Effect of disparity distribution existence in 3D on visual discomfort

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OBJECTIVE: It is well known that many people experience visual discomfort when observing a stereo image. It seems that watching an image that contains several different disparity objects (disparity distribution) is one of the factors to increase visual discomfort. The effect of existence of different disparity objects was examined in this study. The purpose of this study is to compare an observer’s visual fatigue between different disparity conditions. No-disparity realistic stereo image (NDR image) made from monocular image was proposed to check the effect of disparity distribution on visual discomfort. The purpose of this study is to compare an observer’s visual fatigue between different disparity conditions (2D, 3D, NDR).

METHOD:
NDR image is a stereoscopic image without disparity distribution. A monocular image was used as an original image. Original image was displayed to left eye and original image that shifted 40 pixels in a horizontal direction was displayed to right eye in NDR image. In this visual condition, subject perceives an image at the back of display. Subject might feel spatial effect by window flame effect.

Experiment 1 (Movie observation): The twenty healthy university students (22.1±0.94 years old) participated as subjects. The subjects were asked to observe 30 min movies in the three different disparity conditions such as 2D, 3D and NDR in different day. No-disparity realistic stereo image (NDR image) that contains no disparity distribution was made by image shift technique from monocular image. Three subjective evaluations (eye fatigue questioner and general fatigue questioner and SSQ: Simulator Sickness Questioner) and two psychophysiological measurements (CFF: Critical Fusion Flicker and ERP: P300 in Sternberg task palladium) were conducted before and after movie observation. The differences of these indexes were used for evaluation of fatigue caused by movie observation.

Experiment 2 (Driving simulator): The seven healthy university students (5 males and 2 females, 22.1±0.94 years old) were employed as subjects. The subject were asked to drive 60 min using driving simulator (Play Station 3 with 27inches 3D display) in three deferent disparities condition such as 2D, 3D and NDR in deferent day. Same evaluation indexes as Experiment 1 were
RESULTS:
Experiment 1: We found differences among three disparity conditions in subjective evaluation such as an eye fatigue questioner and a general fatigue questioner. The order of fatigue feeling intensity was 3D>NDR>2D. CFF results didn’t show clear differences among three disparity conditions. The order of latency extension of P300 in Sternberg task is 3D-NDR-2D, but not significant (p<0.1).

Experiment 2: We found differences among three disparity conditions only in Disorientation of SSQ (p<0.05). The order of intensity was 3D>NDR≈2D. CFF and P300 results didn’t show clear differences among three disparity conditions.

DISCUSSION: We could show some results that disparity distribution is one of causes to increase discomfort feeling during 3D image observation. However, these were based on subjective feeling only. To understand the mechanism of discomfort during 3D movie, more detail study of brain activity is needed. We are trying to analyze EEG data during 3D image observation (include driving simulation).

CONCLUSION: These results support that the existence of disparity distribution is one of causes to increase visual discomfort. No-disparity realistic image (NDR image) is one of the realistic images that have fixed and controlled disparity. The NDR images can be proposed as a low discomfort stereo image technique.

Keywords: Stereoscopic image, Visual discomfort, Disparity distribution, NDR image