



Join-In

Senior Citizens Overcoming Barriers by Joining Fun Activities

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Design and implementation of the prototype exergames

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1 About Join-In

Join-In aims at providing the methodology and the technologies for elderly persons to participate in social activities and have fun via digital media.

Loneliness in the elderly is a major problem in elderly care. Studies in Britain show that more than half of the people over the age of 75 live by themselves. Many of these suffer from loneliness and social isolation¹. Activities offered by social services do, however, often not reach those most in need. Challenges for the elderly include: social deprivation, low self-esteem or physical inability. Social isolation and health are closely related and may lead to a variety of physical disorders and even depression. Studies have shown the correlation between loneliness and poor health. Especially the effects on immune system, the cardiovascular system and the onset of Alzheimer's disease could be shown²³⁴.

The Join-In project aims at counteracting loneliness in the elderly by providing a concept, the methodology and technologies for elderly persons to participate in social activities.



Fig.1 Join-In Platform

¹ Office of National Statistics: Older people, Living arrangements. At: <http://www.statistics.gov.uk/cci/nugget.asp?id=1264>

² CARMA – Care for the Aged at Risk of Marginalization (QLK6-CT-2002-03421) - Recommendations and Guidelines to Policy Makers. (2005). <http://www.egga.ee/RecommendationsFinalwCoverTOC.pdf> Last accessed:2/10

³ Sorkin D, Rook KS, Lu JL: Loneliness, lack of emotional support, lack of companionship, and the likelihood of having a heart condition in an elderly sample. *Ann Behav Med.* 2002 Fall; 24(4):290-8

⁴ Tomaka J, Thompson S, Palacios R: The relation of social isolation, loneliness, and social support to disease outcomes among the elderly. *J Aging Health.* 2006 Jun; 18(3):359-84

Join-In is setting up a social platform for the elderly; it allows communication by TV, Tablet and PC. A multi-player serious game for the elderly is being developed. The interest in gaming is high in seniors: In a survey performed in Germany with 1200 participants, age above 61, two out of three PC users stated that they enjoy playing games regularly on the internet⁵. Studies⁶ could demonstrate the increase of cognitive skills, reaction times, self-esteem and the sense of well-being in the elderly when playing computer games. Another positive effect is that gaming is multigenerational and enables the elder generation socialising with the younger one, e.g. grandchildren. The concept includes exercising either by exergames or by moderated exercises as physical activity -besides supporting good health- counteracts the feeling of loneliness, while loneliness leads to less physical activity⁷. Recent results indicate that exergames create physical benefits and counteract loneliness⁸. Join-In encourages contacts with peers in the region and with family and friends living further afield - if necessary facilitated by an assistant.

Active participation is vital if the individual is to profit from the Join-In developments. Yet motivation for participation among the elderly is a challenge. One of the problems is the heterogeneity of the elderly, among other things regarding interests and health. Join-In is developing a methodology for elderly persons to participate in social activities. This is based on a thorough user requirement analysis. User groups are set up in Germany, Hungary, Ireland and Norway. The lead user group is based in Munich. Based on the results of the user requirement analysis and the analysis of relevant studies and related work a methodology for setting up a social networking platform which will encourage and enable involving homebound senior persons in social networking activities being developed. Digital inclusion and factors hampering its acceptance -such as accessibility, motivation, lack of skills and confidence- will be tackled and form part of the methodology. The involvement of user groups in four different countries will help us to achieve a European solution which will also be useful in other countries.

The Join-In project web-page:

<http://www.join-in-for-all.eu>

⁵ OE24.at. Deutsche Studie - Sechs von zehn Senioren spielen am Computer.
<http://www.oe24.at/zeitung/digital/article318942.ece>. Last accessed: 2/10

⁶ Basak C, Boot WR, Voss MW, Kramer AF: Can training in a real-time strategy video game attenuate cognitive decline in older adults? Psychol Aging. 2008 Dec; 23(4): 765-77).OE24.at

⁷ Hawkey LC, Thisted RA, Cacioppo JT: Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. Health Psychol. 2009 May; 28(3):354-63

⁸ <http://www.theatlantic.com/technology/archive/2011/02/physical-video-games-may-help-the-elderly-psychologically/71184>

2 Introduction

The aim of this document is to describe the design phase of the exergames in the Join-In project as well as the first implementation for lab testing. The game design is dependent on requirements, and for this reason we refer to requirements described in other documents (D4.1 – platform requirements, D4.2 Design and implementation of the platform, D5.1 exergame requirements and D3.1 Computer based games for adaption / development). Development challenges and the lab tests influence both the requirements and the design, so the final game design will be modified compared to this first design.

Design documents are used for the design and development of the games. These are live internal documents used in the planning and documentation during game design and development. These contain all details about the games, and have gone through several iterations during development and testing. The user groups have been involved throughout the entire process (participatory design). They have been invited to comment on the avatars and the game stories and will later try out several versions of the games. They have also been invited to give feedback on equipment and exercises. Physiotherapists have also been consulted, both for the exercises in the game, and on how they are presented and performed to find the best way to log movements and give feedback to and supervise the players.

The design documents have thus been changed based on experiences from development and technical trials and basic changes in design is described in the implementation sections.

2.1 Methods

When designing exergames for elderly, there are many aspects that will influence the result. Basic requirements, both functional and non-functional, will have to satisfy a number of different needs.

In the first phase of the project we had a wide approach.

- User requirements were defined based on
 - State of the Art about elderly and games
 - Physical and cognitive restrictions common amongst elderly
 - Observations of gameplay
 - Interviews and group discussions after gameplay
 - Questionnaires including questions about computer usage, gameplay and exercising
 - Definition of Personas and Scenarios
- Based on the user requirements, we made User Stories
- We studied exercises commonly used for the target group, by participation, by discussions with instructors and by studying online videos

- Existing platforms and input devices were studied. A description of existing equipment and platforms is found in D 4.1.

Please see D2.1, D5.1 and D3.1 for further information regarding requirements and State-of-the-art.

During the initial phase, several ideas about what a game could be like were discussed, all with the basic requirements in mind. Based on the results in the first phase, we chose some exercises and game types for the first prototypes, and made suitable game stories. Variation is good, so we decided to design three small games instead of one big. In this way we could try out both some of the ideas that we have and try different types of exercises. This would also provide us with feedback from the target group on different approaches since there are not many games for the very old available now. Playing will also be more fun when there are a variety of choices.

The game demos are different, but there will be unifying elements across all the games. For instance the players will be able to keep the same identity across all games, and thus they will also be able to recognise the other players no matter in which game they meet. Coaches or professional carers shall be allowed to follow progress in all of the games. And of course all games should be reachable through the Join-In platform.

At time of writing the state of the exergames are as follows: The cycling game has been both lab tested and piloted with home users, and it is available via the Join-In portal. The AntiqueHunt has been lab tested with users but it will not be piloted with home users, as it needs to be developed further. The walking game has gone through a redesign since the first version, and is currently being made available for lab testing.

2.2 Document overview

Based on the results from the requirement and user story phase of the project, plans were made for several exergames. There will be one walking game, one exerbiking game and one game with other types of exercises (AntiqueHunt).

Chapter 0 gives an overview of the top level requirements that form the basis for all the games. Chapter 3 to 5 give a more detailed description of each of the exergames, both the initial design and the first implementations for lab tests. Appendix 1 gives the layout of the design documents for the games.



A senior at Heracleum senior centre playing Wii Fit Table tilt during the requirement phase

3 Requirements for games

According to D5.1, our target group may have a variety of physical and mental challenges, and therefore exergames for this group must be playable in different modes and speeds, taking these challenges into consideration. For instance, if the game includes walking / stepping, this could be done standing freely, standing while leaning on a chair, using a walking frame or sitting down. For users who find stepping difficult, it should even be possible to only use the hands.

We must also take into consideration that our target group normally has a diminished vision angle and attention span compared to children and young adults. It must be possible to concentrate on one thing at the time and to take the required time to think about what to do next, if the game requires an action. Also the music and visual art should be adjusted. Oral information, could for instance, be given either without or with very low background music or sound. Feedback should both be given visually and with sound, and even tactile feedback could be considered for those with both hearing and reduced eyesight. All this falls into “design for all” that is particularly relevant for the elderly.

The following list sums up the requirements that were recognised as most important for exergames for our target group (see D5.1) as well as general game requirements. The list is not prioritised, since this is difficult both because the nature of the requirements differ between game types and because the target group is rather heterogeneous.

The game

1. rules should be simple
2. layout graphics should be adequate for elderly
3. must offer the possibility to choose difficulty and speed levels for each person
4. must be beneficial for the physical fitness
5. must be perceived as useful for the health
6. should be beneficial for the mental fitness
7. must be fun to play
8. must enable some kind of communication between players
9. must allow for multiple users to play together from different locations simultaneously (at home)
10. Should allow for multiple users to play together at the same location
11. must have the possibility to play cooperatively and competitively
12. must allow the participants to see their progress
13. must give positive feedback
14. must follow “design for all” principles, including
 - a. Adjustable speed
 - b. Possibility to play with limited fine motor skills
 - c. Both visual and sound feedback
 - d. Etc.
15. should allow for goal settings
16. must have different levels of difficulty

17. must allow for pauses
18. should have only one centre of attention, no distractions
19. must be safe to use
20. must allow for indoor exercising (sitting and standing) such as
 - a. indoor walking
 - b. indoor biking
 - c. dancing (standing and sitting)
21. should include some of these types of activities:
 - a. Warm-up
 - b. Cool-down
 - c. Balance
 - d. Strength
 - e. Endurance
 - f. Flexibility (upper part of body)
22. should allow for a coach or health professional to see progress

Some additional requirements are:

1. The games should contain elements that make them playable and fun over time. Games use many different approaches to achieve this. A common possibility is to level up – if you have success in one game level, you could be asked if you want to level up, alternatively this can happen automatically. The game should then become more difficult or contain new challenges
2. Experience or engagement points – many games give experience or engagement points for doing certain things in a game or for the time spent on a game, and these will accumulate each time you play. Players will automatically be upgraded to new experience levels. This can be visible to other players and can lead to a new appearance of the avatar and/or screen, or to new possibilities (there can be more choices for the look of avatars, there can be upgrade tokens on display, etc.)
3. Goals – the players can set long term goals. In a walking or biking game, this could for instance be to walk or bike the distance from Paris to Rome, either alone or together with co-players.
4. Social elements – each player belongs to a group, and there should be a certain peer pressure to participate in the exercise sessions (if the play is simultaneous) or to play a given amount of times during a week (if not simultaneous). The group can get rewards depending on the amount of participants. Also common group goals may lead to peer pressure to participate.

3.1 The Join-In games

Three different exergames are designed, based on the need for variation, use of different exercise equipment, the need for different kinds of exercise, and different physical and cognitive disabilities or specific diseases.

Many of the seniors who tried Wii liked the walking/jogging games, so the Join-In walking game is based on those games, but is adjusted to elderly in user interface and walking speed. The Wii players have also asked for variation. The exercycling is making stationary biking fun. The AntiqueHunt is set in several game scenes with different exercises particularly focusing on arm strength and flexibility, but also balance. The game gives game rewards in addition to exercise rewards.

The exergames are available through the Join-In platform, and the players will be able to use the personal avatars in the Join-In games. Types of feedback, scoreboards etc. should also be standardised throughout the games. In the lab-tests we received feedback on the look and feels that give valuable feedback to the designers and developers.

