

Effects of Emerging Scenes from the Occluding Edges on Visual Attention and Evaluation of the Landscape

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ABSTRACT

The present study examines the influence of the design of exit space on visual attention of a person who is leaving a building and on his/her impression of the outside scene. An experiment using visual simulation was conducted to test the assumption that the visitor's impression of an unfamiliar scene is affected by spatial layout of the exit space of a building. Twelve movies, four kinds of CG animations of opening overlaid on three photographs of different outdoor scenes, were projected on orthographic projection screen, which enabled a subject to observe a wide angle image. After viewing each movie lasting 12 seconds, each of thirty-six subjects, who wore an eye-mark recorder, was asked to rate the overall impression of the scene using seven bipolar adjective pairs. As a result, some aspects of the subject's impressions were found to vary according to the way the scene opened up as one moved through the space. The analysis of the subjects' eye movement revealed that subjects tended to attend the area in the scene coming into sight from the occluding edges, where subjects could find more information than other areas. Combination of these results suggests that subjects' overall impression is affected by the order of appearance of partial scenes (components) in the sight, and the eye movements, which tend to follow the occluding edges that move rapidly toward the periphery.

INTRODUCTION

When we look at a scene through such an opening as window, doorway or gate, the trimmed scene looks more beautiful than seen without it. This is called the “frame effect”, which is one of the common techniques used to enhance a sense of unity in the design of Japanese Garden. However, little is known about the effect particularly when an observer moves through the opening. When we leave a building toward outside, the outside scenes progressively come into our sight at the occluding edges created by the ends of ceiling and walls. The manner of opening up of a vista ahead is constituted by spatial layout of surfaces around the exit space. For instance, if deep eaves stick out, the both sides of vista open up first then upper part comes into sight later.

As Gibson (1979) suggested the perception of three-dimensional space during locomotion depended on the flow of the optic array particularly near occluding edges, where people tended to see the part of the frame of sight that expand outward rapidly. Yamashita et al. (2000) conducted a series of experiment to certify the above effects. The notion of “mystery” of natural landscape by Kaplan may be relevant to this subject. Kaplan (1987) noted about preferred scenes, “the scenes appeared to promise

that more information could be gained by moving deeper into the depicted setting. ” Hidebrant (1999) applied this idea to architectural space to explain enjoyable sequential experiences. When Cullen (1971) used the word “anticipation” to describe one aspect of townscape experienced by moving from here to there, he seems to consider the similar visual effects as our concern in this paper.

The present study examines the influence of the design of exit space on visual attention of a person who is leaving a building and on his/her impression of the outside scene. An experiment using visual simulation was conducted to test the assumption that the visitor’s impression of an unfamiliar scene is affected by spatial layout of the exit space of a building.

Hypotheses

The following hypotheses are examined through an experiment using visual simulation:

- 1) The direction of the visual attention is affected by the movement of the occluding edges created by the ends of ceiling and walls.
- 2) The impressions of the outside scene differ according to the design of exit space.
- 3) The effects above depends on the layout of elements that compose the outside scene

METHOD

Visual stimuli

The experiment used twelve movies, which were combination of three photographs of different outdoor scenes and four kinds of exit spaces. Each of three outdoor scenes used in the experiment (Figure 1) was a virtual scene created by composing parts of photographs taken at different places in order to control the layout of visual elements and to avoid the influence of subjects’ familiarity of existing sites. A super-wide angle lens (fish-eye lens) was used to take the photographs to make orthographic projection image.

Figure 2 shows four different exit spaces in terms of surface layout, which create different movements of occluding edges in the visual field of a person who moves through the space. CG animation of occluding edges for each exit space was made, and overlaid on the images of outdoor scenes.

The movies, each lasting seconds, were projected giving a wide-angle image view (visual angle of 132 degree). Figure 3 shows the movement of occluding edges in each type with the background of scene III.

Experimental instruments

Since the peripheral vision was considered to play an important role, an orthographic projection screen, a curved plastic translucent screen, was employed to present the visual stimulus in the broad visual field (see Figure 4). The orthographic projection image looks normal when it was projected on the screen.

We asked the subject to wear the Eye-mark recorder to get the trace of subject's eye movement.

Subjects

Thirty-six (twenty-two male and fourteen female) subjects were divided into six groups, each consisting of six persons. The order of presenting the visual stimuli to each group was systematically differentiated to avoid the effects of observation order.

