Journal for Geometry and Graphics
Volume 2 (1998), No. 1, 85–91

The Differences in Eye Movements and Visual Impressions in Response to Static Versus Motion Picture Imagery of Streetscapes

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Abstract. This research investigates techniques of urban environment visualization using computer graphics, and the effectiveness of this medium as an evaluative tool for streetscape simulations from a human/environment perspective. In this field, single static pictures and successive static pictures taken at regular intervals are the typical method by which townscape simulations are evaluated. However, by tracking eye movements, we found considerable difference in the visual processes when subjects looked at a still image compared to a motion picture. In a moving environment, visual attention tends to focus on a more limited area which is consistent with the sequential view and continuously reorients itself with the direction of movement. When viewing static images, because the field of vision is not limited by motion, visual attention is dispersed over the whole picture. This gives evidence that perceptions of single static and successive static pictures as sequential environment are different from perceptions of motion pictures which are much closer to real sequential environment.

Key Words: streetscape simulation, CG animation, visual perception, eye movement

1. Introduction

The perception of people in laboratory is different from that in actual situation (Gibson [1]). Our research has revealed the effectiveness of dynamic townscape simulation using computer graphics animation on experiments concerning the visual perception of townscapes and townscape evaluations under sequential environments (Hayata et al. [2]). The usual procedure in this kind of experiment is to use single or successive static pictures showed in regular intervals as an experimental medium. This paper makes reference to previous research about the gradual system of visual perception in Cognitive Science and Perceptual Psychology.

ISSN 1433-8157/$ 2.50

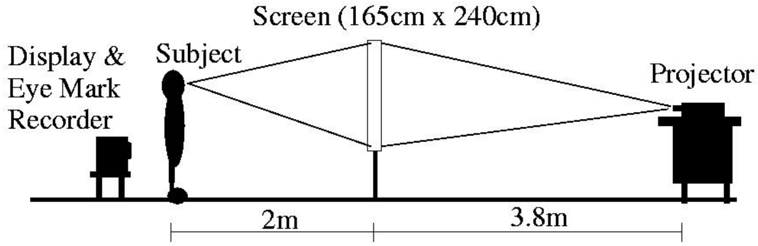
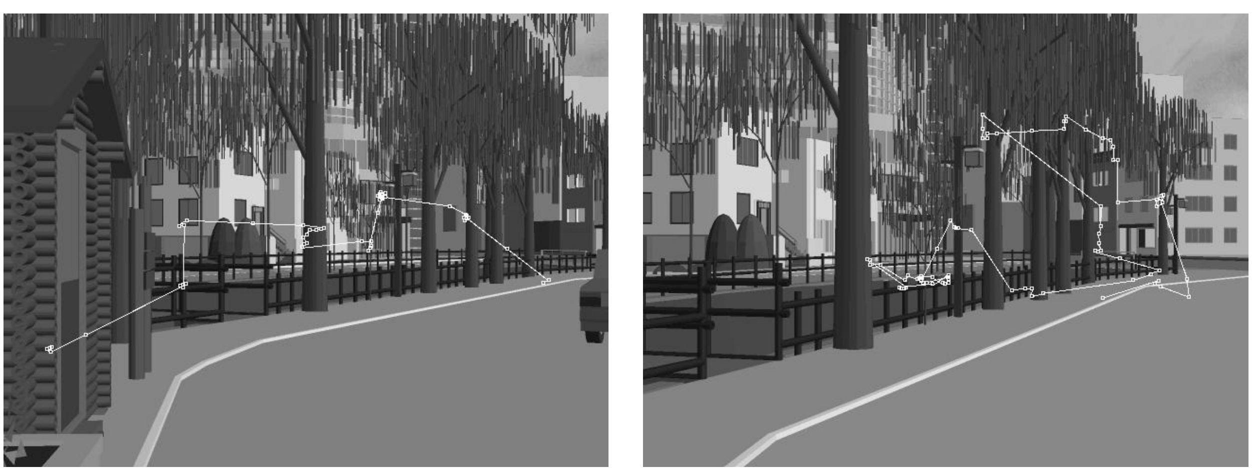


Figure 1: Experimental environment

$10.00'' \sim 15.00''$ $15.00'' \sim 20.00''$

Figure 2: Eye movement on motion picture (video)