When we use images or landscapes, we try to find something that recalls positive memories, and in some games we also enable regionalisation or personalisation, although this has not yet been tried out. For instance in the game “AntiqueHunt” the items can be well known designs from back then in a specific country. Pictures on the walls could even be local or personal, meaning that you might be able to see an image of your own childhood home on the wall in a game scene. The sound and music will also be adjusted to suit an older audience, even though the taste is more varied than amongst the young. Also there is no background music when oral messages are given, to make what is being said easier to hear.

When adapting the games to an older audience, we were careful not to make the games boring. We know that screens with much information are more difficult to get a grasp on when we get older (whereas children love them) and pressure on doing things within a short timeframe can lead to frustration. Also the taste of music and graphical appearance differs with age. We will meet these requirements in our game design although the games are not as sophisticated as planned.

3.1.1 Walking (step aerobics) game

The walking game is a low intensity exercise game which encourages users to walk together. Walking was identified by the German, Irish and Norwegian user groups as an activity that they enjoyed. The walking game makes use of the *Microsoft Kinect* camera to track the user's body. This allows the game to be controlled without requiring the user to familiarise him/herself with a complex game controller. The primary goal of the walking game is to take steps to avoid obstacles in rhythm with the other users in a group.

3.1.2 AntiqueHunt (walk and stretch exercise) game

The game AntiqueHunt is using game elements to hide the fact that the player is exercising, but instead gets the player involved in the search for antiques. The game has different types of exercises for warm-up, flexibility, balance, endurance and stretching. This game is based on some common exercises that are used in training sessions for the elderly, and will also be suitable for the oldest ones.

The design of the game is based on several scenes or where each scene has a different type of exercise. In this project it is planned to only implement a couple of the AntiqueHunt scenes, but the game will be playable. The game will, however, be developed in such a way that new scenes with other (search for antique) exercises and tasks easily can be added. Since both the walking game and exerbiking application are good for leg strength, the AntiqueHunt will start with arm exercises that are also good for the balance when played standing.

The game should be played simultaneously by a group of players. One particular antique is hidden in the game, and only one player can find this (if working hard enough). Since the other players don't see when this is found, they will keep on exercising hard (collecting more items) in the hope of being the lucky ones.

Each player can play at his/her own pace, and there will be several levels (speed / number of items / how far to stretch etc.) that are both taking into account the abilities of the players and the possibility to level up. After each game, a scoreboard will appear, both showing the current and some previous scores, encouraging the players to beat their own previous scores. It will also be possible to follow the scores during gameplay.

3.1.3 Exerbiking

Many people in our user groups have a previous positive experience with outdoor biking, but do not do much biking anymore. This may be due to age related functional limitations, increased road traffic, or their easy access to convenient motorised transport. However, several persons in our user group reports having once acquired an indoor stationary bike, but that they only use it sporadically or never at all.

In the biking exergames, we aimed to recreate some of the positive experiences from outdoor biking in stationary indoor biking. This was done by displaying nice sceneries and outdoor surroundings in the biking game, such as biking virtually through a park. In addition, we aimed to retain a social experience, to remove some of the tedious aspects of indoor biking.

3.2 How the requirements are met by the games

This set of exergames is designed to cover some of the requirements that were found the most important in the requirement phase. They are not prioritized:

Requirement	Walking game	AntiqueHunt	Cycling game
1 Easy to comprehend	OK	OK	OK
2 Adequate layout	OK	OK	OK
3 Choice of speed and level	OK	OK Different levels and scenes	OK Resistance adjusted manually on the exercbike
4 Beneficial to physical fitness	OK	OK Relevant exercises	OK
5 Perceived useful for health	OK	OK exercises	OK
6 Beneficial to mental fitness	OK	OK coordination	OK Indirectly by physical exercise
7 Fun to play	OK	OK	OK
8 Enabling Communication	OK Audio chat	OK Talk in first and last scene	OK Text chat before or after cycling
9 Simultaneous different locations	OK	OK Made for online play	OK
10 Multiplayer same location	OK	No unless with different screens – it is made for online multiplayer	OK
11 Cooperative and competitive	OK Primarily a cooperative game however users can	OK Individual rewards: compete	OK Individual rewards Group cooperatively

	<p>compete with each other to see who can get the most scores</p> <p>Compete with yourself</p>	<p>Group rewards: cooperate</p> <p>Compete with yourself</p>	<p>mainly</p> <p>Compete with yourself</p>
12 See progress	OK	OK	OK
13 Positive feedback	OK	OK	OK
14 Design for all	OK	<p>OK</p> <p>Hearing and sight, no gripping needed but arm movements Can be adjusted to each user's moving abilities. Scenes where arms only are used can be played sitting down.</p>	<p>Partly</p> <p>Some sight capabilities required. Be able to operate a touch screen and to bike on a stationary bike (balance)</p>
15 Goal setting	OK	OK	OK
16 Difficulty levels	<p>OK</p> <p>Dynamically balanced to user skill level</p>	<p>OK</p> <p>Exercise difficulty – speed, balance, coordination</p>	<p>OK</p> <p>By adding resistance</p>
17 Allow pauses	OK	<p>OK</p> <p>Can take breaks by just doing nothing</p>	OK
18 Only one centre of attraction	OK	OK	OK
19 Safe to use	<p>OK</p> <p>should have something to lean on</p>	<p>OK</p> <p>If standing; should have</p>	OK

	nearby	something to lean on nearby	
20 Allow indoor exercising	OK	OK	OK
21 Exercise types	Balance, cardiovascular fitness	Flexibility, balance, strength, (endurance – in later scenes)	Mainly for training strength and endurance
22 Allow carer to see progress	When connected to a carer interface	When connected to a carer interface	When connected to a carer interface

4 The walking game

The walking game has been redesigned to include new gameplay elements in order to improve the experience for the users. The new design is described in section 4.2. This new version is more engaging and also easier to play - having seen from lab tests the kinds of things that cause the users difficulty.

4.1 Original design of the walking game

4.1.1 Overview of the game

The walking game is an online cooperative multiplayer game designed to provide a method of social interaction and low intensity exercise (Figure 1). The basic goal of the game is to walk a set number of steps during each play of the game. The user's steps are recorded using the *Microsoft Kinect* described in Deliverable 4.2.

To add challenge, which is necessary for any game, the user must attempt to walk to a rhythm. The rhythm is indicated by the white bars in Figure 1. The user must take a step every time their avatar is in line with a rhythm bar. The type of step the user must take is indicated by presenting an object to avoid. The potholes in Figure 1 are an example of an obstacle. When the user's avatar meets the first bar in Figure 1, the user must lift their left leg to avoid the pothole. The following two potholes in Figure 1 require the user to take a step with their right leg. Every incorrect or missed step results in the user's avatar slowing down which is indicated by changing the colour of the avatar's body from green to red.

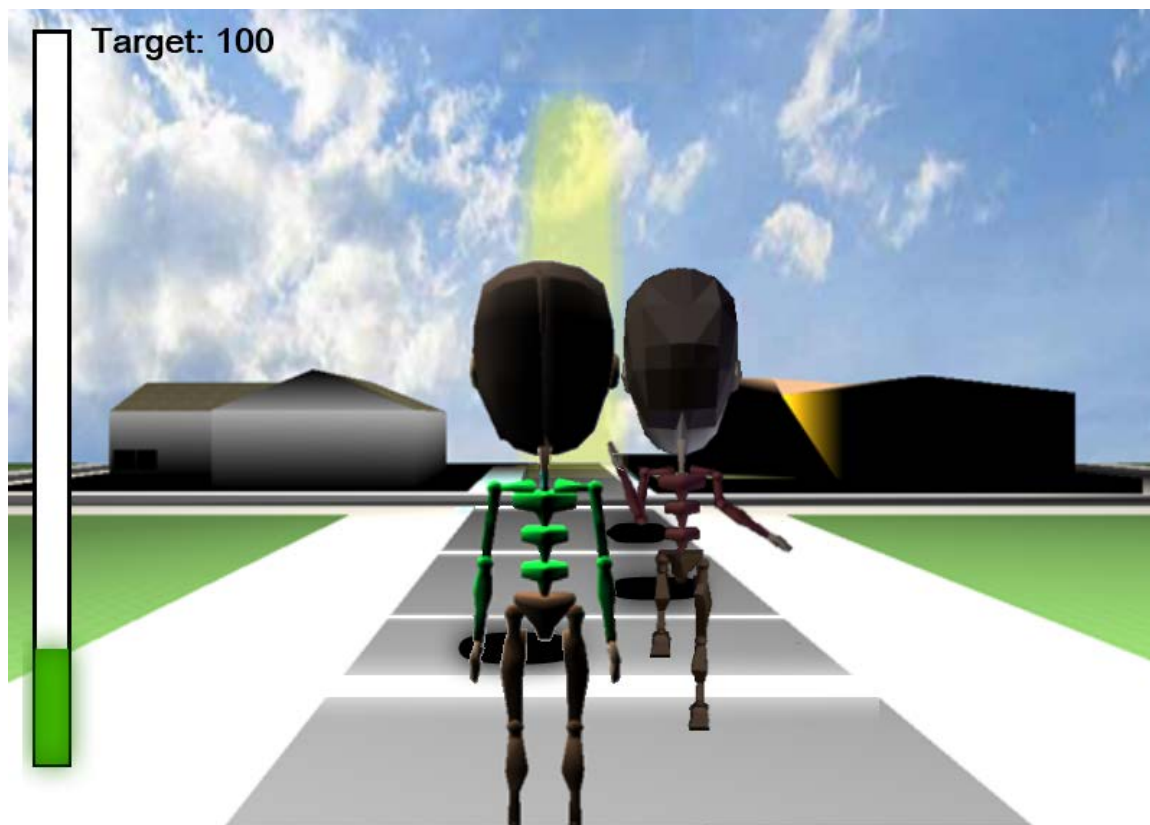


Figure 1: In-game screenshot of two players walking. The white bars along the path represent the rhythm and each black hole is an obstacle. The bar on the left represents the progress towards the goal. The two users must take a step to avoid each pothole.

This exercise is similar to step aerobics, where the user walks in rhythm using a small step, generally between six to twelve inches, which may be used to improve balance. The user may add a real step if he wishes to increase the intensity of the exercise. The commercial exergame *Wii Fit* contains a step aerobics mini-game which uses the *Wii Balance Board* peripheral to measure user steps (Figure 4).

The game is designed to be played in a multiplayer environment, although it may be played by just one user. In the multiplayer mode each user attempts to walk at the same pace; players of a high skill level will see additional obstacles to those presented to a player of a low skill level (Figure 2, Figure 3).

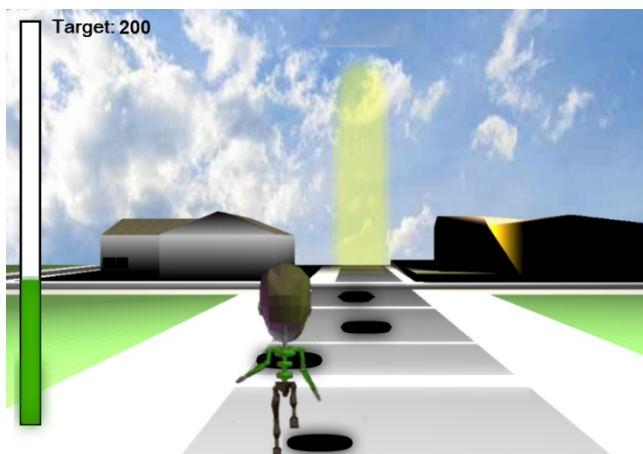


Figure 2: In-game screenshot of a younger player of a high skill level. The target for this user is 200 steps. Younger players have a faster rhythm, indicated by the additional potholes.



