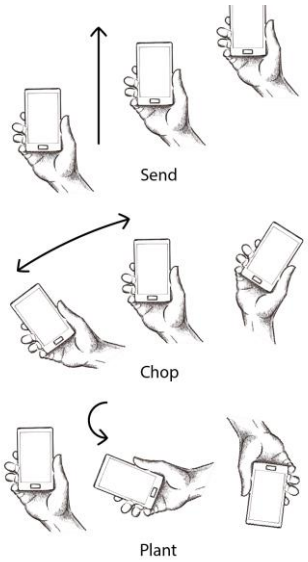

Figure 2: Distinct gestures for interacting with a tree. Players can "send" *Woody* to a tree by pushing the smartphone diagonally upwards, "chop" a tree by swinging it, or "plant" new trees by turning it upside down.

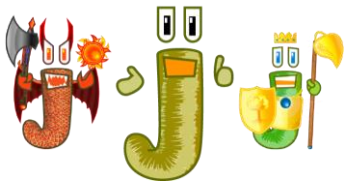

Figure 3: The visual appearance of *Woody* changes based on the player's game strategy. From left to right: Evil, neutral and good attitude.

Players can replant chopped down trees in order to preserve the tree population. They will discover that chopping down all trees in their surrounding areas makes it more difficult to gather new food for *Woody*. These game dynamics are intended to encourage children to think about sustainability, nature, and resource management in urban areas.

To discover and learn about nearby trees, background information is provided to players: Tapping on *Woody* will display random facts about trees, nature and the environment. Players can also explore their surrounding area by using a map view. Trees displayed on the map are classified into three types depending on their rarity of occurrence: Common, rare and special (very rare). Rare and special trees grant additional food (chop gesture) and a higher chance to get new seeds (send gesture). Additional information about each tree (including the species, age, diameter and height) is displayed when tapping on it. A tree database (called "Treepedia", see Figure 4) with accurate data of about 150.000 trees located in the cities of Vienna and Linz (Austria) – including all listed species – complements the game's educational intent.

Evaluation

An empirical study was conducted to evaluate our design decisions, to investigate children's playing experiences in a realistic setting, and to measure *Woody's* influence on outdoor activity. A total of 38 school children (16m/22f) between 11 and 12 years played *Woody* over a period of 12 days. They were split into two equally sized groups: The "outdoor" group (10m/9f) played the location-based variant of *Woody*. The "indoor" group (12m/7f) served as control condition where children could stay indoors while playing (location-independent) with any trees on the map. Google Analytics was used to collect quantitative data about game activities (players' actions), including the number of app launches, the number of game actions performed (i.e. the "chop", "plant", and "send" gestures, the use of the tree database "Treepedia") as well as the durations of each gaming session. The study also employed pre- and post-test questionnaires and group interviews to gather qualitative data.

Results and Discussion

Overall qualitative feedback to *Woody* was very positive and validates our fundamental game design decisions. Children actively and voluntarily played both variants of the game and stated that they enjoyed playing. 15 of the 38 participants enthusiastically shared ideas on how to further improve the game. Children of the outdoor variant stated that playing *Woody* altered their behavior – e.g. some children were willing to take a detour on their way home from school to play the game. Children playing the location-independent control condition stated that they mostly chose not to play outside but reflected that they would have preferred to do so.

Quantitative results revealed significantly higher levels of activity ($p<0.001$) amongst players of the outdoor variant compared to the indoor variant. The daily amounts of activity of indoor vs. outdoor players are shown in Figure 5. Data indicates that the outdoor variant's location-based design was not seen as a demotivating restriction. Instead, it appeared to motivate children towards even more game activity and therefore more time spent outdoors. This explanation is also supported by outcomes of the group discussions.

Figure 4: A comprehensive tree database called "Treepedia" shows information about trees including age, diameter, and species.

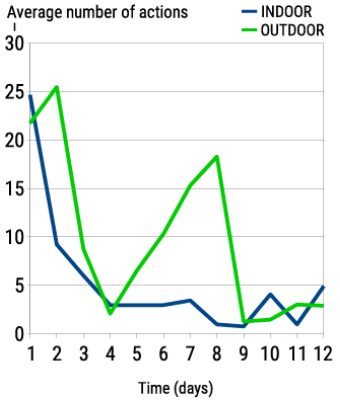

Figure 5: Average game actions (vertical axis) performed by players during the 12-day study period (horizontal axis). Our evaluation revealed significantly more actions by players of the outdoor variant.

Future work is planned to rigorously evaluate the game in a larger study. Interesting research questions concern the user experience provided by the game, choices of game strategy, long-term behavioral effects of playing *Woody*, as well as effects on children's awareness of environmental issues.

Conclusion

A novel pervasive, location-based smartphone game called *Woody* was developed using data from an open data tree catalog. In the game, players had to find and frequent real trees in an urban environment in order to replenish the game character's food supply and energy. The game was evaluated with 38 school children over a period of 12 days. Results indicate that *Woody* was fun to play and that it successfully increased children's outdoor activity.

Acknowledgements

We thank Brigitte Brem for administrative support, as well as Dieter Braunstein and Karin Nemeth from the "GRG23 Alterlaa" school for support with the study, as well as all participating children from this school.

References

1. Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M., and Row-farr, J. Can you see me now. ACM Trans. Comput.-Hum. Interact 13 (2006), 100–133.
2. Berkovsky, S., Freyne, J., and Coombe, M. Physical activity motivating games: Be active and get your own reward. ACM Trans. Comput.-Hum. Interact. 19, 4 (2012), 32:1–32:41.
3. Chang, C.-S., Chen, T.-S., and Hsu, W.-H. The study on integrating WebQuest with mobile learning for environmental education. Computers & Education 57, 1 (2011), 1228–1239.
4. Keung, C., Lee, A., Lu, S., and O'Keefe, M. BunnyBolt: A mobile fitness app for youth. In Proc. of the 12th Int. Conf. Interaction Design and Children (2013), IDC '13, ACM, pp. 585–588.
5. Leyshon, M., DiGiovanna, S., and Holcomb, B. Mobile technologies and youthful exploration: Stimulus or inhibitor? Urban Stud 50, 3 (2013), 587–605.
6. Nova, N., Girardin, F., Molinari, G., and Dillenbourg, P. The underwhelming effects of automatic location-awareness on collaboration in a pervasive game. In Cooperative Systems Design: Seamless Integration of Artifacts and Conversations (2006), pp. 224–238.
7. Rogers, Y., Price, S., Randell, C., Fraser, D. S., Weal, M., and Fitzpatrick, G. Ubi-learning integrates indoor and outdoor experiences. Communications of the ACM, 48, 1 (2005), 55-59.
8. Soute, I., Markopoulos, P., and Magielse, R. Head up games: Combining the best of both worlds by merging traditional and digital play. Personal Ubiquitous Comput. 14, 5 (2010), 435–444.
9. Tiensyrjä, J., Ojala, T., Hakanen, T., and Salmi, O. panOULU conqueror: Pervasive location- aware multiplayer game for city-wide wireless network. In Proc. 3rd Int. Conf. Fun and Games (2010), Fun and Games '10, ACM, pp. 157–165.
10. Vandewater, E. A., Shim, M.-S., and Caplovitz, A. G. Linking obesity and activity level with children's

television and video game use. Journal of Adolescence 27, 1 (2004), 71–85.

11. Yang, M.-J., Chen, J.-H., Chao, L., and Shih, T. Developing the outdoor game-based learning environment by using ubiquitous technologies. In 9th IEEE Int. Conf. Advanced Learning Technologies, 2009. ICALT 2009 (2009), pp. 270–272.