Save 'Em: Hands-On Gameplay

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ABSTRACT
We present *Save 'Em*, an augmented reality-based computer game designed to explore the universal challenge of making computer games more immersive, entertaining and fun.

As in the classic computer game *Lemmings*, *Save 'Em* is based on maneuvering a group of slow-witted characters called Dudes through a treacherous maze. Using augmented reality techniques, *Save 'Em* places virtual game entities directly within the player's physical environment; gameplay takes place on a real game board rather than on a computer screen, and Dudes are being led to their destiny directly through the physical actions of the player in the real world.

We use *Save 'Em* to explore how moving game interaction from the virtual domain into the physical world using augmented reality can affect gameplay and players' overall game experience. Preliminary findings based on a number of informal Save 'Em sessions demonstrate the potential of this approach.

Keywords
Computer games, gaming, interfaces, augmented reality, mixed reality, immersion, control methods.

1. INTRODUCTION
There are a near-infinite number of reasons why people play computer games, but in the end, it all comes down to personal enjoyment; "because it's fun." Of course, some games are more fun than others. These are the games which are more popular, more critically acclaimed, and more commercially successful. It is for these reasons that a keen understanding of what makes games fun is highly important in game development. Unfortunately, there is no single criterion – a concept as nebulous as "fun" is highly subjective and can vary strongly from player to player. That said, there is almost certainly a group of core concepts which are universally contribute to players' enjoyment. One of these core concepts is immersion: the process by which a player dedicates his or her focus to the game, and becomes emotionally involved in its progression. Immersion is valuable to computer gaming because it provides an element of escapism; it encourages players to leave their day-to-day concerns behind and focus exclusively on the task before them. What's more, this intense focus can amplify feelings of accomplishment as players complete tasks within the game. We know that immersion contributes to enjoyable gaming experiences, but the question remains: How can games be created to foster the immersion of their players?

Historically, game developers have sought to immerse players through enhanced realism. This has usually been realized through graphical improvements, although improvements to physics engines, artificial intelligence algorithms and sound systems have also contributed. However in recent years the focus has shifted and immersion is increasingly being cultivated through the use of novel game interfaces, particularly novel control devices [1]. Many game developers are eschewing traditional, generic input devices such as keyboards and gamepads and creating specialized controllers, designed specifically for a single game. By using controllers which create a simple, intuitive mapping between the players' actions and their effects, a significant barrier to immersion is removed. No longer do players have to memorize complicated and often arbitrary key mappings in order to accomplish their goals. Rather, a good interface will allow the player to act naturally, translating physical actions into appropriate outcomes in the game environment.

In this paper, we present *Save 'Em*, an augmented reality game played with a simple, intuitive control device: a handheld "wand". *Save 'Em* harnesses the power of nontraditional control and display interfaces to create gameplay which is accessible, immersive and most importantly, fun.

2. RELATED WORK
Within the last decade, novel control interfaces have become exceptionally common to games. In fact, the entire "rhythm game" genre (which achieved widespread recognition in North America following the release of *Dance Dance Revolution* [2] in 1998) is practically defined by it. Rhythm games challenge players to perform to a musical beat by dancing, playing bongos, or strumming a guitar. The hallmark of these games is their elaborate controllers which seek to mimic real-life analogues. For example, the guitar-shaped controller that comes packaged with the 2005 release *Guitar Hero* [3] is in fact a ¾ scale model of a Gibson SG guitar.

However, despite their recent resurgence in popularity, game-specific control devices are nothing new; light-guns have been a staple of shooting games for almost thirty years. The most recognizable example of a light-gun peripheral is likely the Nintendo Zapper [4], which was released alongside *Duck Hunt* [5] in 1985. However, many arcade cabinets with built-in gun peripherals predate *Duck Hunt*, including *Desert Gun* which was

released by Midway in 1977 and *Triple Hunt*, released by Atari in the same year. Since their inception, light-guns have survived and even thrived and shooting games – complete with light-gun peripherals – are now ubiquitous in arcades.

