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Gaze-based narratives for location-based games

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ABSTRACT

Location-based games require their players to move in the real world in order to interact with a virtual game layer which is spatially connected to the real world. It has been argued that place-related location-based games, i.e., those where the narrative of the virtual layer is closely related to the places in the real world, provide a particularly immersive experience. This position paper suggests enriching these playful immersive experiences with the interaction concept Gaze-Based Narratives. It is proposed to guide the player's eye gaze to real-world objects relevant for the game and to adapt the story of the game dynamically to the real-world objects that have been looked at previously.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design theory, concepts and paradigms**; *Interaction techniques*; • **Applied computing** → Interactive learning environments.

KEYWORDS

Outdoor HCI; Outdoor Play; Gaze-Based Interaction; Gaze-Based Narratives; Location-Based Games

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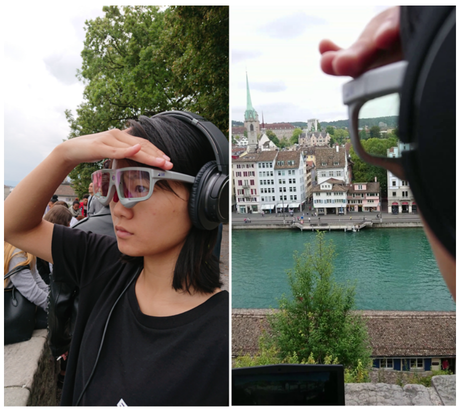

Figure 1: Gaze-based interaction with a city panorama. The system provides audio information about the buildings the tourist looks at [18].

INTRODUCTION

The emergence of affordable mobile phones and reliable positioning technologies at the beginning of the century have led to first research projects on *location-based games* (LBG) [4, 20, 23, 24, 27]. Different to other mobile games, LBGs use their player's position as a crucial part of the game concept. For instance, players of an LBG may be required to move between different locations in order to collect virtual resources or to interact with non-player characters (NPCs).

Some years after this first wave of LBG research, the first commercially successful LBGs became available, where Ingress (2013) [10] and Pokémon Go (2016) [25] are probably the most well-known ones. Research has in the meantime explored different applications of LBGs: the collection of crowd-sourced data [22], tourism [3], teaching [1], and persuasion for healthier lifestyle [6], to name a few. A recent study on parents' perception of Pokémon Go has shown that parents appreciate the increased exercise in the outdoors, as well as family bonding experiences of playing together [28].

Despite the ongoing progress in LBG research, it appears that the interaction modalities used in LBGs do not take advantage of the most current state-of-the-art in HCI. Most LBGs are still played using touchscreens, possibly enhanced by smartphone-based augmented reality (AR). The potential opportunities for LBGs offered by developments in mobile HCI technology, such as, outdoor-capable physiological sensors (e.g., [5]), are not sufficiently explored.

In this position paper, I suggest utilizing *gaze-based interaction in the outdoors* for enhancing the experience of playing LBGs. The idea is facilitated by current developments in pervasive eye tracking which indicate that tracking users' gaze in-the-wild may soon become sufficiently reliable for everyday use [2, 8, 13, 32]. Figure 1 displays an example for gaze-based interaction with a city panorama [18].

For desktop computer games, such as first-person shooters, commercial products using gaze as an input mode are already available[1], and recent research workshops keep driving the topic forward [19, 31]. A good overview on gaze in gaming is provided by three overview articles [11, 29, 33]; none of them, however, considers gaze-input for LBGs.

My main argument in this position paper is that, in addition to those opportunities of gaze input that as well hold for desktop games [33], gaze in LBGs features the particular chance for increasing the player's feeling of immersiveness by guiding her gaze and adapting the game's narrative to what has been looked at (a concept we introduce as *Gaze-Guided Narrative* at this year's CHI, [18]).

[1] For instance, the Tobii website lists 137 eye tracking enabled games at the time of writing [30]

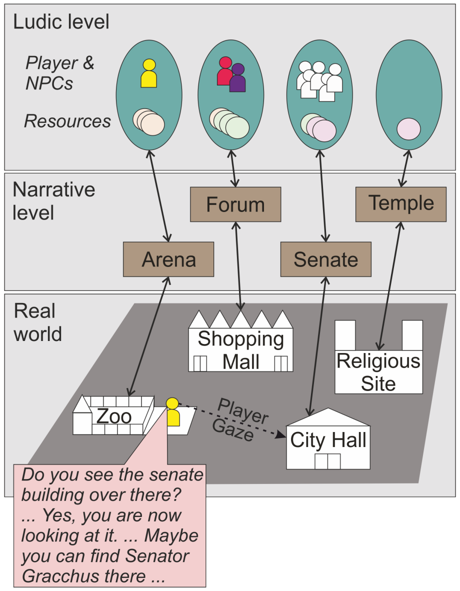

Figure 2: Location-based games overlay the real world with a virtual world, which consists of a narrative and a ludic level [26]. This Figure sketches a hypothetical adventure-style game with a narrative of Ancient Rome. Based on the player's gaze, the game helps with the cognitive mapping between real-world objects and their meaning in the narrative (Gaze-Based Narrative [18]).

OWN PREVIOUS WORK

This position paper proposes the application of gaze-based interaction techniques to LBGs played in outdoor spaces. It combines ideas from two research projects the author has been involved in.