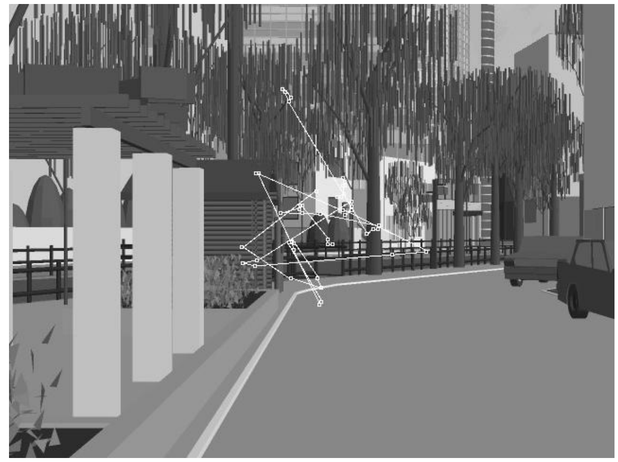
We carried out an examination of visual perception in sequential environments in conformity with this previous concept of the perceptual mechanism. Simulation media should meet such requirements as to give almost the same impressions and evaluations as the ones gathered in a real situation.



$10.00'' \sim 15.00''$ $15.00'' \sim 20.00''$

Figure 3: Eye movement on motion picture (computer graphics)


Eye movement on single static picture


Eye movement on successive static picture

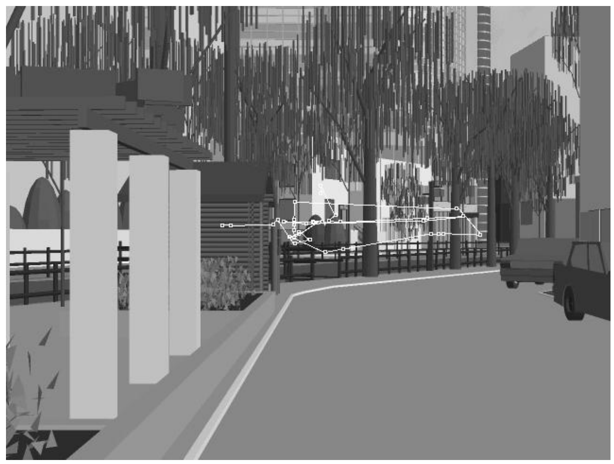

Eye movement on motion picture

Figure 4: Comparison of eye movements between different media

2. Comparative Experiment of Simulation Medium

Do subjects cognize streetscapes from single or successive static pictures in the same way as they do in a real situation? According to Hersberger et al. [3] the public can not understand the sketches and renderings drawn by architects. In this experiment, experimental media for evaluative and perceptual experiments on streetscapes was analyzed. Also the possibility that subjects cognize more details of elements when viewing static pictures than motion pictures, and that motion pictures are more similar to real situations were considered.

2.1. Applying a Hypothesis of Visual Perception

In cognitive science and perceptual and cognitive psychology, the distinction between the functions of central vision and peripheral vision is a topic of great importance. Applying this idea to our cognition of environment we can consider that the function of peripheral vision is to catch sight of the whole outline from surroundings. The central vision, on the other hand can process with a resolution which is a few times higher than that processed by peripheral vision, and can catch sight of the details of elements of the environment which have been fixed by the subject's eyes.

Taking the above into consideration, we can expect the following: First, environmental perception is carried out by gradually catching visual information, which is mainly rough information, using these two different levels of vision. Secondly, people form visual images of the environment gradually, from rough to detailed, by processing the accumulated visual information, and also by grasping the whole space information from different view points.

2.2. Method of the Experiments

We showed a computer graphics animation which was used in a previous study by Hayata et al. [2], and also used single and successive static pictures taken from the computer graphics animation.

2.2.1. Stimuli and apparatus

One of the stimuli was a video that was shot on a part of the street along the Kamo-kamo stream in downtown Sapporo. The other stimuli were based on the same place and created using Macintosh Quadra800, Quadra650 with Radius Studio, Adobe Premiere 4.0 and ArchiCAD ver.4.1.2. These stimuli were of six kinds, single static picture (computer graphic and photo), successive static pictures (computer graphics and photos) and computer graphics animation.

The single static pictures were typical scenes which were taken from the computer graphics animation and video. The successive static pictures were a succession of pictures that were captured every five seconds from the animation and shown successively.

