Integrated Project on Interaction and Presence in Urban Environments

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Initial TimeWarp Demonstrator

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Abstract

This document describes the first year of research within the TimeWarp subproject of IPCity. TimeWarp concentrates on mixed reality game experiences in an urban context. The aim of the project is to develop an edutainment game that makes use of state-of-the-art AR technology and implements various presence concepts such as the use of sound or virtual characters.

The specific objectives for TimeWarp are:

- To develop and evaluate concepts and tools for:
  - Cross-media mixed reality user interfaces and applications
  - Orchestration and authoring interfaces for a broad range of people to shape the edutainment application.
- Further advancing research into the subject of presence in mixed realities in an edutainment context by:
  - Exploring the use of cues for creating a sense of temporal and spatial presence, in particular with respect to travelling between different time periods
  - Examining engagement and augmentation issues that are designed to support a sense of presence

Intended Audience

This document is intended to all partners of the project, the EC, and to the reviewers for the first project's phase.

1 Workpackage Objectives

Objectives Phase I	The objectives of this phase are • To carry out pilot studies on city tours • To develop a game concept for a mixed reality game that fosters physical and social presence • To implement and evaluate the first technology probes
Results Phase I	In this phase the initial concept for the TimeWarp game was developed and tested. Research was conducted in order to identify which devices to use and these were tested using an initial scenario. A questionnaire called “Time and Cityspace” was developed with the aim of exploring temporal aspects of presence. It was also developed to identify the challenges which may be undertaken by the game players. We have also explored the idea of embedding a sense of place within objects and locations through an agent-based system known as “Presence BOBs”. These agents store information about their own preferences and the information gained from real users, this information is then shared with other users using a natural language interface.
Evaluation Results Phase I	The carried out led us to the conclusion that the underlying concept within TimeWarp is appealing for the end users. In addition we identified three main areas which are important to the development of the system these are: interaction style, spectator participation and game play.
Objectives Phase II	During phase II we will: • Further develop TimeWarp • Conduct tests exploring issues related to game play and presence

2 Introduction

TimeWarp is a mixed-reality edutainment adventure game that contains various action and strategy elements. As the game takes place in mixed-reality the players experience real and virtual elements simultaneously. The game takes place in the old town of Cologne. The objective is for the players to find Heinzelmännchen who are local legendary characters, and to rescue them.

This report presents a short review of commercially available technologies such as PDAs and audio books which are used to help people explore a city as well as a study on related work about mixed reality in cultural heritage and about cross media games. The report then details information about the design issues (including issues related to presence). It then provides information on the year one prototype.

3 Field Studies and Initial Concept

During the early stages of the project it became apparent that there had already been significant work carried out into mobile devices for use in urban contexts, such as electronic city guides. Moreover, there had also been some work carried out into mixed reality gaming. These two areas provide an interesting starting point and allowed us to explore technical, content and gaming related issues.

3.1 Related Work: City Guides

To date guidebooks in both paper and electronic form (such as on PDAs) were the main way to help people explore a city. However, since MP3 players and PDAs are objects of everyday life, a growing market for audio city tours has arisen. Several companies publish audio guides or even produce multimedia solutions. For example, Sony provides an own series of guides ("Passport to…") for its PSP.

In the following subsections two examples of digital guided tours are given. The focus is on the use of technology and user experience: how has the user been taken on the tour? To what extent can the user arrange the content? How does the user interface allow content selection? Moreover we were interested in the "time order", i.e. does the tour tell the history in a linear order and cover relevant epochs at each location.

3.1.1 Cologne iGuide

The purpose of iGuide[1] is to present an audio visual city tour. Multimedia "features" are prepared for selected places in the city. The Cologne iGuide consists of 47 different features. The tour takes about 100 min.

Figure 1 iGuide PDA and map

Hardware

The iGuide is based on a Dell Axim PDA. The iGuide software is installed on a 256MB SD card. Additionally a small laminated map of the city centre with numbered markers of the visited places (see Figure 1) is handed out. The features are listed at the back of the map (see Figure 2). A pair of headphones completes the iGuide hardware.

Content

[1] http://www.en.iguide.de/cnt/110805142906.htm

The features are not presented in a chronological order, instead the tour is designed to start and end at the tourist office. Epochs covered are the Roman Empire, Middle Ages, Second World War and the present day.

Each feature has an “anchor“ in the city, e.g. a sculpture, a spring, or a (detail of a) building. In addition to information about the anchor itself, the narrator explains the history of Cologne with respect to the anchor’s epoch. Additional graphical material (photos or paintings, but not videos) is presented on the PDA.

User Interface

The iGuide has a very simple user interface. The hard keys of the PDA are disabled, except the volume control. Selection and play-back of the features are controlled via touch buttons on the PDA’s touch screen. iGuide has four basic screens: welcome, feature selection, play-back, and help.

The welcome screen shows the iGuide Cologne Welcome message. A play button in the left bottom corner starts the first feature.

In the feature selection screen, a number block is shown. The user can enter a number of a feature. Touching the play button starts the play-back of the chosen feature. Also, the user can access the iGuide help.

The play-back screen is tripartite. The header shows the number and title of the current feature, the content (main) area shows pictures in addition to the spoken text, and at the bottom is the navigation bar. It is possible to go the previous or next feature, or to open the feature selection screen.

At the end of each feature, the narrator gives directions to the next place.

Figure 2 iGuide feature list (back of the map)

3.1.2 Bonn MP3 – City Tour

The ‘Bonn MP3 – City Tour’ is a 60 minute audio tour intended for a single traveller. The tour covers the most popular topic for visitors to Bonn, Beethoven. The tour visits 11 locations.

Hardware

The visitor gets a standard MP3 player with the city tour tracks and a brochure. The brochure includes a city map indicating the 11 places of the tour and short texts about each place.

Content

The tour focuses on Beethoven, featuring narratives and music. The tour visits 11 places in the city related to the life of Beethoven, and at each place is a visible “anchor” for that story. At the end of each feature, the narrator gives directions to the next place.

User Interface

The user can control the tour using the buttons on the MP3 player, skipping mp3 tracks or stopping the playback.

3.2 Related Work: Mixed Reality for Cutural Heritage and Cross-media Games

Research in mixed reality for cultural heritage (Vlahakis (2002), Park (2006), Salgado (2001)) has primarily focused on digital content issues like 3D reconstruction or virtual character animation allowing an immersive tour experience at the heritage site. However, the tours still maintain a conventional form that is information centered and don’t create user engagement. Recent research in this area makes us of a gaming approach, but has been related to learning (Ferdinand, P. (2005)), digital story telling (Holweg, D.; Schneider, O. (2004)) and mobile social software (Walz (2006)).

