Wearable Games - An Approach for Defining Design Principles

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Abstract

This paper describes the efforts on designing games for wearable computing technology taken by the 23 students of the project PEnG - Physical Environment Games. Creating wearable game concepts we are faced with a lack of good design principles and therefore found out that some of our concepts are not very playable. Finding out where our concepts failed will result in knowledge about what rules a good design principle for wearable games must follow.

1. Introduction

The design of games using wearable computing technology plays a strong role in the students' project *PEnG - Physical Environment Games*, established at the university of Bremen. The projects goal is to create wearable games, that is, games mixing the real and the virtual world by the explicit use of wearable computing technology to play a game that is set in the real environment.
The usage of wearable technology is a required but not exclusive aspect of the game as it is not intended to create wearable video consoles but new gaming concepts.
The qualifying games are therefore partitioned into virtual and real aspects that need to interact with, resp. that are modified by the player.
During the course of the project it became clear that differences in the design of games with different amounts of interaction between the player and the worn equipment have a high impact on the amount of user attention demanded by the hardware which is therefore not available for the game-play itself. This knowledge soon became a design factor limiting but also improving the possible games by sorting out ideas where the user interaction needed would effectively spoil the game.

2. What is a wearable game ?

When defining wearable games, it makes sense to look at the definition of mobile games. Mobile games are played with mobile devices like cell-phones or PDA's with small and limited input and output possibilities [2]. But still it is possible to convert games, that were implemented for desktop computers, more directly and easier to a mobile game than to a wearable game because the in/output devices are even more limited. It is similar to the effect that occurs when desktop applications in general are converted to a wearable computing application [3]. Thus, except for the used devices, the way of interaction distinguishes wearable games from mobile games.

According to Steve Manns definition of wearable computing [1], we define wearable games as follows:
The player wears a computer, that is seamlessly integrated into the the game. Therefore the used devices have to be small and well mounted to the body. The computer system must be available all the time and support the player during the game. Furthermore the game is not playable without this system.
To maintain the mobility character, the player needs to have the possibility to move freely in a certain area or even everywhere, depending on the radius of the communication techniques (e.g., WLAN hotspot vs. UMTS).

The wearable game itself consists of real and virtual components, were the wearable devices are used for interaction between the two environments. To enable the user to be immersed into the given game scenario, there have to be two different ways of interaction. Firstly, whenever possible, functionalities should be automatically performed by the system. Therefor methods of context-awareness can help to realise these aspects. Furthermore functionalities can be hard coded (e.g., *when an event has taken place, the system performs an action*) or realised with sensors (e.g., *the player arrived at special GPS coordinates*). Secondly,

there are functionalities, were the player has to interact directly within the game. He/She has to fulfill quests and consider how to go on in the story line or about strategic means by manually input. The decision how to act in the game is based on information the system provides either by displays (e.g. HMD (*head-mounted display*) or attached to the body), acoustic signals, speech and/or tactile interfaces (e.g., vibration signal at a special event).

3. The Project - A Progress Report

Stratego is a strategic game with two teams rival each other. It is adapted from the eponymus board game by Jumbo [4]. All players have an individual *rank* with special abilities. Each team also has virtual *bombs* distributed in the virtual game area. Scoring in the game is realised by collecting *flags* that are also embedded in thevirtuall game area.
Each teams aim is to locate the other teams virtual flag and capture it.
If two players from opposing teams get in contact, a game server calculates the winner based on the rank. The inferiour player is not allowed to take part in the game for a certain time.
The wearable computer equipment is used to display a map with the locations of all players, the *rank* of the own team members and the virtual objects discovered so far.

Run 4 The Pilot (R4TP) is mixture of a strategic game and an action game. It was created by the project group based on the idea of paper chases. Like in *Stratego* we have two opposing teams. Each team's goal is to find and rescue a virtual aircraft pilot who crashed in the game area and possesses valuable information. The games area is covered with previously placed real items that represent wreckage from the aircraft. Every piece of wreckage provides information by using wireless technology (Bluetooth). This information needs to be analyzed by team members and holds clues about the location of the pilot. By collecting and analyzing wreckage the pilot's location gets more precise for the teams.

With *Hot Spotting* one project group created a pure action game. Again two teams are rivaling for points. Collecting points is done simply by standing near a WLAN-Hotspot, but each player is equipped with an *Infrared-Weapon* (realised with remote controls) and can *harm* a player virtually by *shooting* with it. A shot taken reduces a players virtual energy level maintained by the wearable computer. If the energy is depleted a player has to return to the team base to recover.

TROIA is a different approach in setting up a game environment.
The players are equipped with a wearable device is used to locate the player by infrared signals. The game area is defined by an artificial room where the walls and the ceiling are covered by low resolution LED-displays. We have created a multi-player version of the classic *Pong*-game concept where each player in the room has an own paddle and scores by hitting targets with a moving ball. The paddles, targets and the ball are virtual objects displayed on the walls. By moving, the players move their paddle in order to deflect the ball.

