
Towering Defense - An Augmented Reality Multi-Device Game

Paul Tolstoi

Technische Universität
München
Boltzmannstr. 3
Garching, 85748 Germany
tolstoi@in.tum.de

Andreas Dippon

Technische Universität
München
Boltzmannstr. 3
Garching, 85748 Germany
dippona@in.tum.de

Abstract

This game aims to present a modern approach for interaction between multiple devices, such as a large screen tablet and a smartphone, using the example of a simple game like tower defense. The player interacts with the game on the tablet by using simple touch input and on the smartphone by using Augmented Reality and gestures. The position of the smartphone relative to the tablet is tracked by using feature tracking of the image on the tablet. Depending on the position of the smartphone the player can select different towers or different floors of a tower for additional interaction inside. Additionally selecting a resource node allows a player to mine it by executing the mining gesture with his smartphone. After selecting an enemy the user can perform gesture based interaction to deal damage directly to the selected unit.

Author Keywords

Games; Multi-display environments; multi-display interaction;

ACM Classification Keywords

H.5.2 [User Interfaces]: Interaction styles, Input devices and strategies.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s). Copyright is held by the author/owner(s).
CHI'15 Extended Abstracts, April 18–23, 2015, Seoul, Republic of Korea.
ACM 978-1-4503-3146-3/15/04.
<http://dx.doi.org/10.1145/2702613.2728659>

Introduction

Nowadays more and more people around the world use mobile devices like a tablet and/or a smartphone. There are several approaches to create a multi-device environment. However most interactions are bound to a single device, at best a second device is used as an additional screen. A possible approach utilizes the additional screen for distributing user interfaces [6], by porting the GUI system to a mobile platform to use the device as remote control. A step further towards simultaneous usage of multiple devices creates an interaction based on the mobile device [3]. An example shows a game where a device either controls the game or serves just as screen for visualization. In this scenario a multi-touch device is used as a controller and screen at the same time.

A concept called Magic Lenses™ [4] adds an interactive and see-through layer between the content, the user sees, and the cursor which the user uses for interaction, allowing content-dependent interaction. The interface can be moved independently of the cursor and can reduce the number of steps needed for the interaction and lower the errors.

The idea behind Magic Lenses was extended by Brown and Hua [5] for usage in an Augmented Reality environment. The Handheld Magic Lens adds additional information about the object the user can see from his perspective.

The space above the tabletop environment is rarely used. Spindler et al. [7] developed an approach dividing the empty space into multiple layers that are shown to the user.

There are several different approaches to combine multiple mobile devices, but most of them are not used for gaming at all. For our game we decided to stick with a simple

game, to make it easy for the player to learn the core game mechanics and to add the interactions between the devices without making the game too complex.

As a core idea we selected a sub-genre of real-time strategy games called tower defense [1]. In a tower defense the player has static units (towers) that attack the mobile enemy units (creeps). The creeps move from their spawn point to a destination point. The task of the player is to prevent the creeps from reaching their target by strategically building walls and towers. If a certain amount of creeps reaches the destination point, the player loses the game.

We created a new interaction technique called Towering Mode (see Fig. 1) that brings two devices together similar to the Handheld Magic Lens but with additional direct interactions on and with the lens. A gesture-based interaction and an interaction based on Augmented Reality increase the immersion by providing natural gestures and deeper perspective into the game.



Figure 1: Towering Mode allows the player to dive into the game and explore it using Augmented Reality.

Game Mechanics

The player can build walls for free and upgrade them to attacking towers, which can be upgraded as well. Each tower can be upgraded to increase the range, attack speed or amount of damage and even alter their attack behavior.

Over the course of the game the creeps get more hit points, making them harder to kill. The player can either deal damage to the enemies directly or indirectly by building towers. There are 40 waves of creeps and if the player manages to kill them all, he wins the game. If 15 or more creeps reach the destination tile, the player loses the game.

After killing a creep the player receives minerals which are required to upgrade walls and towers. Additionally the player can mine resource nodes, that spawn randomly, to earn more minerals.

Setup

The game consists of two devices that communicate over the network to keep the game state in sync. A tablet with the board application lies on the table in front of the player and shows the playing field. Since it can be accessed from all directions we use a flat top down representation of the playing field. The user can use a smartphone with the phone application to look at the tablet through the smartphone and see an augmented 3D representation of the towers and creeps on the board. The different actions to control the game require the user to either use one or both of the devices which is described in detail in the following section.