Besides mixed reality for cultural heritage, research in urban and cross-media games (Lindt (2006), Cheok (2003)), is of interest, which has primarily been related to aspects of gaming. In order to enable exciting story telling or story browsing experiences in mixed reality it is necessary to look at the implications the user interface and content will have. Techniques include things such as dialog and plot deepening, game repeatability, game and player transitioning, non-player character (NPC) arc, NPC to NPC chemistry, relationship building, among many others (Freeman, D. (2003)). TimeWarp seeks to make people feel present in a particular urban situation (place and time) using elements of games.

3.3 Conclusion

From the users perspective most city guides place them in the role of an information consumer, for example the can rarely change or interact with the content. Based on this and other aspects we arrived at the following conclusions with respect to city guides:

- The choice of topics was restricted
- The order in which the users could view the topics was fixed or suggested
- No interaction, they only listened to narrative or viewed videos and pictures
- They were often educational in nature

Mixed reality systems overcome some of the problems outlined above but from the perspective of TimeWarp, however the following issues or challenges remain:

- The experience occurs only within a specific timeframe, we intend to develop systems where users can come and go as they please and also take part in the experience even when not playing the game
- Real-time positioning of mobile players is still a challenge, we intend to use a hybrid approach based on GPS, inertial tracking and computer vision.
- Interaction in mobile computing and especially in mobile gaming is very heterogeneous due to the numerous different devices. We intend to develop mechanisms that allow players rich interaction with the virtual game elements.

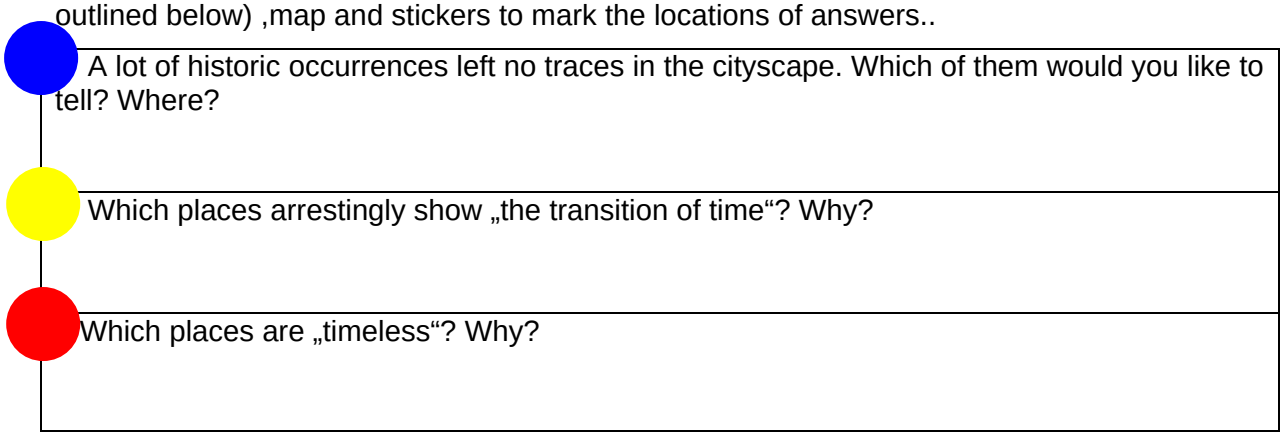
4 Design

The design phase consisted of a number of elements, a questionnaire which was used to identity locations of interest within the City of Cologne. Based the findings of the questionnaire and other aspects highlighted early we developed a design rationale and list of objectives. These along with game play and other scenario issues are highlighted within this section.

4.1 Questionnaire on „Time and Cityscape“

One of the key elements within TimeWarp is to let the users experience the City of Cologne across many time periods. To get information about this a probe containing a questionnaire was sent to approximately 30 city guides. Although the results varied substantially from guide to guide, they did provide a useful insight into area of interest within the city.

The probe consisted of a short description of the project, a questionnaire (the questions are outlined below) ,map and stickers to mark the locations of answers..



Some interesting comments included that the Colonisation appears to be timeless because it dates back to the Roman period but remains in use today. Also that the Cathedral appears to be timeless as it has not changed much since it was built. Both of these comments are relevant to TimeWarp because they provide suggestions of locations which are suitable for use in different periods.

From a data gathering perspective the questionnaires provided only limited information, and we acknowledge that if another study was to be carried out methods such as interviews and perhaps a real city tour would be more appropriate.

4.2 Design Objectives for the Time Warp Mixed Reality Game

As a result of the review into existing technologies and the probe the following design decisions were taken to:

- Design an engaging and exciting game
- Reuse content, context, and locations
- Develop rich mixed reality experiences exploring the full potential of 3D animation
- Allow the player determine the duration of the game
- Make the game foster temporal, physical and social presence
- Make the game play take place within the city

Consequently the game includes following aspects:

- A game element that allows time travelling

- Small, self-contained challenges
- The ability to use the challenges in different cities

4.3 Design overview

TimeWarp is a mixed reality game which takes place in the City of Cologne. The objective is for the players to travel to different time periods and visit local legendary characters known as Heinzelmännchen. The players walk around within the real environment and the display device augments the real location with virtual characters and objects. The result is that they can see objects and changes to buildings which reflect different time periods. While playing the game they also have to answer questions about the history of the city and undertake a range of tasks.

4.3.1 Story

One design decision which is key to the game is to let the players take part at the time of their choosing and also during different gaming sessions. This led to the decision to create a narrative and structure for the game which would allow these types of playing sessions. From a narrative perspective we chose to centre the game around some folk lore characters known as Heinzelmännchen.

Heinzelmännchen are good-natured elves which work in domestic service. They work during the night and carry out a range of domestic tasks. They worked happily for many years and many Cologne citizens enjoyed a relaxed life. However this all changed when a tailors wife decided to find out more about them. Her plan was to spill peas on her staircase so that when the Heinzelmännchen arrived they would fall down the stairs and so that at least she would be able to see them. However her plan failed and instead the Heinzelmännchen totally disappeared.

Today there are many different explanations as to what happened to the Heinzelmännchen and TimeWarp builds upon the myths surrounding their lives and disappearance. In the TimeWarp story players are told that the Heinzelmännchen fell into time portals and now live in different time periods and in a number of locations within the City of Cologne. The players are told that they must find the Heinzelmännchen and bring them back to the present day by travelling through time. However they are told that time travel is fraught with danger and if they succeeded they will be well rewarded.

The time portals within the game act as gates to four different “time levels”:

- Roman
- medieval
- modern
- future

“Time portals” allow the player to be in different times in an informed manner. The player determines the duration of play according to the number of solved challenges.

4.3.2 Gameplay and presence

There is a one-to-one mapping of the locations in the physical world and in the virtual world. Players can interact and play with virtual artifacts through a range of AR devices.

The player moves around in the physical world to reach the different challenge locations and time portals. They have to buy tools to solve challenges, or answer a relevant question.

