COMPARISON OF IMMERSIVE FEELING EFFECTS AMONG THREE WIDE-ANGLE IMAGE PROJECTION TECHNIQUES

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ABSTRACT

An assessment experiment compares three wide-angle image projection techniques: "simple enlargement," "video mosaicing" and "pseudo wide-angle images" and finds what is the most effective in producing an immersive feeling. Results of the assessment experiment are examined by Steel test and factor analysis. The most effective technique is useful in changing our living room into a human-scaled immersive image theater.

Keywords: *entertainment, media, wide-angle image, immersive feeling, assessment*

1. INTRODUCTION

Our future goal is to change our living room into a human-scaled immersive image theater. It is not just a "home theater," which usually use only a flat screen. Our human-scaled immersive image theater uses walls in a non-special room, like a living room, as screens where images are projected. We are surrounded with the projected images that are large, wide–angled and continuous. These images make it possible to excite us and convey an immersive feeling to us effectively. For example, we can enjoy a flight simulator game of Sony PlayStation2 with expanded field of view in human-scale display. Figure 1 shows an illustration of our goal.

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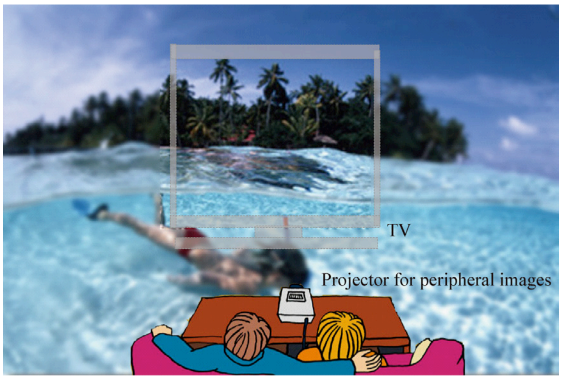
(a) Living room with a large TV



(b) Living room with a TV and peripheral images

Figure 1: Our goal

For this goal, we have studied on wide-angel image projection techniques [1-4]. In recent years, studies in virtual reality have been actively conducted on producing wide-angle images [5,6]. This paper reports assessment results of immersive feeling effects by three major wide-angle image projection techniques.

2. WIDE-ANGLE IMAGE PROJRCTION TECHNIQUES

Three major wide-angle image projection techniques are based on "simple enlargement," "video mosaicing" and "pseudo wide-angle images."

2.1. Simple Enlargement

Simple enlargement does not require any image processings for input images into a projector and simply optically enlarge the images with the projector. This technique is the most common way to have the large projected images.

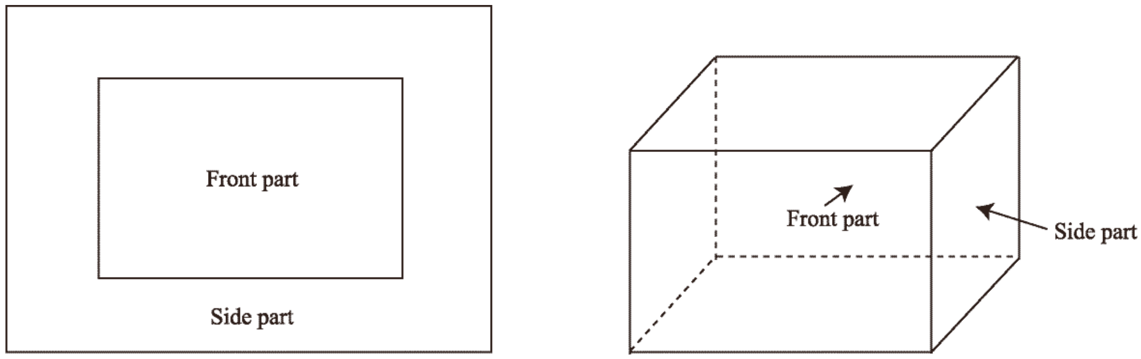
2.2. Video Mosaicing[5,6]

With a technique based on video mosaicing, we can reconstruct wide view angle images of input images by converting the input images into those combined with their peripheral images. The peripheral images are generated from the past frames in the images. This technique provides us with more informative projected images than the simple enlargement does.