Of course, one cannot discuss revolutionary control devices without mentioning the recently-released Nintendo Wii [6]. Nintendo has never shied away from innovation; they were the first to successfully introduce such concepts as force-feedback and touch screens to the North American console market. However, despite their reputation as innovators, many felt that Nintendo risked alienating gamers when it was announced that the Wii would eschew the traditional two-handed gamepad in favor of a one-handed remote containing an embedded accelerometer. However, Nintendo's unconventional thinking has once again paid off. Buoyed by the overwhelmingly positive reaction to its innovative control methods, the Wii has sold over 1.5 million units in the three months following its North American launch.

Although the Wii has set the gold standard for physical interaction in the console market, researchers are developing new ways to give players even more freedom to physically interact with their games. Augmented reality (AR) is a display technique which seeks to integrate synthetic, virtual content with the user's physical environment through the use of head-mounted displays (HMDs), projectors or similar display devices. Already, AR is finding applications in a wide variety of areas, including computer games. One of the best-known uses of AR in gaming is *ARQuake* [7], an augmented reality adaptation of id Software's first-person shooter, *Quake*. *ARQuake* takes the enemies from *Quake* and superimposes them over top of the player's normal vision, placing them in the role of *Quake*'s protagonist. In contrast to *Quake* where players move using a keyboard, *ARQuake* players are given free reign to walk (or run) through a real physical location as they see (and shoot) monsters.

Much as *ARQuake* draws inspiration from *Quake*, the *Human Pacman* project [8] is an augmented reality adaptation of Namco's 1980 classic, *Pac-man*. In *Human Pacman*, it is the goal of the player to collect a series of virtual pellets strewn across a physical arena. As players move, their movements are tracked using GPS monitors, and they can see the virtual pellets floating before them on their HMDs. To collect pellets, players need merely to walk through them. Players can also accumulate cookies by collecting physical ingredients found throughout the playing area. *Human Pacman* also allows players to join the game as "ghosts", whose objective is to kill Pacman by chasing him through the arena and eventually coming close enough to touch him.

Augmented reality interfaces have incredible potential for gaming, placing players directly in the center of the game, with action happening above, below and all around them. More importantly, by moving gameplay away from a monitor, augmented reality interfaces also tacitly encourages designers to break away from generic control peripherals such as the keyboard and embrace new, physically-based interaction techniques.

3. DESIGN

Our aim in creating *Save 'Em* was to create a "casual game" in the traditional of *Tetris*; something which is accessible but also engaging; a game that could easily be picked up and played in a minute, providing immediate satisfaction. Of course, in order to meet these goals, the game would have to be simple in both concept and control. For this reason, we sought to integrate physical control devices as the cornerstone of *Save 'Em*'s design. It was our hope that a well-designed physical control scheme could leverage players' existing knowledge to provide easy-to-