During the game the players can:

- Move around physically in the game area:

    - Some specific places in the game area will be augmented with historic buildings
- Travel in time (Roman, Medieval Times, Modern Times, Future) using the time portals
- See the Heinzelmännchen:
    - In color if they are in the right time
    - Ghostly if they are in the wrong time
- Rescue Heinzelmänncehn
- See non-player characters (NPCs):
    - Virtual NPCs may take part in specific challenges or populates places (see 4.3.3)
- Trade with non-player characters:
    - Some NPCs are traders selling tools needed for solving challenges
- Pick up (virtual) game tools (lost properties):
    - This provides an element of luck within the game
- Hear spatial murmur and time-related sounds:
    - A spatial murmur varying in loudness gives a hint towards challenge locations.
    - Special sounds (e.g. horses, goose steps, Latin speech, music,...) give a hint to the time the player is actually situated.
- Take pictures, videos, text and sound messages for their 'travel journal'

Afterwards, the player has the possibility to browse their travel journal at the Time Warp web page and share their experience with other.

We will explore the contribution of NPCs and sounds to a sense of physical and temporal presence.

4.3.3 Presence BOBs

TimeWarp integrates a concept and prototype system based on characters (or agents) which are designed to enhance sense of place and presence within virtual or mixed reality worlds. The characters are essentially personalities of places which have their own history but also store information about the opinions of real users. The views are then shared with other users as they experience the world using a natural language system through speech or text based interaction. The concept is intended to explore the idea of embedding a sense of place in agents and locations.

4.3.4 Sample Scenario

When Simon arrives at the base station, he is equipped with the TimeWarp system and receives instructions. He decides to go to the Rhine promenade to look for a Heinzelmännchen. There he sees a ghostly Heinzelmännchen. He knows he has to jump to another time period. Looking around, he detects a time portal nearby and uses it. He returns to the Heinzelmännchen, which he now sees in colour. The Heinzelmännnchen rakes the ground. As he approaches, the Heinzelmännchen turns towards him. On his mobile information terminal, a PDA based system, he sees the options available to solve this challenge and decides to answer a question – he does so by tapping on the corresponding symbol. A multiple choice question appears on the PDA. Simon doesn't know the answer. Looking for help he sees an information board. After reading it he enters the correct answer. The Heinzelmännchen is happy and disappears and he hears "plop" sound...

Then Simon decides to go to Cologne Cathedral. On arriving in the square the location aware system informs the BOB system which time period Simon is in and also that he is in the area. He hears a voice but cannot see of hear where it is coming from. The conversation below is from the current BOB system with minor corrections for issues relating to grammar and due to space considerations the stories have been edited. In real a game situation Simon would interact with the BOB via speech.

Bob: What do you think about the Cathedral?

Simon> it is very interesting

Bob: I like the cathedral. Well I can tell you a little about the cathedral so here goes...[story].Do you like the cathedral?

Simon> yes, it has a tall spire

Bob: Cologne Cathedral is one [story] only the steeple of the Ulm Munster is higher. Other than the cathedral is there anything else you see here?

Simon> some people

Bob: I wander what they are doing?

Simon> they are running around and chatting

Bob: Tell me more about the people?

Simon> some are very ugly like the gargoyles on the cathedral

Bob: Peter was telling me about the gargoyles earlier. Do you know much about them?

Simon> no, but they are very ugly

Bob: Why do you find them ugly?

Simon> they are all twisted

4.3.5 Technical Issues

TimeWarp has three main components: the mobile MR system that augments the reality, the mobile information terminal providing information about the game status, a map with the current position of the player, etc. and the Travel Journal, a web application to recall the game experience and for spectators.

5 Year 1 Demonstrator

5.1 Pen and Paper Game of initial concept

The initial concept has been tested with a pen and paper, role-playing version of the game. To date 9 game sessions have taken place involving 23 game players.

During the test a moderator explains the story and rules of the game, introduces the material and gives a short overview of the history of Cologne. The game is played in a narrative way, where the players describe what they are doing (e.g. “going along that street”, “looking around”, “using the jewel”) and the moderator responds to their actions by describing what happens.

Table 1describes the used material.

Material	Description
Map of Game Area (Figure 3)	A map with marks for the base station and time portals.
Base station	A specific place in the city to buy and sell tools
Time portals	A specific place in the city to change ‘time levels’.
Tourist map	A usual tourist map with emphasis on important buildings (Cathedral, Old Town Hall)
Player’s figure	A token the player moves on the map to show his current location
Heinzelmännchen figures (two colors)	Tokens set by the moderator to indicate at which location the player sees a Heinzelmännchen ghostly or coloured.
‘Brain’	The player can pick up the ‘brain’ to get information related to his current location.
Challenge Hint Cards	Cards that are shown to the player at start of the game the location of the various Heinzelmännchen.
Tool list	A sheet with available tools and prices.
Tool cards(Figure 4)	Each card represents a tool available in the game.
Challenge Card (Figure 5)	Cards that show the tools which are required to solve a challenge.
Play money	To buy tools and knowledge.

