Wearable games as a benchmark method for wearable computing research

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Abstract. Games realized on wearable computers used as a benchmark method for comparing wearable computing differently stressed will give an good example about how games could be used to get keys for building successful professional applications. The analysis of the results will give an overview which features of wearable computing are adequate developed for different tasks and which are not, all in an independent form.

1 Introduction

The research area of wearable computing has been active for a number of years now and several truly wearable industrial applications such as data collection systems[9] have been created. Also, wearable electronic devices are omnipresent, and some of them may have been inspired by earlier wearable computing research. However, professional applications of wearable computing are still an exception and this fact is one of the driving forces behind large[10] and small[11] research projects in industrial wearable computing. Another area were true wearable computing has not yet reached maturity are entertainment applications. Altough there are a number of commercial applications available on the market, their main focus is the integration or remote-control[12] of portable audio players or mobile phones. In order to promote consumer applications and to speed up the development of professional applications, we propose the use of games supported by wearable computing as a benchmark for wearable computing in general. Similar approaches have been successfully applied in other domain such as robotics with annual competitions such as Robocup[13]. Within a student project at the University Bremen, we are investigating a number of different game settings for their suitability as a benchmark for wearable computing. This paper presents the game settings and the methods used to evaluate their suitability together with some preliminary findings.

2 Related Work

Can You See Me Now?[3] is a collaboration between *Blast Theory*[2] and the *Mixed Reality Lab*, University of Nottingham[5]. Their concept is to evaluate the effects of the near ubiquity of handheld devices among the general population by letting people participate in a game with one type of players moving in the real world and an other type of players moving in a virtual representation of the real world interacting with each other. They are trying to approximate the possibilities of merging games, the internet and mobile phones.

The GPS-based paper chase with Poker-elements *City Poker*[4] was developed in 2004 at the Laboratory for Semantic Information Technology of Bamberg University[6]. Two opposing teams, equipped with bicycles, a GPS-receiver and a mobilephone, search the city for a fixed period of time for hidden Poker cards to improve their given hand. The project's motivation was to develop certain models that are able to predict a user's next action by taking into account his range of possible actions and his motion profile.

The augmented-reality indoor/outdoor game *ARQuake*[7] is a mobile game converted from a desktop first-person application that was developed at the school of Computer and Information Science, University of South Australia. The players move in the real world fighting virtual enemies adapted from the 3D Ego-Shooter Quake from iD Software. They took a lot of research in interface issues and tracking for augmented reality games.

3 Methods

To cope with the acceptance-problem of professional applications on wearable computing we decided to use games as a benchmark. Games facilitate comparison of different aspects off wearable computing. *Stratego* and *Run for the pilot* are strategic games in contrast to *Dingsen* being more action oriented. By this contrast we are able to make out advantages and disadvantages of fast and profound applications. Furthermore games are a good benchmark because they appeal to a broad audience.

4 Games

In the course of the project we handle with four differnt types of games. There are the strategic-game Stratego, the action-game Dingsen (Thinging), the paper-chase like Run 4 the Pilot and the game-application for the Troia-room. The games differ by the demand on the usability of the wearable-devices.

4.1 Stratego

Stratego is a multiplayer game on wearables. The Idea of the game is to capture the flag of an oppenent team and hold the own flag. First there would be four player in each team. For more action there were some virtuel bombs. If a player reach the flag of the oppenent team, the game will finished.

To realize this Idea we use eight Xybernauts [8]. In the HDM (Head-Mounted-Display) would be a map of the field. Although there will be information about the own team, the position of the own flag, the own bombs and the player of the oppenent team.

Locating the player is realized with some GPS-Devices on the Xybernaut. With this data a game-server will be fed. For the communication of the Xybernauts and the game-server we use a wireless local area network.

To decide when two player from different teams get together we use bluetooth. If they meet each other the bluetooth devices gives there own MAC-Adress in exchange and send it to the game-server. The game-server will respond the effect for the player. Player with an lower rang will be suspended like they have found a virtuell bomb of the oponnent.

Virtual bombs would also be shown in the HMD. A player only see the bombs of the own team. If a player find a bomb of the oppenent team he would get some information about this meeting and be suspended from the game for some time.

The interrupt for the player will be shown in his HMD. In this timeout the player would not get anymore information about the game. The HMD is blank for this time.

At least the position of the own flag would be shown in the HMD. The team only knew the position of the own flag. To find the flag of the adversary the team have to move in the displayed map. If someone find the flag of the adversary the game will finished and all player will get this information in the HMD.

