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Poster

Chameleon Eyes: A Visual Augmentation System to Present Independent Field of View to Both Eyes with Single Gaze Control

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Abstract

Human's left and right eye move cooperatively each other to obtain stereoscopic information of binocular vision whereas chameleon can move their eyes independently to obtain widespread visual field. We propose a visual augmentation system which virtually allows us to realize independent eye movements with suppressing spatial confusion caused by binocular rivalry. User's single gaze input measured from eye-tracker is converted to dual input to achieve selective attitude control of camera viewing different directions. User experience of how chameleon-like oculomotor coordination is perceived is evaluated and the application of the system is discussed.

CCS Concepts

• ***Human-centered computing*** → ***Mixed / augmented reality;*** • ***Computing methodologies*** → ***Perception;***

1. Introduction

Almost animals have two eyes to see environment and gaze directions of them vary depending on species; Some of them look toward same direction while others turn to different ways. Former realizes three dimensional spatial recognition through stereoscopic view whereas latter acquires widespread views of surrounding environment. Human eyes are former and field of view is limited within the front. Therefore we cannot see behind without body movement. It is also impossible to search different visual fields of both lateral sides simultaneously like a chameleon.

To overcome these limitations, various types of extended vision systems have been proposed in virtual reality (VR) and human augmentation (AH) studies, in which live video images shot from the virtual eyes (e.g. head-worn camera) are modified and presented in real-time to extend the limit of biological constraints of human body such as extent of field of view and range of motion [ALM*12] [MHY13] [FHNI14] [KOK*24]. These enable us to see wider field of view to aware whole events happened in surroundings. However because of drastic changes in natural correspondences of sensory and motor representations including relationship between retinal image and spatial orientation, some of these systems requires visuo-motor learning process to get used to the novel visual world. One of challenges in these studies is to realize intuitive user-interface of the augmentation system without massive training. Therefore it is important to evaluate how much visuo-motor transformation will be acceptable for users.

Human's vision system works under the biological constraints of front-facing eyes and parallax views projected onto two retinas are normally perceived consistent 3D scene as long as the difference in the images is slight (i.e. binocular vision). Irrelevant images such as looking toward extremely divergent directions like chameleon cannot be perceived as stereoscopic view and two images are seen superimposed and alternated randomly (i.e. binocular rivalry). This means that to present independent field of view to both eyes can leads spatial confusion and it is difficult to recognize which direction are seen. Therefore some methods to switch superimposed multiple views are necessary for these systems in order to prevent degrading usability of extended vision system caused by the perceptual limitations. For example, a previous system proposed in [MHY13] has independent view control function for head-worn eye-cameras to present selective view. Voluntary control of observing direction using position sensors and trackballs can provide clues to determine the source of perceived view. Also perceptual dominance in binocular rivalry for salient input such as larger optical flows appeared in moving view can suppress the perception of stationary non-attended view. However this method requires two manual inputs for independent view control, therefore hand manipulations to the environment is restricted while using the system.

In this study, we propose a novel method for extend vision system which virtually allows to realize selective view control to both eyes using single input of user's gaze recorded from eye-tracker embedded in head-mounted display (HMD). In comparison to using manual devices, eye-gaze input can achieve intuitive camera control in immersive 3D environment (e.g. [BNBP*20]). The system configuration and features are shown in following section.

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2. Proposed System

2.1. System Overview

Proposed method works on a visual display system in which live stereo view for user's both eyes are acquired via virtual eyes embedded in some wearable system (head-worn camera) or telepresence system (remote host's eye-cemera). In either case they require independent attitude control of camera platform beyond biological constraints of human eye such as motion range and conjugated movements (e.g. [MHY13]). Here, a telepresence system with equipping specific configuration which satisfies the requirement ([IK22],1) is adopted to evaluate the proposed method.

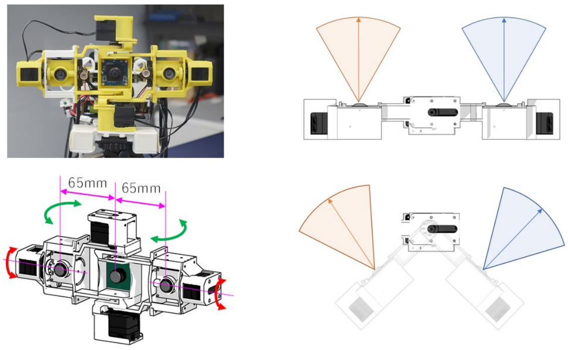

Figure 1: *Overview of System Platform. Two cameras for both eye's images revolve beyond biological constraint*

2.2. Selective Camera Attitude Control Using Gaze Position

This method assumes that user's eyes move cooperatively and gaze directions of them relative to the origin (theoretical cyclopean eye) are same. The common gaze line is projected onto a point on the head-centered spherical coordinates and azimuthal and polar angle relative to sagittal axis of head can be defined. These angles indicate deviation from the FoV center and can be used as a 2D signal like a joystick to control camera attitude of panning (yaw angle) and tilting (pitch angle). In order to distribute the single input to two attitudes, the input field is split vertically and they are assigned to both side (e.g. glancing leftward leads abducation of left eye-camera and vice verse). The amount of deviation from "deadzone" (central field within certain threshold) of the gaze point and the residence time in the input field are proportionally used to apply additional rotation of one-side view toward outward(2). The divergent view caused by the rotation can be relieved after reentry the deadzone with some delay and relaxation time.

3. Conclusion

Currently we developed experimental setup to conduct evaluation of the proposed method and the usability of the system is verified. Also, the behavioural change in user's inter-ocular motor coordination is investigated to check whether perceiving artificial divergent view for each aye affects the normal ocular alignment. Also, it is possible that voluntary and repetitive experience to see different views for each eye may weaken inter-ocular motor coordination and the changes have to be longitudinally investigated.

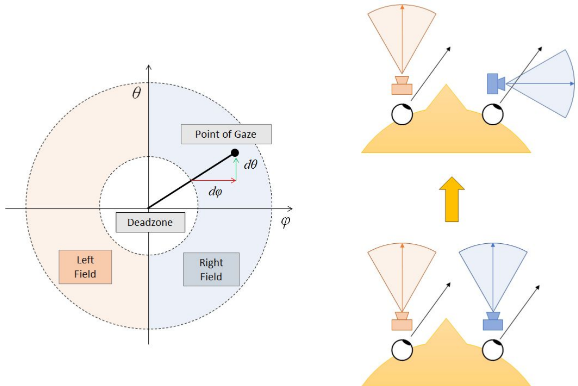

Figure 2: *Splitting Gaze Input System. Vertically split two visual fields are assigned as outward panning control for each eye-camera.*

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