Table 1 Material of pen and paper game

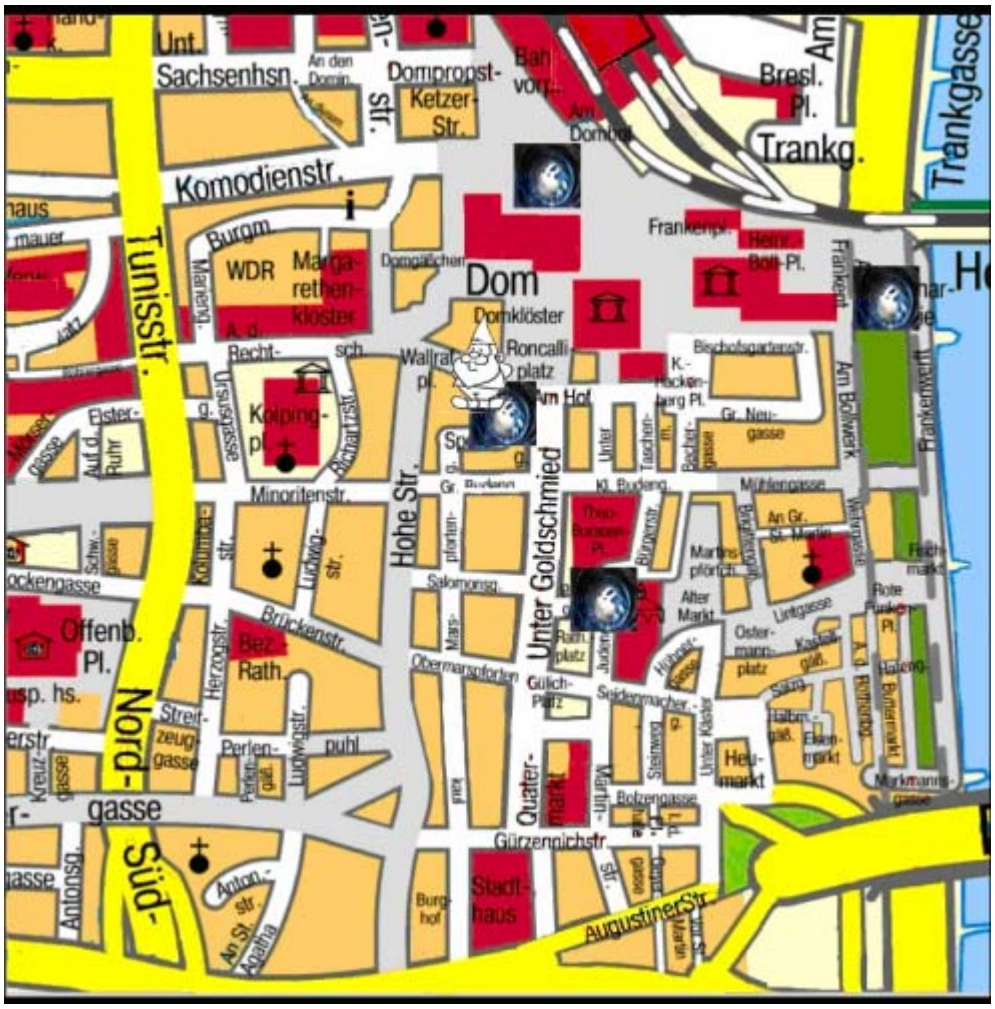


Figure 3 Map of game area

Figure 4 Tool cards

Challenge Cologne Emblem

Challenge Fight the lion

Challenge Gardener

Challenge Gargoyle

Challenge Roman Street

Challenge Space Shuttle Station

Challenge Cologne Trade Rights

Challenge Towers of Cologne Cathedral

Figure 5 Challenge cards

5.1.1 Testing / Evaluation

All players were a little bit confused for the first few minutes of the game and did not know what they were supposed to do. After they had found the first Heinzelmännchen and solved the first challenge, it seemed that they found the game play easier. As a result of these testing sessions a number of suggestions for improvement were made and are outlined in the remainder of this section.

Virtual markets and street hawkers

The distance between the challenge locations and the base station is too long. It would take to much time to go back to the base station to buy a missing tool.

Play money

With the introduction of markets, the access to tools should be restricted somehow, so that play money was introduced.

Lost properties

Lost properties could be introduced as luck element in the game.

New ways to solve challenges

Without any restriction, the players developed a variety of ways to solve the challenges.

Player's motivation

The introduction story should motivate the player, in particular why they should aim to rescue the Heinzelmännchen.

Player's abilities

The introduction story should explain why the player is able to see the Heinzelmännchen either in color or as a ghost and why they are able to change 'time portals'.

Tools

The first set of tools includes fighting devices like swords or guns. It was decided to avoid fighting devices.

Action or Question

The first draft has foreseen only the usage of tools to solve a challenge. It was decided to introduce the possibility of solving a challenge by answering a question.

The implementation of the initial concept as a pen and paper game improved the game during its early stages of development, moreover it concentrate on the game experience and did not tie it down to any platform specific issues. Disadvantages of this approach are the missing sense of place and time. Players mentioned that it is hard to imagine being in Cologne and that in reality would take them longer to go to a certain place.

5.2 Mobile AR System

The hardware of the mobile AR system for a player includes:

- A processing unit:
  - Including wireless high-speed network device to connect to the game engine
  - Connection of all local devices
- A head mounted display with tracking devices for visualization and localization
- A human interface device (HID) to allow for location independent interaction:
  - Prototype 1: a wireless mouse

  - Prototype 2: a wand including a 3DOF orientation sensor and a click wheel.
- A headset for speech recognition (interaction with virtual characters)
- A supporting frame to carry this equipment

For the mobile AR system three basic requirements can be identified:

- Advanced augmentation of the cityscape: Reconstruction of historic buildings, virtual characters, images, audio and video are to be displayed. This requires a strong processor.
- Mobility: The player should be able to freely move around the city.
- Connectivity: When a wireless connection to a server is not available, the mobile AR system has to be able to cope with disconnections.

Different hardware configurations (Figure 7) have been evaluated with the first test scenario, where an animated Heinzelmännchen character stands in front of the reconstruction of a historic building, the Stapelhaus (Figure 6). Figure 8 shows a close up of the head-mounted display.