Geogames and LBG Relocalization

The author's first work on LBGs in the 'Geogames' project was centered around the question how traditional board games can be converted to outdoor LBGs without introducing imbalance caused by small speed differences between players [27]. We were interested in the spatial and temporal aspects of playing outdoors, e.g., whether games are played at discrete locations or in a spatial continuum [16], and how these aspects influence game mechanics. Game balancing was achieved by introducing breaks, which we proposed to fill with edutainment content related to the current place [15].

One insight from the project was that one important factor for the success of LBGs is whether their narrative is related to the place or not. Place-independent games can rather easily be ported ('relocalized') to new places automatically [17], which facilitates their dissemination. Place-dependent games, on the other hand, have a narrative closely related to the place, which leads to more immersive experiences but at the same time makes them difficult to relocalize without a human expert.

In recent work, the author has proposed a theoretical model for the automatic relocalization of LBGs that considers also the narrative level [26]. The idea is to have several possible narrative embeddings for one LBG concept and choose the one which fits best to the points of interest available at the player's current location. That is, the rules and game mechanics (on the ludic level) are fixed but their semantics are adopted to the spatial context automatically. For instance, the algorithm would choose an Ancient Rome narrative when the game is played in an Italian city (see Figure 2), whereas it would choose a Viking narrative in Scandinavia. Both variants would still have the same game mechanics, such as, the requirement for collecting virtual resources or interacting with NPCs.

Gaze-Based Interaction with Outdoor Spaces

The author is currently leading the GeoGazeLab research group (http://geogaze.ethz.ch/), which uses eye tracking for the analysis of spatio-temporal decision making, and for gaze-based interaction with spatial information and with outdoor spaces [14].

Gaze-based interaction in outdoor spaces, with a focus on a tourism scenario, is the scope of the LAMETTA project ('Location-Aware Mobile Eye Tracking for Tourist Assistance', http://geogaze.ethz.ch/lametta/). We have developed a gaze-based tourist guide which provides audio information during the visual exploration of a city panorama (see Fig. 1). Computer vision methods are used to match the field video of a head-mounted eye tracker with a reference image in order to identify the building looked at [2]. We chose audio instead of AR in order to avoid visual distraction from the real world.

Table 1: Applying the systematization of game mechanics relying on player's gaze from [33] to LBGs. Examples for interaction with the real world (RW) and with the virtual world (VW) are listed.

Navigation	
RW	*Retrieving navigation cues from environment [9].*
VW	*Steering an NPC using gaze.*
Aiming&Shooting	
RW	*Shooting a virtual cannon ball at a real building.*
VW	*Shooting at a virtual NPC in AR.*
Selection&Commands	
RW	*Assigning a narrative role (e.g., 'warehouse') to a real building.*
VW	*Picking up a virtual resource (e.g., a piece of gold) in AR.*
Social Gaze	
RW	*Game recognizes eye contact in multi-player game.*
VW	*Game recognizes eye contact with an NPC in AR.*
Responsive Environment	
RW	*Game tells story when gaze is on building [2].*
VW	*AR objects react to gaze.*
Adaptive AI	
Both	*Game guides user's gaze if problems in visual search are detected [18].*
Visual Effects	
VW	*Placing an AR selection dialog close to the player's current gaze.*

At this year's CHI, we are presenting a novel gaze-based interaction concept and its evaluation in virtual and real urban environments (*Gaze-Based Narratives*, [18]). The system takes the role of a tourist guide which interactively guides the tourist's gaze to buildings it is talking about. It also adapts the audio content to the objects the tourist has looked at before, e.g., by comparing the architectural style of two buildings. These two mechanisms – *gaze guidance* and *content adaptation* – could also be applied to gaze-based interaction in LBGs. Figure 2 illustrates gaze guidance for a hypothetical LBG.

TOWARDS GAZE-BASED INTERACTION IN LBGS

Eye tracking can be used to measure an individual's gaze on a stimulus [7]. The resulting gaze data are used as an indicator for a user's visual attention and, quite often, also for inferring cognitive processes [12]. In gaze-based interaction, gaze is used in real-time for the control of an interactive system [21].

For desktop gaming, Velloso and Carter [33] have extracted 5 different gaze-based game mechanics from existing games (navigation, aiming&shooting, selection&commands, implicit interaction, and visual effects). Implicit interaction is further split into social gaze, responsive environments, and adaptive AI. Table 1 lists examples for each type of game mechanics from [33] applied to LBGs.

LBGs are different to desktop computer games because players interact with both, a virtual and a real world, where these two worlds are spatially connected (refer to Fig. 2). Note that the virtual world can be overlaid to the real world visually (in AR), but it does not have to. Many LBGs rely on their player's imagination instead with the aim of avoiding visual overload. In the case of AR-enabled LBGs, almost all game mechanics as for desktop games can be applied. For instance, one could determine whether the player searches eye contact with an NPC shown in AR and adapt the NPC's behavior accordingly. Exception are mechanics related to navigation, since they are limited to steering virtual characters. A conceptually very different situation occurs when gaze-based interaction takes place with the real-world (RW in Table 1): since the mapping between real-world objects and their meaning in the game is sometimes not obvious, I suggest using Gaze-Based Narratives to ensure that the player looks at those real-world objects the game is referring to (e.g., by audio).

CONCLUSION

This position paper aims at starting a discussion on whether and how gaze-based interaction can be applied to LBGs – an opportunity that has not been explored in literature yet. I have particularly argued that Gaze-Based Narratives [18] could be used for bridging the gap between the real world and the game semantics in non-AR-enabled LBGs.

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