Figure 3: In-game screenshot of an older player of a low skill level. The target for this user is 60 steps. The rhythm is slower than in figure 2 with only 2 of the potholes the same for both users (meaning the older player has fewer obstacles).



Figure 4: In-game screenshot of the Wii Fit Step Aerobics mini game.

4.1.2 Game mechanics

The following section is a detailed description of the game mechanics which are the procedures and rules of the game. Every video game consists of a set of mechanics. See Appendix 1 in this document.

Dynamic Difficulty Adjustment (DDA)

Dynamic difficulty adjustment is a key mechanic of the Walking Game which allows users with different skill levels to play together. The adjustment system developed for this project is similar in design to the *SiN Episodes* Personal Challenge system. There are several methods of possible adjustment each represented by an advisor. Rubber Band Artificial Intelligence (AI) is an example of an advisor used which refers to a method of difficulty adjustment typically found in racing games such as *Pure* and *Mario Kart*. The goal of rubber band AI is to constantly challenge the player by adjusting the speed of the computer controlled racers relative to the players speed. Other advisors adjust different game settings in an attempt to increase usability.

The system attempts to assess why the players are currently failing based on suggestions from the advisors, then attempts to select the most suitable method of adjustment. If a player or group of players continue to fail after the initial adjustment, that method will be given a lower success rating and an alternative method will be attempted. The benefits of this approach are that the DDA system can customise itself to suit each user as a method of adjustment may be successful for some users but not others.

4.1.2.1 Space

The game space consists of real world environments. These real world environments are designed to create a sense of familiarity allowing users to walk in local areas. In addition to creating a sense of familiarity the user may select environments in areas they would like to visit but are no longer capable of travelling to, which will particularly be useful for home bound users. The size of the game world is relative to the difficulty setting. If the user is playing the game on a hard difficulty setting, a large number of steps may be required to meet the goal to complete the game. The world size will be larger for a user who has a higher target step counter.

4.1.2.2 Objects

The objects in the world consist of:

- The player model which is a one to one representation of the user.
- Rhythm bars which indicate when the user must perform a step action.
- Potholes which are obstacles which the player must avoid.
- The goal zone which is the destination of the walk.

There are also objects such as building and trees which are used as scenery only and are not affected by the player's actions.

4.1.2.3 Actions

The user has full control over their in game avatar. The actions required to play the game are a step motion, using both right and left legs. The degree which a user is required to lift a leg in order for the step motion to be recognised adapts to suit each individual. The adjustment is handled by an advisor as part of the DDA system. A threshold value which is

used to determine how high the user raises their knee in order to perform a step is adjusted based on the user's motions. This allows the intensity of the exercise to be adapted to suit each individual. The user is prompted to take some calibration steps which sets the initial threshold variable. This variable is recalibrated if a user increases or decreases their step motion.

4.1.2.4 Rules

The user must attempt to meet a target number of steps on each play of the game. The number of target steps for the user to complete is adjusted as a result of the user's previous progress. The immediate adjustment is that if the user can't make it to the target, the following target will be lower. If the user completes the target distance the next goal will be higher. The amount the target increases or decreases are dependent on the degree to which the user failed or succeeded to complete the previous target distances. A proactive adjustment, predicting how the difficulty will need to adjust to the user's perceived skill level is implemented by assessing the player's progress over time and attempting to predict a suitable series of future targets. In addition to meeting the target steps the user must perform each step in reaction to an in-game rhythm. The user must perform a step as each rhythm line matches the player's position. The DDA system checks if the player is making the correct motion but missing the time, if that is the case this advisor recommends reducing the precision required for taking a step.

A primary adjustment of this DDA system is to increase or decrease the games rhythm based on the user's performance in an attempt to find the most suitable pace for that individual. If a user is continuously failing to match the rhythm and the pace adjustments are not successful then the precision required to match the rhythm is decreased.

4.1.2.5 Skills

The user needs the ability to perform the necessary physical movements required to complete the step motion in the game. As the obstacles are presented to the user continuously in time with the game's rhythm the user's reaction speed is tested. The number of potholes presented to a user increases for those who have a higher perceived skill level.

4.1.2.6 Chance

The patterns of the potholes which the user must avoid are randomly determined to prevent boredom created by repetition. This also tests the user's ability to react to an unknown pattern rather than simply remembering the previous one.

4.1.2.7 Player profile

A player profile consists of the following attributes:

- Player ID
- Name
- Profile picture
- Friends list
- Skill level

- Player stats (used to evaluate progress over time)

4.1.2.8 Software Design

The block diagram (Figure 5) displays how the game components are connected.

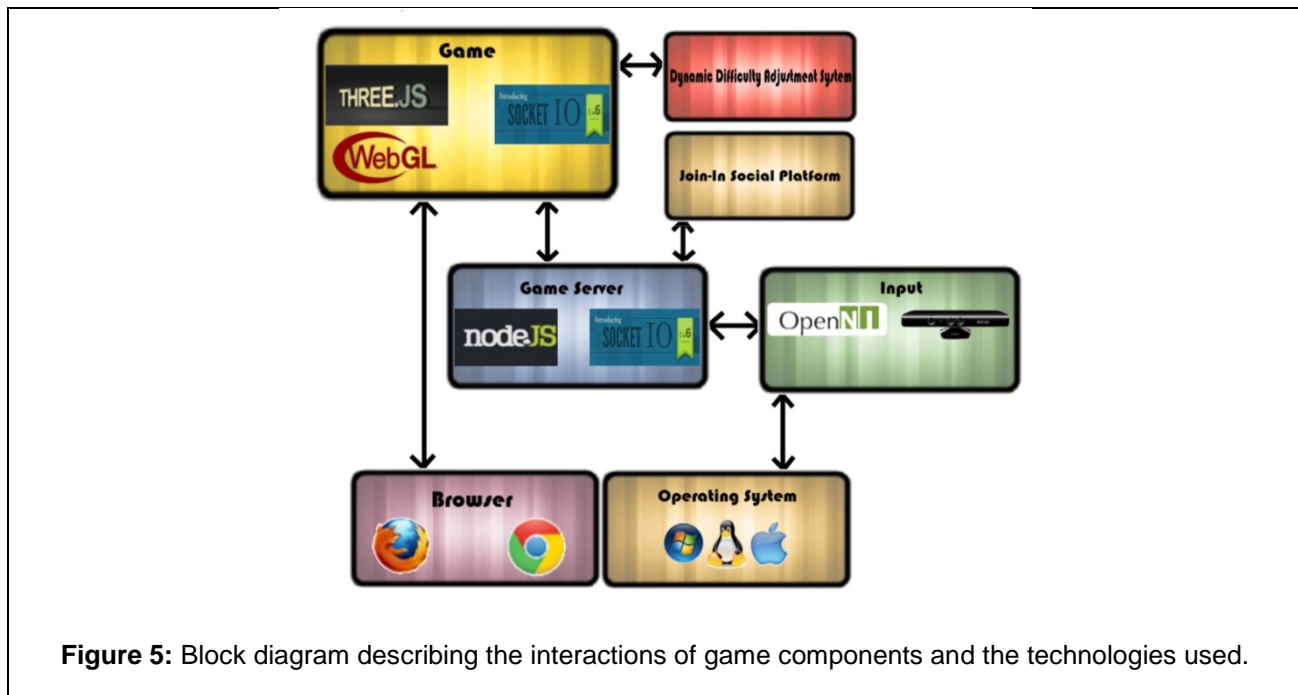


Figure 5: Block diagram describing the interactions of game components and the technologies used.

Descriptions:

- Operating system layer runs the browser and connects with the input layer. The system is designed to be multiplatform in order to increase accessibility.
- Browser layer connects with the game layer; all games are designed to run in HTML5 and WebGL compatible browsers.
- Input layer runs the OpenNI and SANDRA software to access Kinect skeletal data (see section 6.5.1).
- Game sever receives data from the input layer and social platform, this data is then sent to the game layer. The game sends requests to receive data from other layers through the game server. The game server used node.js and socket IO to send and receive data.
- Join-In social platform contains user data. This data is sent to the game layer through the server. The data may be used for matching friends, viewing user statistics and balancing data for the Dynamic Difficulty Adjustment system.
- Dynamic Difficulty Adjustment system adapts the games difficulty to constantly provide a challenge and to facilitate competitive, cooperative and intergenerational gameplay.
- Game layer contains the core game logic. It is run from the browser and connects with the server and Dynamic Difficulty Adjustment layer. Socket IO is used on this layer to send and receive data from the server. WebGL and Three.js are the selected technologies for loading and rendering models, using data structures for games (such as Vector classes) and for loading and playing audio files.

4.1.2.9 User story walking game

To help in the planning of games, different user stories have been defined. The user story of the walking game is presented in the following with a description and conditions of satisfaction.

As a user I wish / target / desire	Under what conditions I get satisfaction
... to walk at my own pace to not feel pressured.	<ul style="list-style-type: none"> • I want to see my avatar move while I walk • I want the game to find a speed that suits me • I want friends and family to be able to walk at their own pace
... to tell stories to others	<ul style="list-style-type: none"> • I want to see other users' avatars walk with me • I want to be able to talk with other users • I want to be able to hear others • I want to be able to turn my microphone on and off
... to walk in a world based on a real area so it feels familiar	<ul style="list-style-type: none"> • I want to select a world to walk in • I want to see the world I walk in • I want to have the option of walking in local areas • I want to have the option of walking in areas I would like to visit
... to walk with my family to feel socially connected	<ul style="list-style-type: none"> • I want to be able to walk at my pace while younger generations playing can walk faster • I want to be able to chat with my family as we walk • I want my family to find the game challenging without the difficulty increasing for me • I want to always be able to see the people I'm walking with
... to see my progress	<ul style="list-style-type: none"> • I want to see how many steps I have taken • I want to see how many calories I have burned • I want to compare my results with friends and family • I want to be able to keep my results private
... to easily navigate the menu	<ul style="list-style-type: none"> • I want all the options to be clear to see • I want to be able to select an option using the same controller I play the game with • I want the options to do what they say and not be confusing

4.2 Lab test implementation

4.2.1 Walking Game Overview

The walking game aims to make walking a more engaging activity by giving users the opportunity to walk around a 3d hedge maze with their friends, and to encourage social interaction by enabling users to chat to each other as they play. It is an online cooperative

multiplayer game designed to provide a method of social interaction and low intensity exercise. It includes three dimensional animated avatars selected by the users and designed by HappyWise and gives feedback to the users about how far they are presently away from the exit (should they manage to take the quickest route). The user's steps are recorded using the *Microsoft Kinect*, as described in Deliverable 4.2.

The player's goals include getting out of the maze in fewest steps, walking at least a set number of steps during each play of the game, and also walking at a suitable steady rate (not too fast and not too slow). That is, the player who gets to the end first doesn't necessarily win (as we do not wish to encourage the players to go at a dangerous speed and risk injuring themselves). Another mode involves players locating and gathering some items in the maze before they can get through the exit.

