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Short Paper

SPIRIT
- Entertaining Encounters with Ancient History

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Abstract

The paper describes the ongoing project "SPIRIT", in particular the design of novel and entertaining forms of heritage communications through mobile augmented reality. The SPIRIT concept is based upon a strong storytelling metaphor. By using mobile devices (smartphones, tablets) as "magic equipment", users can meet the restless spirits of historical characters. Beyond the use of mobile technology as a guide, our system enables enjoyable experiences of interactive storytelling, involving users as players. We describe the overall technical augmented reality concept that integrates positioning and media delivery technologies and a framework for structuring interactive narrative experiences. Further, we show our first use scenario that has been developed in collaboration with a Cultural Heritage site, a reconstructed Roman fort and archaeological museum. It includes a first working demonstrator that illustrates issues to be solved as a foundation for defining future work.

Categories and Subject Descriptors (according to ACM CCS): [Human-centered computing]: Mixed / augmented reality, Interaction design process and methods, Ubiquitous and mobile computing. [Applied computing]: Interactive learning environments, Computer games

1. Introduction

In the ongoing project SPIRIT, we design and implement a framework for mobile location-based serious games that enhance history lessons by interactive entertainment. Off-the-shelf mobile devices (smartphones, tablets) are literally transformed into 'magic equipment' that allows users to meet 'restless spirits' of historical figures in augmented reality (AR). Beyond their use as museum guides, the designed virtual ghost characters interact with visitors at their 'whereabouts', keeping their historical roles,

A first use scenario has been developed in collaboration with the Saalburg Roman Fort, an acknowledged Cultural Heritage (CH) site and archaeological museum near Frankfurt, Germany. Existing educational services of the museum—such as regularly performed reenactments of Roman fort life and a great media pool—are not meant to be replaced by the system. Rather, the mobile application has the potential to reach new and younger target groups before they know about the museum, by involving them in location-aware activities that reward players if they pay the site a visit. After arriving on location, the user is given the task to walk across the CH site's area, to meet spirits of the past and have conversations with them.

This paper briefly describes the project's concepts, integrating mobile Augmented Reality (AR) with Interactive Storytelling (IS) technologies. A first running demonstrator is also described, as well as future work.

2. Related work

Many applications of mobile devices rely on the identification of a user's 'context', in order to deliver suitable information situation-dependently. First and foremost this concerns the tracking of the location of a device, complemented by other environmental data such as time, noise, orientation, concurrent tasks or social settings. For cultural heritage (CH) applications, especially the 'location-aware' aspect is of interest, as many historic artefacts are bound to geographic places. The augmentation of perceivable physical remains with digital information, including views into the past, is attractive for educating about history [SDS*01], but is challenged by simpler AR solutions that rely on prepared markers.

With the *Augmented Reality Markup Language ARML* [OGC13] the *Open Geospatial Consortium* (OGC) has developed a standard to store location-based content for outdoor spatial AR applications such as Wikitude [Wik14] and layar [Lay14]. A good overview on tracking tech-

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niques for indoor and outdoor AR is given by [vKP*10]. They conclude that "unprepared outdoor environments still pose tracking problems with no single best solution".

Also storytelling has for long been recognized as a tool for conveying historical information. Thus, integrating the above concepts into mobile interactive storytelling has been a field of research with prospects for CH applications. We base our concept on a pioneer example that we co-developed, the project *GEIST* [KCS*01]. Long before mobile devices and services became ubiquitous on the market, this project used the metaphor of magic equipment for mobile AR, as it also used reference image data to achieve markerless tracking. Meanwhile, a trend towards Mobile AR games has been observed [BLH*08]. For example, *Haunted Planet* provides "outdoors mystery adventure games" [Haa12] with the task to track down single ghosts in the neighbourhood, but without further interaction nor educational content. There have been various applications of storytelling on mobile devices for CH that focused on virtual guide characters, delivering entertaining information about exhibits [LD*12]. *REXplorer* [BKW*08] introduced a device metaphor of 'magic wands' to cast spells, in order to add fun to history information. Set in a graveyard, the project *Voices of Oakland* made voices of deceased inhabitants audible to visitors with appropriate equipment, providing location-based narratives [DLO*05]. The project *CHESS* augments physical artefacts with historic visual information [KPR*13], delivering variable and personalised AR narratives adaptable to user profiles.