Procedure

Each subject observed six movies, combination of each of three outdoor scenes and two types of exit space (standard type and one of asymmetry types). After viewing each movie subject was asked to rate the overall impression of the scene using seven bipolar adjective pairs.

RESULTS AND DISCUSSIONS

Overall impressions

The results of each subject's response concerning overall impressions of the scene were standardized (variance=1, mean=0) before calculating the average of all subjects. Figure 5 shows the differences of overall impressions according to the type of exit space. As for "bright-dark" and "quiet-lively" scales, no significant differences were obtained. This suggests these aspects of impression are affected only by the outdoor scenes but not by the spatial layout of the exit. On the other hand, the impressions rated by other adjective pair scales differ according to the spatial types in some cases. Particularly, on the "unity – incoherent" scale, the wall type in both scenes I and III, gives more sense of unity than the ceiling/wall type. This may suggest that the "frame effect", that is supposed to give a sense of unity, is valid not only in case of static vision but also vision in motion.

Trace of eye movement

The eye movement of each subject (see Figure 6) was recorded and analyzed. Figure 7 shows a typical eye movement in the case of scene III. The analysis of the subjects' eye movement revealed the following general tendencies: 1) when a characteristic component comes into sight from the occluding edge, it draws observer's attention, and 2) when there is no attractive component in sight, observer's eyes follow the occluding edges that move rapidly toward the periphery, where subjects expect to get much information. However, some differences in the eye movement were noted according to the combination of the exit space type and the outside scene. We

consider that these differences in eye movement may affect the subjects' overall impressions.

Some causes of the different impressions

As shown in Figure 3, the appearing order of components in the outside scene differs according to the type of exit space. In the early stage of the movie, the sky above the temple appears in the ceiling type, and the greenery extended horizontally to the both sides in the wall type, and a high-rise building appears on the right of the temple in ceiling/wall type. Figure 7-1 shows a typical trace of eye movement in the ceiling type space. It shows that visual attention follows the edge of ceiling, which moves rapidly earlier stage. This vertical eye movement and attention to the sky may be one of the reasons why the movie of the ceiling type was rated as giving broader impression than other types.

Figure 7-3 shows a typical trace of eye movement in the ceiling/wall type space. The observer's eye were first led by the edges in the top and right side, then he/she found the high-rise building and pay frequent attention to it. A strong contrast between the traditional temple and the modern building seemed to be intensified by the way they appear. Therefore, the movie of the ceiling/wall type was rated as giving more incoherent, characteristic and artificial impressions than other types.

As for the scenes I and II, similar discussions was able to make based on the appearing order of components in the outside scene and the eye movement as one moved through the space.

CONCLUSION

The present study examined the influence of the design of exit space on visual attention and evaluation of outdoor scenes, and revealed that the overall impression varied according to the way the scene opened up even the outdoor scene is the same. Subjects' overall impression was affected by the order of appearance of partial scenes, or components in the visual field, and the eye movement led by the movements of the edges. This study revealed, at least in some cases, that spatial layout of exit space affected on the impression of a person who goes through it although the cause of the effect is not clearly explained.

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	scene	scene	scene
scene			
visual stimuli			
characteristics	many components are scattered over the scene	components are located on both sides of the scene	components are located in the center and on both sides of the scene
components of the scene	trees/old apartments / high-rise buildings	sea/blue sky /high-rise buildings	temple /high-rise building / Ferris wheel