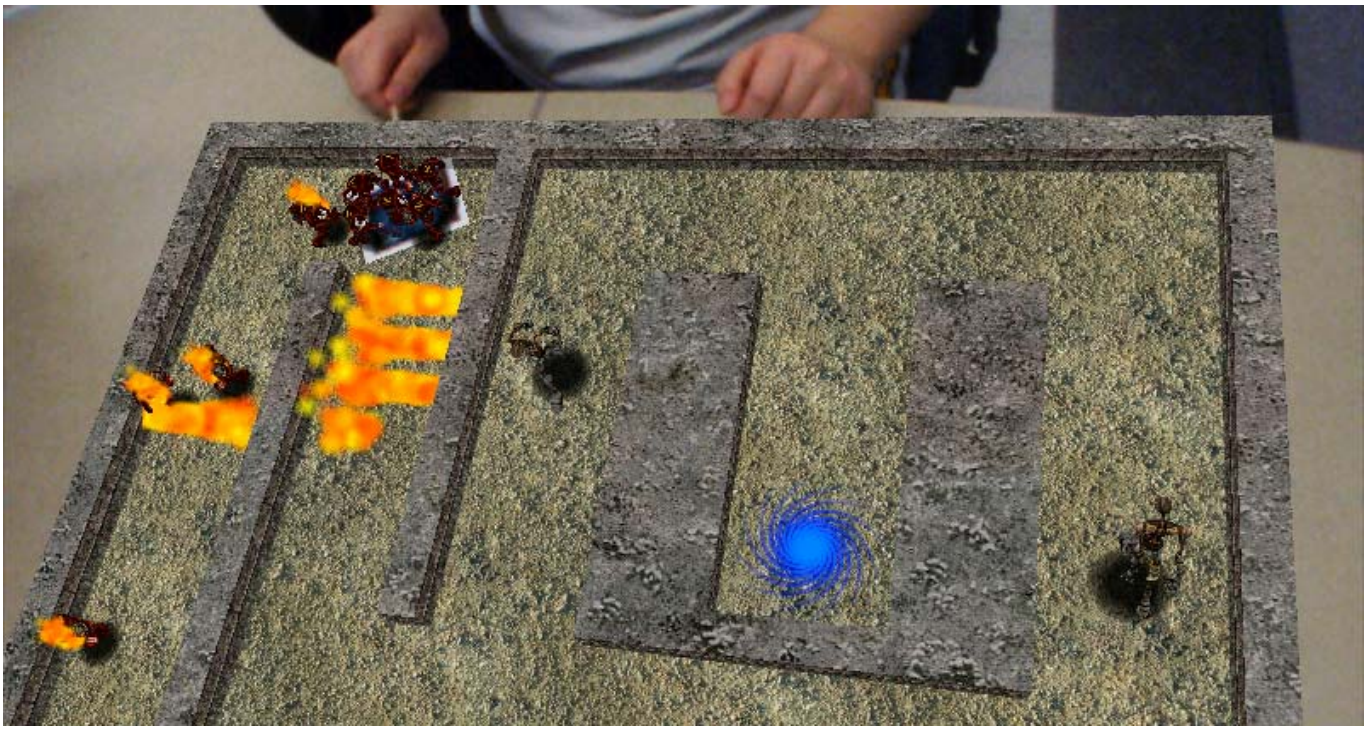

Figure 1: Guiding the Dudes using the control wand.

learn, intuitive gameplay. In order to support this physical interface, *Save 'Em* was also designed with an eye towards augmented reality. Initial designs centered on a "board game" concept wherein a flat, rectangular area could be designated as a playing surface, and all player interaction would happen on, above, or nearby this board.

Inspiration for *Save 'Em*'s gameplay came from Psygnosis's hit 1991 computer game, *Lemmings* [9]. In *Lemmings*, a group of ambling, mindless creatures are let lose in an arena filled with a series of deadly obstacles including fatal drops, pits of lava, and spring-loaded traps. It is the goal of the player to guide the lemmings safely past these hazards and into the arena's exit. This simple task is complicated by the fact that the player has no direct control over the lemmings themselves. In fact, all the player can do is assign behaviors (such as digging, or climbing) to the lemmings, who are otherwise free to walk to their death.

The task of coordinating virtual entities within a danger-filled arena seemed tailor-made for our board game concept, but the behavior-assigning controls of *Lemmings* were too complex to translate cleanly into the simple, accessible control interface we desired. To address this problem, we opted for a similar but distinct premise. In *Save 'Em*. the player is tasked with herding a group of dim-witted virtual characters (who we affectionately refer to as "Dudes") through a danger-filled maze. As in *Lemmings*, the player is forced to complete this task without ever controlling the Dudes directly. Instead, the player must lure the Dudes by holding a physical object – a "control wand" – and moving it over the surface of the playing area. As the player moves the wand, any nearby Dudes will run directly toward its tip, allowing a strategic player to direct Dudes past enemies and around traps, much as one might entice a mule to move using a carrot on a stick (Figure 1). A successful player will be able to keep casualties to a minimum as she moves the Dudes towards the maze's exit.

