Photogeist
Snapping Ghosts' Pictures in an Augmented Realty Game

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ABSTRACT

We discuss the design of *Photogeist*: an augmented reality game which is based on a physical metaphor of a handheld camera as its main game interface. The gameplay requires the player to physically move around the game scene, sneak up on ghosts, and snap effective pictures documenting them using her paranormal phenomena-sensitive camera. The paper presents the motivation for *Photogeist*, its game design, implementation and resulting gameplay, as well as brief discussion of related games.

Categories and Subject Descriptors

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

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Input devices and strategies, interaction styles*.

K.8.0 [**Personal Computing**]: General – Games.

General Terms
Design.

Keywords
Games, interfaces, augmented reality, photography, ghosts.

1. INTRODUCTION

Recent trends in commercial video games suggest great potential for games that make use of novel interfaces and interaction techniques. Consider *Guitar Hero*, the billion-dollar [5] franchise which uses guitar-music as the impetus for gameplay. At its core, *Guitar Hero* is not an especially original game; it's a straightforward adaptation of the "rhythm" genre, which challenges players to perform some task to a musical beat. In fact, there are several guitar games which used a similar formula several years earlier, most notably *Um Jammer Lammy* (1999) and *Gitaroo-Man* (2002). What made *Guitar Hero* an unparalleled success while *Um Jammer Lammy* and *Gitaroo-Man* achieved only cult-fandom? We believe that the games' interfaces strongly affected their popularity: while *Um Jammer Lammy* and *Gitaroo-Man* were controlled using a standard gamepad, *Guitar Hero* shipped with a guitar-shaped controller designed especially for the game. The controller was designed in such a way as to

evoke the image of a real guitar – in fact, its body was modeled after a popular electric guitar, the Gibson SG.

The impact of this specialized interface was profound; it forced players to stand while they played, and to hold the device as they would a real guitar. Even players' hand-movements over the buttons on the neck of the controller mimicked the appearance of a guitarist fretting and shifting chords. In short, this specialized device not only encouraged but forced its players to act like guitarists while they played. As a result, *Guitar Hero* is very compelling, very immersive game; by encouraging players to physically get into the game, *Guitar Hero* tacitly invites players to suspend their disbelief, and embody the guitarist they see onscreen. As one *Guitar Hero* reviewer put it: "I am frankly astonished by how much playing this game feels like playing the guitar for real" [4].

The success of *Guitar Hero* and similar games should be of great interest to game designers, and other creators of electronic entertainment. It suggests that a game's interface – the link between the game and the player – can be as important as the content itself when it comes to creating an engaging, entertaining experience. The simple introduction of affordances and strong physical and spatial mapping between interface and task can be extremely powerful [6, 7], and in a game context can transform a lame gameplay into a fun one.

In was this belief that guided our design of *Photogeist*, an augmented reality video game which is equal parts bird-watching and *Ghostbusters*. *Photogeist* is played using a handheld camera peripheral which the player uses to take photos of floating virtual ghosts. As in photography, the goal is simple: to take the best, most visually-striking photos that the player possibly can. As in photography, this is easier said than done, and *Photogeist* requires the player to physically move around the game scene, smartly sneaking up on the ghosts in order to get good quality shots.

2. PHOTOGEIST

2.1 Premise

In *Photogeist* the player assumes the role of an amateur paranormal researcher who has made it their life's work to expose the ghosts living among us. On an afternoon like any other, a scrap of paper slides under their door. It's an anonymous tip, describing a haunted laboratory nearby! Grabbing their trusty camera off their bookshelf, the player runs out the door. "This is it," they think. Tonight, they will document this event with as many ghost-filled photographs as they can take, and to use this evidence to prove the existence of ghosts once and for all!

Figure 1: Our makeshift camera.