Figure 1 The three outdoor scenes used in the experiment

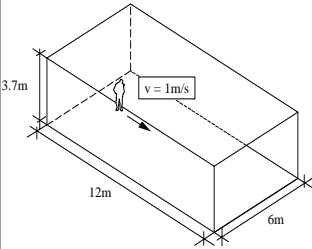
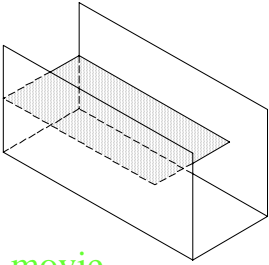
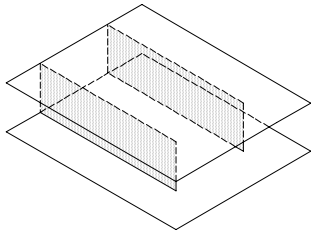
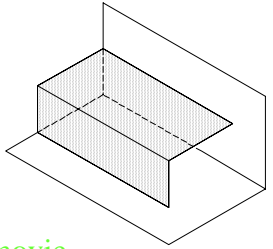
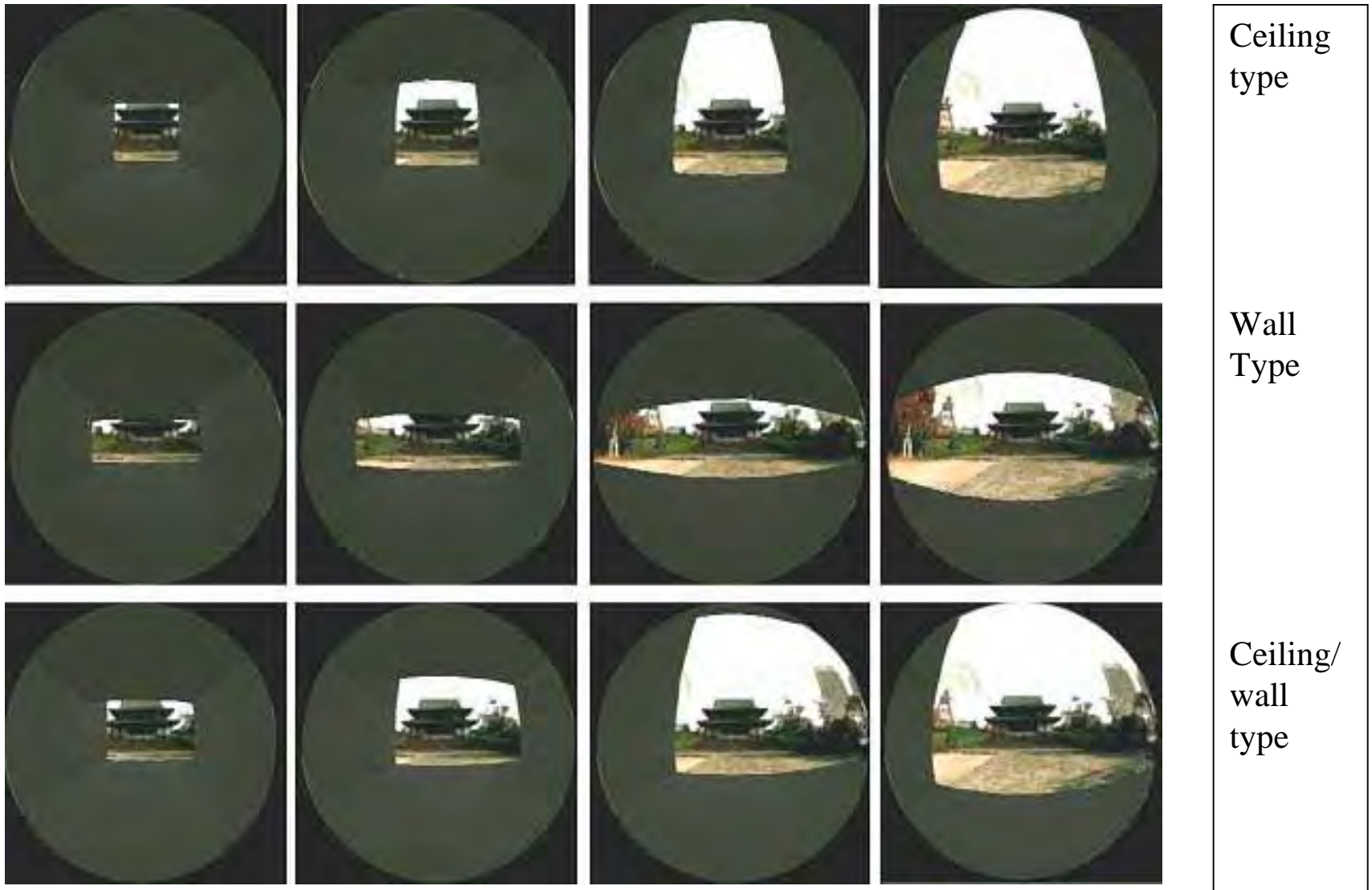
	symmetrical type	asymmetrical type		
		ceiling type	wall type	ceiling/wall type
shape		 movie	 movie	 movie
surface characteristics	all surfaces have equal length	the ceiling is shorter than the walls	the walls on both sides are shorter than the ceiling	the ceiling and the wall on the right are shorter
movement of the occluding edges	the occluding edges move uniformly on all sides and disappear at the same time	the occluding edge at the top moves faster and disappears at an earlier stage	the occluding edges on both sides move faster and disappear at an earlier stage	the occluding edges at the top and the right-hand side move faster and disappear at an earlier stage