2.3. Pseudo Wide-Angle Images[2-4]

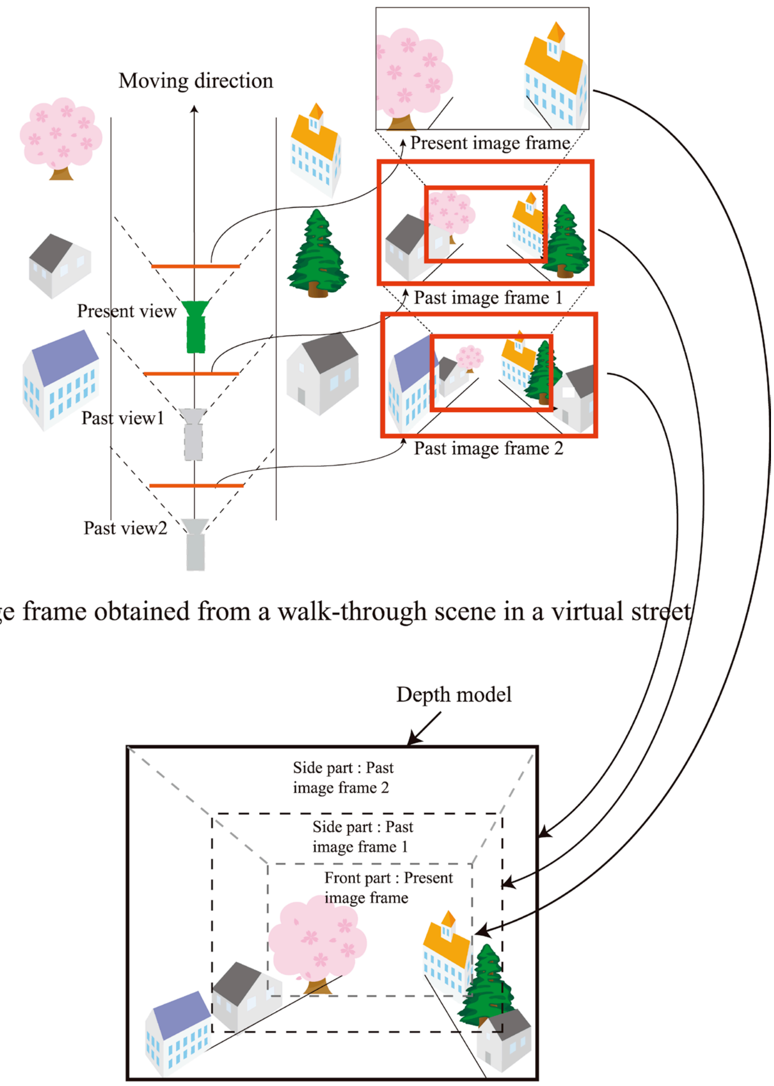
Pseudo wide-angle images are similar to the video-mosaicing-based images, except it uses a pseudo depth model of the scene in the images for the purpose of providing a sense of the depth in the projected images.

Figure 2 shows models for generating peripheral images. Figure 2 (a) is a flat model for the video mosaicing technique and Figure 2 (b) a pseudo depth model for the pseudo wide-angle images technique. Figure 3 explains the overview of the pseudo wide-angle images technique.



(a) Flat model for video-mosaicing (b) Pseudo depth model for pseudo wide-angle images

Figure 2: Models for peripheral images



(a) Image frame obtained from a walk-through scene in a virtual street

(b) Extraction and mapping of peripheral image information by using a depth model

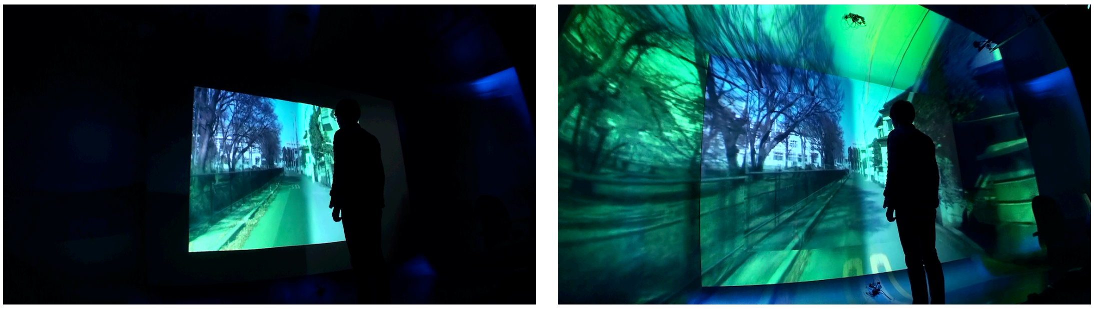
Figure 3: Pseudo wide-angle images

3. ASSESSMENT EXPERIMENT

In our assessment, we chose nine image contents, which were three videos and six computer graphics (CG) including a driving game and a flight simulator game.

These nine image contents were projected with the simple enlargement, video mosaicing and pseudo wide-angle images techniques. Except the game contents, the images without their peripheral images were projected for five seconds and then those wide-angle images were projected for ten seconds. To test several game operations, the game contents were projected longer than the other image contents were. It was twenty seconds for the game images without their peripheral images and forty seconds for those wide-angle game images. We repeated continuously this process twice for each image content.