2.2 Peripheral

As we have suggested, Photogeist requires a special peripheral to play – a handheld camera device. The peripheral we use is not a camera in the truest sense of the word; rather, our "camera" is made up of two separate pieces of off-the-shelf hardware. An ordinary web camera (the Creative Live Ultra for Notebooks) serves as our camera's lens. The webcam is connected via USB to our second piece of hardware: a tablet PC (the LG C1 Express Dual) which serves as both our camera's LCD screen and the platform on which the game is run. Together, these two devices form a digital camera facsimile (Figure 1). The webcam provides a real-time video stream to the LCD display, which the players can use to compose their shot before taking a picture. Taking a picture is as simple as pressing any button on the tablet's face.

2.3 Gameplay

Photogeist is a game which blends real physical data with synthetic digital data to create a unified augmented reality. In *Photogeist*, the player, her camera, and the video feed coming from the camera are all real. However, when the player looks at the world through the LCD screen of her camera she will also see virtual ghosts floating through the air (Figure 2). Although these ghosts are entirely virtual, their position is tied to a real, physical location in three dimensional space – ghosts move themselves through the world, independent of the player or her camera.

Fundamentally, *Photogeist* is all about taking pictures. The player's goal is to take as many high-quality pictures of these ghosts as possible before the game's time elapses. A photo's quality is determined according to three criteria:

1. Distance: A simple measure of the distance between the camera and its subject – this represents an approximation of how well the subject of the photo fills out the frame, since objects appear larger as you get closer to them.

2. Facing: The extent to which the subject is facing the photographer. Photos in which the subject faces the photographer will score higher than those where the subject is facing away.

3. Centering: A measure of how close the subject is to the center of the photograph. Well-centered photographs score better than those which are not.

In *Photogeist* – as in photography – it may be necessary for the player to reposition themselves in order to establish a good shot. In fact, the ghosts in *Photogeist* are notoriously camera-shy; ghosts will always try to maintain a distance between the player and themselves. As a player moves, nearby ghosts will speed up and scatter in an attempt to escape the player's gaze. If a player gets too close to a ghost, the ghost will simply dive into the cloud-covered surface of the floor, and resurface at another position. Thus, the player must tread carefully – the closer she gets to a ghost, the harder it will be to take its picture. A wise player will recognize that it may be necessary to give ghosts a wide berth in order to get the perfect picture.

The player may take a picture at any time by pressing one of the shutter buttons on the surface of the tablet. When she does, a photograph will be taken and added to the player's "scrapbook" for the game. After any photo is taken, the camera must cool down for a period of roughly two seconds. This encourages players to line up their shots carefully before taking a picture, rather than constantly shooting pictures in the hope that one will turn out well.

Gameplay proceeds with players chasing ghosts and taking pictures for two minutes. After this time, the game is over, and the player is allowed to review her scrapbook of photos that she took over the course of the game. Each photo is ranked according to its

Figure 2: *Photogeist*, as seen by the player.

Figure 3: In-depth information on a photograph.

quality and awarded a score from zero to five stars. By selecting a specific photo, the player can see in-depth information on that photograph, including a breakdown of its individual scores, and a suggestion of how to improve in the future (Figure 3).

3. IMPLEMENTATION

3.1 Tracking

In addition to our camera peripheral, *Photogeist* requires one other piece of "hardware" to be played – the 2.6 m^2 board on which the game is played. The board is a slab of heavy plastic covered with tracking markers, which acts as a tracking device monitoring the position of the player and the orientation of her camera.

Photogeist uses a form of visual-based tracking provided by the ARToolkitPlus software library [1]. We've covered the board with ARToolkitPlus' flat, high-contrast tracking markers, and recorded the spatial relation between each marker ahead of time. When the player points her camera towards the board, one or more of these tracking markers will become visible within the view of her camera. ARToolkitPlus can then analyze the position, orientation and scale of these markers to determine their position and orientation relative to the camera, and it returns this information in the form affine transformation matrix. This information is necessary to create *Photogeist*'s augmented reality – using this matrix to transform our rendering allows us to display virtual entities that retain their position and orientation in 3D space, regardless of the player's viewpoint.