The game starts with an empty playing field consisting of multiple hexagonal fields. In the top left corner a green tile represents the destination, a red tile in the bottom right corner represents the spawn tile.

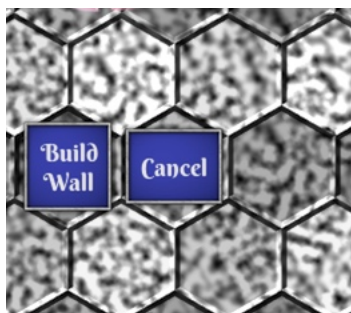


Figure 2: The "Build Menu" after tapping on the tablet.



Figure 3: A user playing Towering Defense.

Animated arrows indicate the path the creeps cover, thereby the player always knows which path through the maze the creeps will take. As soon as the player builds the first wall, a timer starts and after 10 seconds the first wave of enemies spawns.

Interaction using Two Devices

The user can build walls by tapping a tile on the tablet and select "Build Wall" on the shown ring menu (see Fig. 2). In order to upgrade a wall to a tower or further upgrade a tower the user can make full use of Augmented Reality. To perform an upgrade the player has to select a tower or wall on the smartphone.

When the player taps on a tower on the smartphone, a bigger version of the tower (ghost tower) is shown next to the board. Now the player can use the smartphone to look around inside the tower and buy upgrades. This can be performed by moving the smartphone towards and into

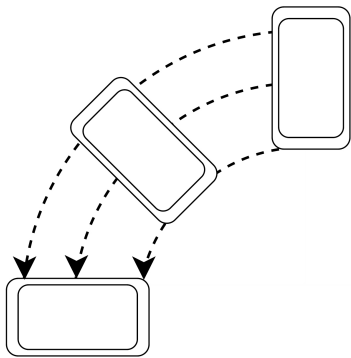


Figure 4: Sketch of the mining gesture.

the AR ghost tower. Depending on the position, the player can see the interior of the tower. The roof and the floors are hidden if they would hinder the player from seeing a certain floor. The tower offers different upgrades depending on the current upgrade state.

An other interaction, based on gesture recognition, uses the acceleration of the smartphone to detect gestures the player performs. The player can use this interaction to deal damage to the creeps directly as well as for mining the resource nodes. For either interaction the player has to select the unit or the node first. Now the player can perform a mining gesture as if he would use a mining pick instead of his smartphone (see Fig. 4). Each time the gesture is performed either the selected creep takes damage or the amount of minerals of the selected resource node decreases and the minerals are added to the player's account.

Acknowledgments

We want to thank Prof. Gudrun Klinker, Ph.D. for the valuable input and the great work environment during this project. Special thanks to Dr. Patrick Maier for his great idea on how to improve the gesture detection.

Thanks to Blut Games for their free animated model [2] we used for the enemies.

References

- [1] Tower defense - wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Tower_defense, 2014. [Online; last accessed 16-09-2014].
- [2] Unity - asset store - skeleton, tiny monster. <https://www.assetstore.unity3d.com/en/#!/content/17495>, 2014. [Online; last accessed 16-09-2014].
- [3] Bassbouss, L., Tritschler, M., Steglich, S., Tanaka, K., and Miyazaki, Y. Towards a multi-screen application model for the web. In *Computer Software and Applications Conference Workshops (COMPSACW), 2013 IEEE 37th Annual*, IEEE (2013), 528–533.
- [4] Bier, E. A., Stone, M. C., Pier, K., Buxton, W., and DeRose, T. D. Toolglass and magic lenses: the see-through interface. In *Proceedings of the 20th annual conference on Computer graphics and interactive techniques*, ACM (1993), 73–80.
- [5] Brown, L. D., and Hua, H. Magic lenses for augmented virtual environments. *Computer Graphics and Applications, IEEE* 26, 4 (2006), 64–73.
- [6] Sjölund, M., Larsson, A., and Berglund, E. Smartphone views: building multi-device distributed user interfaces. In *Mobile Human-Computer Interaction-MobileHCI 2004*. Springer, 2004, 507–511.
- [7] Spindler, M., and Dachsel, R. Paperlens: advanced magic lens interaction above the tabletop. In *Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces*, ACM (2009), 7.