Development of technology to prevent influence of images upon viewers

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Abstract

To prevent biological influence of images upon viewers, we investigated the characteristics features of images and of viewing environments which can cause photosensitivity seizures and visually-induced motion sickness, and developed some methods of detection and conversion of images that can cause such influence.

1. Introduction

In Japan, some cases of biological influence of images upon viewers have been reported; about 700 children watching a TV animation received medical treatment at a clinic because of photosensitivity seizures (PSS) in 1997, and 36 junior-high students were sent to a hospital because of visually-induced motion sickness (VIMS) in 2003, they were watching a self-produced video projected on large screen.

On the one hand, large displays such as home theater projectors, PDP and LCD TV sets are becoming popular as well as small displays such as mobile phones and PDAs. These various types of displays cause various forms of viewing environments as for visual angle and viewing distance. Although these various types of viewing environments should affect viewers differently, few technologies to prevent influence of images upon viewers in consideration of actual viewing environment have been developed.

We investigated the characteristics features of images and of viewing environments which can cause PSS and VIMS, and developed some methods of selective conversion of images that can cause such influence in consideration of viewing environment. This paper reports the outline of this research.

2. Prevention technology of PSS

Photosensitivity seizures (PSS) are triggered by visual stimuli, such as certain types of flashing or flickering light or patterns. Based on information from medical findings[1] and the experience of broadcasting, Independent Television Commission in UK has drawn up guideline[2]. After the PSS incident, similar guideline has been drawn by Japan Broadcasting Corporation and the National Association of Commercial Broadcasters in Japan[3].

Some devices[4,5] that detect scenes of video which can cause PSS have been developed in conformity to these guidelines criteria, but they detect inappropriate scenes on the assumption that the majority of viewers watch video contents in the standard viewing environment.

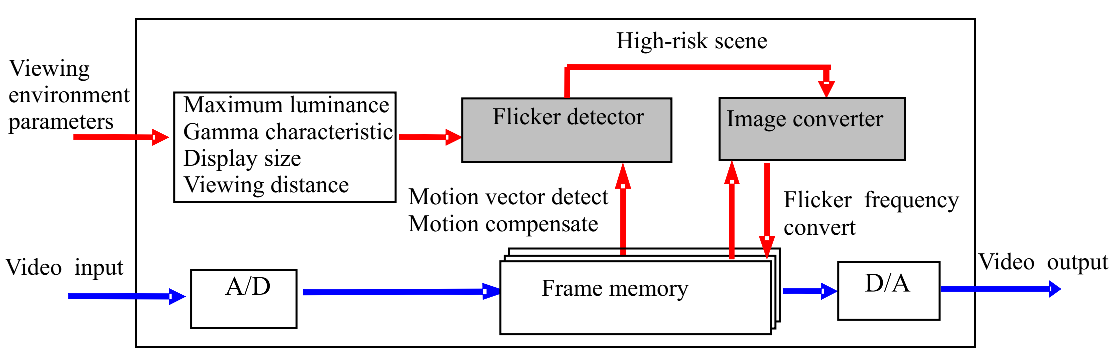


Fig.1. Image conversion equipment to prevent viewers from PSS in consideration of actual viewing environment

TABLE 1. SSQ Items and weights[7]