Figure 2 The four exit spaces used in the experiment



4 seconds → 6 seconds → 8 seconds → 10 seconds

Figure 3 Movement of occluding edges for the three asymmetrical types of exit space
(scene)



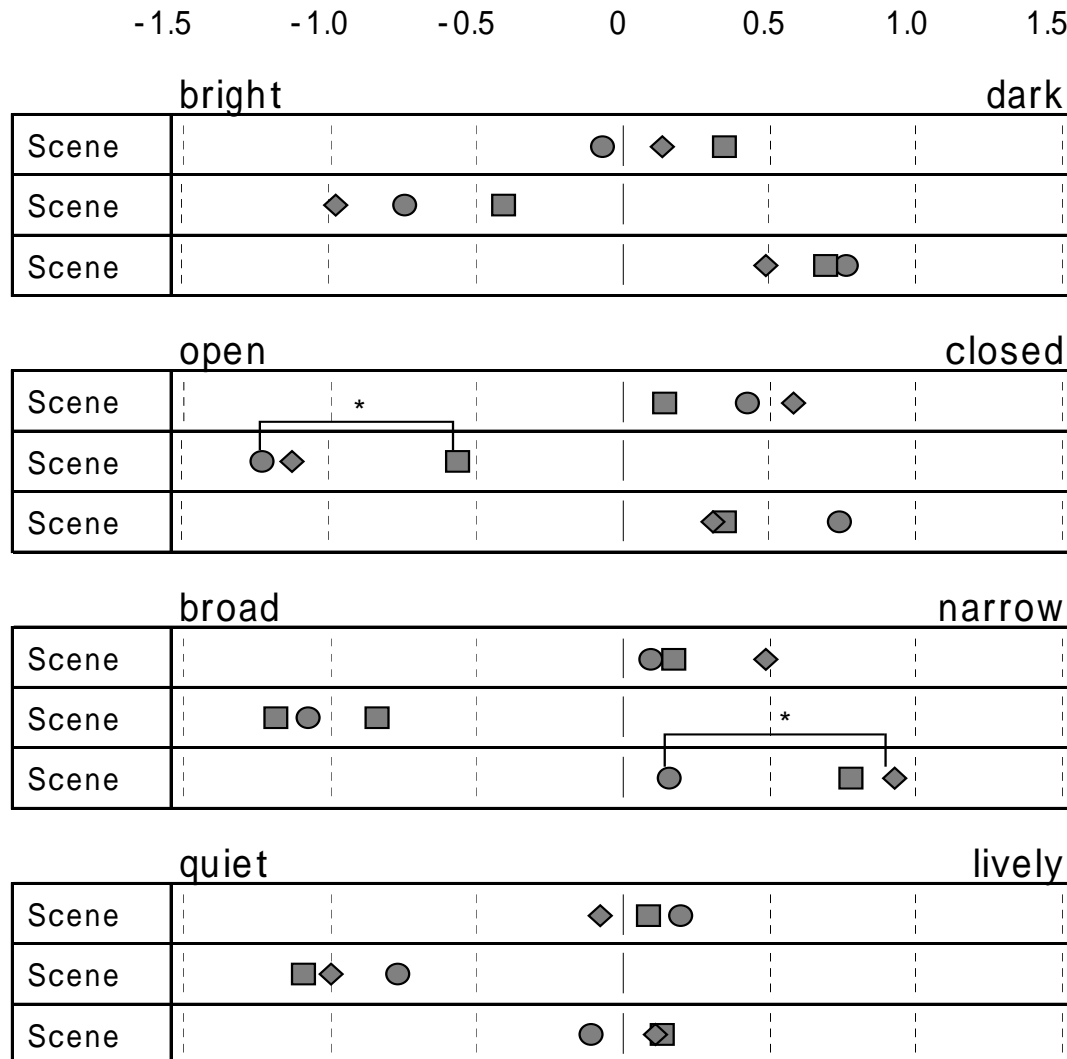
Eye-mark recorder

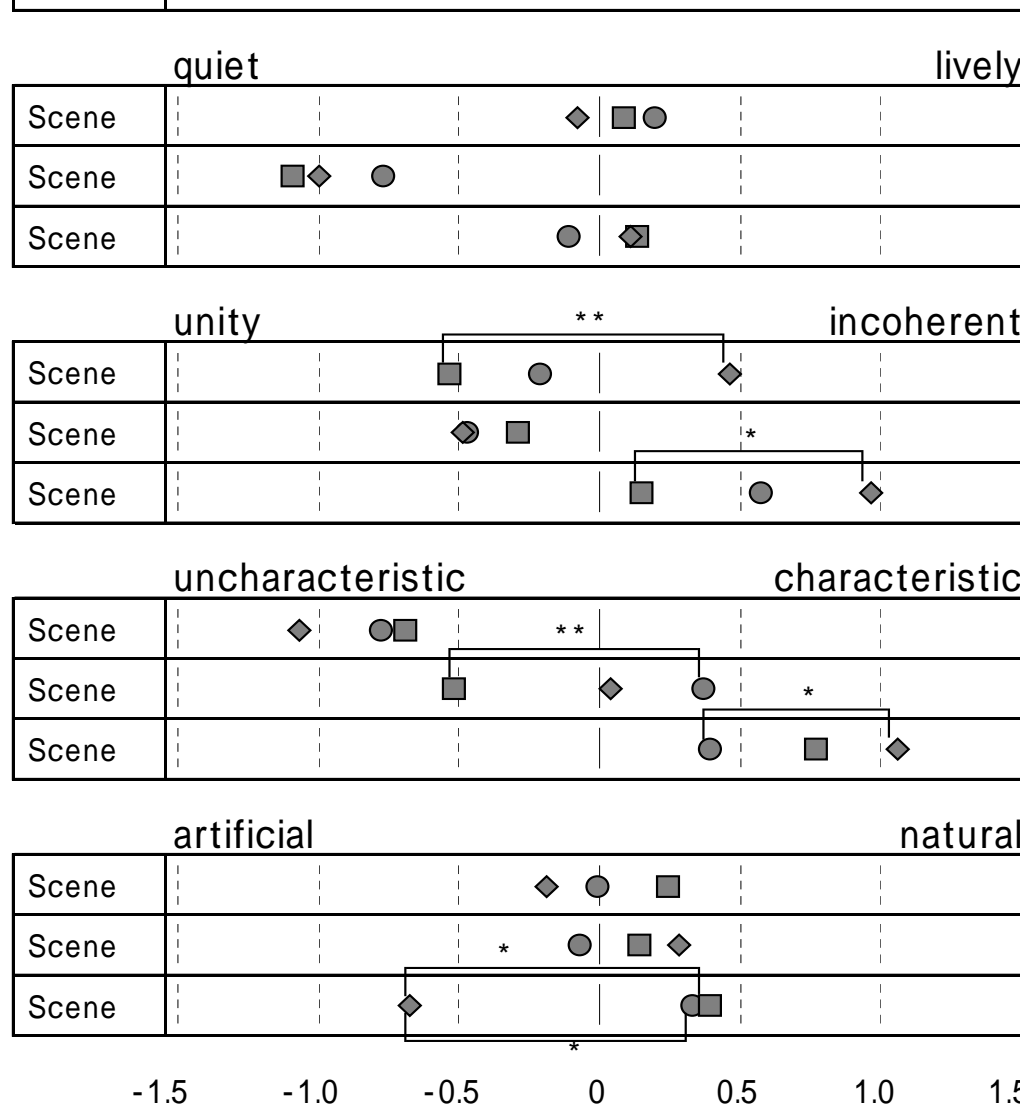


Figure 4 The orthographic projection screen

Figure 5-1 Differences in overall impression ratings according to exit space type

