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Effect of Scene Emphasis by Pseudo Displacement of Viewing Distance in Stereoscopic Image

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Abstract

In a three-dimensional vision, as for the picture exhibited by a monitor or a screen, size and the aspect ratio of the images are usually fixed. However, we think that scenes can be visually emphasized more by changing the presentation position of an image, i.e., the position of a screen, or a viewing angle. In this research, we examined the displaying method that Pseudo-screen is placed in the Stereoscopic 3D (S3D) space. Pseudo-screen induce changing the viewing distance artificially. And pseudo-screen itself displays S3D images. We verified whether the scene would be emphasized, in other words, the sense of “watching it nearby”. The prior study or displaying method about previously described are uncommon.

As a first step, we evaluated visual pattern of the pseudo-screen and surrounding by the impression evaluation experiment for students. At the second step, we displayed the visual stimulus, in which the position of pseudo-screen changes with the field of view of shots. These shots constituted a scene as montage. In the examination, we verified whether the stimulus caused change of viewing distance, emphasis of the scene, and is recognized as montage. Regarding the pattern evaluation, the images that wireframe or plane is extended from edge of the pseudo-screen are suitable for the display method. And, in the scene display examination, the shots constructed simple wireframe or plane are evaluated. Most participants recognized that the position of the screen is changed, and “watching it nearby”.

As a result, we considered that changing viewing distance caused by changing position of pseudo-screen is effective for emphasis of the scene.

Keywords: S3D image, pseudo-screen, scene emphasis

1. Introduction

When we watch a Stereoscopic 3D (S3D) images displayed on a television monitor or a screen, as well as 2D images, as for the picture exhibited by a monitor or a screen, size and the aspect ratio of the images are usually fixed. Regarding video contents, in a scene, each shots have different field of view related to the property of a camera or lens. When a subject is shot with the same visual size, the distance to a subject of camera with wide-angle lens is shorten than camera with normal lens. Because the image of the wide field of view by wide-angle lens can emphasize a sense of dynamism, it is an effective element emphasizing the impression of the shot more. In S3D image, when the image of wide angle of shot is compared with that of normal angle of shot, visual size of the subject with wide angle is smaller than the normal one, because depth information increases. In wide field of view, depth is emphasized more than normal, and this causes the miniature garden effect in S3D [1]. When it comes to S3D, the image with wide field of view which causes originally sense of dynamism, results lack in it adversely. However, we consider that the impression of the shot of the S3D image can be emphasized effectively by adopting wide angle of shot to enable dynamic expression of the point-blank range.

In this research, it is verified whether the sense of “watching at a S3D image at point-blank range” can be given to viewers by changing a setup of depth position of S3D image according to a viewing angle. And it is verified whether the display method is effective.

2. Background and Purpose of this research

In our research on S3D digital archives of Shinto theatrical dance (Kagura), using stereo cameras, the dedication of Kagura-dance to Shinto shrine was filmed. The "Buzen Iwato Kagura" handed down from ancient times in Buzen-shi, Fukuoka prefecture, became the Intangible Folk Cultural Properties of Fukuoka 1999, and tradition is inherited by six groups now. The group is called "Kagura-ko", and, in every autumn season, the Kagura dedication to a Shinto shrine is performed praying for a bountiful harvest flourishingly [2]. Variation of the dance “Mai” in Kagura exceed 30 kinds, and the styles of the dance are slightly different in each area, too. The Kagura dedication is performed in a stage "Kagura-den" which is built at the Shinto shrine, and it is endless, a dance is continuously performed from the early morning to the middle of the night. Local people called the parishioners “Ujiko” go to the Shinto shrine and sit in the porch of the stage and watch "Kagura dance" at close range, and many dances are performed (Fig.1). Dancers take a communication with Ujiko while they are dancing. In our research of digital archive of Kagura, S3D format video data was utilized not only as historical data, also as educational contents. And we produced S3D movie contents to contribute to local promotion and performed screening events in a museum or a public hall to spread charm of the Buzen Iwato Kagura inside and outside Fukuoka.

Fig.1 Buzen Iwato Kagura (dedicaction of Kagura)

The educational contents and S3D movie contents will help solving a problem of the tradition due to the depopulation.

