Let's Get Physical: How Physical Control Methods Make Games Fun

Min Xin
Department of Computer Science,
University of Calgary.
2500 University Drive NW
Calgary, AB T2N 1N4 Canada
xinm@cpsc.ucalgary.ca

Cody Watts
Department of Computer Science,
University of Calgary.
2500 University Drive NW
Calgary, AB T2N 1N4 Canada
wattsc@cpsc.ucalgary.ca

Ehud Sharlin
Department of Computer Science,
University of Calgary.
2500 University Drive NW
Calgary, AB T2N 1N4 Canada
ehud@cpsc.ucalgary.ca

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CHI 2007, April 28 – May 3, 2007, San Jose, USA
ACM 1-xxxxxxxxxxxxxxxxxx.

Abstract
Despite their widespread acceptance, traditional computer gaming interfaces such as the monitor and keyboard fundamentally serve to separate players from their games. In this paper, we examine how physically-based control methods – which leverage the physical movement of their players as a method for playing games – can be used to foster player immersion, creating games which are intuitive, accessible and fun. An examination of how a mixed reality interfaces support (and even encourage) physical controls follows, where we discuss two of our mixed reality game implementations – *Save 'Em* and *Napkin Chess*.

Keywords
Mixed reality, augmented reality, electronic entertainment, physical interaction, tangible user interfaces

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces—Interaction Styles

Introduction

The electronic entertainment industry has seen tremendous growth in recent years. With innovations in graphics, physics, and animation, an increasing number of people are drawn to the rich multimedia content and flexible gameplay that electronic entertainment can provide. Despite the advancements made, less attention has been given to improving the human interfaces required for gameplay. Traditional control devices such as the keyboard have persisted through decades of electronic games from the text-based *Zork* in 1980 to the first-person shooter *F.E.A.R.* in 2005. Recently, the success of the Nintendo Wii console and games such as *Dance Dance Revolution* has encouraged the use of physical interaction for gameplay. Although the consensus seems to be that games become more fun when physically controlled, the benefits of applying physical interaction to electronic games are seldom documented or recognized. In this paper, we promote the notion of physical interaction for games by analyzing its advantages, explaining the utility of mixed reality for implementation, and reflecting on the concepts presented with two games (figure 1) we have created.

Many of the concepts presented for Tangible User Interfaces can be applied to physical interaction for games. First, the sense of physical immersion is enhanced in games with the use of intuitive tangible controls. In *Guitar Hero*, a rhythm based game is played using a realistic-looking guitar and natural guitar-playing hand gestures. This direct correlation between interaction in the physical and game worlds enables players to temporarily suspend disbelief and lose themselves in the game.

figure 1. Physical interaction in an electronic game

Second, physical interaction allows games to be played in more creative ways. For example, playing on the Nintendo Wii console requires a wide range of physical movements such as tossing, swinging, and punching. Unlike the traditional abstract controls, game designers don't have to worry about maintaining consistency across games because physical interaction capitalizes on the common knowledge people possess from everyday interaction in the physical world. In turn, this intuition also makes game controls easier to learn and retain, resulting in wider accessibility to the masses.

Finally, physical interaction for electronic games augments the potential for social exchanges during gameplay. Unlike traditional games played in the physical world, in which observers of the game can easily understand the transparent activities of gameplay and feel comfortable participating, electronic

games typically require the use of abstract controls that are often incomprehensible to others and send the message that players are not to be disturbed during gameplay. With the increased popularity of electronic games, the activity of playing games has shifted from the social gatherings of traditional games played in the physical world to a more personal and private form of entertainment. By replacing abstract controls with intuitive physical interaction, not only does wider accessibility provide more opportunities for social exchanges, but the transparent and understandable gameplay also invites observers to comment on or participate in the game.

With the motivation of applying physical interaction to electronic games established, we now introduce mixed reality as a sensible technique for connecting intuitive tangible controls with rich multimedia content during gameplay [1]. Mixed reality is a display technique which attempts to merge physical and virtual worlds often by overlaying virtual entities on top of live video. Visual coherence is achieved using a tracking system, giving virtual entities physical handles which can be used for direct manipulation. We believe it is natural to couple mixed reality with physical interaction for electronic games, where the former allows virtual content to be displayed within the physical world, and the latter provides intuitive tangible control. Several projects involving the use of mixed reality and physical interaction for games have been attempted [2, 3, 4], and most of them focus on one comprehensive interaction paradigm for gameplay. The approach we are taking is to both demonstrate the flexibility and feasibility of mixed reality and physical interaction through the exploration of a variety of simple games with unique interactive characteristics. In the following sections we describe two games, *Save 'Em* and *Napkin Chess*, which use mixed reality and physical interaction for gameplay. They are implemented using the popular development library, ARToolKitPlus [5], where pattern markers are used for visual tracking, allowing virtual entities to be overlaid on top of the physical scene in the correct orientation.