● Ceiling type ■ Wall type ◆ Ceiling/Wall type * $p < 0.05$ ** $p < 0.01$





● Ceiling type ■ Wall type ◆ Ceiling/Wall type * p<0.05 ** p<0.01

Figure 5-2 Differences in overall impression ratings exit space type

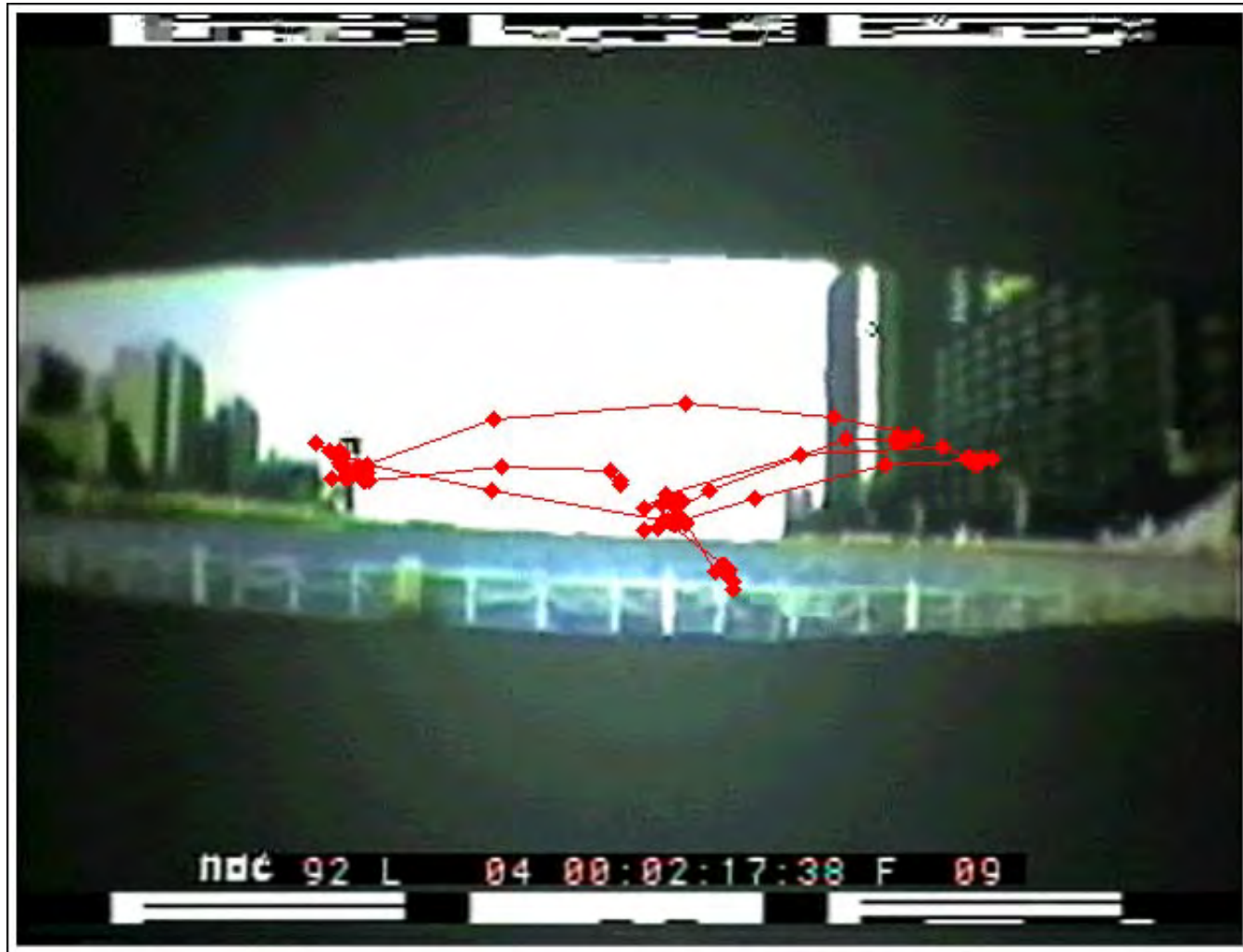
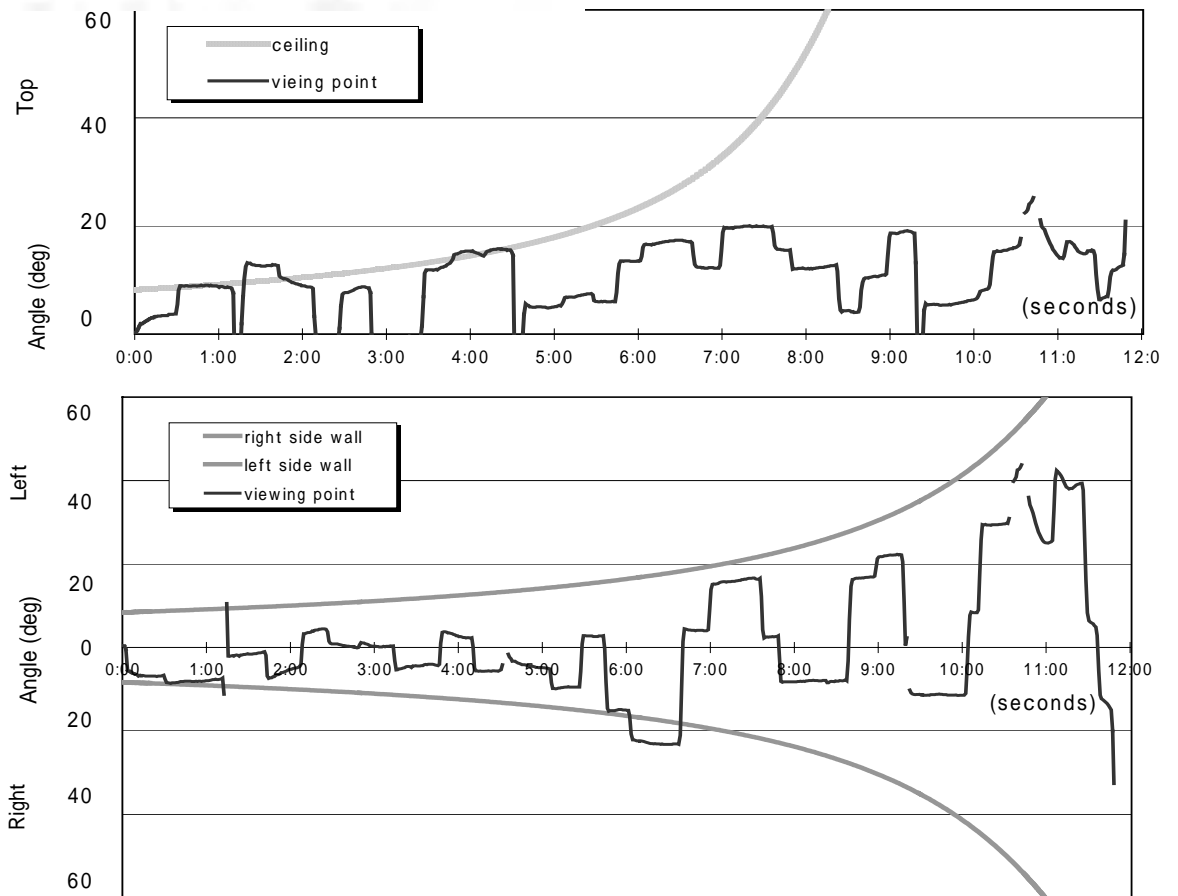
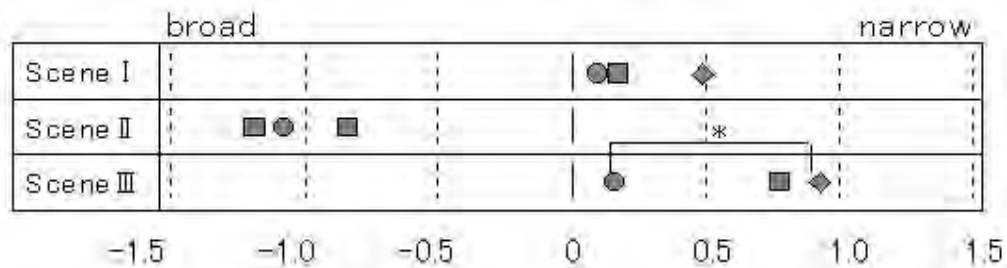