Our approach is different in the sense that coherent storyworlds of 'spirits' for a historical theme—beyond ancient artefacts—are created by authors and historians. With the framework, adaptable story components support the production of playful content, conveying aspects of ancient life rather than objects. Single interactions at various locations get connected by an overall narrative arc, including quests and user involvement, thus embedding CH content into an entertaining user experience. It also combines museum onsite information with playful experiences in the home or remote neighbourhood of potential visitors. From a technical point of view, a story engine will be developed based on narrative logic structures that cater to CH experiences, modelling fiction, quests and facts distinctively. Further, a combined image matching and GPS-based approach is used for tracking the user's position in an unprepared outdoor environment, complemented by indoor positioning. To augment the environment, the use of video snippets will be explored as a novel form of Visual Asset in AR.

3. Concept and story

The SPIRIT approach relies on a holistic story metaphor that integrates all concepts—from logical content and narrative structure down to special media effects and interaction. For example, design decisions at the interface style level are also constrained by the theme in a constructive way. Users need to master the 'magic equipment' in order to encounter ghosts. At the highest narrative level, 'contacting' and 'revealing' (visualising) ghosts with the equipment implies that it is not easy to hold 'the connection', which playfully excuses imperfections in AR rendering. Within the humorous metaphor, 'reality' is not an issue, but 'believability', to be achieved by consistent behaviour of the equipment and of the characters.

From the point of view of the CH site, our virtual characters are not meant as 'guides' in a fun wrapping. The world of spirits rather serves as an extra layer with its own rules—the rules of the specific past culture that the site represents, including their confrontation with today's visitors. For example, in one of our example prototype stories, the player has to support the community of Roman spirits to retain their 'curse', in order to help them keep up the memory of history at this place.

3.1 First demonstrator and scenario

Figure 1 shows our first demonstrator, for which a short scenario has been developed. It can be played at any geographic location. Starting anywhere outside, a visual radar screen feedback on the device indicates the proximity of a spirit, which can then be tracked down by walking closer. In Figure 1, the magic equipment has visualised a Roman soldier nearby a group of trees. The haunting Roman asks the user whether she is able to understand Latin, beginning a simple conversation. He finally invites the user to visit him at his Roman fort, the Saalburg. If the CH site is visited with the magic equipment after this encounter, the soldier will welcome the user there, following up on previous events. This demonstrator scenario will further be fleshed out to become a more complex interactive story structure with conditional events and situations. The concept will also adhere to educational goals.

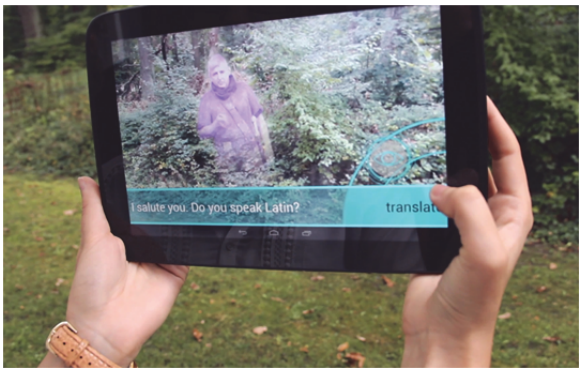

Figure 1: *First demonstrator of the magic equipment with basic interaction possibilities.*

3.2 Story structure

The goal of SPIRIT is to achieve interactive storytelling (IS) experiences, implying that users can influence to a certain extent what is being presented. As we do not intend

to guide users linearly through the CH site or museum, a story engine adapts the narrative enabling different orders of events or different outcomes according to user actions. A plot-planning logic that distinguishes different categories of information and allows for procedural content delivery is under development.

'Spirits' are visually represented as concatenations of short video snippets. Each pre-produced video corresponds to an atomic narrative act, for example, a spoken sentence or a physical action. These narrative acts can then be connected ad hoc in variable ways during runtime, depending on each acting situation the user may get into [MSS13]. We also explore the production pipeline and design efforts involved. We deliberately chose the video snippet approach over producing 3D animated representations. Our hypothesis is that with video production, higher acceptability can be achieved by the typical small media teams involved in CH projects. On the other hand, clear disadvantages of the video solution will remain, lying in the inflexibility of the medium when it would need adaptation to circumstances. They can only partially be compensated by metaphorical magic effects, and need to be tackled by more research into production principles as well as rendering and delivery.

4. Video-based augmented reality

According to the OGC Augmented Reality Markup Language 2.0 (ARML) draft specification [OGC13], a feature is a representation of a real world object that can be augmented. An anchor is an augmentation of a feature. Anchors define links between the digital and the real world. The *Visual Asset* is the representation of the anchor in the composed scene. While ARML 2.0 limits Visual Assets to *label*, *fill*, *text*, *image* and *3D model*, the SPIRIT project explores the use of *video* as Visual Assets.