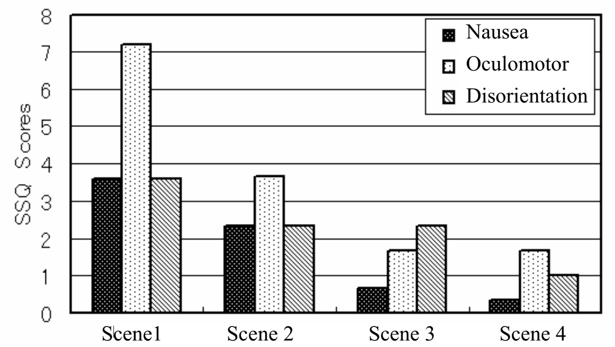
SSQ Symptom Scored 0,1,2,3	weight		
	Nausea	Oculomotor	Disorientation
General discomfort	1	1	0
Fatigue	0	1	0
Headache	0	1	0
Eyestrain	0	1	0
Difficulty focusing	0	1	1
Increased salivation	1	0	0
Sweating	1	0	0
Nausea	1	0	1
Difficulty concentrating	1	1	0
Fullness of head	0	0	1
Blurred vision	0	1	1
Dizzy (eyes open)	0	0	1
Dizzy (eyes closed)	0	0	1
Vertigo	0	0	1
Stomach awareness	1	0	0
Burping	1	0	0
The weighted sum	[a]	[b]	[c]
Subscale score	[a]×9.54	[b]×7.58	[c]×13.92
Total sickness score	([a]+[b]+[c])×3.74		

Consequently, we have developed image conversion technique to prevent viewers from PSS in consideration of actual viewing environment[6]. This technique estimates risk of PSS with video signal, display size, maximum luminance and gamma characteristic of display and viewing distance, and convert only high-risk scenes to safe scenes by flicker frequency conversion. Fig.1 shows image conversion equipment using this technique. All converted videos which include high-risk scenes by this equipment showed that physical quantity was within guidelines criteria optically regardless of difference in viewing environment (display device, display size, viewing distance).

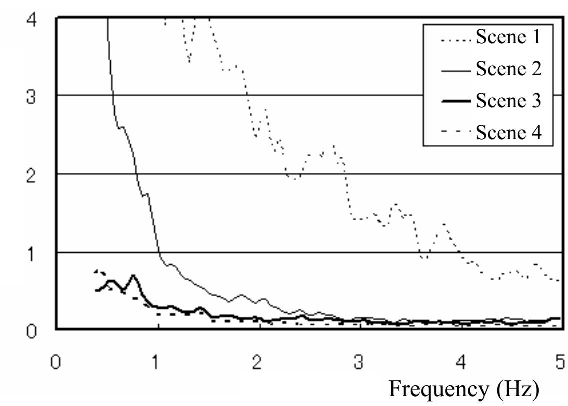
3. Prevention technology of VIMS

The symptoms of visually-induced motion sickness (VIMS) include dizziness, headache, nausea and eyestrain. VIMS can be brought on by moving visual stimuli without body motion, unlike in the case of general motion sickness such as car and sea sickness. Although simulator sickness, virtual reality sickness and virtual environmental sickness belong to VIMS, VIMS can be also caused by natural video sequences. In particular, video sequences shot by handheld cameras are often affected by camera shaking, and can cause VIMS for viewers.

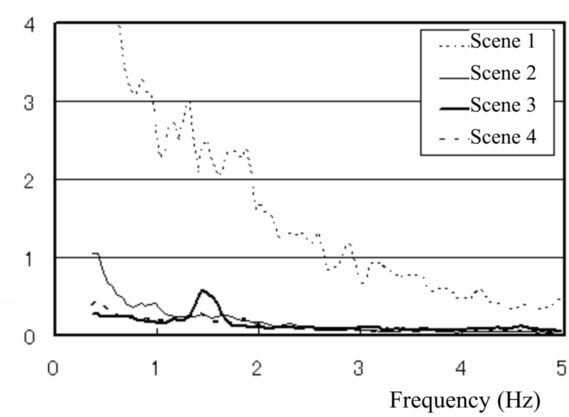
To evaluate the degree of VIMS, we employed the Simulator Sickness Questionnaire (SSQ)[7]. SSQ has



(a) SSQ Scores



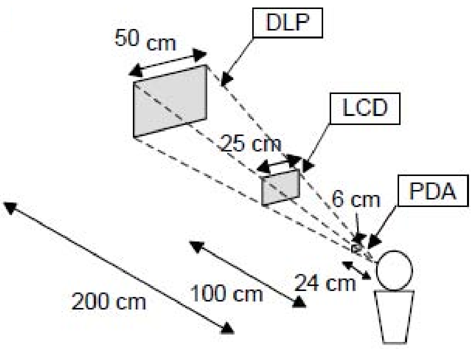
(b) Power Spectrums of horizontal translation



