Snail Light Projector: Interaction with Virtual Projection
Light in Hyper-Slow Propagation Speed

Keisuke Matsuzaki  
Osaka University
1-3 Machikaneyama,
Toyonaka, Osaka, Japan  
matsuzaki@sens.sys.es.osaka-u.ac.jp

Daisuke Iwai  
Osaka University
1-3 Machikaneyama,
Toyonaka, Osaka, Japan  
daisuke.iwai@sens.sys.es.osaka-u.ac.jp

Kosuke Sato  
Osaka University
1-3 Machikaneyama,
Toyonaka, Osaka, Japan  
sato@sys.es.osaka-u.ac.jp

ABSTRACT

We propose a novel video projection system, the Snail Light Projector, where light emitted from a video projector travels at virtual hyper-slow speed. We define hyper-slow light as the light that creates a number of spatio-temporal video containing images with emitting time that differ between the video projector lens and the projection screen. As a result, the user can browse the images by moving a projection screen, and control the emitted light by moving a handheld projector. We believe the Snail Light Projector can be an innovative entertainment system, achieving interaction by using hyper-slow speed light, which enables the user to experience virtual physical phenomena directly.

Categories and Subject Descriptors
H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented, and virtual realities

General Terms

Design

Keywords

Projection-based MR, Interaction in real 3D space

1. INTRODUCTION

Researchers have applied computer graphics (CG) and mixed reality (MR) technologies to obtain simulations of imperceptible physical phenomena so that users can virtually experience them. In this paper, we focus on light propagation which is usually too fast to be perceived, and we propose the concept of hyper-slow speed light (HSSL) and try to virtually realize it.

We define HSSL as the light that creates a number of spatio-temporal video containing images with emitting time that differ between the video projector lens and the projection screen. Fig. 1 shows an example that illustrates the difference between normal light and HSSL, in which a series of images that represent a flowering process are projected. When a normal projector projects the same images, the projected image instantaneously reaches at the screen (Fig. 1 left). In contrast, when the virtual projected light is propagated at hyper-slow speed (Fig. 1 right), the image which is just emitted from the projector lens (flower) does not reach the screen while the previously emitted image (bud) is displayed on the screen. Intermediate images are also propagating between the projector lens and the screen. Hence, while the virtually traveling light is not dissipated, users can interact with these images by the following two methods: (1) browsing the images by moving the screen, and (2) controlling the emitted position and direction of the images by moving the projector. We believe that these types of interactions create novel possibilities for entertainment systems.

We propose the "Snail Light Projector" system which realizes the proposed interaction techniques by virtually simulating the concept of HSSL. This paper introduces two prototypes: one is the moving-projection-screen (MPS) system, in which users move the screen to browse the propagating images, while the other is the moving-handheld-projector (MHP) system in which users move a handheld projector to control the position and direction of the emitted images.

2. SNAIL LIGHT PROJECTOR

2.1 Moving-projection-screen (MPS) system

This section illustrates the MPS, the system in which users move a screen to browse the propagating images. Fig. 2(a)
illustrates the concept of MPS. In MPS, a number of video frames are propagating between the projector lens and the screen in chronological order. Thus, a spatial-temporal video image is achieved where hundreds of video frames exist in a real 3D space at the same time and travel along to the projector’s optical axis[1]. Fig. 2(b)(c)(d) show demonstrations of an MPS projecting a movie in which two people walk from the left to the right.

In MPS, users can search a video frame just by moving the screen back and forth according to the optical axis, which is analogous to browsing a cross-sectional image of the spatial-temporal video according to the time axis. Fig. 2(b) shows an example of projected image when a user is moving the screen forth toward the projector. Consequently, the user can explore "future" movie contents, because the images near the projector lens contain "future" information as opposed to those near the screen which display "present" information. We propose applying an afterimage effect to the image displayed on the screen to enhance the perception of HSSL. Moreover, users can simultaneously cut several propagating images by inclining the screen. A cross-sectional image of the spatial-temporal video is displayed on the slanted screen, which consists of a part of each video frame. Fig. 2(c)(d) show an example of two video frames being superimposed by moving the projector forward to the screen; one is an image projected in the past, and the other is the image being projected just now. As a result, the user can create an image which shows two human figures which are the same person but in different video frames.

2.2 Moving-handheld-projector (MHP) system

This section illustrates the MHP, the system in which users control the emitted position and direction of the images by moving a handheld projector. Fig. 3(a) illustrates the concept of MHP and the others show demonstrations of MHP in which the same movie used in the previous section is projected.

The HSSL image cannot reach the screen immediately after it is projected from the lens as shown in Fig. 3(b). Thus, when users change the direction of the projector from the right of the screen to the left or from the top to the bottom, the displayed position of each projected HSSL image on the screen varies with some delay according to the direction. Fig. 3(b) shows the afterimages of the projected HSSL images when the user is moving the projector horizontally. Moreover, users can also superimpose two projected HSSL images by moving the projector forward to the screen; one is an image projected in the past, and the other is the image being projected just now. Fig. 3(c)(d) show an example of two video frames being superimposed by moving the projector forward to the screen faster than the speed of light. As a result, the user can create an image which shows two human figures which are the same person but in different video frames.

3. CONCLUSIONS

This paper has presented the concept of HSSL which is a type of light virtually propagated from the projection lens to the screen at a much slower speed than the actual one. We implemented two prototype systems of Snail Light Projector to put the concept in practice. The first system allows users to browse the slowly propagating images by moving the screen, while in the second system they can control the emitted position and direction of the images by moving the projector. We confirmed that the Snail Light Projector can constitute a novel entertainment system which enables users to intuitively control the time domain of the projected image contents. In the future, we plan to develop applications for editing movies simply by movement in real 3D space or for watching movies containing a variety of images with different time parameters, such as the movement and change of celestial object over time.

4. REFERENCES