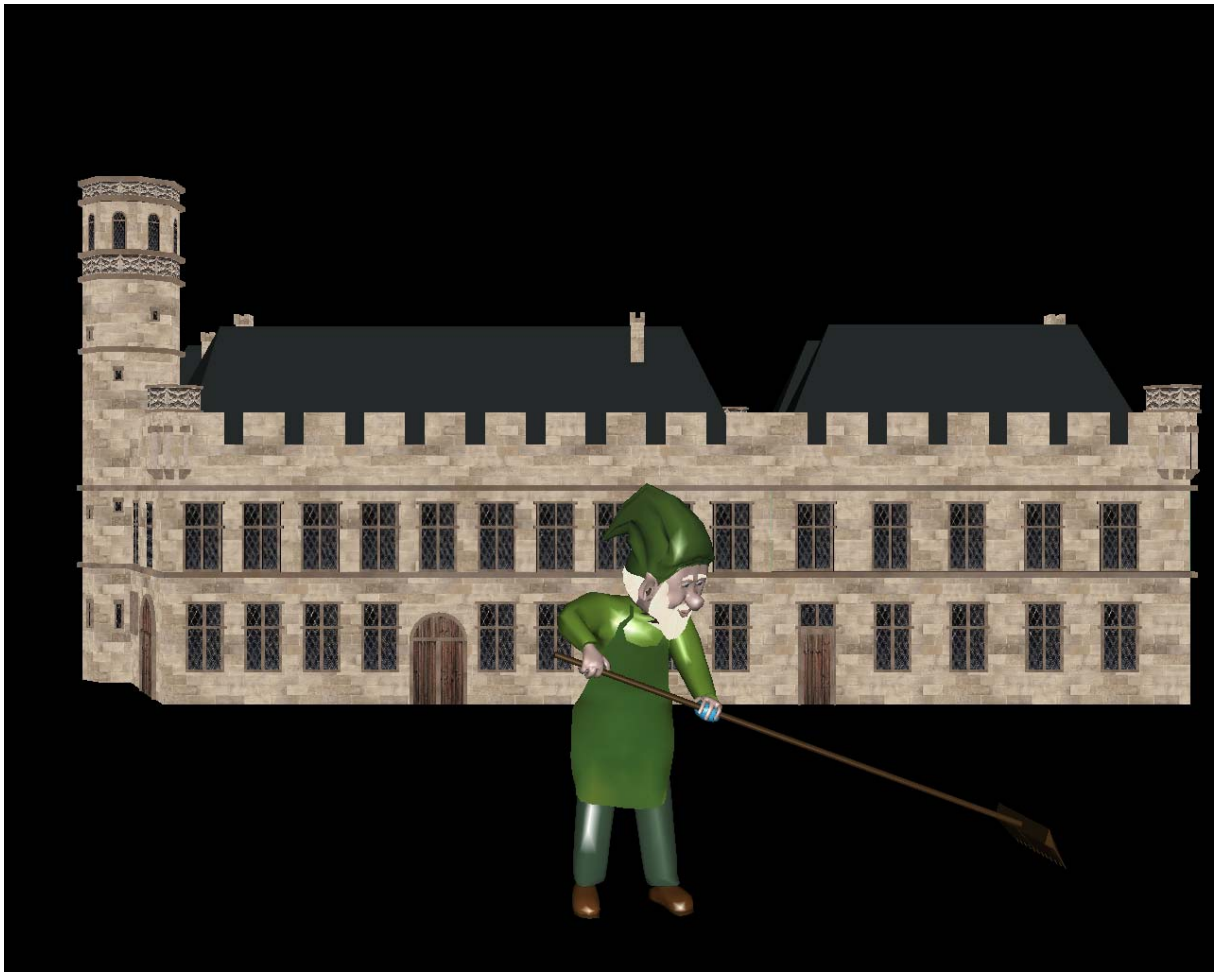


Figure 6 Challenge 7 scene, ~16.000 polygons + virtual character object

Figure 7 Mobile MR system assemblies

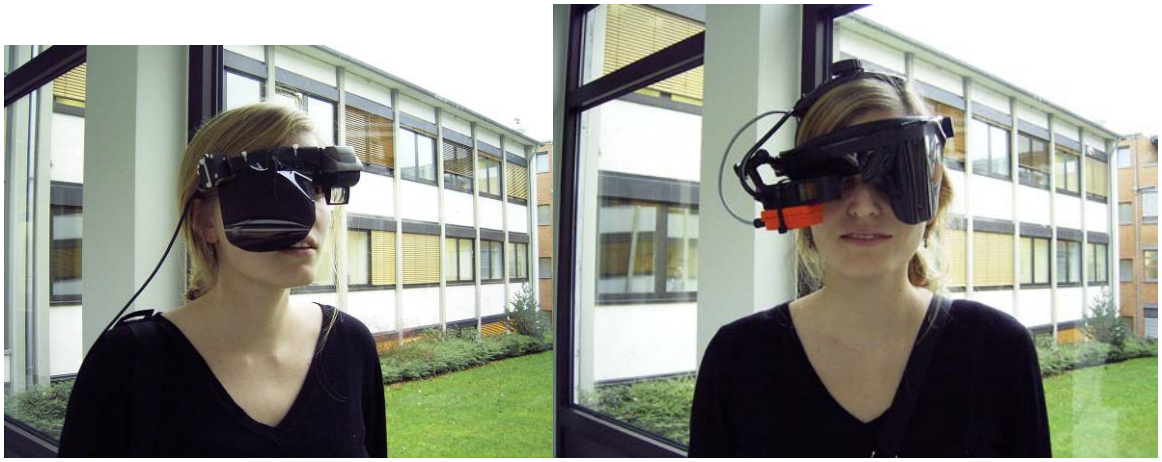


Figure 8 Close up at headsets, Shimadzu Data Glass 2 + IC3 (left), Liteye LE-750 +MTi (right)

5.2.1 Technology Probe I

The hardware configuration has been tested with a small application at the Birlinghoven campus of Fraunhofer.

Hardware and OS	• DELL Latitude D429 • Shimadzu Data Glass2 (Figure 8 left) • Intersense InertiaCube3 (IC3) • Holux GPSlim240
Software	• Morgan Framework, DEVAL realizing 6DOF user tracking • Morgan Viewer with Cal3D XSG
Core Features	• 6DOF User Tracking • Rendering
Status	stable prototype
Intended users	People who wants to play the game
Research Workpackages	WP4 & WP5: using provided infrastructures and tools

5.2.2 Technology Probe II

Hardware and OS	• Sony Vaio VGN-UX100 • Liteye LE-750 (Figure 8 right) • Xsens MTx • Holux GPSlim240
Software	• Morgan Framework, DEVAL realizing 6DOF user tracking • Morgan Viewer with Cal3D XSG
Core Features	• 6DOF User Tracking • Rendering
Status	stable prototype
Intended users	People who wants to play the game
Research Workpackages	WP4 & WP5: using provided infrastructures and tools

5.2.3 Testing / Evaluation

Both hardware assemblies fulfill the requirements described above.

A wearability and performance evaluation will be done within a test run scheduled for month 14.

6 Dissemination

A work in progress paper for CHI has been submitted

7 Appendix

This section describes the initial concept of the game and introduces the intended hardware.

7.1.1 Game Design Overview

Time Warp (TW) is a mixed-reality edutainment adventure game with elements of action and strategy. Players participate both in the physical and in a virtual world. The game will be physically played in the old town of Cologne.

The game story is about Heinzelmännchen, good-natured elves that perform helpful services at night, that have disappeared because a tailor's wife overcome with curiosity, resolved on having a peep at them.

The game objectives are to find the Heinzelmännchen in space and time, and to succeed several challenges to rescue the Heinzelmännchen by gathering information about the city's history.

Rich interaction with virtual characters from the past, presence and future will foster players' engagement.

The target group is technically savvy people interested in history and technology. They like playing adventure games. The minimum age to play the game is approx. 12 years. The game should appeal to both women and men.

7.1.2 Core Features

- **Participate in mixed-reality adventure game.** TW is an adventure game where the real world becomes the game area. Run around in the physical world for rescuing Heinzelmen.
- **Experience the city in the past, presence and future.** The player should learn about the history of the city
- **Rich Mixed Reality Experience in urban spaces.** The game area is the old town of Cologne (1st Prototype)

7.1.3 Story and Setting

A saga tells about numerous of elves called Heinzelmännchen who did all sorts of work in the city of Cologne. They baked bread, washed, and did any sort of domestic labour at night. This went on till a tailor's wife overcome with curiosity, resolved on having a peep at them. Accordingly she strewed peas up and down the stairs, so that they might fall and hurt themselves, and she might get a sight of them next morning. But the project missed, and since that time the Heinzelmännchen has totally disappeared.

We now know what happened to the Heinzelmännchen: they have fallen into 'time holes' and do services in different times.

Equipped with MR technology, the player has access to different 'time levels', tracks down the Heinzelmännchen, and solves challenges to rescue them. But it is dangerous to travel in time; the Cologne craftsmen offer a generous award to everyone, who will face the risks and bring back the Heinzelmännchen.

The time portals within the game area are gates to four different 'time levels':

1. Roman
2. Medieval
3. Modern Times
4. Future

In order to pass the challenges, the player needs different tools and all his cleverness.