4. IMPLEMENTATION

The implementation of an augmented reality interface requires two key systems: a display system which allows the user to see both physical and digital entities, and a tracking system which gathers information about the user and the world around her. We selected to use an HMD as our display system in *Save 'Em* for two significant reasons. Firstly, the use of HMDs fosters immersion; by placing the display directly in front of the players' eyes, peripheral distractions are blocked, allowing players to focus solely on the game. What's more, an HMD is a hands-free display, which is necessary for compatibility with the handheld control wand we had decided upon for *Save 'Em*.

Save 'Em was implemented using the eMagin Z800 3D Visor HMD. The Z800 rests on the player's forehead, placing a small organic light-emitting diode (OLED) screen over each eye. Each display can be moved laterally to adjust the interpupilary distance, allowing wearers to focus the display to their liking. The Z800 also includes a set of earpieces which supports *Save 'Em*'s music and sound effects. Because the Z800's OLED screens are opaque, it was necessary to attach a webcam to the front of the visor, roughly between the player's eyes. The video feed from this camera is augmented with graphical content provided by the *Save 'Em* game engine, then routed to the screens of the HMD, allowing the wearer to effectively "see through" the display.

For tracking, *Save 'Em* employs the marker-based visual tracking provided by ARToolkitPlus [10]. Flat, high-contrast tracking markers have been affixed to the surface of the playing board (which is simply a poster board measuring 720 by 658 centimeters) as well the head of the control wand. Using computer-vision algorithms, ARToolkitPlus identifies the distance, position and orientation of these markers relative to the camera within any frame of video. By tracking the frames coming from the webcam affixed to our player's HMD it is possible to display virtual entities that retain their position and orientation in 3D space, irrespective of the player's viewpoint.

The primary use of the visually-based tracking is to determine the position of the tracking markers in relation to the camera. However by inverting the transformation matrix created by the tracking algorithm the position of the camera in relation to the tracking markers can also be calculated. This feature has been used in *Save 'Em* to provide the game with 3D positional audio. By tracking the position of the camera mounted on the player's head, we can determine the player's distance from the game board. As the player moves his or her head towards the surface of the playing area, sounds begin to emanate from entities on the game board, including the crackling of flames and the shuffling of zombie footsteps. As the player moves her head away, the sounds attenuate with distance, just like real audio, further enhancing the illusion that the virtual entities of *Save 'Em* have a real, physical presence.

Marker-based tracking relies on having a clean, unobstructed image of the tracking markers to provide adequate detection. This is often a problem in *Save 'Em* where players will reach across the board, unwittingly obscuring markers with their arm. To compensate for this problem, *Save 'Em*'s playing surface has been covered with twenty evenly-spaced markers to provide redundancy. Since the relative position of each marker is known beforehand, the entire board can be effectively tracked from a single visible marker.

5. PRELIMINARY FINDINGS

Although a formal user study has yet to be conducted, a large number of players have already played the game in a casual setting. Thus far, observation of these players has been very encouraging in suggesting that the physical gameplay techniques