We considered that the image of wide angle of shot taken at the close range from the stage is indispensable for dynamism of Kagura. Actually, viewers gave a high evaluation on the image of wide angle of shot, when we performed an interview at the screening event. However, in the present circumstances, Mixed images of the three-dimensional vision with the normal field of view and a wide field of view are displayed on the fixed size and aspect ratio of a screen (or a monitor). And some viewers claimed that they felt the visual size of subject of wide field of view is smaller than the normal. S3D image displaying, with depth information, when a wide image (taken from close range) and a normal image (taken from distance) are projected on the screen of same size and aspect ratio, the distance from a subjects to camera is changed, a sense of "watching it in close range" will not be suitable. To resolve this issue, we set up the hypothesis that changing the distance between the screen and viewers will be the effective display method to emphasize the sense of watching it at short distance for viewers. However, it is not practical to move a physical screen instantly. In this research, we examined the displaying method that a pseudo-screen is placed in the S3D space. And pseudo-screen itself displays S3D images. The pseudo-screen induce changing the viewing distance virtually. We verified whether the scene would be emphasized, in other words, the sense of "watching it nearby"

The purpose and goal of this research is to establish the displaying method for S3D image.

3. Related works, research

The study on display method to place a pseudo-screen in a S3D space is not seen. In the IMAX format S3D movie, *Encounter in the Third Dimension* (1999), there was a scene jumping into the S3D world of 3D TV monitor, and the TV monitor is placed in a room which was also displayed in S3D (Fig.2).

Here, the viewer will watch a S3D images containing two depth information at the same time in S3D space projected on physical screen, by a pseudo-3DTV monitor being placed in it,

Fig.2 *Encounter in the Third Dimension* (1999)

In this shot, the room and other elements are displayed in S3D, and the image on TV monitor is also S3D.

and a feeling of depth is emphasized more. However, it is considered that various things around the monitor cause visual fatigue, if viewer watch it for a long hours. In our method, the pseudo-screen is the image to let viewers focus on, and surrounding environment in S3D space will be minimum visual information they can grasp a sense of depth with it, thus, they won't get visual fatigue.

Ofuji analyzed the absolute localization of viewer in S3D [3]. This study was inspection as to whether viewers got a sense of instant change of their viewing position when they were watching S3D shot replaced from other S3D shot, these shots were took from different positions. It is considered that because fixed images of the same size were projected on physical screen, the sense of changing position has been occurred to viewers. In our research, it is considered that the sense of the change of viewing position can be reduced by moving the screen (pseudo-screen) itself virtually.

4. Concept of the method

Generally, a S3D image on physical screen has one depth information, we arranged two steps of screen positioning. One screen is physical screen usually, and other one is virtual screen (**pseudo-screen**). In the space constituted from S3D image, another S3D screen (pseudo-screen) is positioned in it (Fig.3). Pseudo-screen is located various position in the space artificially. Thus, viewers will emphasize the sense of watching the (pseudo-) screen at short distance.

In the method, two Convergence Point (CP) should be set for physical screen and pseudo-screen. Controlling CPs is important for viewers to watch S3D images on pseudo-screen without incongruity. To rectify these CPs, S3D images on pseudo-screen was created first, then images of S3D space (in which pseudo-screen was placed) on physical screen was created.

Flow of the setting of the display technique is as follows.

1. Edit images of right eye and left eye for pseudo-screen, convergence point (CP) is set at the screen.
2. Create a virtual 3D space, and pseudo-screen is placed in it.
3. Using virtual stereo camera, right image is rendered with right image on pseudo-screen, left image is rendered with left image on pseudo-screen. CP is set at the physical screen.