Save 'Em

The *Save 'Em* project (figure 2) was created to explore visually-tracked mixed reality as a platform for gaming. Our aim was to create a game that took advantage of a mixed reality interface while remaining simple and accessible to players; something which could be picked up and played in a minute, providing immediate gratification. In order to immerse players in the game experience, *Save 'Em* is played wearing a head-mounted display outfitted with a camera. A live video feed, combined with overlaid virtual entities replaces the user's natural vision allowing them to see the game entities directly before them, as though they were real physically persistent object.

Although the initial designs for the game that would eventually become *Save 'Em* were highly varied, it quickly became apparent that the visual tracking provided by ARToolKitPlus was best suited to a "board game" where a flat, rectangular playing-area was marked out, and players could play the game in a controlled manner within this zone. Working within the board game model, it became clear that the use of physical, tangible control mechanisms would be necessary. After all, a game which players were free to see, but not touch would not produce a compelling experience.

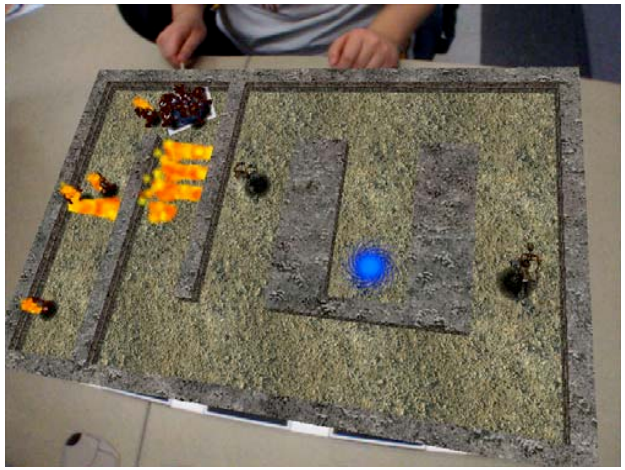

figure 2. Leading the "dudes" in *Save 'Em*

The inspiration for *Save 'Em* 's gameplay comes from Psygnosis's hit 1991 computer game, *Lemmings*. In *Lemmings*, a group of ambling, mindless creatures are let lose in an arena filled with a series of deadly obstacles including lethal 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. The player's only method of control is to assign behaviors (such as digging, or bridge-building) to the lemmings, who will otherwise walk to their inevitable doom.

The task of coordinating virtual entities within a danger-filled arena seemed tailor-made for our board game concept, but the controls of *Lemmings* were too complicated to translate cleanly into a physical interface. In the end, we opted for a similar but distinct premise. In *Save 'Em* it is the task of the player to herd a group of dim-witted virtual characters – who we will henceforth refer to as "dudes" – through a danger-filled maze, without ever controlling them directly. Instead, the player can provoke the dudes to move by holding a physical object – a "control wand" – and moving it over the surface of the board. As the player moves the wand, any nearby dudes will run directly toward the wand's tip, allowing the player to direct dudes past enemies and around traps with the strategic use of the wand, much as one might entice a mule to move using a carrot on a stick. A successful player will be able to keep casualties to a minimum as he or she moves the dudes towards the maze's exit.

Save 'Em exemplifies how a physically-based control scheme can be used to adapt concepts from traditional computer games and present them in a way that is novel and enjoyable. Because of the extremely simple-to-use control wand, the game's learning curve is almost nonexistent. Players will quickly discover that their physical movements translate directly into control over the dudes, allowing for some of the most intuitive controls possible – just as a person will move his arm without consciously thinking, so too will he control the game. *Save 'Em* is also extremely accessible – non-gamers who shy away from games because of the need to memorize a complicated control scheme will find themselves watching *Save 'Em* and thinking "I can do that!" In no time, these players will quickly find themselves immersed in task of saving the dudes, scarcely realizing they are playing a game.