4.1 Anchors

In SPIRIT, two types of anchors defined in ARML are supported: a *location anchor* and a *trackable anchor*. The *location anchor* defines a point or a polygonal geometry in spatial coordinates. Once the user comes close to the point location or enters the defined polygonal area, the Visual Asset linked to the anchor will be triggered. Currently, GPS is used as location tracker, limiting its use to outdoor environments. For indoor scenarios, we currently use a video-based tracker. It is further planned to develop indoor location tracking based on beacons within the project. The *trackable anchor* defines a reference image of a feature. A video-based tracker is used to detect the defined 'trackable' and to trigger the Visual Asset of the anchor. Trackable anchors have a spatial location in addition. In outdoor environments, this location can be used to filter trackables based on the user's location and to reduce the computation time of the video-based tracker. The video-based tracker has been implemented using OpenCV and the ORB algorithm [RRKB11] for image matching.

4.2 Video as Visual Asset

The camera display of the mobile device is used as a see through display. The view is augmented with videos that show partial transparency, being pre-produced using green (or blue) screen technique. By removing the backgrond color through chroma-keying, filmed characters can be presented as ghosts 'floating in thin air' (see Figure 2).

The adaptation of the respective technology to the Android platform has been a challenge, as videos need to be rendered with transparency. The current Android MediaPlayer does not support video codecs with alpha channel; concequently, we implemented an own video rendering system. First, inspired by [Wik14], an alpha channel is encoded in the (visible) video image. After doubling the height of the video frames, the RGB part of the video is stored in the upper half of the frame and the alpha channel as greyscale in the lower half. Next, the video is loaded using the MediaPlayer Android API. The Android MediaPlayer plays the sound of the video file and creates an image output stream on a SurfaceTexture. These textures can be modified using Fragment Shaders. That way, the original height of the video is rebuilt with full RGBA data in each fragment. As a disadvantage, the video's file size is slightly increased. Our approach is fully hardware accelerated. Therefore, performance has not been an issue so far, even for 720p or 1080p videos.

A proper AR feeling is achieved with the so-called *Absolute* mode, in which the ghost video 'stays' floating at the feature where it was triggered. Once triggered, a reference picture is created ad-hoc using the current camera frame. The video is then positioned on screen using this reference picture. Thus, if the user changes his point of view, the placement of the video on screen changes accordingly. Further, a video is always oriented toward the user. It is not possible to walk around ghosts to watch them from behind. However, by a priori designing the videos including 'ghost effects' in accordance with the magic equipment metaphor, such as wiggling, floating, swirling or a 'disturbed channel', we are able to work around some of the artefacts involved.

5. Summary and future work

We presented ongoing work of the project 'SPIRIT', its concepts and first results. Our first running demonstrator shows the basic interaction principle. It has been used for specifying further development of the system and the content structure. Future work includes the development of indoor tracking technology, in order to be able to use all kinds of locations at museum sites. Further, we will develop a story engine with an authoring framework for media designers that caters to our video-based approach. Finally, a case study will be completed with the support of the Roman fort museum Saalburg.

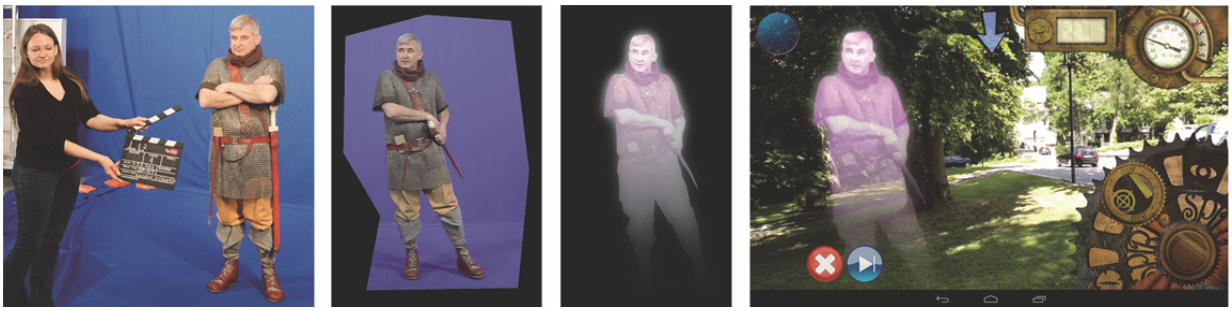

Figure 2: *Production steps. The original video has been semi-automatically edited and filtered in several passes, before its rendering as the transparent video Visual Asset for AR. The right picture includes another draft of the interface.*

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