7.1.4 The Game World

7.1.4.1 Relation between Physical World and Virtual Game Worlds

There is a one-to-one mapping of the locations in the physical world and in the virtual world. Players can interact and play with virtual artefacts by means of AR devices.

The player has to move around in the physical world to reach the different challenge locations. As the game area is quite large (600m x 300m), he has got a map to get an overview.

7.1.4.2 Player Characters

Players are adventurers who love risks and generous awards; they might play together in a team or in competition (see 7.1.7 for details).

7.1.4.3 Spectators

A public web page with access to the story and a number of observations cameras will be set-up for the purpose of the game.

The travel journals will be made public for reading.

7.1.4.4 Non-player Characters

Table 2 lists the non-player characters of Time Warp.

No	Name	Description
1	Merchants	Selling different useful tools to the player Merchants either have a stall at a market or are street hawkers.
2	Roman legionary	Supervises construction work of a street
3	Cologne citizen	Interrogates a Heinzelmännchen
4	People on the street	Extras in the game area to visualize the ‘current’ time. Virtual characters dressed in clothes usual for that specific time, and ‘time whispers’, snippets of conversation and music usual for that time give the player a cue in which time s/he is in.

Table 2 Non-player Characters

7.1.4.5 Heinzelmännchen

The Heinzelmännchen are the primary NPC’s that are distributed over the game area. A Heinzelmännchen does not roam in the game area but is stick to a certain place – the challenge location.

7.1.4.6 Tools

The player needs different tools (see Table 3 Tools)to solve a challenge, but it is possible to solve a challenge with a variety of tools. Available tools are shown in the system help, current tools the player owned are shown in his tool list. The list of tools is open.

No	Tool	Description	Used In
1	Beamer	Device for bringing remote items close to one	1,4,8
2	Herbicide	Weed poison	3
3	Cameo of Agrippina	A Roman jewel	5
4	Steak	Food, buyable from a street hawker or at market stall	2,8
5	Downspout	A rain pipe	4,8
6	Magic dust	Powder for different purposes: sleeping powder, herbicide powder	2,3,5
7	Crystal	A jewel to burn weed or blind people and animals	2,3,4
8	Spade	A digging tool	1,5
9	Laser pointer	A device to point or burn	1

Table 3 Tools

7.1.4.7 Time Portals

There are at least 12 time portals in the game area, three for each ‘time level’.

Physically, time portals are duct covers that are nearby the challenge locations.

A time portal leads to exact another ‘time level’, that are Roman, Medieval, Modern Times and Future.

7.1.4.8 Locations

Table 4**Fehler! Verweisquelle konnte nicht gefunden werden.** lists the locations of the game

No	Name	Description
1	Challenge Locations	See 7.1.5.2
2	Markets	The markets of the game are at the locations where the real markets were.
3	Time Portals	See 7.1.4.7

Table 4 Locations

7.1.5 Game Play

In the following, HM is the abbreviation for Heinzelmännchen.

7.1.5.1 Game Play Overview

During the game the players can:

- Move around physically in the game area.
- Travel in time (Roman, Medieval, Modern Times, Future)

- See HM
    - In color if they are in the right time
    - Ghostly if they are in the wrong time
- Rescue HM
- See non-player characters
- Trade with non-player characters
    - The player has an initial deposit of 150 units
- Pick up (virtual) game tools (lost properties)
- Hear spatial murmur and time-related sounds
    - A spatial murmur varying in loudness gives a hint on challenge locations.
    - Special sounds (e.g. horses, goose steps, Latin speech, music,...) give a hint to the time the player is actually situated.
- 'Buy' knowledge
- Take pictures, videos, text and sound messages for their 'travel journal'

Afterwards, the player has the possibility to browse his travel journal at the Time Warp web page and share his experience with other.

7.1.5.2 Challenges

Challenge 1: Cologne Emblem Puzzle

Description: The HM puzzles the Cologne Emblem. This task is transferred to the player, he has to point at the correct master.

Location: Am Hof (where a Cologne Emblem is nearby)
Time Level: Medieval

Challenge 2: Saga of Hermann Grin

Description A lion attacks the HM (and another character). The player has to "fight" against the lion.
Location at the Old Town Hall
Time Level: Medieval

Challenge 3: Gardener

Description: The HM weeds in the Rhine Garden.
Location Rhine Garden
Time Level: Modern Times

Challenge 4: Gargoyle

Description: The HM works as a gargoyle at the Cologne Cathedral. The 2 gargoyles next to the HM retain it.
Location Cologne Cathedral
Time Level: Medieval

Challenge 5: Roman Street Construction

Description: The HM works as construction worker.
Location: Roman Street next to the Roman Germanic Museum

Time Level: Roman

Challenge 6: Space Shuttle Station

Description: The main station is in the future a Space Shuttle Station. The HM returns from a Space Mission. The autopilot of the shuttle is broken; the player has to steer via a remote control.
Location: Stairs at Cologne Cathedral with view to main station
Time Level: Future

Challenge 7: Cologne trade rights „Stapelrecht“

Description: "Stapelrecht" is a special Cologne trade right: each merchant shipping his goods on the river Rhine has to offer this good at Cologne. A Cologne citizen interrogates a HM regarding the "Stapelrecht". As the player approaches the HM, a parchment is shown displaying the questions.
Location: An Groß Sankt Martin/Fischmarkt
Time Level: Medieval (Stapelrecht was introduced 1259)

Challenge 8: Towers of Cologne Cathedral

Description: The HM is on top of one of the towers, afraid to climb down.
Location: Cologne Cathedral
Time Level: Modern (1880 Prussia 'finished' construction work)

7.1.5.3 Game Flow

Entering the Game

- The player arrives at the base station (for Cologne: the Heinzelmen well)
- A brief video about the history and future of Cologne is shown including the Heinzelmen saga. Also the extension about the new technology to be able to switch between different ‘time levels’ and to find and see the Heinzelmen is mentioned. The video gives first hints.
- The equipment is handed out and explained.

Moving Around

Players can freely move around the game area but need to carry positioning equipment. At specific locations (challenge locations and locations of time portals) precise and accurate positioning is required, but otherwise the precision of GPS is sufficient.

Solve Challenge

A challenge is solved by either using an appropriate tool or answering a question.

Interacting with Non-player Characters

If the player is close (~2 m) to a NPC, the NPC starts a dialog.

If the player is in proximity (~15 m) to a NPC, he hears the NPC yelling.

This does not apply to the NPC4 (people on the street).

Buy Knowledge

Besides the possibility to gain knowledge from the real environment, e.g. reading public information panels or asking people on the street, the player can call the game’s knowledge system. Depending on his current geographical position, he obtains a piece of information

about the history. For example, near the Stapelhaus, he would get information about the Stapelrecht.

The calling of the game's knowledge system costs 5 units.