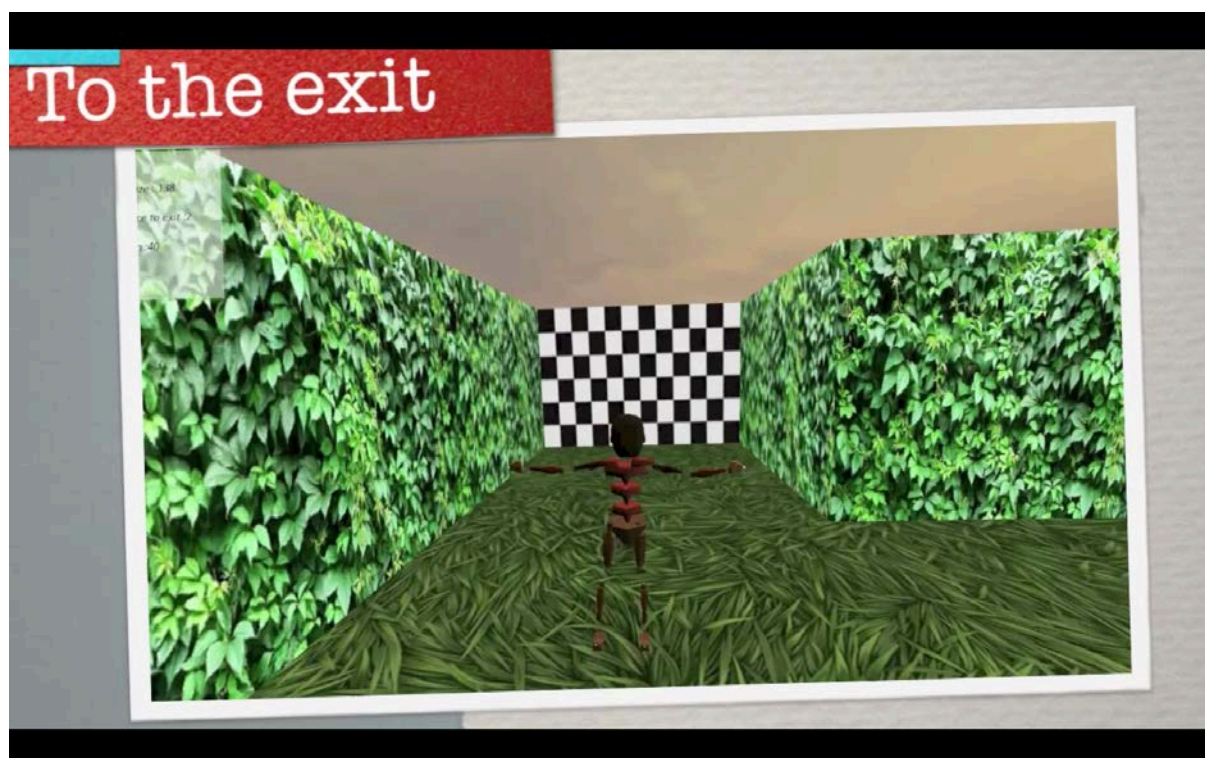
4.2.2 Space

The players traverse a 3d hedge maze, as shown in the below screenshot.



4.2.3 Objects

There are avatars to represent each person in the maze, and collectible items. There is also an end goal of the maze (shown in the figure below).



4.2.4 Actions

The player can walk, turn left and right, pick up a collectible item, and (possibly) activate a powerup.

4.2.5 Goals and Rules

To complete a level, the players must find the end of the maze in the fewest number of steps. To exit the maze, they must also have collected items scattered throughout the maze.

4.2.6 Skills

The player needs to be able to:

- walk at a steady pace
- collaborate with other people to get out of the maze
- remember where items are located in a maze

4.2.7 User stories

The user stories are listed in order of priority to enable the least important to be cut should the development time not permit them to be developed.

As a player I want to be able to move around in a maze

Conditions of Satisfaction

- walk at my own pace (not feel pressured.)
- see my avatar move when I walk (in front of Kinect)

<p>As a player I want to be able to see my progress</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • See a clear display of the number of steps to the exit
<p>As a player I can talk to the other players</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Can hear the other players talking • Can turn my microphone on and off
<p>As a player I can play with other players</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • can see other players' avatars move when they walk • Generate same maze for all users in multiplayer game
<p>As a player, I can win</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Wins if gets to the end of the maze • Sees a game over [replay or return to portal dialog]
<p>As a player I want a simple Menu System</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Pause game • Help (eg short video) • Settings • Return to Portal
<p>As a player I want to be able to see my [long term progress]</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Player can see number of steps taken • Can see how many calories burned
<p>As a player I can pick up an object</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Can pick up the object • Special power available
<p>As a player, I can activate my powerup [walk through one wall]</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Activate my powerup with a gesture
<p>As a player, I want to be able to walk at my pace while younger generations playing can walk faster</p> <p>Conditions of Satisfaction</p>
<p>As a player I want to be warned if I am walking dangerously fast</p> <p>Conditions of Satisfaction</p> <ul style="list-style-type: none"> • Warning displayed, avatar stops for a few seconds [panting animation]

As a player I want to be able to compare my results with friends and family

Conditions of Satisfaction

- Show achievement
- Option to keep results private

4.2.8 Technical Details

The game is written in JavaScript/HTML5 and uses WebGL for 3D graphics in Browser (this means it has a minimum spec in terms of graphics card/drivers (see <http://get.webgl.org/>). Player movement is captured by a Microsoft Kinect and software based on the Microsoft SDK, which streams the data to the game on the browser (over Websockets). Multiplayer gameplay is facilitated via Websockets and a game server written in Node JS. The game also interfaces with the Join-in portal via the Social Connector API.

5 The AntiqueHunt exergame

This chapter contains a high level abstract of the design document, as well as a description of the implementation for the lab-test.

5.1 Design of the Antique Hunt exergame

5.1.1 Overview of the game

The main game story goes like this: The players shall collect items for an antique market for the benefit of the local senior centre. An old friend has given a lot of nice old stuff to them, but they have to pick it up in a big old house. In the house there are different rooms and many floors. In different scenes they have to stretch, bend, climb stairs, etc. An animated (or filmed) instructor shows the correct movements. The players can talk to each other in the first scene in front of the house and in the last scene in the garden behind the house – actually in game lobbies before and after the game itself.

The AntiqueHunt is made up of several scenes, each with different types of exercises. Since the game is to be social and will be played together with others, each scene has a set length, and it starts and ends at the same time for all playing together. The scenes are played in a fixed order, but each player can exercise at their own pace and also take breaks without the others noticing. Each player can also have different levels or personal settings independent from the other players.

The players can talk with each other in the opening and closing scenes. In the other scenes they may only see the avatars of the others performing predefined movements (animations). They will also see an NPC (non-playing character) instructor showing them what to do (correct movements). All players must start the game at the same time - they cannot enter an on-going game. The opening scene acts as a meeting scene (lobby).

The game story for AntiqueHunt consists of 7 scenes:

1. Front garden: Opening and Warm-Up, stretch, chat (oral) is possible
2. Hall: Warm-up, arm strength and stretch
3. Kitchen: Coordination, leg and arm strength
4. Stairs: Endurance, leg strength
5. Attic: Body flexibility
6. Living room: Balance
7. Back garden: Cool-down and end, stretch, chat (oral) is possible

Please note that for the Join-In project only a couple of the scenes will be implemented and tested, but those will be fully playable as a game. The rest of the design is for a future commercial game.

The main features of the game:

1. An old house full of old things
2. An antique expert who shows how to move to collect things or stretch out
3. Rooms (scenes) where you have to stretch, bend or balance to collect items from shelves, chests or the wall
4. Stairs that move as a background as you step up or down
5. A front yard where you can talk to other players online
6. A back garden where you can chat with other players online
7. Indication of fitness in this session and in earlier sessions (exercise rewards)
8. Scores for collections (game rewards)
9. Some kind of group rewards (how many times played / how many present)

Each room gives a different minigame, and the objects and actions differ from room to room, but basically the players perform different kinds of exercises by grabbing objects and placing them somewhere, by walking or by following an instructor.

The game can be extended with new scenes with new exercises that can take place in new scenes or locations.

The final game will also allow for personalised or “regionalised” game graphics, as we assume that the elderly will like to have familiar elements in the game. For instance pictures on the walls or background images can be local / national or well known to the players and the items can be items typical for that region 50-70 years ago (vases, plates and cups, tools, etc.).

Game goal/Display of achievements

Goals are defined on a personal and on a team level. The personal goals are divided into fitness goals and game goals.

Personal goal are: get regular exercise, get in a better or at least not get in a worse physical shape





Personal exercise rewards: strength points for performance (steps, number of things collected etc). Previous exercise points (for instance best this week, best the three last months) will be displayed together with the day’s achievement so that the players can see how they are doing.

Common goals are: have fun while training. Maintain a group (meaning that new members might have to be added since this is a vulnerable age group).

Common rewards: Points for each participant and every time the group plays. A special treasure is hidden in each game, but will only be found if the player who has the treasure does well enough. If the treasure is found, it will be on display in the back garden, and it will be added to the team collection. Only the lucky player will know that it has been found until it is displayed in the last scene.

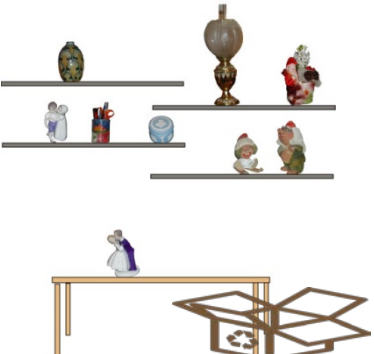
5.1.1.1 Front garden minigame – the game story

Goal: meet each other, perform some initial warm-up movements.

	A group of seniors are going to arrange an antique market for the local senior centre (or another charity) and they collect things for the market.
	An old friend has given a lot of nice old stuff to them, but they have to pick it up in a big old house.
	<p>They meet outside the house together with an expert on antiques. This is the game lobby.</p> <p>The players can see each other, walk and wave to each other or chat orally</p>
	<p>The expert says they should all do as she does both to take care of the antiques and their bodies</p> <p>Start of warming up:</p> <p>They all hug (embrace themselves)</p> <p>“Role your shoulders, it’s going to be hard work!”</p> <p>“The key is beside the window, you have to stretch to reach it!”</p>

5.1.1.2 Hall minigame

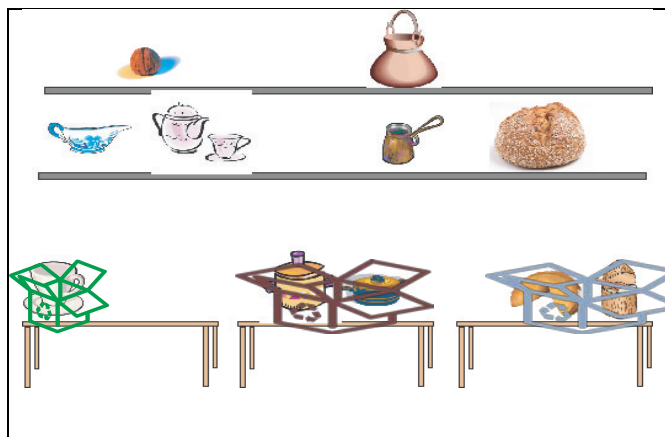
Goal: proper warm-up: perform arm movements, stretch and strength

	<p>Catch Antiques (arm and whole body movements)</p> <p>(2-3 minutes)</p> <p>They open the door and enter a room with many shelves. The expert shows them how to lift things carefully down and put them in a paper box on the table. They can see the others in the background (but they only see their own</p>
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	<p>real movements).</p> <p>“Now we are finished here. We should move on.”</p> <p>The hidden treasure can be in this scene.</p>
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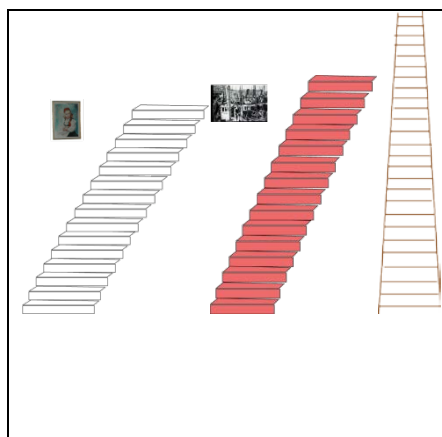
5.1.1.3 Kitchen minigame

Goal: perform arm and leg movements, strength, flexibility and coordination

	<p>Catch and sort Antiques (coordination)</p> <p>They have promised to help empty the kitchen cupboards in return for all the old items. There are three types of things in the cupboard: food, saucepans and china. They put the things in three different paper boxes on three different tables, and have to move sideways. They can keep the china.</p> <p>The hidden treasure can be in this scene.</p>
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5.1.1.4 Stairs minigame

Goal: endurance by stepping.