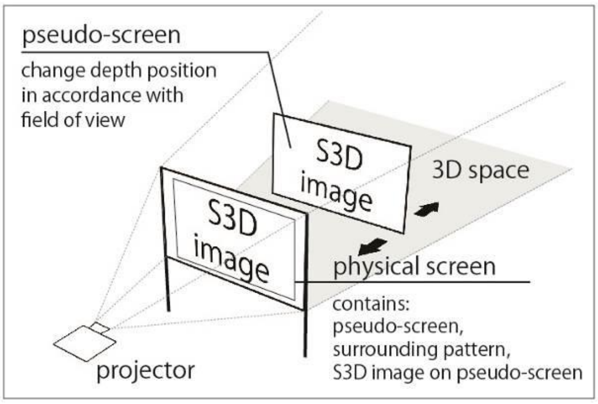

Fig.3 Concept of "Pseudo-screen in S3D space" display method

There is a possibility that viewers cannot recognize the connection of the shot as montage because the visual size changes in every shot. We thought that the connection of shots is recognizable by adding artificial depth information, the sense that the screen got closer to viewers is emphasized. In this research, we also perform the verification, that the unity of shots with different depth position will be recognized as a scene, from the view point of montage.

5. Experiment1: Display Pattern Inspection for Pseudo-screen

For "Pseudo-screen in S3D space" display method, we inspected appropriate visual pattern (pseudo-screen and surrounding element). First, we inspected suitable visual pattern of 3D space surrounding pseudo-screen. It is considered that a pattern of the line extended from the vanishing point, one-point perspective, can create the sense of depth [4]. As visual stimuli, patterns were created with wireframes and planes.

5.1 Stimuli

The S3D image displayed on pseudo-screen is the primal visual image which must be focused on. As for the visual information surrounding pseudo-screen, it is considered that too much S3D factor around pseud-screen would become hard to be watched for viewers. There are some patterns about visual information that let viewers recognize depth [4], in this study the depth expression was simply constructed by wireframe or plane, based on perspective.

Three ways of depth expression were set.

Depth expression 1: Wire frame (or plane) expands toward viewers from the edge (or the corner) of pseudo-screen as the starting point of the depth. **(LD, PD)**

Depth expression 2: Pseudo-screen is surrounded by the S3D space (in front and behind). **(EW, SP)**

Depth expression 3: Only pseudo-screen is placed in the blank space. **(NB)**

Five patterns were used as stimuli for this research. Pseudo-screen of all patterns are placed at same depth position. Convergence point was set at the physical screen. Depth position was set where visual size of pseudo-screen is 64 percent of the physical screen. Live action Kagura dance was used as a S3D image on pseudo-screen. All patterns are created using Adobe After Effects5.5 and Premier6.0, and are Full HD Mpeg2 format.

Pattern1: Extended Wireframe Type "EW"

Extension line from the structure in the picture with a wire frame (Fig 4).

Pattern2: Linear Depth Type "LD"

Wire frame starts from the corner of pseudo-screen, extend toward viewer(Fig 5).

Pattern3: Planar Depth Type "PD"

Planes are extended from the edge of pseudo-screen, toward viewer (Fig 6).

Pattern4: Space placement Type "SP"

Grid image as background is placed in S3D space, pseudo-screen is placed above it (Fig 7).

Pattern5: No Background Type "NB"

No background, the visual information is pseudo-screen only (Fig 8).

Fig.4 Pattern1: Extended Wireframe Type **"EW"**

Fig.5 Pattern2: Linear Depth Type **"LD"**

Fig.6 Pattern3: Planar Depth Type **"PD"**

Fig.7 Pattern4: Space placement Type **“SP”**

Fig.8 Pattern5: No Background Type **“NB”**

5.2 Experiment Procedure

14 students from Kyushu University participated the experiment (10 males, 4 females, all Japanese). All participants had experience to watch S3D movie. The experiment was carried out in the studio with condition of no illumination. Equipment used in the experiment are two DLP projectors (Full HD, 4000lm), circular polarizing filters, 150 inch silver screen and polarizing glasses. Mac book pro and Blacmagic Design’s Ultrastudio 3D are for playing S3D images.

Paired comparison method was used for this test. Combination all five stimuli including anteroposterior order are tested (20 pairs). For example, precedent stimulus EW (named as “A”) and following SP (named as “B”) were displayed, each stimuli was displayed 10 seconds with no sound. After paired (“A” and “B”) stimuli were displayed, a white blank image is displayed twenty seconds, participants responded to three evaluation items (“visibility” “depth” “visual size”) by five phases of evaluation standards. The evaluation sheet was notation in Japanese (Fig.9).