We can also invert this matrix to determine the position of the player's camera relative to the onboard-markers. We use this information to track the player's movements through the physical world. This allows ghosts to be aware of the player: to "see" when the player is nearby, and to take appropriate evasive maneuvers. We can calculate the camera's view vector using a similar process – simply multiplying the inverted matrix by the default view vector, (0, 0, 1).

3.2 Taking Photos

The process of taking and storing a photograph is actually quite simple – it is merely a matter of saving a copy of the current screen buffer into texture memory. Unfortunately, the process of scoring a photo is considerably more complex. In order to score a photo, four pieces of information are required: the subject's position, the subject's facing direction, the position of the camera, and the facing direction of the camera. The camera's position and facing can be established using ARToolkitPlus and the method we described above. However, it still remains to determine the subject of the photo. This is a difficult task, because the subject of a photograph is inherently ambiguous – it is impossible for the system to determine the player's intentions at the time she took the photo. Therefore, before the photo can be scored, the system must attempt to guess what the player was aiming at. To determine a photo's subject, we compare the position of every ghost in the world with our camera's view vector. The ghosts which fall outside our camera's field of view (roughly 78 degrees) can be eliminated from consideration immediately. The positions of the remaining ghosts are evaluated, based on a formula which considers their deviation from the camera's view vector and their absolute distance from the player. Whichever ghost produces the

lowest weighted combination of these two factors is assumed to be the intended target of the photo. In the event that all ghosts are outside the camera's field of view, then the photo has no subject and is immediately awarded a score of zero.

Once a subject has been selected, the three scoring metrics are calculated. Distance is calculated as the magnitude of the vector between the camera's position, and the subject's position. Facing is calculated as the angle between the subject's view vector, and camera's view vector – the closer this value is to 180°, the closer the photographer and the subject are to facing each other. Centering is calculated as the angle between two vectors: the camera's view vector, and the vector between the camera and the subject. The larger the discrepancy between the two, the farther the subject is from the center of the photo.

After values for each of these three metrics are calculated, their values are normalized on a scale from zero to five. A weighted average of these scores is taken to produce a final, overall score for the photo. An appropriate commentary for the photo is selected from a set of stock responses, based on the photo's individual scores. For example, if a photo scored well overall, but had poor centering, the commentary may read: "Use the onscreen targeting reticule to center your subjects before you shoot. This will significantly improve your photos."

4. DISCUSSION

Our goal in designing *Photogeist* was to create a game which would be fun, accessible and that would encourage physical activity. We wanted players to be able to pickup *Photogeist* and intuitively play it. To this end, we chose two common activities to form the basis of our gameplay: physical locomotion, and photography affordances.

Little needs to be said on the topic of physical movement; virtually everyone who would be interested in playing *Photogeist* knows how to walk. In Photogeist, we have encouraged players to move as they play by creating ghosts which are constantly moving and reacting to the player's presence. In *Photogeist*, ghosts will naturally seek to avoid the player. If the player stands still, she will find herself with very few opportunities to take compelling photos. Thus, if the player wants to score highly, she will find it necessary to move and position herself throughout the game.

Photography affordances is a major part of *Photogeist*'s gameplay, and although an understanding of photography is not as ubiquitous as that of physical movement, it is still exceptionally widespread. With the proliferation of digital cameras and cameraphones, almost everyone has used a camera at some point in their lifetime. Even for those who haven't, the concept is very easy to grasp. Using a camera is as simple as pointing and clicking. *Photogeist* game interface has the physical affordances of a rather bulky digital camera. Consequently, there is very little room for error or confusion.

Although a formal user study has not yet been performed for *Photogeist*, initial findings based on informal play sessions have been encouraging. As predicted, players need very little instruction on how to play the game – it is typically sufficient to describe the goal of the game, and to point out the "shutter button" on the tablet before players can begin to play.

5. RELATED WORK

In this paper, we have examined the interface of the computer game, *Photogeist*. In the context of gaming, the word "interface" has many different meanings. We use it to refer to a physical system which serves as an intermediary between a game and its player. Such interfaces are comprised of two essential components; a control device which allows the player to input to the game, and a display device which allows the game to output to the player.