	<p>Endurance (3-5 minutes)</p> <p>They have to climb stairs, one after the other. The players don't see each other, just the expert in front – moving at exactly the same speed as themselves.</p> <p>The stronger ones must even climb a ladder. When time is up they enter the attic. They can watch pictures on the walls on the way up – and maybe spot a surprise around a corner</p>
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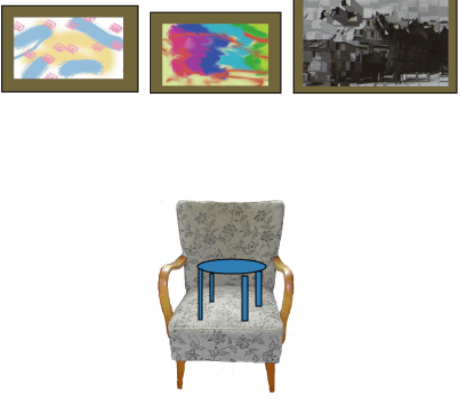
5.1.1.5 Attic minigame

Goal: flexibility by rotating the upper body

	<p>Attic – flexibility</p> <p>(2-3 minutes)</p> <p>The expert points at some chests on the floor and tells them to open them and pick up things and put them on the table. They have to rotate the upper body to reach the items.</p> <p>They see the others in the background (but only see their own movements)</p> <p>The hidden treasure can be in this scene.</p>
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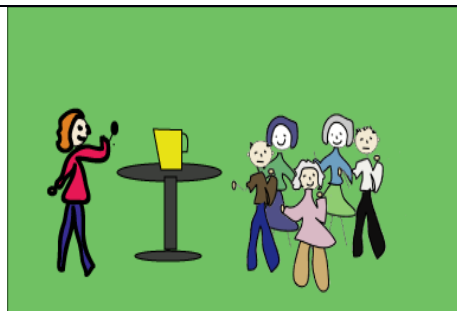
5.1.1.6 Living room minigame

Goal: balance.

	<p>Balance</p> <p>(3-5 minutes)</p> <p>When time is up they enter a living room that is almost empty, but there are many pictures on the wall. They have to stand on a rickety stool on top of an armchair to get the pictures down, sometimes even on their toes, or just on one foot. This requires a good balance.</p> <p>The expert shows them how she thinks they can reach the pictures safely. They hand the pictures to the expert. In this scene they don't see the other players.</p>
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5.1.1.7 Back garden minigame

Goal: perform stretch out movements and say goodbye.



Cool-down, stretch and goodbye

(3-10 minutes)

Now they are finished, and they gather in the garden for a glass of juice and some stretching.

The expert gives instructions. "This was almost like a training session, let's stretch out!"

After the stretching they can say goodbye and chat a bit (again orally). Maybe they can discuss some of the pictures from back then that they have seen on the wall

5.1.2 Game mechanics

The game consists of multiple levels or areas within a traditional home. For each different area within the home the user has to perform different tasks to progress to the next area. The tasks vary from stretching (to reach for objects on shelves) to reaching down for objects and to walking up ladders and stairs to an attic.

The player is controlled by the Kinect device and is represented on screen by an animated character. The character has numerous animations in-built to mimic the actions of the user taken from the Kinect data.

5.1.2.1 Sensors

The user's movements are detected with a Microsoft Kinect XBOX360 device connected to the USB port of the user's PC. The Join-In Client (SANDRA – see 5.1.4) performs all the logic needed to identify whether the user is:

- posing to stop, resume or quit the game
- walking on the same spot
- hugging him/herself
- rising his or her arms over his or her head
- bending to pick up an object which is on the floor

It is also responsible for pushing the user's movement information to the game server using Java sockets.

SANDRA works on top of a slightly modified OpenNI framework. OpenNI is multiplatform and open source. It supports different devices, including the Kinect. The packages required for using OpenNI are: the hardware driver PrimeSensor module, a middleware Natural Interaction PrimeSense module, and the OpenNI library itself. However, it will also be necessary to install and configure a suitable USB port communication driver like libusbJava.

Therefore, after setting it up, the OpenNI framework allows SANDRA to get the user's joints data. That is, the space position of 15 of his or her joints: head, neck, shoulders, torso, hips, knees, feet, elbows and hands. Knowing where those positions are in the space SANDRA can compute them and generate events which will be sent to the game server and used in the game as inputs. For instance, if the user is performing a game where he or she has to go up some stairs, he or she will have to move his or her legs mimicking the real life movement of going up the stairs. His or her joint positions will be monitored and they will produce a 'walking' movement if his or her knees move fast and high enough. Then, that event will be pushed to the game server so that the game can update the player's position, animation, score or any other movement-related parameter.

5.1.2.2 Space

Each location is a scene with actions and can be defined as a minigame. So far we have defined:

1. In front of a house – a front garden in front of a house where all players meet.
2. Hall – a room with many shelves and tables.
3. Kitchen – a room with many open cupboards and shelves plus some tables
4. Stairs – several stairs and ladders. The image will move as the player descends.
5. Attic – a room with chests and tables.
6. Living room – a room with many pictures on the walls.
7. Back garden – a garden with a lawn where there is room for all to stretch out.

5.1.2.3 Objects (all elements the player can engage with)

The main objects of the game are (the objects differ from room to room):

- In front of the house:
 - a key to open the door to the house.
 - It is either on the ground, attached to a hand or in the door keyhole.
 - There is only one key in the game, other players see the player who picks up the key first.
- The hall
 - Items on a shelf:
 - They can be collected. They are either on the shelf, attached to a hand or in a paper box (invisible).
 - All players have the same items, it is not visible what other players do with their items.
- The kitchen:
 - Items in open cupboards.
 - The items are either in the cupboards, attached to a hand or placed in a paper box.
 - The items can be placed in the correct box or in a wrong box.
 - All players have the same items, what other players do with their items is not visible
- The hall:
 - Stairs, that will be scrolled as you walk (up or down)

- The attic:
 - Chests with things to pick up.
 - Items are either in the chest (partly visible), attached to the hand or on a table.
 - One similar item to each player, what other players do with their items is not visible
- The living room:
 - Pictures.
 - The pictures are either on the wall, attached to a hand or on the floor (only the last one collected is fully visible)
 - All players have the same items, what other players do with their items is not visible
- The back garden:
 - None
- A treasure: One of the items in one of the scenes *for only one of the players* is a treasure. It will normally be one of the last items on a shelf or in a box. The treasure is either on its place, attached to a hand or on display in the status area until the last scene.

5.1.2.4 Actions

Each scene has different kinds of exercises as the main objective, but exercises are done by performing game actions that give game rewards.

- In front of the house:
 - Wave to each other
 - Hug each other (or yourself if the player is not near another player – or actually yourself)
 - Stretch for key
 - Oral chat
 - Exercise goal: Warm up arms,
 - Game goal: One player gets the key
- The hall:
 - Stretch to collect an object. Move the object to a large paper box (kitchen bench height, shall not have to bend).
 - Exercise goal: stretching, arm strength (and indirectly balance)
 - Game goal: collect all items and place them in the paper box, search for hidden antique.
- The kitchen:
 - Collect objects by walking sideways and touching the chosen item.
 - Place the selected item in the correct paper box (food, pots & pans or china).
 - Exercise goal: walk and stretch, flexibility and coordination, balance.
 - Game goal: collect all items, correct placement of items, search for hidden antique
- The stairs:
 - Step stairs to move up.
 - Exercise goal: as many steps as possible
 - Game goal: reach the top of a ladder

- The attic:
 - Rotate to pick up things from chests on the floor
 - Exercise goal: flexibility
 - Game goal: get all items out of the chests; search for hidden antique
- The living room:
 - Balance on one leg, tip toe etc to reach pictures on the wall
 - Exercise goal: balancing and flexibility
 - Game goals: collect all pictures
- The back garden:
 - Stretch out following a video (NPC expert tells what to do)
 - Oral chat
 - Exercise goal: stretching out
 - Game goal: having successfully played all the minigames

5.1.2.5 Rules

The players are asked to perform different tasks in each scene or minigame. In most of the scenes, the players are asked to collect items. They are shown by a video or animation which movements to do and the movements will be tracked by Kinect. The rules in each scene are to copy/repeat the shown movements to perform game tasks.

Risks and rewards:

Since the minigames are played standing up, there is a risk of falling in all of the games. The players should have a chair, a walking frame or something else close by to lean on if needed.

The game can also be adjusted for sitting players, except the stair climbing (it is hard to detect this movement with the Kinect sensors)

- Front garden:
 - Rewards for successful hugging (embrace yourself)
 - Rewards for reaching the key first
 - Risk: not able to hug each another
 - Risk: Loosing balance, stumble or fall
- The hall:
 - Rewards for stretching (reaching the items)
 - Rewards for each object placed in the paper box
 - Extra rewards if all objects are collected
 - Risk: Loosing balance, stumble or fall

The kitchen:

- Points for every collected object
- Points for correct placement of object
- Extra points for collecting all objects
- Risk: Problems with sorting
- Risk: Loosing balance, stumble or fall

- The stairs:
 - Rewards for every second step.
 - Extra rewards for each floor
 - Risk: Loosing balance, stumble or fall
- The attic:
 - Rewards for each item placed on the table
 - Extra rewards for all items
 - Risk: Loosing balance, stumble or fall
- The living room:
 - Rewards for balancing
 - Rewards for each item
 - Extra rewards for all items
 - Risk: Loosing balance, stumble or fall
- The back garden:
 - Points for some movements (must be defined)
 - Extra common game points if someone has found the treasure
- The game:
 - Group rewards for all participants
 - Personal trophy for finding the hidden antique
 - Total game and exercise points

5.1.2.6 Skills

The players must be able to control their movements and to follow the movements and instructions from an NPC or video / cut scene.

The players must be able to stretch, step, bend and balance.

The players must be able to recognise items, stretch for them and place them where they belong.

The exercises are real.

5.1.2.7 Chance

Items may differ – only a subset of the total set will be on display in each scene. The number of items that each player gets will depend on each player' level.

There may be some real risks: if the players are not careful, they might fall or hurt themselves.

There is one treasure in each game that can be found in one scene by one of the players. The placing will be random, but it will be in the last 50% of items in a shelf or box.

5.1.3 Player profile

All players will have a profile that will be used for all the Join-In games and the platform.

Name

User ID

Score

The total game score of the user across multiple games.