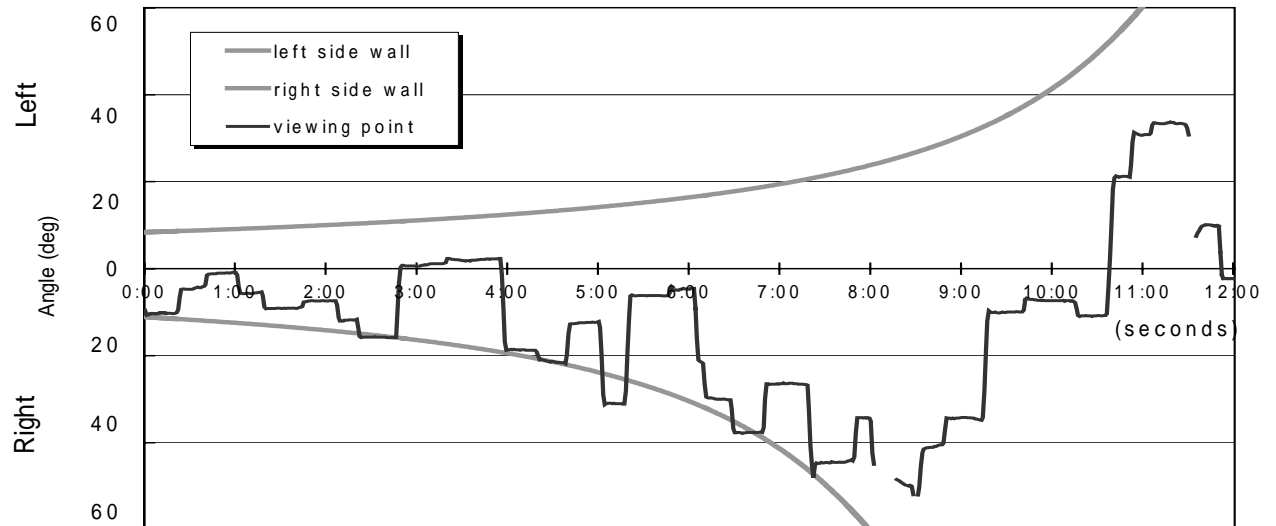
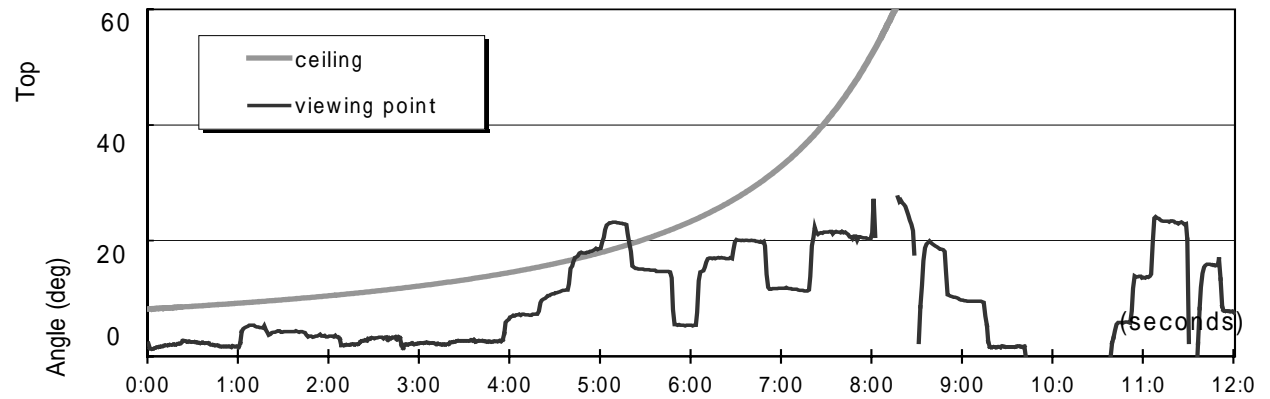
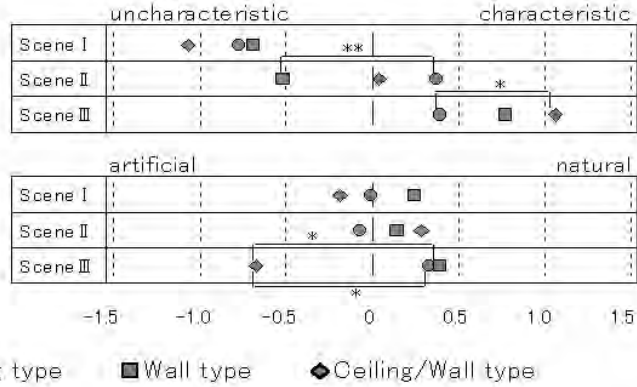
Figure 6 An example of an eye movement trace (scene II, wall type)



1. Ceiling type
-Scene III
(subject F-5)

[movie](#)

Figure 7-1 A typical eye movement trace



3.Ceiling/wall type -Scene III (subject E-4)

[movie](#)

Figure 7-3 A typical eye movement trace