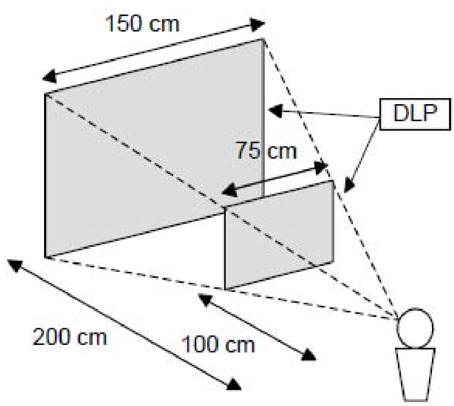
(c) Power Spectrums of vertical translation

Fig.2. SSQ scores and power spectrums of translations components of global motion

been used in a lot of studies on VIMS to measure the level of VIMS. SSQ contains 16 questionnaire items with the 4-point scale. TABLE 1 shows the SSQ items and weights for the computation of a Total sickness score and three subscale score. To compute the weighted sums [a], [b] and [c], each symptom variable score (0, 1, 2, 3) is multiplied by the appropriate weight, and the weighted values are summed down the column to obtain the weighted sum. Subscale scores of Nausea, Oculomoter and Disorientation are obtained as [a]×9.54, [b]×7.58 and [c]×13.92. The



(a) 14deg visual angle



(b) 42deg visual angle

Fig.3. Schematic view of the experimental layouts

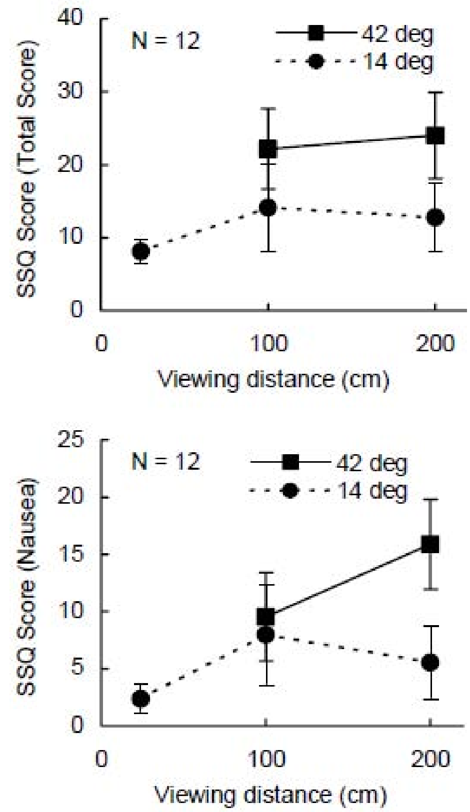


Fig.4. Effects of visual angle and amplitude on VIMS

Total sickness score is obtained as ([a]+[b]+[c])×3.74.

Four scenes clipped from three kinds of movies which have induced VIMS previously were evaluated by five participants with SSQ. Additionally we calculated global motion of each scene. Fig.2 (a) shows the means of the three subscale scores. Larger score represents severer symptom. The time of each scene was 5 min. There was no sound in the scene. Fig.2 (b) and (c) show power spectrums of translation components of global motion. As a result, it was shown that a scene with large translation components on about 2Hz or less may induce VIMS[8].

