Parallel Eyes: Exploring Human Capability and Behaviors with Paralleled First Person View Sharing

Shunichi Kasahara†, Mitsuhito Ando‡, Kiyoshi Suganuma‡and Jun Rekimoto†
†SonyCSL, Tokyo Univ, Tokyo, Japan, ‡YCAM Interlab, Yamaguchi, Japan
kasahara@csl.sony.co.jp, ando@ycam.jp, suga@ycam.jp and rekimoto@acm.org

Abstract

Our research explores how humans can understand and develop viewing behaviors with mutual paralleled first person view sharing in which a person can see others' first person video perspectives as well as their own perspective in realtime. We developed a paralleled first person view sharing system which consists of multiple video see-through head mounted displays and an embedded eye tracking system. With this system, four persons can see four shared first person videos of each other. We then designed a simple chasing game with our view sharing system and studied the human behavior. Our results show that people can develop their viewing behaviors to understand their own physical embodiment and spatial relationship with others in complex situations. Our Insights derived from Parallel Eyes will contribute to building design experience in paralleled view sharing and exploring augmentation of human embodiment.

Keywords: Video Communication, Shared Experiences, Wearable, First Person Video, Embodiment

Concepts: •**Human-centered computing** → *Empirical studies in interaction design;*

1 Introduction

As small wearable networked cameras emerge as common technologies, first person video is becoming a significant form of media for sharing one's experiences. The combination of a wearable camera and a head mounted display (HMD) will provide significant benefits for parallel experiences in various applications. The relationship between visual perspective and embodiment is tightly connected. Therefore, connecting, unbinding and reconstructing those relationship will provide an interesting field of research ,art and technical development to produce brand-new experiences [Hachiya 1993] [Philippe et al. 2014] [Kasahara and Rekimoto 2015]. We think that mutual view sharing is one of the possible configurations to augmenting human embodiment. It will produce a practical impact upon education, reality games, technology mediated sports and entertainment.

To explore this scenario, we developed a "Parallel Eyes system" which is a system in which users wear a HMD which shows multiple shared first person video perspectives as well as one's own perspective in realtime. This system generates a mutual visual shared parallel experience among four persons in realtime (Fig. 1). Our aim is to investigate and analyze how humans develop their viewing behaviors to acquire their own embodiment and spatial relationship in such paralleled visual sharing situations. Therefore, we designed the "game of tag" with Parallel Eyes.

Figure 1: *Parallel Eyes: a system for creating a mutual visual shared parallel experience. With Parallel Eyes, users wear a head mounted display which shows shared videos of each other's perspectives as well as one's own perspective in realtime.*

2 Parallel Eyes System

To create a mutual visual shared parallel experience and to investigate and analyze how humans acquire and develop their behaviors, we developed the Parallel Eyes system. With Parallel Eyes, users wear a HMD which shows each other's shared perspectives as well as one's own perspective in realtime. Furthermore, the embedded eye tracking camera reveals how users watch displayed paralleled shared first person video.

The Parallel Eyes system includes a HMD (Google Cardboard) with a smartphone screen as shown in Fig. 2. The smartphone also has a camera that captures the wearer's field of vision so that we can create a video see-through HMD. Four head mounted smartphones are connected via a wireless connection. The video captured from the camera of the smartphone is displayed on the smartphone screen, and it is additionally transmitted to other head mounted smartphones. On each smartphone display, the wearer can see a video stream of the others' fields of view as well as one's own perspective. These video images are displayed with a four split layout as shown in Fig. 1. To investigate and visualize unconscious watching behaviors , we embedded a eye tracking system including small IR camera and IR-LED inside the head mounted smartphone goggles.

2.1 Game of tag with Parallel Eyes

In a "game of tag with Parallel Eyes", players play a game of tag with the Parallel Eyes on a specially designed stage (Fig. 4). On the game stage, several cardboard columns were placed at regular

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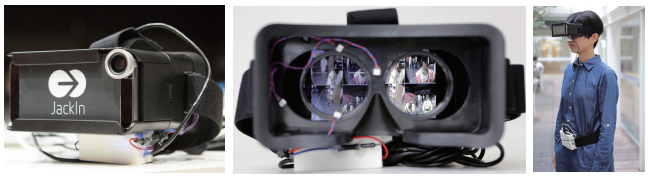

Figure 2: *A wearable system for Parallel Eyes: a video see-through HMD, a small board computer, and a small battery module attached to the body.*