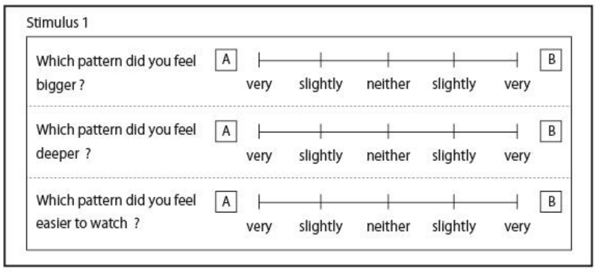

Fig.9 Evaluation sheet for experiment 1

5.3 Factor Analysis and discussion

Based on the collected data, one-way analysis of variance (factor: display pattern) and ranking by the evaluation point are performed (Table.1 and Table.2). As for the evaluation items, “visibility” and “depth”, the significant difference are confirmed (p<0.01). Regarding “visual size”, there is no significant difference. EW, LD, and PD were highly evaluated in “visibility” and “depth”. Especially as for EW, many participants got the sense of depth from building shaped image, wire frames were extended in front and backward from pseudo-screen. On the other hand, SP and NB considerably had low evaluation. As a reason, in the case of SP, screen seemed to float in the 3D space, and there were many opinions that participants had sense of incongruity. As for NB, there were many opinions that participants could not judge where pseudo-screen was located. It is considered that there is a visual difference between ED, LD, PD and SP, NB. The former are images in which wire frame or plane was extended from the edge of pseudo-screen, then participants can recognize depth easily.

Based upon the foregoing, we judged that EW, LD and PD were suitable for display method and decided to use it for the next experiment. SP and NB are excluded.

visibility ** p<0.01

Source	SS	df	F
between	6.31644	4	11.84333 **
within	5.33333	40	
total	11.64977	44	

depth ** p<0.01

Source	SS	df	F
between	5.86666	4	7.14285 **
within	8.21333	40	
total	14.08	44	

Table.1 Analysis of variance table (“visibility” and “depth”)

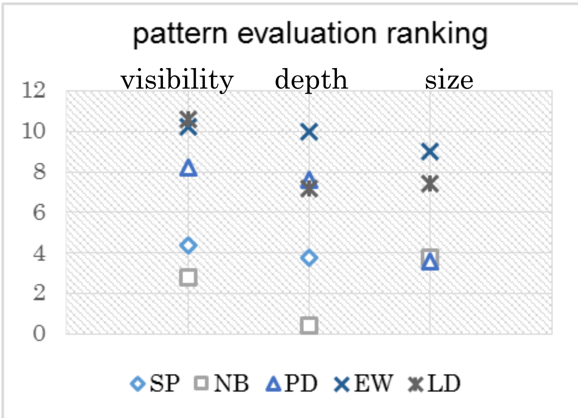

Table.2 ranking by evaluation point

6. Experiment2: Scene Effectiveness Inspection for Pseudo-screen

From the result of previous experiment, three patterns (EW, LD and PD) are used as stimuli for next experiment. In this experiment, we verified whether the connection of shots with different depth position will be recognized as a scene, from the view point of montage.

6.1 Stimuli

In each pattern, pseudo screen was located in the S3D space which has the convergence point at physical screen. The image of normal angle of shot was set as "shot 1" and following image of wide angle of shot was set as "shot 2", and these images are constituted as a scene. As for the position setting of pseudo-screen, shot 2 was set at convergence point (at the position of physical screen). Shot 1 is set at deeper position from physical screen. We verified whether viewers could feel that shot 2 came close to them. In addition, it is considered that the differences of distance between the image of wide angle of shot and the image of normal angle of shot would affect the impression of the shot, then two depth positions of shot 1 were set (Fig.10).

1. Depth position was set where visual size of pseudo-screen is 78 percent of the physical screen. **(EW1, LD1, PD1)**
2. Depth position was set where visual size of pseudo-screen is 64 percent of the physical screen. **(EW2, LD2, PD2)**

Thus, six scenes are created as visual stimuli for the experiment (Fig.11).

The procedure of the scene creation is similar to that of previous experiment.