Photogeist's interface takes the form of a handheld camera peripheral which serves as both a display and an input device. Although the use of photography has previously been explored by such video games as *Pokemon Snap* (1999), *Fatal Frame* (2002) and *Beyond Good and Evil* (2003), *Photogeist* represents an evolution of this concept. While these games used a generic game controller to take virtual photographs of virtual objects, *Photogeist* allows players to take real pictures of an augmented reality scene using a real, physical camera.

In creating *Photogeist*, our goal was to design a game where the player would be not only free, but encouraged to physically move as they played. This goal was well-suited to augmented reality; an interface technique which integrates virtual content with the user's physical environment. Simply put, augmented reality allows a player's physical space to become the world of the game – a shared space where the player and virtual entities coexist, move, and interact.

ARQuake is an augmented reality adaptation of id Software's *Quake* created by the Wearable Computer Lab at the University of South Australia [8]. In *ARQuake*, the player takes on the role of *Quake*'s protagonist marine, and the university campus becomes the game arena. In contrast to Quake where players move using a keyboard, ARQuake players are given free reign to physically walk through the campus. As they move, virtual monsters will appear on the player's head-mounted display. As in *Quake*, the player's *modus operandi* remains simple: shoot them all!

In the same way that *ARQuake* is an homage to *Quake*, the *Human Pacman* is an augmented reality project [2] that draws inspiration Namco's 1980 classic, *Pac-man*. In *Human Pacman*, the player walks through a physical environment collecting virtual pellets which appear before her on her head-mounted display. As players move, their progress through the environment is tracked using GPS monitors, allowing a player to collect a pellet merely by walking through it. *Human Pacman* also allows players to join the game as "ghosts", whose objective is to hunt down the player acting as Pacman by chasing her through the arena, eventually coming close enough to touch. Another notable entertainment example for this type of interaction is the "witch fighting" component of *Game-City* [3].

The advantage of augmented reality in games such as *ARQuake*, *Human Pacman* and *Game-City* is straightforward: with augmented reality, the scope of the game is no longer constrained to a flat screen three feet in front of the player. Rather, players can now be placed directly in the center of a game, with action happening above, below and all around them. In *Photogeist*, augmented reality gives players the freedom to dictate how the play; players can move themselves, position their camera, and line up their shots however they see fit.

6. FUTURE WORK

As of this writing *Photogeist* is complete enough to demonstrate. However, we feel that the game could benefit from the addition of features which reward the player for taking good shots and encourage further play. Currently, any photos taken by the player are lost when the game ends. By allowing players to save their favorite photos, or creating a "Hall of Fame" which collects the best photos from each player, we could adds an element of socialization to the game by giving players a way to show off their photographic prowess. This Hall of Fame concept could even be extended into an online *Photogeist* community, where players could upload their photos as well as comment on photos taken by other players.

Additionally, we believe that the concept of photography-as-gameplay is robust enough to support a variety of other gameplay designs; while brainstorming for *Photogeist*, we imagined several such games. One of these games was a mystery game where the player would assume the role of a crime scene investigator. The player is presented with a pre-arranged crime scene and her goal is to solve the case with the aid of a handheld camera/computer. In addition to taking photos to document evidence, the player could use her camera's augmented reality interface to see invisible clues such as fingerprints, stains, and so on. By making effective use of her crime-fighting tools, the player should be able to piece together enough evidence to create a case against a fictional culprit. We feel that this crime scene concept and others like it have the potential to further demonstrate the utility of a novel interfaces in creating fun new games.

7. CONCLUSION

We presented the design motivation, implementation and gameplay of *Photogeist*, an augmented reality game that requires the player to snap pictures of ghosts in physical space. *Photogeist* uses a very simple, yet we believe very powerful, physical metaphor for its main interface: a handheld camera which allows the player to view and document paranormal phenomena while physically moving around the game scene. We believe that the affordances of *Photogeist's* interface, the camera, and how it matches in form and gameplay task a physical camera, all resulted in a fun, and highly intuitive, game experience.

8. REFERENCES

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