Figure 6. A couple of screenshots of an avatar outside the old house

Ability/Difficulty

Players must have the following physical ability to perform movements:

- Eyesight – if the sight of the player is reduced, fonts will be bigger and there will be a louder audio feedback
- Hearing – if the hearing is reduced, there will be a clearer textual and visual feedback
- The movements required will be adapted to the abilities of the individual player
- There will be several levels with a different amount of items

Avatar ID

Multiple avatars will be stored for use in the games. This is a URL to the specific one that a user has chosen to be his/her virtual self. The players can use the same avatar across games, and thus be recognised by game friends.

5.1.4 Software design

There are 3 components to the AntiqueHunt ExerGame and these are:

- **SANDRA** which is a cross platform client application developed to access multiple devices.
- The “**Game Server**” that sends the connected users the game logic and temporally stores data for use in the game.
- The “**Browser**” that is a traditional browser, which compiles and runs the JavaScript game logic sent from the server. The game is a 3d environment built using Three.js.

We considered using the WiiMote as another suitable sensor device. It has some advantages such as the possibility to be used by people while they are seated on chairs, better navigation control or the fact that it is a physical device that the users have to hold in their hands.

Nevertheless, the most noticeable drawbacks are that its buttons are not convenient for the users' hands and that the exercising movements cannot be controlled as accurately as they can with the Kinect for the kind of movements needed throughout the exergame. These two main flaws made us choose the Kinect for this game.

There are multiple approaches to the creation of the player model. We wanted to use animations for each movement of the avatar for two reasons: First, at the moment the Three.js framework doesn't handle rigged skeletons directly. Second we think it is better not to show the real movements of the users in the game since they can be leaning on a chair because they are tired, they may be trembling and the avatar would tremble too, etc. However, there were not enough resources for the development, so real movements were chosen. The technical basis is the same for the walking and AntiqueHunt games.

5.1.4.1 Overview of system architecture

Below in figure 7 is a graphical description of the AntiqueHunt system architecture design listing all the components used in the game itself.

In the final version the AntiqueHunt minigames will be activated from the "Social Media API" described in D4.2, and the GameServer will use "Social Media API" described in D4.2 to validate the user profiles and get avatar information.

1. "**SANDRA**" is a cross platform java application developed in Join-in complete with web sockets for transmission of device data. This application will run on the user's machine and send filtered device data from devices, such as Microsoft's Kinect, to the game server or to a specified I.P address in JSON serialised form. It also contains a logic library to filter the data and web sockets to send the serialised data to the game server specified.
 - To capture the device data it uses a modified version of "OpenNI" complete with "libusbJava", which allows the connection to the USB port for data retrieval. Once the data is captured it is then processed from its raw state into usable enumerations by various algorithms. These enumerations represent the actions that the user wants to perform in the game such as walk, run, reach. The data is then serialised by a "JSON" java alternative called "GSON" and using web sockets transferred to the game logic as a method of controlling the game.
2. The "**Game Server**" is a remote NodeJs server that sends the connected users the game logic and temporally stores connected user's device data for use in the game. The user's session data such as profile information is also found on the game server. The *Join-In Device manager* sends the user's movement to be stored on the game server so that the browser can request the data, per frame, to be used in the game logic to interact with the virtual world.
3. The "**Browser**" is a traditional browser, Chrome and Firefox, which compiles the game logic sent from the server and renders the output to screen. The game is a 3d environment built

using Three.js which is a wrapper for WebGL. The client uses SocketIO/web sockets to connect to the game server to request their Kinect data and profile information and also other (connected) user's data.

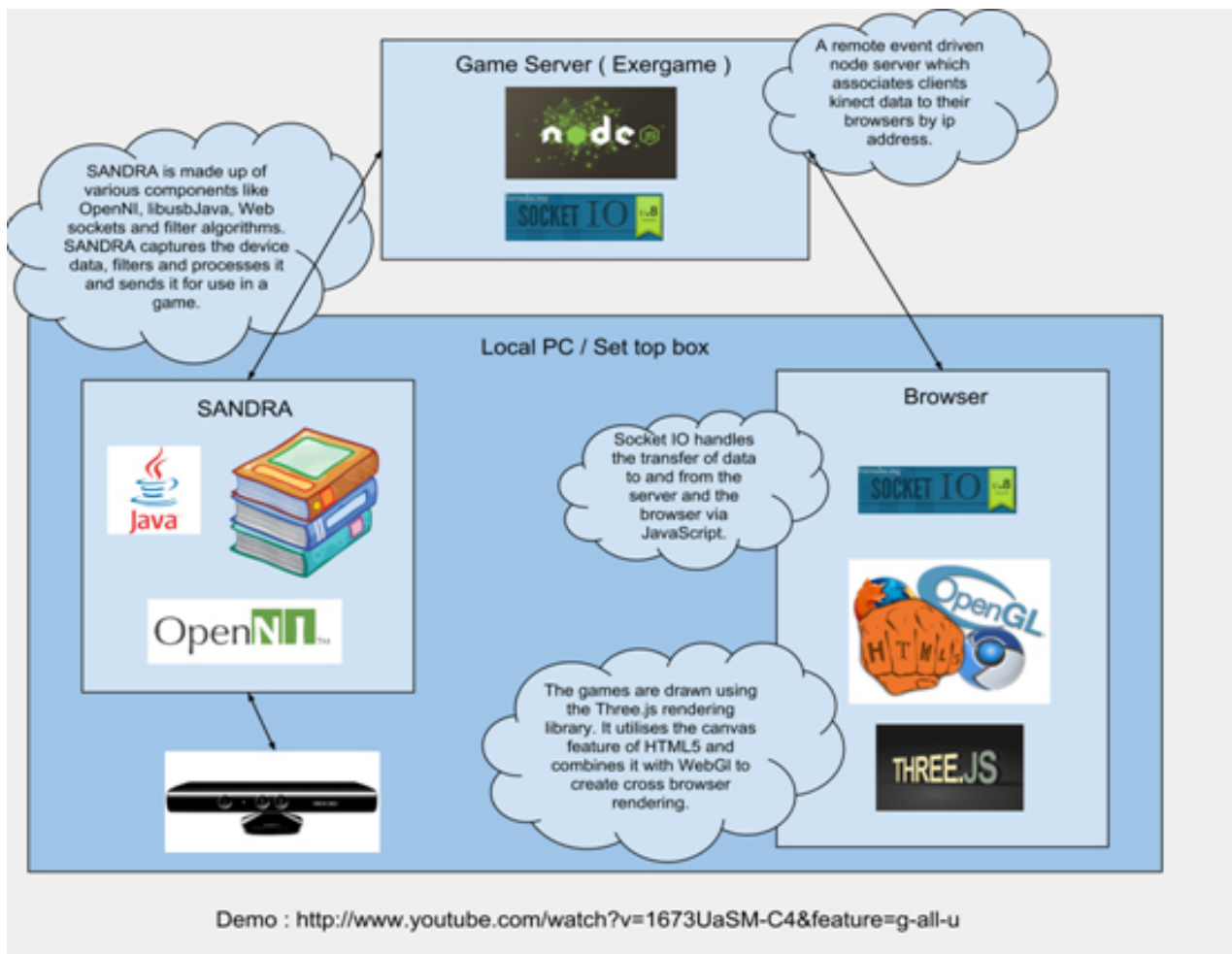


Figure 7: AntiqueHunt System Architecture

The diagram in figure 8 shows the interactions between the various states in the system. The user initiates this sequence by clicking on a play Exergame elements located on the Join-In social media page. This is further described in D4.2. The profile for that user is forwarded to the ExerGame server which it stores to be used in a game. The ExerGame server then forwards the game logic to the user's client browser. For the game to begin the server must have established a connection to the user's SANDRA, otherwise it remains in a waiting state. After these conditions are met the stream of data to the game server commences from SANDRA which is stored remotely. The user can then request for their device data and also the data of the other users connected to that game.

5.1.4.2 High-level interaction design

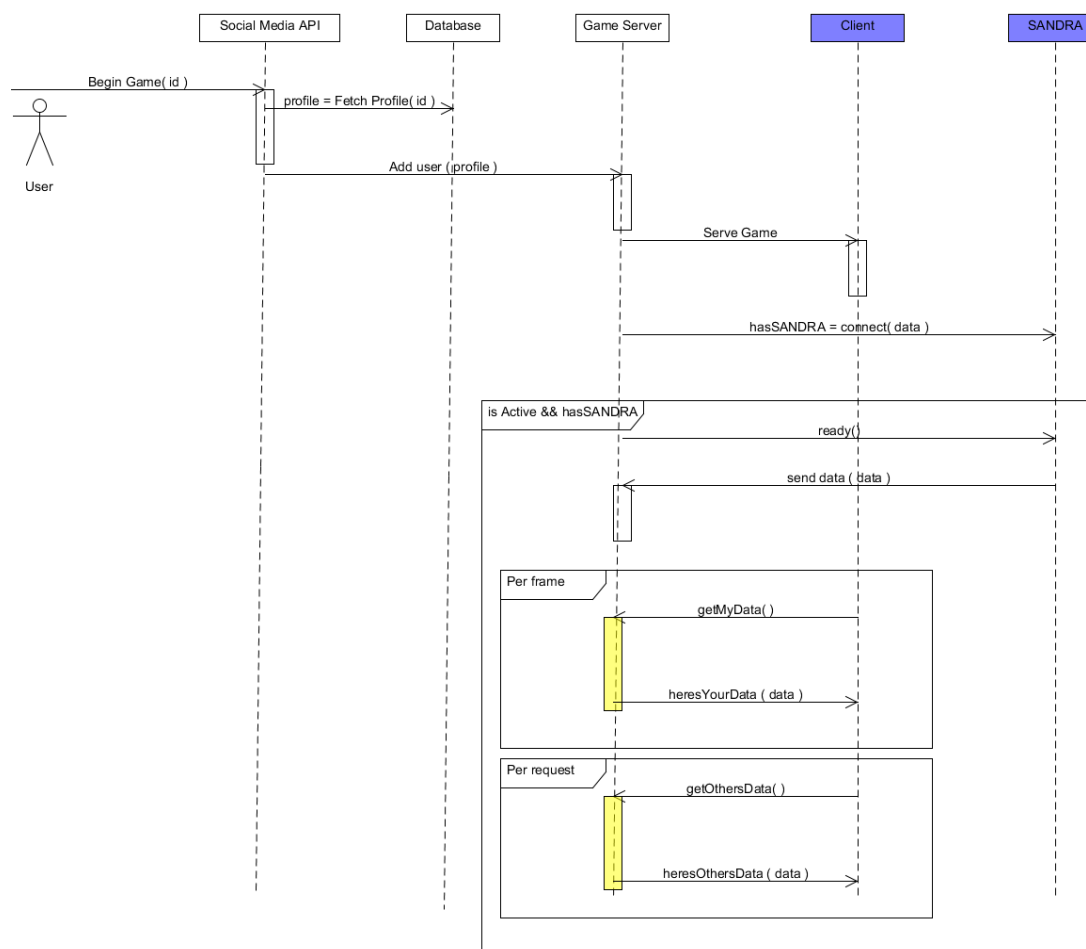


Figure 8: System interactions

5.1.4.3 User story game with different exercises (AntiqueHunt)

To help in the planning of games, different user stories have been defined. The user story for the AntiqueHunt game is presented below with a description and conditions of satisfaction.