Figure 4 shows examples of the projected images. Figure 4 (a) shows a scene of the video projected without its peripheral images. Figure 4 (b) is the pseudo wide-angle video images of Figure 4 (a).



(a) Images without their peripheral images (b) Pseudo wide-angle images

Figure 4: Projected images

The total of 27 projected image contents was evaluated for twelve assessment words on the bipolar scale of seven ratios. The assessment words were chosen to be related with an immersive feeling and an uncomfortable feeling, as shown in Table 1. For the games, we added two more assessment words for evaluating their enjoyment.

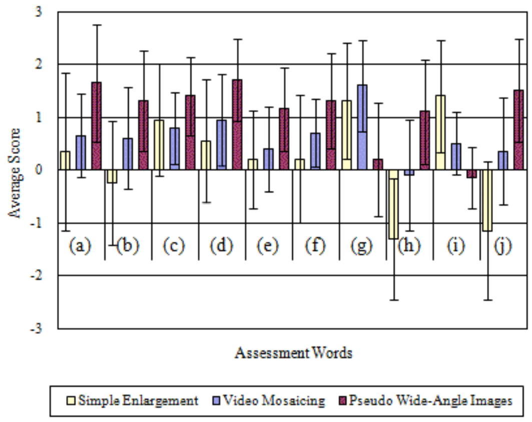
Table 1: Assessment words

Immersive feeling		Uncomfortable feeling	Enjoyment of the game
Immersive	Perspective	Uncomfortable	Enjoyable
Powerful	Broadening	Eye-friendly	Speedy
Impressive	Expansive	Wearisome	
		Favorable	

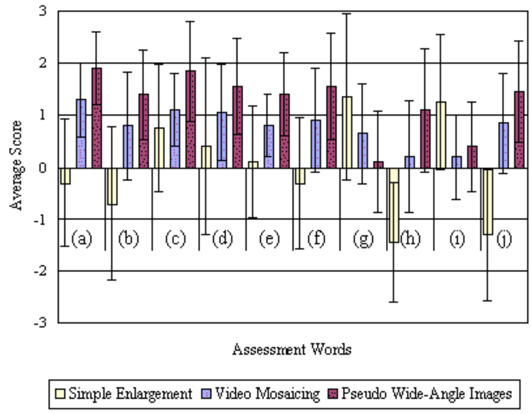
Fourteen men and six women in their twenties were participated in the assessment.

4. RESULTS AND CONSIDERATIONS

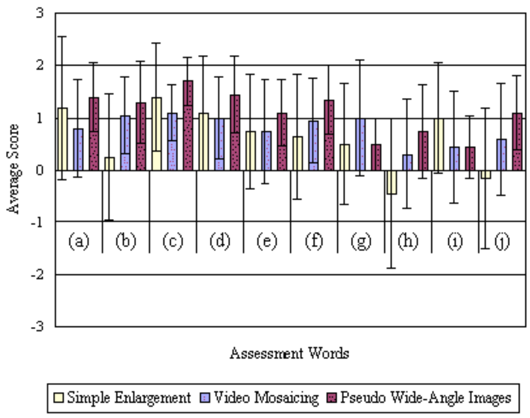
We computed the average score of the twenty subjects for each assessment words, as shown in Figure 5. For all the images used in the experiment, the pseudo wide-angle images technique scored higher than the enlargement technique did. Except playing the driving game, it was also higher compared with the video mosaicing technique.



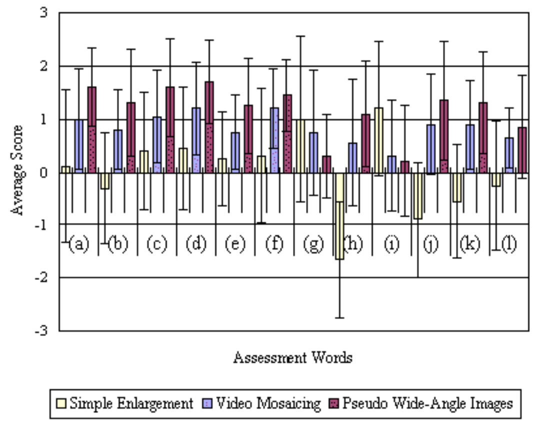
(a) Video images



(b) CG images (simple)



(c) CG images (complex)



(d) Playing a flight simulator game

Figure 5: Results of the average

(In the graphs, (a) Immersive, (b) Perspective, (c) Powerful, (d) Broadening, (e) Impressive, (f) Expansive, (g) Uncomfortable, (h) Eye-friendly, (i) Wearisome, (j) Favorable, (k) Enjoyable, (l) Speedy)

On these results, we examined whether the significant difference existed among the three techniques according to a non-parametric multiple comparison method: "Steel test." For all the projected images, the significant difference between the simple enlargement and pseudo wide-angle images techniques appeared on the five or more assessment words. As for the difference between the video mosaicing and pseudo wide-angle images techniques, it was significant on the more than three assessment words for the four projected images.

