THEMATIC SESSION: ENVIRONMENTAL COGNITION AND PERCEPTION

AMBIENT VISION OF THE ENVIRONMENTAL PERCEPTION: DESCRIBING AMBIENT VISUAL INFORMATION

Ryuzo Ohno, Kobe University

ABSTRACT

The nature and role of ambient vision in environmental perception, as opposed to focal vision, is discussed based on recent findings in physiology and psychology, and a method which describes ambient visual information is proposed and tested by applying it to assess outdoor spaces of housing neighborhoods. The information obtained by ambient vision is hypothetically defined as a statistical measure of an array of visual surfaces which surround an observer. The visual surfaces in the environment were divided into basic units (components) on the basis of their "affordance", such as surfaces of pavement, earth, grass, trees, building and sky. A personal computer program was developed to measure the solid angles of visible area of the components and the volume of visible space around a given point in a proposed environment. Empirical studies, in which subjects rated sequential landscapes of different housing neighborhoods, revealed that the global impression, or feelings of a place can be well explained by some of the measures obtained by the program.

INTRODUCTION

Our perception and appreciation of the environment may depend not only on some dominant elements but also on the their background. As Ittelson (1973) suggested, environments, as opposed to objects, include peripheral as well as central information. Moreover, people rarely fix their eyes on a point or in one direction but rather look around and explore their surroundings to gain a feeling about an environment. The area behind us is no less a part of the environment than the area in front. As I will discuss below, I call this potentially visible information that surrounds people ambient visual information as distinguished from focal visual information with which traditional object-oriented study in psychology has concerned itself.

With some exceptions (Rapoport, 1977; Gibson, 1978; Thiel, 1981), ambient visual information in environmental perception has rarely been taken into account as a environmental variable by environmental researchers and designers since it is not easy to describe the whole visual field surrounding people by conventional methods. Thus it is worth having an alternative tool to describe ambient visual information of the environment.

This study presents a personal computer program which was developed to provide a visual representation and statistical analysis of the ambient visual information at a given point in a proposed environment. Empirical studies examine relevance of these measures obtained by the program to the human feelings of a place.

Parallel processing: focal and ambient vision

Environments include enormous amounts of information from which we gain necessary information very fast and without appreciable effort. How do we deal with this mass of incoming information from the environment?

One possible answer, which I support, would be parallel processing in the visual system which is suggested by physiological and psychological studies. It is suggested that parallel visual pathways in animals, which concurrently analyze different properties of the visual scene, subserved separate visual functions (e. g. Trevarthen, 1968). Two roles of vision are distinguished: one, ambient vision, involved in orienting the animal in space and guiding its larger movements, the other, focal vision, used for the detailed examination and identification of objects. Evidence of similar parallel pathways has also been demonstrated in humans (Bassi, 1989). Computer scientists think that the quick and effortless performance of our vision is likely to have a computational solution using a parallel algorithm, and parallel processing may be essential for competent vision systems because the serial architecture of conventional computers is too inefficient to deliver the massive amount of computation required (Ballard, Hilton and Sejnowski, 1983).

Although ambient and focal vision are different in their functions, they must interact with each other in some way to obtain perceptual synthesis. On the interplay between the two channels of visual analysis, Julesz and Bergen (1983) regarded ambient and focal vision as preattentive and attentive visual systems respectively. Based on findings of experiments on texture discrimination, they suggested the existence of a separate preattentive visual system that cannot process complex forms, yet can, almost instantaneously and without effort or scrutiny, detect differences in a few local conspicuous features regardless of where they occur. They noted, "The preattentive process appears to work in parallel and extends over a wide area of the visual field, while scrutiny by local or focal attention is a serial process, which at any given time is restricted to a small patch. " Preattentive vision, therefore, was believed to serve as an early warning system by pointing out those loci that should be attended to. With this interplay of two visual systems, we can pick up wanted information from a wide area of the environment with limited attentional effort.

Although the above discussions were extracted from experiments under special laboratory situations, a hypothetical model of environmental perception can be speculated upon based on the dual mode of vision. The model is schematically represented in Figure 1, which shows the relation between the perceiver and the source of visual information. Focal vision is characterized by an active visual line fix on an object, while ambient vision is characterized by numerous radiant visual lines converging on the station point, which I call "visual radiation. " Some of the differences of the two visions are summarized in Table 1.

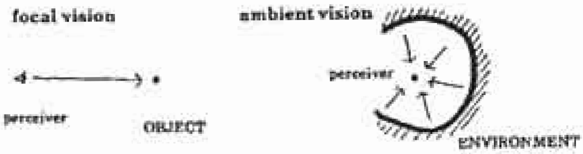


Fig. 1 Dual mode in visual perception of the environment

Table 1 The differences of focal and ambient vision

	focal vision	ambient vision
source of information	discrete elemental features (objects)	continuous environmental features (surfaces)
perceiver's attitude	focal attention conscious / attentional	scattered attention unconscious / subliminal
nature of information processing	perceptual selection detailed inf. per element time consuming process	perceptual integration limited inf. per element instant process
outcome functions	understanding detection / recognition of objects	global impression / feeling body locomotion attention evocation / orientation

Hypotheses and design criteria of the program

In order to develop a tool to describe ambient visual information, discussion about the nature of ambient vision has to be extended to postulate hypotheses which serve as design criteria of the program.