Each visual stimulus has 20 seconds (shot 1: 10 seconds, shot 2: 10 seconds)

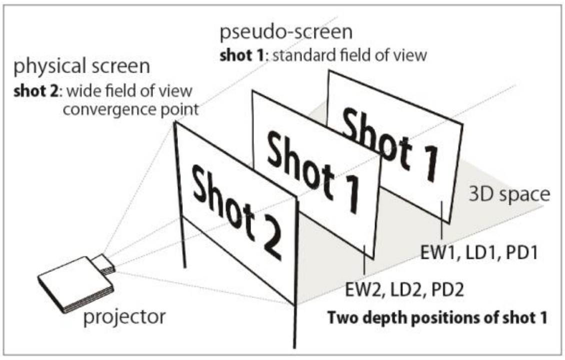

Fig.10 Concept of experiment 2

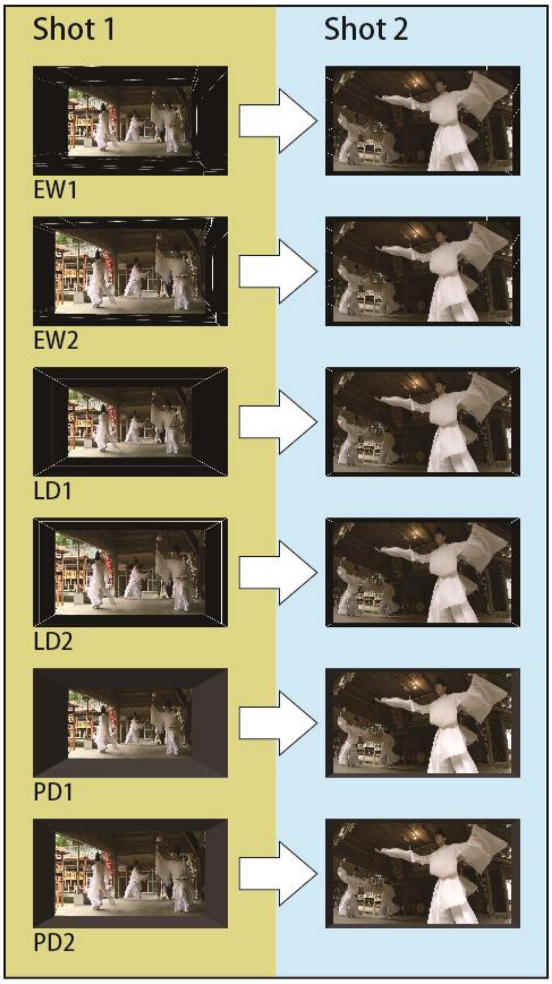

Fig.11 Visual stimuli for experiment 2

6.2 Experiment Procedure

20 students from Kyushu University participated the experiment (15 males, 5 females, all Japanese). All participants had experience to watch S3D movie. The experiment was carried out in the studio with condition of no illumination. The devices for the experiment are the same as previous.

Paired comparison method was used for this test. Combination all six stimuli including anteroposterior order are tested (30 pairs). For example, precedent stimulus EW1 (named as "A") and following PD2 (named as "B") were displayed, each stimuli was displayed 10 seconds with no sound. After paired ("A" and "B") stimuli were displayed, a white blank image is displayed twenty seconds, participants responded to five evaluation items (details will be described below) by five phases of evaluation standards. The evaluation paper was notation in Japanese (Fig.12). Two sessions were carried out including a break (two minutes) as one session with 15 pairs.

In the experiment, we inspected as to whether the viewing distance is changed and the scene is emphasized, by the combination of position change of pseudo-screen. Evaluation items are as follows.

"**visibility**": Visibility of the display method
"**close-up**": Sense of watching the screen in short range
"**montage**": Semantic combination of shots as montage
"**farness**": Recognition of distance
"**size**": Unity of subject's visual size

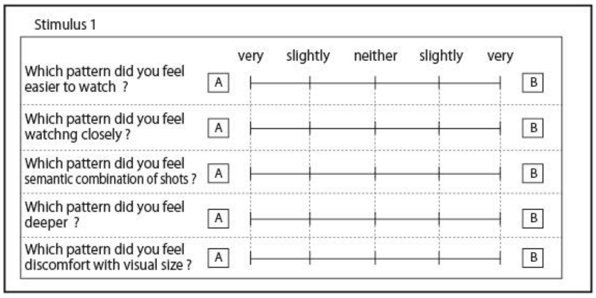

Fig.12 Evaluation sheet for experiment 2

6.3 Factor Analysis

Based on the collected data, two-way analysis of variance (factor 1: display pattern, factor 2: depth position of shot 1) and ranking by the evaluation point are performed. As for the analysis of variance table, in all evaluation items, interaction between factor 1 and factor 2 is not confirmed. Regarding "visibility" and "montage", there were no significant differences between the two factors (Table.3).