The game's knowledge system is realized as a 'voice out of the sky' in the 1st prototype; in a later version, animated, virtual characters that are famous for the city (e.g., for Cologne Tünnes and Schäl) will tell something about history.

7.1.6 Travel Journal

The travel journal is a (shared) media album at the TimeWarp web page.

During the game, the player(s) create media content such as photos, videos, and voice or text messages. The content is enriched with context information such as creator, geographical location, real time, 'time level' in the game.

The travel journal shows all created media in the game area map, i.e. location related.

The on-line travel journal provides different filters to the media:

- By player
- By type
- By game time

Also, the path that the players have taken during the game can be shown individual.

As each player is tracked during the game, the individual path of a player is stored. The Travel Journal is able to show the track of an individual player at the map.

7.1.7 Multiplayer

In a multi-player session, the players additionally can

- Exchange game items (tools)
- Being together across different 'times levels'
    - Although players are on different 'time levels', e.g. one at the Roman level and another at the medieval level, their interaction with each other is not restricted.
- See information about other players on their mobile information terminal
    - Location (Position and current 'time level')
    - Scoring

Competition aspects of the game are:

- First solving a challenge
- Limited number of tools

Nevertheless, the player can cooperate during the play to solve the challenges.

7.1.8 Technology

For the realization of the game, several systems are integrated. The basis for the software development is the Morgan AR/VR framework from WP4 and WP5 together with its gaming extensions.

7.1.8.1 Mobile AR System for Players

The mobile AR system allows a player to move around freely in the game area and to see and hear the virtual elements.

The *mobile AR system hardware* includes

- A processing unit
    - Including wireless high-speed network device to connect to the game engine
    - Connection of all local devices
- A head mounted display with tracking devices for visualization and localization
- A human interface device (HID) to allow for location independent interaction
    - Prototype 1: a wireless mouse
    - Prototype 2: a wand including a 3DOF orientation sensor and a click wheel.
- A headset for speech recognition (interaction with virtual characters)
- A PDA to realize the mobile information terminal
- A supporting frame to carry this equipment

7.1.8.2 Visualization

The visualization of the Heinzelmen and other virtual characters as well as of virtual buildings requires a 3D rendering software. The Morgan Viewer that renders VRML files will be used.

7.1.8.3 Sound

The Morgan framework provides a sound component.

7.1.8.4 User tracking

The user tracking (positioning) is realized by a hybrid approach.

The game area is divided into tracking zones that required different positioning accuracy. Table 5 describes the different requirements,

Level	Name	Description	Technology
0	Position only	For most of the game area there is no visual augmentation, the GPS signal is sufficient to track the player's path.	GPS
1	Position + Orientation	For some of the visualization such as virtual character an accurate registration is not required.	GPS + inertia tracking
2	Exact Registration	For some visualization like augmentation of buildings, a correct overlay of virtual and real elements is required.	GPS + inertia tracking + computer vision

Table 5 User tracking levels

Positioning with the required quality of Level 0 and Level 1 is already provided by the Morgan framework (e.g., the framework contains components for GPS tracking, InertiaCube3 and XSense tracking devices), but positioning for Level 2 has to be developed.

7.1.8.5 Human Interface Device

The 1st prototype might have limited interaction possibility, but a generic interaction device will be designed, that adapts to the usage of the different tools. This generic device integrates a 3DOF orientation sensor, an acceleration sensor, a scroll wheel and buttons. As an alternative to this self-made device the new Nintendo Wii controller (Figure 9) will be evaluated.

Figure 9 Nintendo Wii Controller

7.1.8.6 Speech recognition and text to speech

The Morgan framework provides a speech component based on IBM ViaVoice for speech recognition (speech to text) and text to speech.

7.1.8.7 Mobile information terminal

This component will be based on the Morgan Light Framework.

For means of orientation, the player has got a mobile information terminal. The display shows an augmented interactive map of the game area and provides access to the Travel Journal web page. Table 6**Fehler! Verweisquelle konnte nicht gefunden werden.** lists the functionality. Information about the player's game status: tools he owns, actual deposit, time left

Access to the video rewards for solved challenges

No	Name	Description
1	Zoom function	The player can zoom in and out of the map. Three zoom levels are supported: • Level 1: Shows the complete game area • Level 2: Shows a quart of the game area • Level 3: Shows the 200m area of the current player's position
2	Information filters	• Player's path (all levels) • Nearby time portals (Level 3) • Nearby markets (all levels)
3	Navigation function	Navigation back to the base station
4	Note function	During the game, the player might take a note for a specific position. With a pen, he taps on the map and an edit text field pops up.
5	Online Travel Journal	Access to the Travel Journal web page.

Table 6 Functions of handheld device

7.1.9 Travel Journal

The Travel Journal (Figure 10) is a web page providing information about the game. Players can upload own content, but also automatic content such as paths and score is shown. Table 7 explains the interactive content.