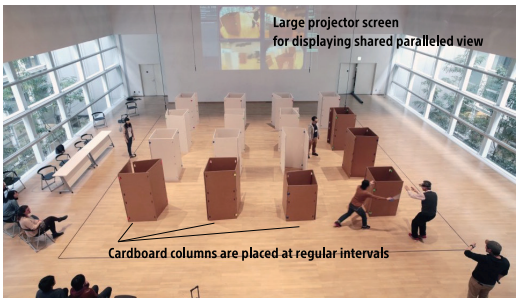

Figure 3: *Stage design of chasing game. Cardboard columns are placed at regular intervals.*

intervals (Fig. 3). In addition, there is a large projector screen to display four streamed perspective images and eye tracking pointers of each players. This is also essential setup to provide the sense of the each player's viewing behavior in real-time, which also produces engaging experience for the audience of the games.

In the beginning, some participants found it very confusing to walk around; however, by guiding them to find their own perspective (for instance, having them look down to find their own foot), they found a way to recognize their own body. In the earlier stage of the game, several participants were astonished when they found themselves in the perspective of the chaser. However, as the game proceeded, they got used to Parallel Eyes and started to develop viewing strategies.

Observation of actual games revealed that people can develop their viewing behaviors to understand their own physical embodiment and spatial relationship with others in complex situations [Kasahara et al. 2016]. We found that viewing strategies were pursued in accordance with two successive factors. The first one is a visual "attention cue," which made the person find something that is related to their own body. The second is "context building," where the person understands the relationships between the attention cue and their own body, then produces information to determine the next action. The revealed patterns of viewing behaviors indicate design factors for both conscious and unconscious action. Those findings led to design implications which will contribute to building design experience in mutual paralleled view sharing applications, brand new technology mediated sports and broad research agenda about human perspective and embodiment.

Figure 4: *Game of tag with Parallel Eyes : Participants play a game of tag with Parallel Eyes on a specially designed stage.*

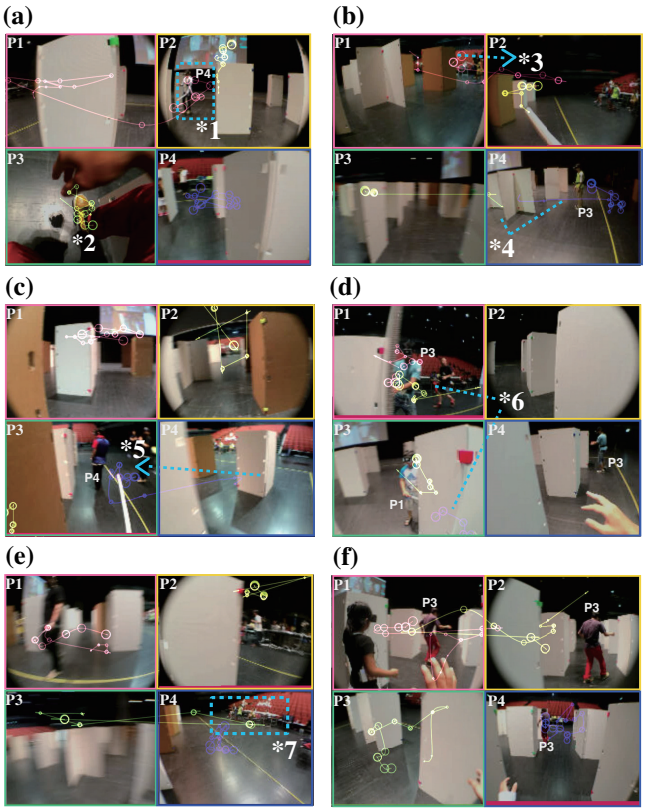

Figure 5: *Example of moments during game of tag with Parallel Eyes. Traces of color line indicate eye movement history of each player. (a) shows moment when P1(Player 1) found chaser (*1) in P2's view, P3 is in the "stealth" mode (*2). (b) shows that P1 is looking at P2 (chaser's) view (*3), P3 found his own (*4) in P4's view (c) shows that P4 is escaping using the perspective of the chaser P3 (*5). (d) shows that P2 and P4(*6) are engaged in watching the event between P1 and P3. (e) shows the moment when P3 unconsciously a found item (*7) with a similar color to their own clothing. (f) shows the moment when P3 could be found in other 3 views.*

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