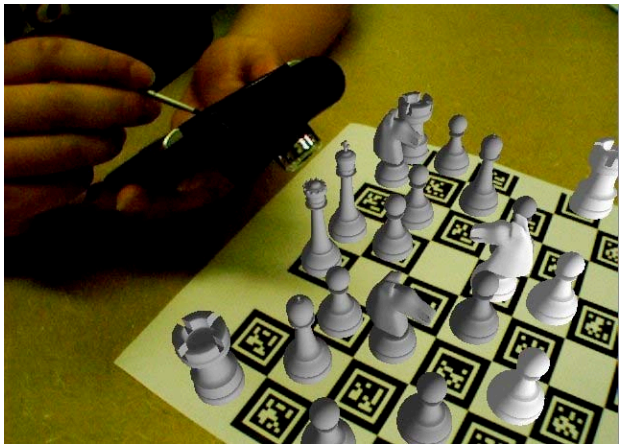

figure 3. *Napkin Chess*

Napkin Chess

Napkin Chess (figure 3) is the first prototype of a series of mobile mixed reality games attempting to bring the virtual gaming environment onto a physical setting. The idea is to use a napkin or a sheet of paper decorated with ARToolKitPlus markers to provide a physical reference for the virtual gaming environment. In *Napkin Chess*, a PDA equipped with a camera is used as a mixed reality viewing window. By looking through the device onto the decorated napkin, players can see virtual chess pieces appearing on the live video of the physical surface and interact with them by directly pointing and dragging them to the desired physical location. When the game stops, players can fold up the napkin and store it in their pocket or wallet. The next time the napkin is unfolded, the game resumes from where the players left off.

Although our chess game currently has little merit over traditional physical chess, the design concept can be beneficial to a variety of electronic games played on mobile devices. For example, in strategy games such as *WarcraIt* where an army of virtual entities need to be coordinated in a vast virtual world, players can intuitively navigate around the game environment by moving and looking at the napkin from different view points through the PDA. Acting as an anchor for the game in the physical world, the napkin allows players to intuitively explore the virtual game world and interact with virtual entities in a direct physical manner. By playing mobile electronic games on top of a physical surface, not only does the approach provide a solution to overcome the lack of display space and interface real estate on mobile devices, it also gives players the opportunity to reveal the activities of gameplay to others in their immediate environment. With the increasing ubiquity of mobile devices such as PDAs and camera phones, interested bystanders can use their own mixed reality viewing windows to observe or even participate in the gameplay. We hope the physical interactions involved in game activities and the physical napkin representing the game can generate interest for observers and provide more opportunities for social exchanges.

Discussion

Save 'Em and *Napkin Chess* are the first steps in our exploration of applying physical interaction to electronic games. They have given us insight into what makes games engaging and fun, and have helped us to better understand the essential concepts of using physical interaction for gameplay. *Save 'Em* is a playable game which is being enjoyed by members of our lab and visitors. Although we have not performed a proper user study, our preliminary impression and evaluation of the game indicates player enjoyment and

engagement. Most current players also find the interaction easy and intuitive to learn. At this point we can only speculate about the impact of *Napkin Chess* and its successors. However, we strongly believe by allowing players to reveal activities of gameplay to others in their immediate physical environment, we can create both more social and enjoyable experiences because not only do people like to play with each other, but they often like to play while others are watching.

Future Work

Save 'Em and *Napkin Chess* offer a look at how a mixed reality interface can be used as a compliment to a physically-based control scheme. However, these two implementations just barely scratch the surface of what is possible. Needless to say, there are multitudes of ways in which the mixed reality/physical control paradigm can be extended. However, we believe that the development of more subtle, natural interactions between the player and the virtual world will provide the most enjoyment to players. We imagine a game where virtual entities react to a player's very presence, rather than specific, targeted actions – consider the gameplay possibilities when virtual entities flee from a player's approach, startle at loud noises, or freeze when trapped in the beam of a flashlight. Ideas such as these expand the role of the player within the game, promoting the player's entire body to a control device, rather than relying on some small aspect thereof.

Conclusion

Despite decades of advancement in electronic entertainment, traditional interfaces between the player and the game continue to constrain interaction. In this paper, we have presented a case for the application of physical interaction in electronic games, which heightens immersion, accessibility, and sociability by eschewing generic and abstract devices and allowing players to control the game through more intuitive physical movements. Our game prototypes, *Save 'Em* and *Napkin Chess* demonstrate how mixed reality can be used in tandem with physical interfaces to create distinct and enjoyable experiences for gameplay.

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