"close-up": In factor 1, there is significant difference between levels ($p < 0.05$).

"farness": In factor 2 there is significant difference between levels ($p < 0.05$).

"size": In factor 1, there is significant difference between levels ($p < 0.05$).

6.4 Discussion

As for "visibility", significant difference is not confirmed. Though pattern "LD" is highly evaluated. It is thought that the pattern that expressed perspective in a simple line is easy to look in the combination of the shots. Regarding "montage", there is no significant difference too, however, according to the oral interview, all participants did not have sense of incongruity of the combination of shot 1 and shot 2 as montage. It is considered that participants recognized the unity of shots by different screen size, as one scene. As for "close-up", PD1 was highly evaluated. It is considered that shot 1 is placed at longer depth position, participants felt that pseudo-screen approached more close to them. And about "farness", EW1, PD1 and LD1 were highly evaluated, and it is confirmed that pseudo-screen had an influence on sense of depth. As for "size", PD1 had the lowest evaluation, though it had the highest evaluation in "close-up". As a result, it is considered that sense of unity of visual size depends on the depth position and pattern. Moreover, regarding the general average, LD1 and LD2 was highly ranked (Table.4), then it is considered that the suitable visual pattern is the image with simple lines that viewers can recognize perspective at least.

closeup *p<0.05

Source	SS	df	F	
Factor 1	1.63	2	3.53111	*
Factor 2	0.00375	1	0.01624	
interaction	1.39	2	3.01119	

farness * p<0.05

Source	SS	df	F	
Factor 1	0.07583	2	0.13817	
Factor 2	1.17041	1	4.2651	*
interaction	0.00583	2	0.01062	

size * p<0.05

Source	SS	df	F	
Factor 1	1.21583	2	3.24318	*
Factor 2	0.66666	1	3.5566	
interaction	0.28583	2	0.76244	

Table.4 Ranking with average scores

rank	average	score	visibility	close_up	montage	farness	size
1	LD2	0.66	LD2	PD1	LD2	EW1	LD2
2	LD1	0.64	LD1	LD1	PD2	LD1	PD2
3	PD1	0.5825	PD2	LD2	PD1	PD1	LD1
4	PD2	0.55	PD1	EW1	LD1	EW2	EW2
5	EW1	0.525	EW2	EW2	EW2	LD2	EW1
6	EW2	0.49	EW1	PD2	EW1	PD2	PD1

Table.3 Analysis of variance table
("close-up", "farness" and "size")

7. Conclusion

In this research, we examined the displaying method that Pseudo-screen is placed in the Stereoscopic 3D (S3D) space. Pseudo-screen induce changing the viewing distance artificially. And we verified whether the connection of shots with different depth position will be recognized as a scene.

It is considered that the suitable visual pattern for the display method is the image with simple lines to let viewers focus on pseudo-screen. And it is considered that the change of the position of the pseudo-screen did not have an effect on the connection of the shot as montage. Thus, the display method is confirmed to be effective in S3D contents production. However, it is needed to be inspected about the depth position of pseudo-screen affecting the unity of sense of subject's visual size.

We focused on the depth position of pseudo-screen, with no aspect ratio modified. As for the cause that felt sense of incongruity to the visual size of the subject, it is considered that some participants felt that pseudo-screen changed its size simply, sense of depth was not recognized. To solve this issue, it is necessary to inspect it about the effect by the change of the aspect ratio of pseudo-screen. A shape of the screen changes according with angle of field. Pseudo-screen with image of wide angle of view is modified more widely. We consider that dynamism of the image can be emphasized by enlarging the horizontal field of vision, minimizing the change of the depth position.

As a proceeding in future, we will inspect the relationship between the depth position and the shape of pseudo-screen that effects the emphasis of scene.

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