Evaluation of guiding visual attention using partial stereoscopic images

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ABSTRACT

This study shows the empirical results regarding visual guidance effect when viewers have no awareness given by partial stereoscopic images. Partial stereoscopic images were presented such that the levels of parallax were gradually increased until the participants noticed the changes. While the directions of gaze were continually monitored. As a result, it was found that visual guidance effect was observed in some cases. Also, the time to notice the parallax image was different despite that the same amount of parallax was given. It was concluded that not only the amount of parallax, but also the features of the object to which parallax was given may affect the time to notice the change of images.

Keywords: partial stereoscopic, guiding visual attention, 3D, parallax

1. Introduction

Use of partial stereoscopic images has been a potential technique for guiding visual attention (Koido.et al., 2010). Such a technique benefits users for reducing loads and hence, enhancing usability (Hata.et al., 2015, Hagiwara.et al., 2013) Partial stereoscopic images are defined an image converted to 3D by giving a cross parallax to a specific object in a 2D image without giving parallax or giving a non-cross parallax to the other part (Koido.et al., 2010) (Kandachi.et al., 2013). It has been reported that there is an effect of eye-gaze concentration on objects with cross parallax (Koido.et al., 2011). Also, it is reported that eye-gaze concentration can be observed even though viewers were not aware of protrusion from the screen by parallax (Koido.et al., 2010). There is a substantial demand for the technique for guiding visual attention without being noticed by the user. According to Lori.et al., (2012), when people feel factitious induction, their impression of the information becomes unfavorable. As far as we know the amount of parallax inducing eye-gaze concentration has not been clear to date when viewers have no awareness, thus, it is difficult to estimate the optimal condition that visual attention is naturally guided to the information intended to the user. Therefore, the objective of this study was to clarify whether the eye-gaze concentration when viewers have no awareness given by partial stereoscopic images can be observed and in what conditions users perceive changes without having a sense of contrivance. The final goal of our study is to design a guideline for a new technique where the image itself can guide viewer’s visual attention naturally. In this report, the experiment was conducted where the parallax was changed gradually in stepwise order. By analyzing eye tracking data, we investigated how much parallax can be seen in concentration of eye-gaze without conscious awareness of himself when the image was presented to the participants.

2. Method

2.1 Participants

We conducted experiments with 10 male university students as participants.

2.2 Measurement environment
Fig.1 shows the empirical setup. An eye tracker (EyeLink II, SR Research) was used for eye movement measurement. 3D VISION 2 (NVIDIA Inc.) using an active shutter method, and 3D display 27-inch display (ASUS, VG 278 E) were used for 3D image presentation. Chin stand was used to control the positional relationship between the participants and the display. Also, by attaching a scene camera (camera for external image capture) (EL II - BSC, SR Research) to the eye tracker, measurement of the movement of the line of sight against the actual landscape was established.

2.3 Experimental image

MIT data set (Borjii, Ali and Itti, Laurent, 2015) was used for experimental images. This data set included general images and the detailed results of eye tracking data with respect to the image. Seven images were chosen such that the line of sight was varied from the data set to the whole screen, and that, in the images, several objects existed in which eye gaze tended to be concentrated. Among the data set, four out of seven images were added parallax and thus, they were used as partial stereoscopic images. The data set chosen as stereoscopic images are shown in Fig.2. The remaining three images were changed in their attributes other than parallax, that is, color, transparency and position, which was intended for dummy changes.

2.4 Flow of experiment

The experimental procedure is shown as follows:

(1): Image with a white cross mark was presented at the center of the display for 5 seconds.
(2): Experimental images were presented 20 seconds.
(3): (1) and (2) are repeated.

At this time, the experiment image was replaced in a phased manner with adding the level of feature changes. This procedure was repeated until the participants noticed the changes given to the image. Participants were then asked where of the image was changed and what kind of change was found. Each trial consisted of the procedures (1) - (4). A total of seven trials were performed with different images. While an image with a white cross mark was being presented, the participants were instructed to gaze at a white cross mark, and the line of sight position at the start of the experiment image was stabilized. Also, while the image was displayed they were instructed to look freely at the places of interest own the entire image. Participants were only told that part of the image changes with a certain feature and where and how they specifically changed were not given to the participants.

![Fig.1 The empirical setup](image)

![Fig.2 Test data images selected for parallax changes](image)

3. Results and Discussion

Fig.3 shows the degree of protrusion when each participant reported awareness of protrusion. As shown in Fig.3, the concentration of eye-gaze without conscious awareness was present at the degree of protrusion between 3[mm] and 9[mm] smaller than the degree of protrusion noticed by the protrusion. Fig.4, also indicated that changes in the average degree of protrusion reported awareness of protrusion were apparent by the images. This result also implied that the factor yielding to the recognition of protrusion due to parallax depended not
only on the size of the parallax given to the image but also on some attributes peculiar to the image of the objects with the parallax. The results were in consistent with Kandachi.et.al. (2013), where they reported that the trends in apparent attention by the object giving the parallax affected the concentration of eye-gaze towards partial stereoscopic images. Therefore, when designing the partial stereoscopic images, it is necessary to provide an appropriate parallax in consideration of the attribute peculiar to the image to the object to be subjected to parallax.
4. Conclusion

In this report, the experiment was conducted where the parallax was changed gradually in stepwise order. By analyzing eye tracking data, we investigated how much parallax can be seen in concentration of eye-gaze without conscious awareness of himself when the image was presented to the participants. As a result, the concentration of eye-gaze without conscious awareness was present of the degree of protrusion between 3[mm] and 9[mm] smaller than the degree of protrusion noticed by the protrusion. This result also implied that the factor yielding to the recognition of protrusion due to parallax depended not only on the size of the parallax given to the image but also on some attributes peculiar to the image of the objects with the parallax. As further investigation, what kind of the attributes specific to the image subject to parallax, especially the noticeable effect to the perception of protrusion will be clarified.

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