As a user I wish / target / desire	Under what conditions I get satisfaction
...to be able to play standing with a chair or something as support if I need it	<ul style="list-style-type: none"> The game equipment is easy to set up at home It is possible to play without being afraid to fall or hurt myself
... to move / step at my own	<ul style="list-style-type: none"> No time constraints on user actions Not feeling under pressure

pace	
... to be able to forget that I am exercising	<ul style="list-style-type: none"> • Fun or entertaining game • It is a type of activity that I like to do
... to profit from the exercises	<ul style="list-style-type: none"> • Playing the game means exercising • The exercises are useful for my health
... to be able to play with others	<ul style="list-style-type: none"> • See that there are other players • Recognise the other players (same avatars across games)
... to choose a suitable difficulty level	<ul style="list-style-type: none"> • We shall all appear to move at the same speed, even when some of us take a break or move slower • The group reward is not diminished even if I have a bad day, as long as I am present
... to follow my own progress from session to session and be able to set targets	<ul style="list-style-type: none"> • Store and display performance (for instance numbers of steps or lifts in a session) • Display how well I performed this time compared to “best ever”, last session and average of a period • Display results on charts by date to see improvements and declines
... to communicate with others	<ul style="list-style-type: none"> • Able to chat with the others in parts of the game • Know when we can hear each other and talk • See when the microphone is off
... that menus and information are easy to understand	<ul style="list-style-type: none"> • Easy to understand menu options • Menu terms are the same across all games
...to be able to identify with the game	<ul style="list-style-type: none"> • I want to be able to choose and personalise my avatar • I want surroundings that I recognise or find pleasant • I want a game story that is relevant / that I can identify with • I want images and music that can be personalised

5.2 Lab test implementation

The first version of AntiqueHunt is made up of three scenes, a garden in front of the house, in a room and back to the garden. The players collect items in the two first scenes, and to continue to the next scene – or level – they have to collect a certain amount of items. The scenes are played in a fixed order, but each player can exercise at their own pace and also take breaks without the others noticing. Each player can also have different levels or personal settings independent from the other players. As it is now the room scene does not have a fixed time, the players must collect all the antiques to get to the next scene.

On top of the window the players will see both themselves and own scores as well as other players and the scores that they get.

The first lab test version works best for single player since the other player avatars are not visible, just their points. The avatar so far is a “skeleton” and just made for trials.

5.2.1 Game mechanics

5.2.1.1 Sensors

In the first version we developed SANDRA that worked on top of a slightly modified OpenNI framework. OpenNI is multiplatform and open source. It supports different devices, including the Kinect. The packages required for using OpenNI are: the hardware driver PrimeSensor module, a middleware Natural Interaction PrimeSense module, and the OpenNI library itself. However, it will also be necessary to install and configure a suitable USB port communication driver like libusbJava. Since this solution was not stable, and there was problems with fetching the initial start pose, and also an unsolvable problem when others entered the space in front of the Kinect camera.

Therefore SANDRA was replaced with a new client program that uses the Windows SDK beta 2, library. The user's movements are detected with a Microsoft Kinect XBOX360 device connected to the USB port of the user's PC. This new client program does not have any of the above mentioned problems that SANDRA had.

The new client program (SANDRA2) gets the user's joints data. That is, the space position of 15 of his or her joints: head, neck, shoulders, torso, hips, knees, feet, elbows and hands. Knowing where those positions are in the space the client program can compute them and generate events which will be sent to the game server and used in the game as inputs. For instance, if the user is performing a game where he or she has to go up some stairs, he or she will have to move his or her legs mimicking the real life movement of going up the stairs. His or her joint positions will be monitored and they will produce a 'walking' movement if his or her knees move fast and high enough. Then, that event will be pushed to the game server so that the game can update the player's position, animation, score or any other movement-related parameter, using Java sockets.

The client program performs all the logic needed to identify whether the user is:

- ☐ posing to stop, resume or quit the game
- ☐ walking on the same spot
- ☐ hugging him/herself
- ☐ raising his or her arms over his or her head
- ☐ bending to pick up an object which is on the floor

The client program will maybe be updated to use the newest Microsoft Kinect for Windows SDK, and the Kinect for Windows Kinect camera, as we assume this solution will be even more stable.

5.2.1.2 Space

The locations are in 3D with limited space so as not to get lost, but still big enough to move.

- In front of a house – a front garden in front of a house where all players meet.
- A room where antiques are collected.

5.2.1.3 Objects (all elements the player can engage with)

The main objects of the game are collectibles

- In front of the house (in the start of the game):
 - a key to open the door to the house.
 - It is "floating" somewhere.
 - There is only one key in the game, other players see the player who picks up the key first.
- The room
 - Items seen as antiques ("bulbs") hanging from the ceiling:
 - They can be collected and in this first version disappear when collected.
 - All players have the same items, it is not visible what other players do with their items.
- In front of the house
 - All the collected items are somewhere on the lawn, and the players gets a badge when they have walked up to the items.

5.2.1.4 Actions

The actions in the first implementation are:

- Walk – step in place (to get key, to get close to other players, for each antique, to reach the collected items)
- Turn – lift right arm to turn right and left arm to turn left
- Touch (to grab key or items)
- Hug (embrace yourself)
- Wave (to other players)
- Stretch arms (to grab antiques)

5.2.1.5 Rules

In the front scene:

- hug other players (embrace yourself) to get points
- Walk to find key and other players
- Try to grab key first (walk into it)

In the room: Stretch to grab antiques until there are none left. Arms have to be taken down between each antique.

Risks and rewards:

Since the game is played standing up, there is a risk of falling. The players should have a chair, a walking frame or something else close by to lean on if needed.

The players get points for performed tasks

Outside these actions give rewards:

- Hugging
- Getting the key

Inside these actions give rewards:

- Collecting antiques

Overall:

Group scores for total combined achievements

5.3 Software design

There are 3 components to the AntiqueHunt ExerGame and these are:

- **The user Client** which is a windows application developed to access a Kinect device and send the users data to the game.
- The **“Game Server”** that sends the connected users the game logic and temporally stores data for use in the game.
- The **“Browser”** is a traditional browser, which compiles and runs the JavaScript game logic sent from the server. The game is a 3d environment built using Three.js.

There are multiple approaches to the creation of the player model. We wanted to use animations for each movement of the avatar for two reasons: First, at the moment the

Three.js framework doesn't handle rigged skeletons directly. Second we think it is better not to show the real movements of the users in the game since they can be leaning on a chair because they are tired, they may be trembling and the avatar would tremble too, etc. However, there were not enough resources for the development, so real movements are chosen. The technical basis is the same for the walking and AntiqueHunt games.

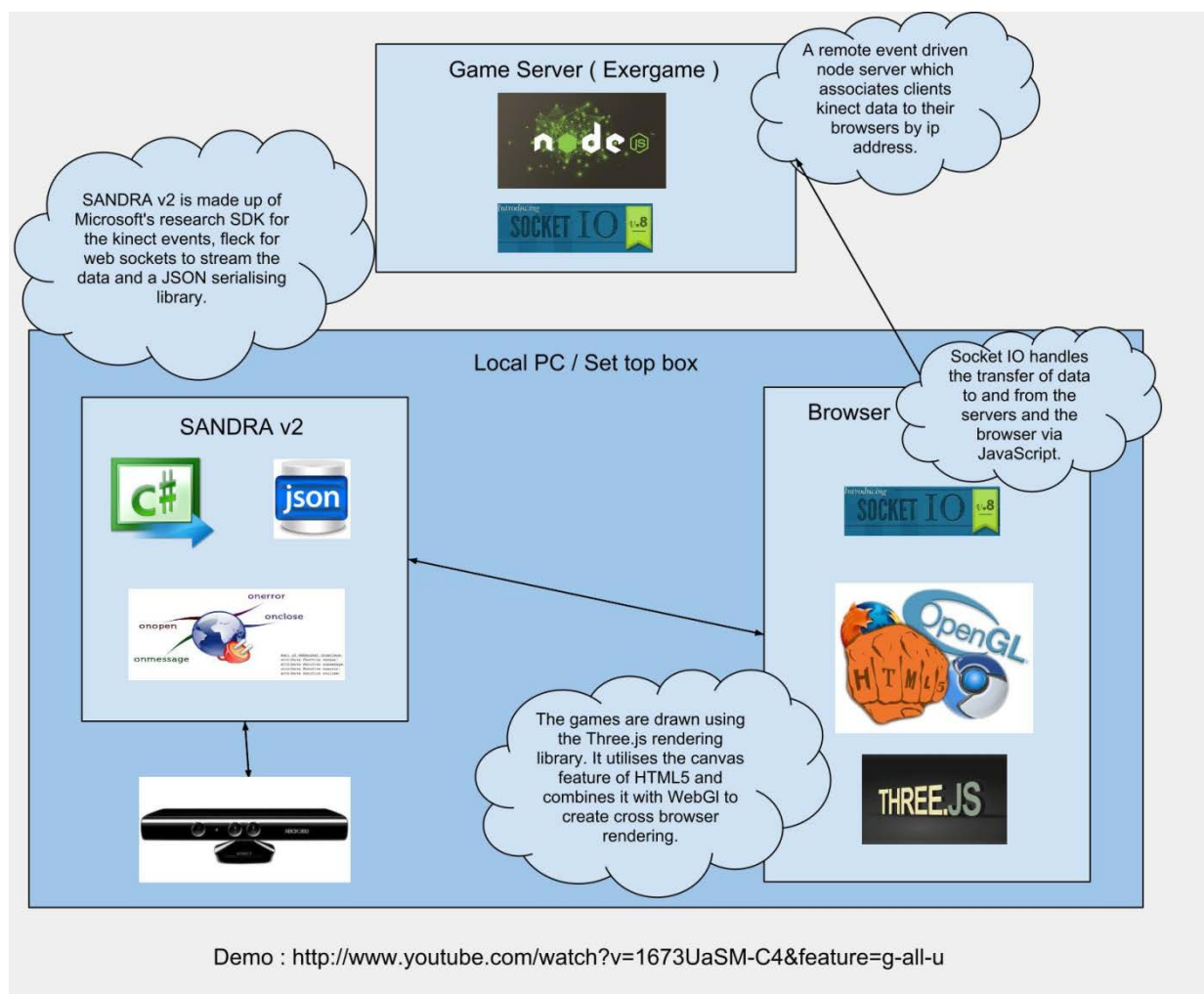
5.3.1 Overview of system architecture

Below in figure 7 is a graphical description of the AntiqueHunt system architecture design listing all the components used in the game itself.

In the final version the AntiqueHunt games will be activated from the “Social Media API” described in D4.2, and the GameServer will use “Social Media API” described in D4.2 to validate the user profiles and get avatar information.

1. The “**user client**” is a windows C# application complete with web sockets for transmission of Kinect data. This application will run on the user’s machine and sends filtered device data from Microsoft’s Kinect to the game via web sockets in JSON form.
2. The “**Game Server**” is a remote NodeJs server that sends the connected users the game logic and temporally stores connected user’s data for use in the game. The user’s session data such as profile information is also found on the game server.

The diagram in figure 8 shows the interactions between the various states in the system. The user initiates this sequence by clicking on a play Exergame elements located on the Join-In social media page. This is further described in doc D4.2. The profile for that user is forwarded to the ExerGame server which it stores to be used in a game. The ExerGame server then forwards the game logic to the user’s client browser. For the game to begin the server must have established a connection to the user’s SANDRA, otherwise it remains in a waiting state. After these conditions are met the stream of data to the game server commences from SANDRA which is stored remotely. The user can then request for the data of the other users connected to that game.



6 Exerbiking

This chapter gives an overview of the exerbiking game and a description of the lab-test and pilot-trial implementations.

6.1 Overview of the game

The biking exergame enables users to take part in multiplayer online biking trips using their home stationary exercise bike. The players are able to bike together through nice sceneries of outdoor surroundings, such as biking virtually through a park or a coastal route. The outdoor sceneries, the map of the route, and participant information are displayed in a web browser application on a bike-attached Tablet. Figure 9 below shows an example with an exercise bike set-up.