4.2 Dingsen

Dingsen is a game where two teams rival for points. Each team consists of at least two players, each equipped with a Xybernaut[8], an infrared-gun and a vest for simulating hits by enemies and signals by teammates.
Originating from different start points each team has to increase its score by entering a field partitionend into sectors and with a checkpoint in the centre. The closer to the checkpoint a player is, the more points will be added to his or her teams scorelist.

On the technical side checkpoints are realized by WLAN access points so a players distance, and by this the amount of points credited to the teams score, can be computed by signal-strength.
Game-items such as ammunition, bombs, etc. are represented by small bluetooth devices that can be found at special places.

The Xybernaut is constantly connected to the access point not only to count the teams score but also to transmit signals to the player by display or the worn vest. This mechanism also provides inter-player communication.
In order to make the vest useable as an output device, small electrical motors are controlled by the Xybernaut. If a player is hit or receives a signal, the motors action on different places (like on shoulders or belly) makes the player aware of these events.
Using the infrared-gun players are able to attack other players decreasing their amount of energy.

4.3 Run for the pilot

The idea behind this game is the conversion from the old-known paper chase concept to a wearable-computing application. For the realization of the idea a lot of different techniques are used. Each player is equipped with class-specific devices, e.g. every player uses a mobile computer (Xybernaut [8]), a W-LAN or UMTS card for communication and GPS-Positioning - but devices like HMD's, cameras and headsets are limited to special classes (e.g. fast unit, communication unit).
Since this is a multiplayer game there are two teams competing with each other. Both teams have a team-leader, called operator, giving tasks to the others by transmitting audio-signals. The operators will get a map-overview with all tasks the team has to solve, the single player in the field will get a map highlighting only his or her specific task. Furthermore, the operators will get video-, positioning- and audio-signals from the players.

The tasks, that must be fulfilled, depend on the chosen scenario. We chose an airplane-crash scenario with two rescue-teams searching the pilots. Therefore Bluetooth-devices are hidden in one part of the field representing parts of the crashed airplane. To evaluate this pieces of wreckage a riddle has to be solved for each found piece, by solving a riddle the team-operator will get the GPS-coordinates of new pieces. This Bluetooth-devices are very simple and only need to be discoverable for the computers worn by the players, what in fact should only be possible if the user has got the task to locate this specific device. To make it not to easy for the player to discover the pieces, the Bluetooth-devices hidden in the field use modules of the class 3, which only have a range of approximately ten meters.
Additionally to the coordinates of pieces in the first part of the field, the team will get information about the second part, in which the position of the pilots is located. This means, the more tasks are fulfilled (riddles solved), the more exact the position of the devices representing the pilots is given to the team.
The team reaching the pilots first is the winner of the game. When no team reaches this goal in a defined period of time the team with more solved riddles wins.

This concept would create a framework that could be used for several scenarios by only changing the story and the events by finding a Bluetooth-device.

4.4 TROIA

TROIA stands for *temporal residence of intelligent agents* and is a room built by BBM[1]. Its walls and ceiling are equipped with controllable light panels with a front of milky perspex allowing the display of graphical information. Additionally, visitors of the room are equipped with so called *ArmPods*. These are wearable computers that can be located inside the room via infrared and have no input devices but a small display and audio capabilities.

We have adapted the classic game '**pong**' to this room using the localization of room visitors for controlling the game and the walls to display the game. Different to the original, we have choosen a game concept allowing more than two players. Each player has a personal score resulting from hitting displayed targets with a moving ball using his or her paddle to deflect the ball. Using the walls we need to keep in mind their low resolution. The largest display is the ceiling that is able to display 104x80 pixels in grayscale over an area of about $10x13m^2$.

Localization in the room is limited to knowing if a certain player is inside a fixed area of about $1m^2$. This is not sufficient for the game as we need direction and speed of the player. That is why we interpolate these values from changes of localization over the time. We can also record and recreate a game by collecting the measurements and inserting them back into the system. The collected data allows to see how fast a player is and by what action he or she reacts to certain game events.

The lack of input devices makes it necessary to limit game aspects to reaction to player movements.

5 Discussion

We have so far not collected evaluable data from the TROIA-project, as technical issues had to be solved first.
By the strict constraints due to the hardware we expect however information about how well localization and interpolation can be done on one side and the possible conflicts between a players perception and the representation of the game on the other side.
The virtual reproducibility of games from data and the controllable environment make a detailed study of wearable affected human interaction possible.

Projects with the Xybernaut[8] have been more evaluable by now. Fast interaction with these wearable computers is nearly not needed. This is a contrast to strategic games that could use the full power of this equipment. From this perception we see that the manageability of those devices is one of the greatest disadvantages of wearable computing. Our next aim is to find ways of solving this problem.

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