The stimuli were projected onto the screen from the back. The length between the screen and subject, and between the screen and projector were calculated so as to preserve the right perception of scales (see Fig. 1).

Eye movements were detected by an eye mark recorder of NAC fabrication, model EMR-7.

2.2.2. Eye movements tracking

The tracking data of eye movements were collected from nineteen subjects. The reason for the few number of subjects was the difficulty to find apt subject s to fulfill the severe requirements of the eye mark recorder (see Table 1). We selected people who had good sight without glasses, no astigmatism, big eyes, no long over hanging eyelashes.

category		number
sex	male	15
	female	4
age	20–24	13
	25–29	3
	30–	3
graduate students and faculty (behavioral science)		6
graduate students (architecture)		5
others		8
total		19

Table 1: Classification of subjects (eye movement)

We projected three types of medium onto the screen. After tracking the subjects' eye movements with the eye movement detective unit that was set on the subject's head, we analyzed the data from focal points taken every five seconds, and plotted them together on the middle frame of these five seconds.

2.2.3. Hearings of Impressions

After showing the three media onto the screen, we carried out a hearing session where eight subjects (see Table 2) answered freely about the impressions and the differences of those media.

category		number
sex	male	6
	female	2
age	20–24	5
	25–29	2
	30–	1
graduate students (architecture)		5
graduate students (other)		3
total		8

Table 2: Classification of subjects (hearing)

3. The Differences of Visual Perception in Simulation Media

Several differences of visual perception in simulation media appeared in the results of the experiments.

3.1. The Differences in Eye Movements

The computer graphics animation experiment was first compared to a video of the same scene, as shown in Figs. 2 and 3. Although there were a few more number of fixation points on the animation experiment than on the video, it resulted in a similar pattern of eye movements. This result agree with previous research (Hayata et al. [2]) and confirm the usability of computer graphics animation as a similar media to videos and consequently to real situations scenes.

On the other hand, we found a clear difference of eye movements's pattern between motion (animation) and static (single and successive) pictures, as shown in Fig. 4. During single and successive static pictures, eye movements spread chaotically over the whole images. By contrast, eye movement pattern on the motion pictures was found to run follow the perspective lines of the elements placed along the direction of sequential scenic changes.It was also shown that attention is placed on the direction of movement,and is under the influence of sequential changes of pictures.

Motion Picture

- Easy to understand the space construction
- Notice sequential change of streetscape
- Cannot remember the details
- Easy to imagine of the real space
- Strong impression
- Never focused on the details

Successive Static Picture

- Have impression of the details
- Comparatively easy to grasp spatial features
- Do not perceive as sequential environment

Single Static Picture

- Have only impression of the details
- Difficult to grasp spatial features
- Difficult to form spatial images

Figure 5: Spatial grasping and impression according to simulation media

3.2. The Differences in Impressions

Seven subjects answered that through computer graphics animation it was easier to understand and grasp the whole space than through the other medium, and only one subject said that successive static photos was a more effective media. Nobody answered that single static pictures (computer graphic and photo) are the best media for this purpose. We considered that the results are related to the invariant structure, advocated by Gibson [1].

In the case of single static pictures (computer graphic and photo), all subjects focused on the details of the medium. In the case of successive static pictures (computer graphics and photos), four subjects focused on the details of the media. So, six subjects had a strong impressions of the details of single static pictures, and three subjects had a strong impressions of the details of successive static pictures. Nobody focused on the details of the motion pictures and thus no one had a strong impression of the details. Four subjects answered that the motion pictures were suggestive of the real situation, and only one subject answered that the successive static photos were suggestive of the real situation:

4. Conclusion

Judging from the results above, the conventional methods of experiment using static pictures cannot lead to accurate results of perceptual and evaluative experiments of sequential environments. Granted the effectiveness of peripheral vision, the differences of eye movements bring about the differences of perception and cognition of streetscapes because the information collected by using the function of focal vision with high resolution is different. Furthermore, dynamic simulation using motion pictures is a valuable tool for revealing sequential environments' perception and cognition, because the perceptual mechanism was reproduced pretty well in the experiments.

Acknowledgements

We wish to thank Regional Science Institute Corp. for their generous financial assistance. We are indebted to Professor Majima for his helpful suggestions, and also indebted to Miss Kamada, Mr. Kaketa and Dr. Kojima for their valuable advice as psychology specialists.

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Received November 26, 1996; final form May 5, 1998