Figure 9: Exerbiking

Social facilitation by performing an activity together is an important aspect of life, and we exploit this possible joy and peer motivation in the exerbiking game.

A biker participates from home in an online group and using his/her stationary exercise bike. A certain number of biking sessions per week will be prescheduled for the group, with a new stage for each session. Together the stages compromise a tour, and the tour lasts for a predefined number of weeks. While biking, the bikers will see scenery images of the stage on a tablet. The tablet will also show a photo of the other bikers participating. Group biking is intended to make the activity more social and thereby attractive, and scenery

images are intended to make the biking less tedious and more fun. In this way we try to make the home biking activity more sustainable over time.

6.2 Lab-test and pilot-trial implementation

The exerbiking is designed for multiplayer home groups and implemented for tablet computers attached to an exercise bike.

For the **lab-test version** we had to simulate the presence of a group since the application was to be lab tested individually. The lab-test version was at that time not integrated with the Join-In social portal, but ran directly from the exerbiking game server. However, all languages were supported, a selected set of biking routes was provided, and most of the functionality was implemented.

The exerbike game **pilot-trial** implementation is fully functional and integrated with the Join-In social portal. Group exerbiking sessions can be scheduled for Join-In users in the portal, and users can access the sessions from the Join-In portal.

7 Avatar design and development

During the very first game sessions with the elders it was found that they liked to have an avatar representing themselves in the game situation. The purpose of the avatar development process was to develop characters suitable for the walking game that would also please the elderly users. We received users' comments on the avatars in existing commercial games such as Wii and Kinect. According to that feedback the avatars were too young looking, and some of the characters especially in Wii were too transparent and difficult to see for the users. On the other hand, the Join-In games' users are the elders, their children and grandchildren, meaning that each of the players should be able to find an avatar for himself.

The design process of the avatars began with a graphic designer from HappyWise drawing avatar heads with different styles, genders, animals, expressions and moods in one document. We sent the document to our partners asking their and the user-groups' opinions about the avatars.

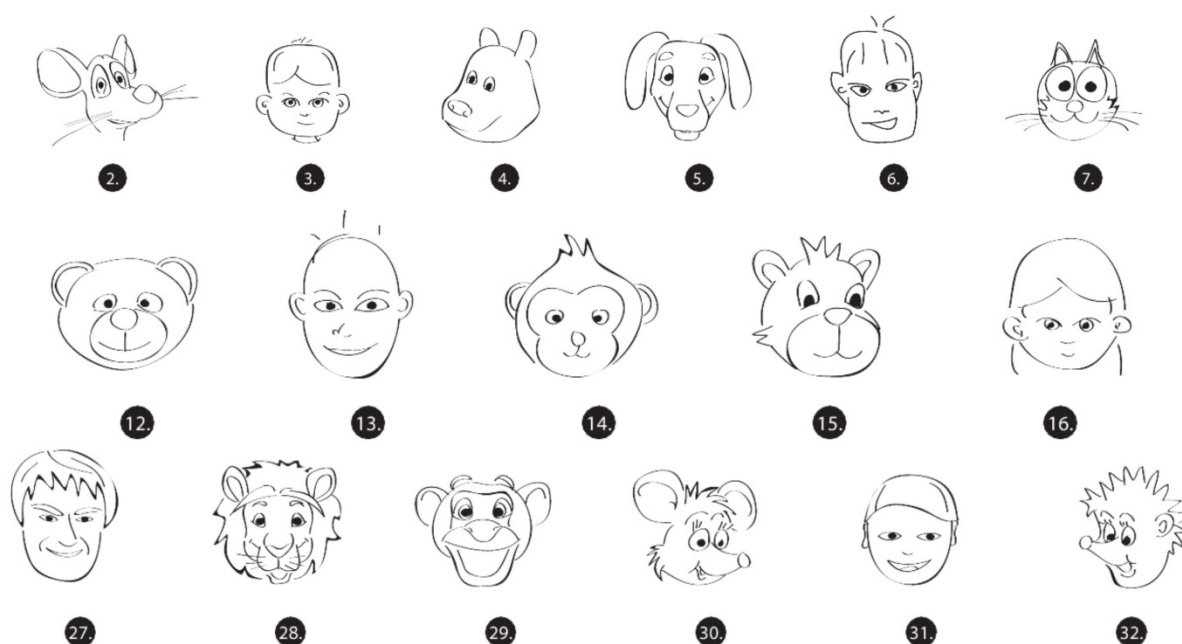


Figure 10: Images: Samples of different avatar head styles

The small scale research results turned out heterogeneous. Different countries were pleased with different styles. Some of the comments and votes were not in line. Old human characters did not get points in the votes, but more elderly characters were required in the comments, whereas animal characters were liked but the feedback from

the test-groups indicated that they were not certain whether the animal avatars would work in a game situation.

The characters voted for had all happy or nice expressions, whereas the mean, angry or sad looking characters did not get any votes.



Figure 11: The first versions of Join-In avatars

HappyWise decided to design three test avatars: one male, one female and one animal character. The male and female characters were designed to look like adults that are in good shape, glad and full of energy, as it was the tendency of the vote results. The animal character was chosen to be a lion because it got the most votes.



Figure 12: The development process of the male avatar

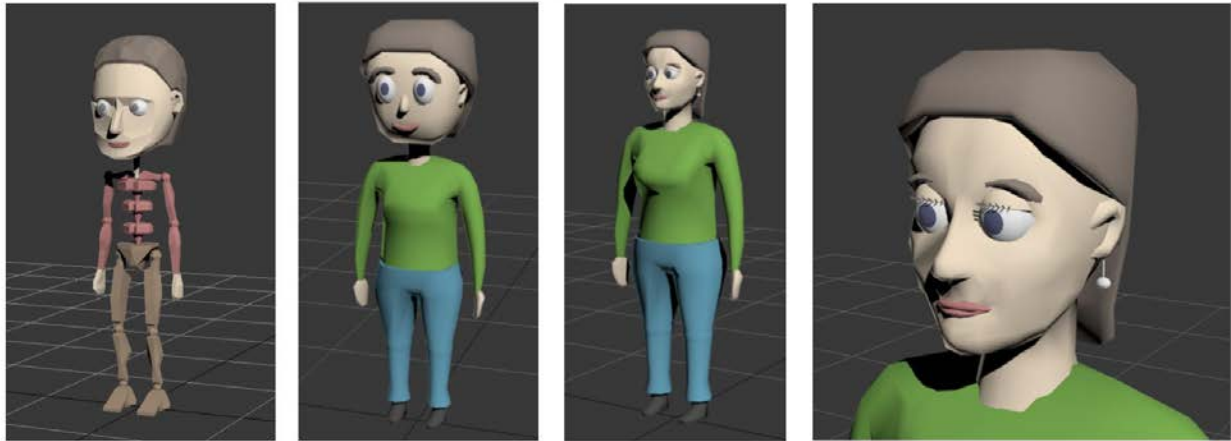


Figure 13: The development process of the female character



Figure 14: The development process of the lion model

The research indicated that both partners and users wanted to modify the avatars so that their friends could recognize the players from the avatars. This wish is supported by the theory from Treppe and Reinecke: “Identification with Avatar is positively related to video game enjoyment” (Avatar Creation and Video Game Enjoyment by Treppe and Reinecke

For the piloting and testing the avatars were designed only with one pair of clothing to save the workload to get more feedback before making new characters. However the users’ wishes were taken into consideration when creating the test avatars, the different outfits and hair-looks might be added on them later on.

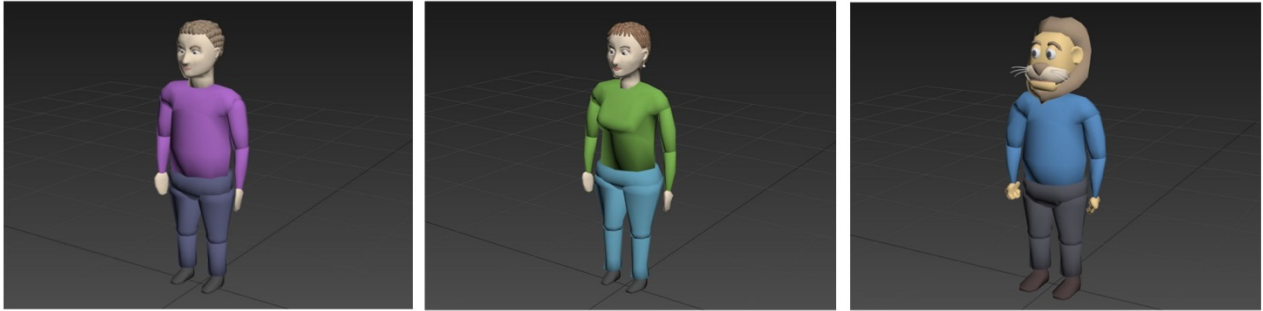


Figure 15: The final versions of the characters

During the development phase the three test avatars have been presented to the partners in biannual meetings and the avatars were modified according to the comments. The three models are now ready for piloting and gaming. Because of the time used in modifying the avatars' looks the process of developing took longer than expected and there will be no resources for further development.

Appendix 1 – Game design document template

1. Overview of the Game

- What is the game genre and setting?
- What does the player control?
- What is the player supposed to achieve in the world? (Describe a player's activity during a typical session of the game).

2. Game mechanics

Defines detailed description of the game mechanics, the procedures and rules of the game. This section can be broken down into:

2.1 Space

Defines the various places that can exist in a game and how those places are related to one another. Spaces can be continuous or discrete.

- What are the boundaries of the space?
- How many dimensions does it have?
- Are there sub-spaces? How are they connected?
- Is this world better than the real world?
- Is this world simpler than the real world?

2.2 Objects (all elements that the player can engage with)

Objects, Attributes and States - a space has objects (cars) in it, objects that have attributes (maximum and current speed), each attributes having a current state (200km/h, 90km/h).

- What are the objects in the game?
- What are the attributes of the objects?
- What are the possible states for each attribute? What triggers the state changes for each attribute?
- What states are known by all players?
- What information does the player need that isn't obvious just by looking at the game world?
- When does the player need this information?
- How can this information be delivered to the player, so it doesn't interfere with the player's interactions?

Game objects usually have many attributes and states, so it is often useful to construct a state diagram for each attribute to make sure you understand which states are connected to which, and what triggers state changes.

2.3 Actions

Actions - the "verbs" (protect, build, move, jump, shot, avoid) of game mechanics, representing the base actions a player can take.

- Some verbs may act on multiple objects;
- Goals can be achieved more than one way;
- What does it mean to make progress in the game?
- What are the operative actions? What are the resultant actions?

2.4 Rules

Rules - define the space, the objects, the actions, the consequences of the actions, the constraints of the actions and the goals.

- What is the problem the game asks the player to solve?
- Are the rules fair enough for the player to continue to solve the problem? (Inconsistent game rules may unfairly impede the player's progress).
- Do the players feel in control and powerful?
- What are the rewards and risks this game delivers?

2.5 Skills

Skills - every game requires players to exercise certain skills (physical, mental, social skills).

- What skills does the game require from the player?
- Are the required skills real or virtual?

2.6 Chance

Chance - is an essential part of a fun game because chance means uncertainty, and uncertainty means surprises. Chance requires interactions between all the other mechanics.

- What in the game is truly random?
- Do players have the opportunity to take interesting risks in the game?
- What is the relationship between chance and skill in the game?