Character Interaction with Handheld Projectors

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ABSTRACT

I present a summary of my research dealing with character interaction using handheld projectors. My work draws from the tradition of pre-cinema handheld projectors that use direct physical manipulation to control projected imagery. I build upon this work with a system allowing users to interactively control characters by moving and gesturing with the handheld projector itself. This creates a unified interaction style where input and output are tied together within a single device. I present a prototype handheld platform, several games, and augmented reality application scenarios to illustrate the approach.

Author Keywords

Interaction techniques, handheld projector, pico projector, character, gesture, movement, augmented reality.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, Experimentation, Human Factors, Theory.

INTRODUCTION

Handheld projectors have the ability to situate projected imagery side by side with physical objects in almost any space. The affordances created by their size allow users to grasp them in a single hand, attach them to their bodies, or move them from space to space. Market research predicts as many as 39 million devices with embedded projectors on the market by 2014 [4]. Despite these projections only a relatively small amount of research has focused on developing new applications and interaction techniques for handheld projectors [e.g. 1,2,5,7].

One of the major challenges when dealing with handheld projectors is to develop interaction techniques that accommodate movement. Projected imagery moves, shakes, and distorts with the users every move. My approach utilizes gestural movement of the projector to control and interact with projected characters (Figure 1). I label this the *MotionBeam* metaphor [6], as the projected character
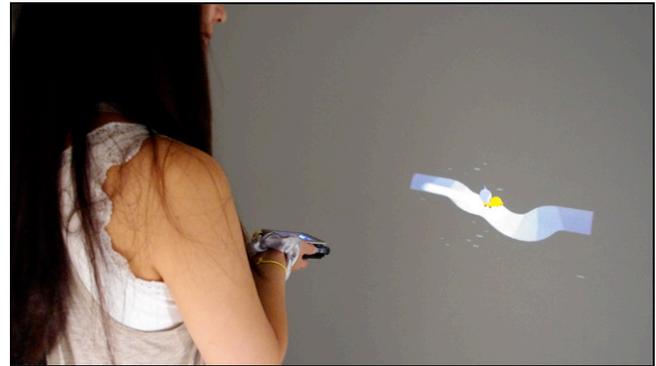
Figure 1. Character interaction with a handheld projector and a prototype racing game.

behaves as if it is attached to the end of a metaphorical beam. The approach draws from the tradition of pre-cinema handheld projectors, such as the Japanese *Utushi-e* performance [3], that use direct physical manipulation to control projected imagery. This creates a unified interaction style where input and output are tied together within a single device. To outline the use of the *MotionBeam* metaphor, I have developed a handheld projection device, several prototype games, and augmented reality (AR) application scenarios.

The *MotionBeam* metaphor is a powerful tool to blend virtual characters into the physical world. Character interaction has applicability to a range of important domains such as games, educational software, virtual worlds, storytelling, and numerous other applications where an avatar is used to represent a user. Characters will not only perceive and react to physical objects in the environment, but will increasingly be able to 'push back' on the world to actuate and control physical objects. Although these future technologies will no doubt empower new forms of interaction, we can build the foundations for richer interaction with virtual content in the physical world today.

PROTOTYPE

The character interaction prototype is implemented using an iPod Touch, a laser projector, and a sensor unit (Figure 2). Attached sensors include an ultrasonic distance sensor, a 9DOF accelerometer/gyroscope/magnetometer, and an infrared receiver.

Figure 2. The components used in our prototype. From left to right, a sensor unit, a handheld projector, an iPod Touch.

Figure 3. A projected character starts bouncing when it encounters a trampoline in the environment.

Character Game

The character game interaction is based on guiding a character through the game space by pointing the projection device up, down, left, and right. The goal is to search for the character's missing car by following a trail of 'bread-crumbs'. The position of the character stays fixed to the middle of the projection frame, and the background scrolls based on the direction of movement. Along the way the user encounters objects to be collected such as stars, and objects to be avoided such as 'bad-guy' characters.

Racing Game

The aim of the racing game is to guide a character along a racetrack without falling off. The user controls the direction of the vehicle by tilting the projection device from side to side (Figure 1). As the game progresses the speed of the vehicle increases and the track becomes gradually more difficult. The perspective of the game can be changed by tilting the device downward; this allows the user to navigate their way through tunnels and around other obstacles not visible from the top down view.

Augmented Reality Interaction

In addition to the character and racing games I have explored several interaction scenarios that link character interaction to the physical world. An IR receiver attached to the device is used to detect the presence of IR 'tags' –small LEDs that emit IR light at timed intervals much like a conventional TV remote control. These interactions were developed as an interactive standby screen for each of the two games. In each scenario a character is projected from the device and its behavior changes when moved over an IR tagged sticker. For example, a character starts bouncing when it finds the trampoline sticker (Figure 3), or a character's vehicle starts spinning when it drives over a puddle sticker.

I developed a preliminary example demonstrating how the *MotionBeam* metaphor can be used to affect objects in the physical environment. In this interaction scenario the user 'drives' a character along the top of several picture frames. When the character jumps from one picture frame to the

next, it jolts the picture frame out of place and causes the car to fall from the screen. The ability to perceive and respond to the immediate physical environment is a key component of augmented reality systems. Characters that respond by actuating the physical world further enhance the illusion of virtual content existing side by side in the 'real world'.

SUMMARY

Handheld projectors have the potential to seamlessly merge virtual content into the physical world. The ability to situate virtual content with physical objects *in any location* opens up numerous avenues for exploration. We are now on the verge of being able to design our environments and interact with them like never before. The challenge remains to imagine just how we want the world to be.

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