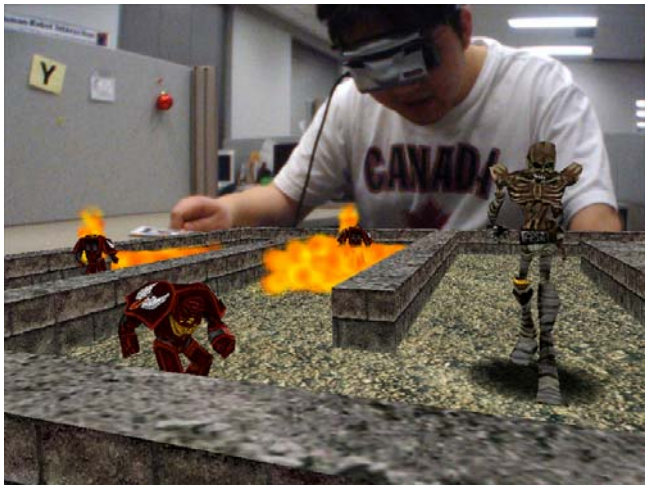

Figure 2: Playing Save 'Em using the head-mounted display.

we implemented accomplished our stated goals of creating an accessible, immersive and fun experience. Although players seldom manage to "save the Dudes" on their first attempt, a significant majority of them will (unprompted) request to try again, whereupon they fare much better. In fact many players manage to save every dude on their second or third try.

Perhaps the most encouraging sign of *Save 'Em*'s potential is that when the game is left running unattended, people have been known to wander over without invitation and begin playing. We believe this indicates a general interest in the game itself and further solidifies the notion that *Save 'Em* is an accessible, approachable game which people are eager to try.

Why does *Save 'Em* appeal to players, including those without backgrounds in computers or computer games? We believe it is due to the game's easy-to-use controls. Physically moving a wand with your hand is so natural that the game's learning curve is almost nonexistent. In fact, new players can usually begin playing straightaway after watching another player, even without explicit instructions on how to play. The wand metaphor is a useful construct because it allows players to draw on their preexisting experience. Just as one issues directions to a friend by pointing on a map, so too do the players of *Save 'Em* guide the Dudes through the use of their wand.

6. FUTURE WORK

As of this writing, *Save 'Em* exists as playable single-level demonstration, designed as a prototype to gauge the effectiveness of our proposed design. Based on the positive feedback we have received so far, a sensible avenue for future work would be to extend the scope of the game by adding new, more challenging levels which introduce new enemies, traps, and puzzle elements.

Following this, we also hope to conduct a more formal user study to evaluate the effectiveness of our chosen control methods. How this study might proceed is still uncertain. However, one possibility would entail reimplementing *Save 'Em* for a standard computer gaming platform, using a game controller or the traditional mouse-and-monitor interface. It would then be possible to perform a comparative user study to examine the appeal of each interface to players.

We are also working to extend our goal of promoting enjoyable gameplay through simple, innovative control mechanisms with an altogether new augmented reality game, tentatively titled "*Ghost Snap*". In *Ghost Snap*, players are placed in an augmented reality environment filled with virtual ghosts. The player's goal is to take as many pictures of the ghosts as possible using a head-mounted camera. Ghost Snap makes use of the camera-tracking described in this paper, allowing for ghosts which move and react to the player's presence. If a player gets too close before taking a photograph, nearby ghosts will fly away in fright. At the conclusion of the game, the player's photographs are judged based on the quality of their composition – clear, well-angled photos will earn high rankings and be eligible for entry into the *Ghost Snap* hall of fame.

7. CONCLUSION

Save 'Em is a preliminary exploration of some of the basic questions that need to be addressed by all game designers: How can games be made more engaging, entertaining and fun? We, like others, see moving gameplay to the physical world as the next significant breakthrough in computer game interaction.

Save 'Em has allowed us to explore this direction by immersing the player in an augmented reality environment, facing her with a virtual task unfolding on a real game board. Gameplay is controlled using physical movement of a handheld wand, which is directly mapped to the actions of entities in the virtual game environment. *Save 'Em* has also integrated an awareness of the player's physical location, enhancing the exploration of the game through sound effects that change dynamically according to relative distance and orientation between the player and the virtual entities of the game.

Based on a series of informal games, preliminary findings suggest that the *Save 'Em* augmented reality experience does seem to afford an intuitive gameplay which is also highly entertaining.

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