Ghost Hunters: Ambient Light and Hand Gesture Utilization in Mobile Augmented Reality Games

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ABSTRACT
This paper presents the current status of work-in-progress in developing Ghost Hunters that is targeted to explore the possibilities of incorporating gesture control and ambient lighting in a mobile augmented reality game played with smart glasses. We present the design and implementation of the current prototype, together with a small feasibility evaluation of battery consumption and gesture control.

Author Keywords
Pervasive games; augmented reality; smart glasses

ACM Classification Keywords
H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – *Artificial, augmented, and virtual realities*

INTRODUCTION
Pervasive games take place in real life environments and expand the context of gaming. Such games are not just entwined with everyday life, but at some level also aim at blending seamlessly into their environment [3,8]. A particular type of pervasive games is mobile augmented reality (AR) games where a live view of the physical real-world environment is augmented or supplemented by computer-generated game objects.

With their high quality see-through displays and many sensors, modern smart glasses such as Microsoft HoloLens [5] and ODG R-7 [10] offer new possibilities for blending the game world with the real world. Further, they can be worn as spectacles which frees the user's hands for other tasks such as gesture control which in turn enables natural interaction with AR objects and novel forms of user input.

In this paper we introduce Ghost Hunters, a pervasive mobile AR game. Our objective is to explore the benefits of gesture control and ambient lighting in a mobile AR game played with smart glasses. We believe that smart glasses will enable truly mobile gesture control that can be utilized in many application including pervasive games. We present the design and implementation of the current prototype, together with a small feasibility evaluation of battery consumption and gesture control.

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BACKGROUND
Ambient lighting has been utilized in pervasive games before. Boktai's [11] game cartridge includes a photometric light sensor and the player wields a Solar Gun. A larger array of ambient data is utilized in Sensorium's selection of games [9] where each player is given a "mote" equipped with sensors for collecting data about the environment. In Mythical: The Mobile Awakening [11] players perform rituals dependent on contextual variables such as lighting.

AR elements in gameplay are a well-established way of integrating fantasy elements and views of virtual environments into the game scenes. Invizimals [12], TimeWarp [2] and other games have shown how AR objects do not just augment the game experience but also hide the seams between the boundaries of reality and the game world.

Gesture control has been incorporated in intangible interaction with virtual or AR objects with different hand tracking methods and with auxiliary devices such as gloves and Leap Motion [7]. Pervasive games have not yet taken full advantage of gesture control, possibly due to the lack of truly mobile gesture tracking equipment. The rare exceptions are 2084–Safe New World [4] and Ghost Hunters presented in this paper. The future deployment of HoloLens may change this as there already are interesting demos highlighting future possibilities of the device.

GHOST HUNTERS

Design
In Ghost Hunters the player takes the role of a hunter who uses smart glasses (dubbed as goggles in the game) to find ghosts overlaid as AR objects into the scene and capture them with particular hand gestures. A ghost can only be seen when the player is sufficiently close to it in the physical environment. The design of the game and gestures for capturing the ghosts are inspired by the well-known game of rock-paper-scissors. There are three type of ghosts - paper, rock and scissors (metal) – each rendered with a unique texture and colour. A particular type of ghost can only be captured with the matching gesture: paper with scissors, rock with paper and scissors with rock. Using a wrong gesture to

capture a ghost is not punished. The goggles are charged using ambient light from the environment. If the player does not manage to capture a ghost within ten seconds of its appearance, the light charge of the goggles is reduced by 10%.

Implementation

The game was implemented using the Unity3D game engine [1312]. Since the engine's API cannot access the light sensor, a light sensor plugin was developed in Android Studio. For rendering the ghost we used Kudan SDK [6] which provides markerless AR tracking that determines the edges of objects and assigns random points of interest to render the ghost according to its position. Gesture control was implemented with Augumenta SDK [1]. A couple of action shots of the UI of the current prototype are shown in Figure 1.

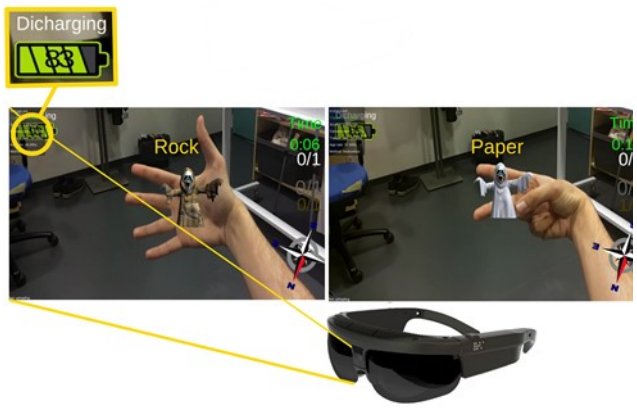

Figure 1. Action shots of the player's view through ODG R-7 smart glasses when capturing rock and paper ghosts.

Feasibility Evaluation

Battery Consumption

To have realistic expectations of playing time, we evaluated the battery consumption of the game on ODG R-7 smart glasses and Nexus 9 tablet as a reference device. As Table 1 shows, Nexus 9 has a much larger battery thus it is drained much slower relatively speaking. We see that on ODG R-7 the maximum expected playing time is roughly 30 minutes, which should be sufficient for a pervasive game where players are required to move around actively.

Device	Battery capacity (mAH)	Relative battery consumption (% per minute)
ODG R-7	1300	3.4
Nexus 9	6700	1.5

Table 1. Relative battery consumption of the game.

Gesture Control

The gesture control of the game was evaluated during a two-day event organized on our campus for high school students. 30 participants (12 female) of 17-19 years in age played one game session where they were supposed to capture three ghosts. The ghosts were located in the same place thus the participants did not have to move around. The game session was so short that the goggle's light charge could not become empty. We wanted to explore novice (untrained) use of gesture control with the goggles, thus participants were not given a chance to practice gestures with the goggles before the game session. However, all participants reported being familiar with the rock-paper-scissor gestures in advance. We gathered questionnaires, field notes and video data.

Not all participants managed to capture all three ghosts. From the video capture of 22 game rounds (we were not able to capture all 30) and 51 ghosts that appeared 30 (59%) ghosts in total were captured within 10 seconds of their appearance. Although all participants reported to know the gestures in advance and most of them reported that using them in the game was smooth and natural (Figure 2), many of the participants needed guidance in using the gestures with the goggles, for instance bending their wrist so that gestures were directed toward the goggles. We may be able to address this by adjusting game graphics and making the different ghosts' types more apparent.

Figure 2. Participants' responses to statement "Using gestures was smooth and natural" on 7-point Likert scale. Three participants did not answer the question.

CONCLUSION

This work-in-progress shows that it is technically feasible to incorporate gesture control in a mobile AR game played with smart glasses. The first user evaluation revealed that for novice users it can be somewhat difficult to use with smart glasses even well understood and established gestures like rock-paper-scissors.

In the future we hope to incorporate more complex interactions between the environment, the player and the game. Eventually, we hope that this work will yield useful findings on incorporating smart glasses and gesture control in 3D user interfaces, not just for leisure games but for other application domains, as well.

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