Studying the different games, we found that their dynamics always exceed our expectations and lead to exhausted players in a short period of time. Also there are possible threats to the worn equipment and the players themselves because the game play becomes very fast and uncontrollable. While our ideas looked promising in the beginning we found that the dynamical behaviour of interaction between virtual and real game elements is very hard to predict.
One conclusion we took, is that it would be nice to be able to restrict the movement speed of the players. Therefor sensors have to watch the players' speed or specific biometrical signals of the body like pulse or breathing rate and when a defined level is exceeded all displays with important information are shut off till the player slows down.

4. Methods

In our project we initially started to collect ideas for physical environment games that are supported by wearable computing devices.
In order to evaluate our concepts, the games were played without using wearable devices where the devices tasks were carried out by project members (that is, guiding the players if needed and ensuring conformance to the rules of the game).
Additionally, some game aspects were evaluated by creating software prototypes.

Along the four mentioned games we see that the adaption of board and desktop games on wearables fails!

Based on this experience we try to find new design principles for wearable games. In doing so we decided to borrow and adapt design patterns used for mobile games. The book *Game Design Patterns for Mobile Games* by Ola Davidsson, et. al. [5] shows some important models which have to be taken in account when creating games on mobile platforms. Keeping this knowledge in mind we try to take

new approaches in analyzing game concepts and scenarios.

Our current approach in game concept analysis is to divide the whole concept into 30 atomic constituent sub-concepts. These are in turn analyzed from three distinct points of view.

TEC-Analysis:
First we analyze a concept along technical feasibility. We look at the target platform and the resources we have to acquire in order to realise it. Therefore several technical possibilities to implement a concept and their effects on the game are analyzed.

BIZ-Analysis:
The second analysis is taking into account economical feasibility. Because we have limited financial capacities in our project this is a very limiting criterion. If a sub-concept needs a platform which is unaffordable the whole game concept cannot be further followed.

FUN-Analysis:
The final inspection is considering the amount of fun a concept brings into a game concept. Each sub-concept is assigned a score and a *high-score* is formed by summing them up. The high-score gives us an indication of the overall fun factor of the game concept.

If we find a game sub-concept that is technically feasible, affordable and has a high fun factor it makes sense to implement it.
When the analysis was finished, a library of usable sub-concepts was created, of which each sub-concept can be easily appended to an implementation of a game concept or makes it easy to analyze the sub-concepts of a new game idea for the technical, economic and fun factors.

5. Related Work

ArQuake [6] is an adaption of the desktop first-person shooter Quake from iD Software. When developing this game, they primarily concentrated on user interfaces, tracking and the conversion of desktop applications to AR environments. The game that arised from their work fulfills all these requirements and truly shows, that an adaption of a desktop game to an AR application is possible. What this project did not take into account, is the physical strain of the users.
The WUI Toolkit [7] is an approach to design a toolkit for adaptive, context-aware user interfaces for wearable devices. Therefore, guidelines are proposed to develop a toolkit that satisfies the requirements of wearable computing user interfaces.
In *Game Design Patterns for Mobile Games* [5] mobile games are analyzed according to their game-play mechanics. Game design patterns were used to evaluate existing games for mobile devices.

6. Conclusion

In this paper, based on our prototypes, we have showed the adaption problems of traditional computer game concepts to wearable computers, which need to be very dynamic to interact with the physical environment. Therefore, our suggestion is to solve this adaptation problem at the design stage. Besides, we have described how our analyzing methods assist to find new design approaches for wearable games. Our next step in the future is to find and implement a concrete game concept with the use of these design principles.

References

[1] Steve Mann. Wearable Computing as means for Personal Empowerment. In: International Conference on Wearable Computing (ICWC'98), Fairfax VA, May 1998.

[2] Christian Geiger, Volker Paelke, Christian Reimann. Mobile Entertainment Computing. In: Lecture Notes in Computer Science, Volume 3105/2004, 142 - 147. Springer Berlin / Heidelberg 2004.

[3] T. Starner. The challenges of wearable computing: Part 1. IEEE Micro, vol. 21, no. 4, pp. 4452, 2001.

[4] Stratego, Jumbo
http://www.jumbo.nl/servlet/nl/nl/product?id=18812

[5] Ola Davidson, Johan Peitz, Staffan Bjoerk, Game Design Patterns forMobile Games

[6] Bruce Thomas, Ben Close, John Donoghue, John Squires, Phillip De Bondi, Michael Morris and Wayne Piekarski. ARQuake: An Outdoor/Indoor Augmented Reality First Person Application. In: Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00), Pages 139-146. IEEE Press, 2000.

[7] Hendrik Witt. A Toolkit for Context-aware Uster Interface Development for Wearable Computers. In: Doctoral Colloquium at the 9th International Symposium on Wearable Computers (ISWC'05), Osaka, Japan, October 18-21, 2005.