Viewing environment is an important factor to understand the mechanism of VIMS. To investigate the interaction between the effects of visual angle and display size, there were 2 visual angle conditions (14 deg and 42 deg for horizontal size). The viewing distance varied depending on the physical display sizes. Fig.3 shows a schematic view of the conditions of visual angle and viewing distance. We calculated the Total sickness scores and Nausea subscale scores of severity. The means of the Total sickness scores and Nausea subscale scores are plotted in Fig.4. The 42 deg visual angle conditions caused severer symptoms than 14 deg in Total sickness scores. These results support previous studies showing that larger visual angles induce severer VIMS. Although the effects of viewing distance (physical display size) had no significant effect for Total sickness score, Nausea subscale showed an interaction effect between visual angle and viewing distance[9]. These results suggest that even if the visual angles are identical, the perceived size of physically larger display became larger by size constancy effect and improve the sense of presence and visually induced self motion perception.

Fig.5 shows an adaptive video stabilization method which we proposed for the purpose of reducing VIMS. In our method, the scenes including oscillatory motion which can cause VIMS are selected to be stabilized for each motion parameter (r:zoom, θ:rotation, p:horizontal translation, q:vertical translation). The residual scenes are not stabilized in order to avoid degradation. Two threshold parameters describing the velocity and frequency of the oscillations which should be removed are introduced for the selection of scenes. The parameters can be set depending on the visual angle which is a parameter of viewing environment. We tested the proposed method on a

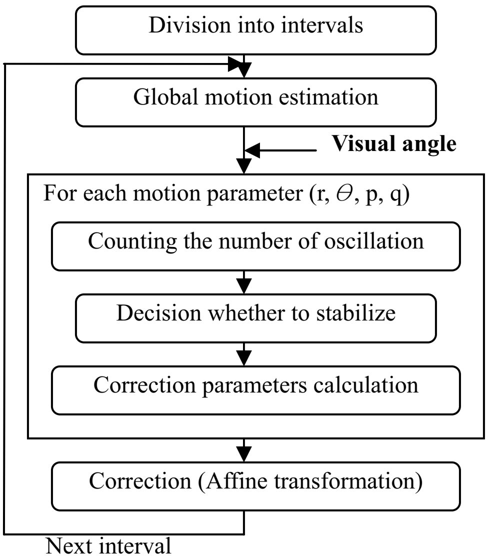


Fig.5 Video stabilization process

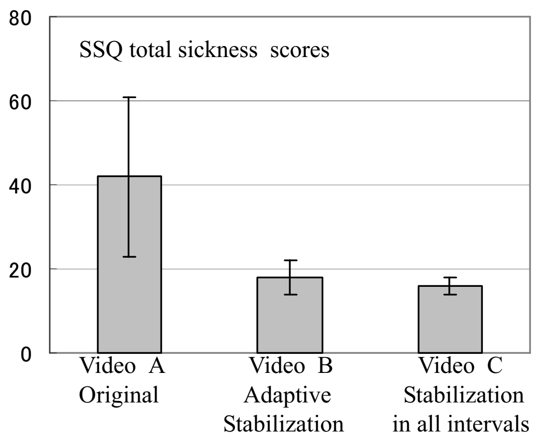


Fig.6. SSQ Total sickness scores

short time video sequence acquired by a handheld video camera. Three participants watched three types of video sequences and evaluated then by SSQ. Fig.6 shows the results of SSQ. The video (A) was the original 15 minute video sequence. The video (B) was the stabilized video sequence of (A) by the proposed method. The video (C) was also the stabilized in all intervals of (A). A number of stabilized intervals in (B) was almost a half number of (C). The video (A) has large sickness score, and the severe sickness is caused. Both the stabilized video (B) and (C) have smaller sickness score than the original video. In the video (B), only part of the intervals are stabilized, but VIMS is much reduced[10].

4. Conclusion

The characteristics features of images which can cause PSS and VIMS were investigated, and some methods of selective conversion of images that can cause such influence upon viewers were developed in consideration of variations of viewing environment.

It is difficult to produce safe video contents for diverse viewers with diversified viewing environment. Therefore, the outcome of this research can offer effective another means than guidelines to provide the environment where everyone can enjoy video contents in comfort.

5. Acknowledgements

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