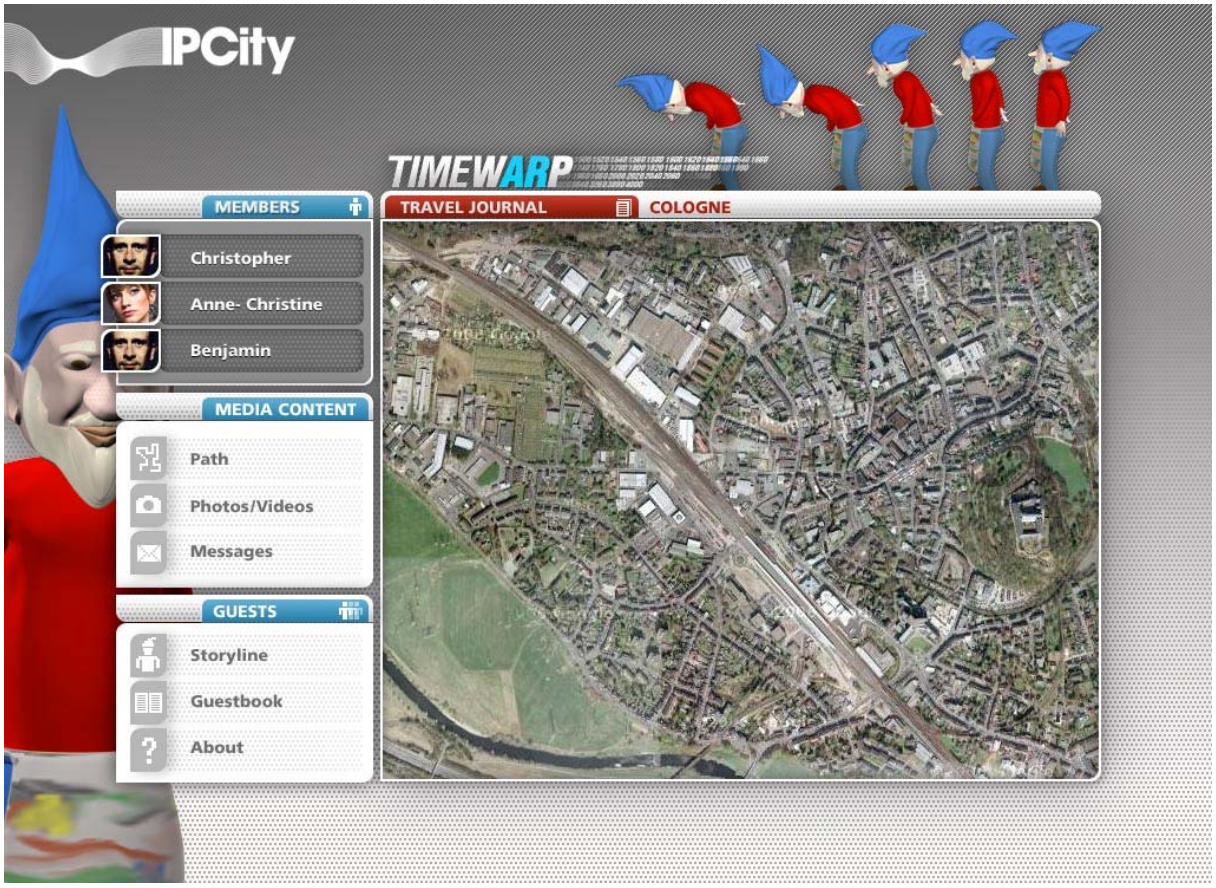


Figure 10 Design of the TimeWarp web page

Nr	Name	Action	Interface
1	Members	Show all members of the group. A single click on an individual member enables filtering by person. A double click on an individual member shows details about the selected person in a pop up.	Interface to BSCW
2	Media Content	Show media content. A single click on a specific media type enables filtering by this type. A double click on a specific media type opens a pop-up window listing all media of that type. Media is show as icons on the map (see 5+6)	Interface to streaming server
3	Guests	In the guest area, spectators • have access to (Augmented) Life Cams[2], • can edit the Guestbook and • can read more about Time Warp.	• Interface to streaming server • Message Center • static content
4	Map	A zoom able map of the visited game area.	Interface to map server
5	Path	The recorded path of the players.	Interface to map server
6	Media icons	All media contains geographical information and can be embedded in the map. A double click on a media icon (thumbnail) opens a pop-up.	Interface to map server
7	Time Warp link	Link to the TimeWarp homepage	Static content
8	IPCity link	Link to the IPCity homepage	Static content

Table 7 Functions of the Time Warp web page

7.1.10 Authoring Interface

An authoring interface will be implemented to observe the game, to drop fortune elements and to add or remove time portals.

7.1.11 Other Functional Requirements

Additional to the TimeWarp game, the showcase should provide analysis tools.

7.1.11.1 Logging

The game engine and Travel Journal application write data into text files. The format is defined by the analysis tool provided by WP 4.

[2] Usage of public webcams possible (technical and legal)?

7.1.11.2 Testing

For testing and demonstration of Time Warp without the need for somebody being physical in Cologne, a small application playing back pre-recorded GPS data is used.

Additional, a variant of the mobile information terminal can be used to move a player.

Augmented videos of the challenge locations are produced to use for demonstration issues.

7.1.12 Non-functional Requirements

Non-functional requirements for the TimeWarp game are summarized in this subsection.

7.1.12.1 Performance

The system performance should not disturb the game play and the game experience. The realization should consider network latencies, position tracking inaccuracy and temporary disconnection. Also, the computer graphics update rate has to be sufficient for real-time augmentation.

7.1.12.2 Configurability

The game can be configured with respect to the game area, used device, number of players (per team), location of time portals and NPCs, used tools, and number of challenges. All configuration parameters are specified in a configuration file.

7.1.12.3 Safety

Safety of the players of the TimeWarp game is an issue. The game will not be played in a secured environment, i.e. we cannot take actions to secure the environment such as put up barriers since we are in public space. Therefore the player must be aware of the events around him. The hardware, especially head-mounted display and headset, doesn't totally block the reality: the player has a 'naked' eye and can hear alarm sounds.

For the game design, locations are chosen in pedestrian zones.

7.1.12.4 Security

There are no special security requirements since the prototype does not contain sensitive data.

References

Cheok, A. D.,S. Wang Fong, K. Hwee Goh, X. Yang, W. Lui, F. Farzbiz (2003): Human Pacman: a sensing-based mobile entertainment system with ubiquitous computing and tangible interaction, NetGames '03: Proceedings of the 2nd workshop on Network and system support for games

Ferdinand, P. (2005): The Middle-Rhine Eduventure Project – on the way to a new technology enhanced learning approach. In: Proceedings of TESI 2005 Conference (Training, Education & Simulation International), 22.-24. March 2005, Maastricht, The Netherlands

Freeman, D. (2003). Creating Emotion in Games: The Craft and Art of Emotioneering. Indianapolis (Ind.): New Riders.

Holweg, D.; Schneider, O. (2004): GEIST- Mobile Outdoor AR-Informationsystem for Historical Education with Digital Storytelling. In: Federal Ministry of Education and Research: Virtual and Augmented Reality Status Conference 2004 [CD-ROM]. Leipzig, 2004

Lindt, I., J. Ohlenburg, U. Pankoke-Babatz, W. Prinz, S. Ghellal (2006): Combining Multiple Gaming Interfaces in Epidemic Menace. Experience Report, Conference on Human Factors in Computing Systems (CHI 2006), April 24-27, Montreal, Canada, 2006

Park D., T. Nam, C. Shi (2006): Designing an immersive tour experience system for cultural tour sites, Conference on Human Factors in Computing Systems (CHI 2006), April 24-27, Montreal, Canada, 2006

Salgado L., E. Rendón, R. Artola (2001): System architecture for tourist orientation: the TOSCA high-end system, Proceedings of the 2001 Conference on Virtual Reality, Archeology, and Cultural Heritage, Glyfada, Greece, November 28-30, 2001

Vlahakis, V.: Karigiannis, J.; Tsotros, M.; Gounaris, M.; Ioannidis, N.; Stricker, D.; Gleue, T.; Daehne, P.; Almeida L.(2002) : Interactive Augmented Reality Touring of Archaeological Sites, Laval Virtual, International Conference on Virtual Reality, 19-21 June 2002, Laval, France.

Walz, S.P, R. Ballagas, J. Borchers, J. Mendoza, S. Kratz, C. Wartmann, C. Fuhr, M. J. Tann, D. Y. Shin, B. Hameed, L. Bardos, L. Hovestadt (2006): ll Spell-Casting: Designing a Locative and Gesture Recognition Multiplayer Smartphone Game for Tourists, Proc. PERGAMES, Third International Workshop on Pervasive Gaming Applications at PERVASIVE 2006

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