Factor analysis with the unweighted least squares method and promax rotation produced two factors: "Projection Effect" and "Comfort." Factor loadings are shown in Table 2. Figure 6 depicts a scatter plot of factor scores. The horizontal axis is "Projection Effect" and the vertical axis "Comfort." As shown in Figure 6, in terms of "Projection Effect" and "Comfort," the pseudo wide-angle images technique was the best among the three wide-angle image projection techniques and the video mosaicing technique was better than the enlargement technique.

5. CONCLUSIONS

With the aim of changing our living room into a human-scaled immersive image theater, we needed to find the wide-angel image projection technique that was effective in producing an immersive feeling. According to all the results of the assessment experiment, the pseudo wide-angle images technique provided the most immersive feeling effects among the three wide-angle image projection techniques.

As our future tasks, the pseudo wide-angle images technique will be improved images continuity and robustness of real-time processings.

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Table 2: Factor Analysis

Assessment words	"Projection Effect" factor loading	"Comfort " factor loading
Powerful	0.962	-0.284
Impressive	0.804	-0.107
Broadening	0.801	0.011
Expansive	0.776	0.089
Perspective	0.709	0.059
Immersive	0.705	0.162
Wearisome	0.184	-0.751
Eye-friendly	0.233	0.699
Uncomfortable	0.147	-0.692
Favorable	0.455	0.536

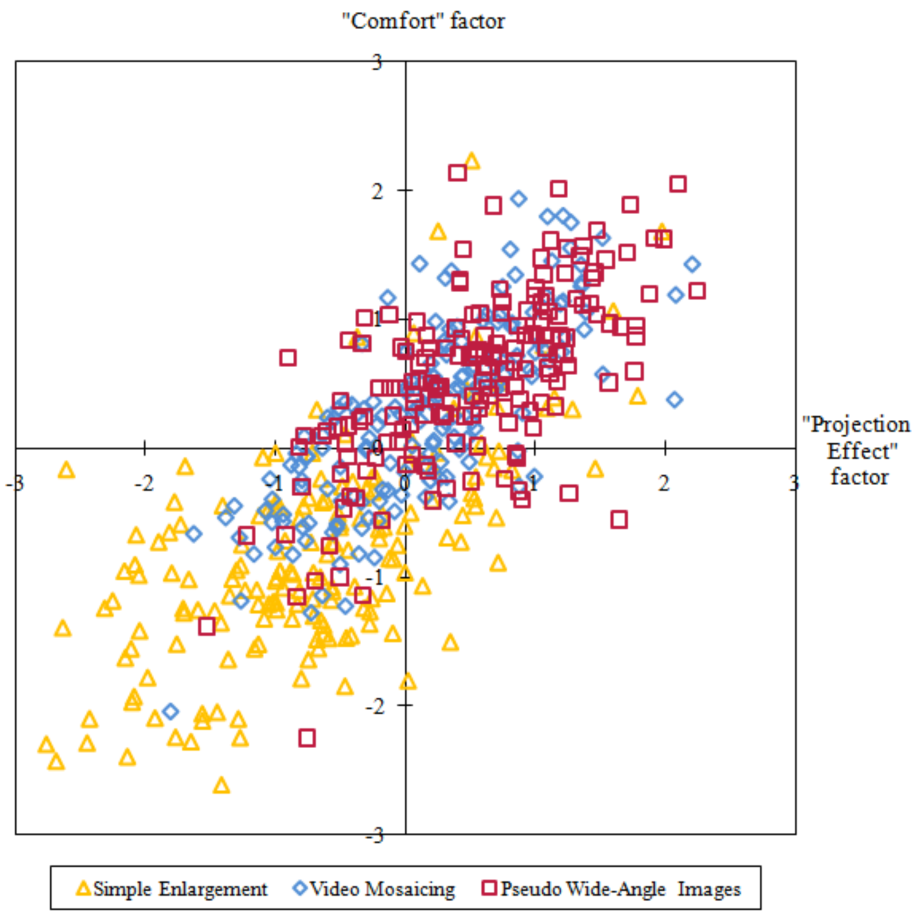

Figure 6: Factor Scores