Continuous environmental surfaces were considered to be the source of ambient information. The basic units which convey ambient visual information were postulated to be areas of visible surfaces divided up by differences in meaning for basic human behavior or differences in their "affordance" (in Gibson's term, 1978). They are, in this study, surfaces of pavement, earth, grass, trees, building and sky. Pavement, for instance, affords walking but can afford neither digging nor laying, trees afford going through or under but building wall cannot afford. The way of dividing environmental surfaces is similar to Thiel's (1981) concept of "basic pattern areas" in his "notation" and is virtually made following his ideas, but is different in two aspects: (1) objects are excluded because they are likely to become a source of focal vision, and (2) surfaces of the same affordance are not distinguished regardless of their texture or color.

The two visions can be characterized by the difference of strategies for controlling the flow of information. Focal vision eliminates unwanted information by selective attention while enhancing the elements attended to. Ambient vision deals with broader areas, with scattered or unconscious attention and grasps the global impression very fast. The instant process which integrates information from broad areas implies that ambient vision performs a simple statistical analysis. The program, therefore, must assess visual information from all directions around the perceiver and conduct some statistical calculation for integration although accuracy of details is not required.

The program, in practice, assesses surrounding scenes by numerous scanning lines radiated from a station point in all directions with equal density, and records the array of visible surfaces of various components and the distance between the surfaces and the station point with which spatial volume is calculated. The concept of spatial volume is similar to Benedikt's (1979) "Isovists", although the measurement method is different.

Having this data, it then calculates various measures which are expected to describe the impact of "visual radiation" from the surfaces surrounding the perceiver. A more detailed explanation of the program and process of its application will be made in the following exploratory case study.

A CASE STUDY

Settings

Two adjacent public housing sites on the hillside of Kobe city were chosen for testing the program. Both of them have five story multi-family housing (see site-A and site-B in Figure 2). They have, however, quite different site plans in terms of land configuration (artificially formed vs. natural), layout of buildings (regular vs. irregular), road pattern (grid vs. curving), amount of vegetation (small vs. large), and capacity of parking space (large vs. small). Therefore, people may have different views of landscape and may have different feelings in response to the views.

In order to confirm these differences, thirty-seven individuals were interviewed about their impressions of the places after visiting the two sites. From the responses obtained by the free interview (701 words and phrases), descriptions of the state or quality of particular elements (e. g. "well maintained garden") as well as direct expressions of preferences (e. g. like to live") were omitted, and adjectives which express the global impression of the places were extracted and compared. The following are typical responses which clearly show the contrast between site-A and site-B respectively as: ordered vs. disordered, monotonous vs. varied, artificial vs. natural, restless vs. restful.

Creating data of the site in computer memory

Based on the site plan, graphic data was created in the frame memory of a personal computer. Building shapes and borders between different land covering materials were first drawn on the display, and then painted according to a color code to identify building height and land covering

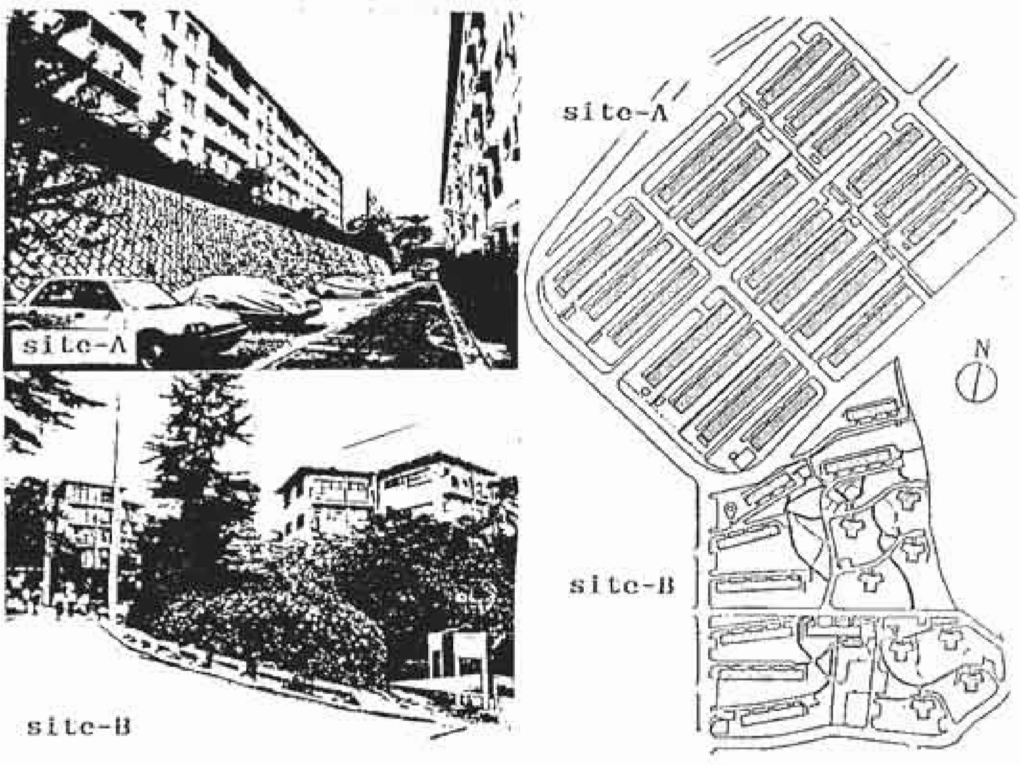
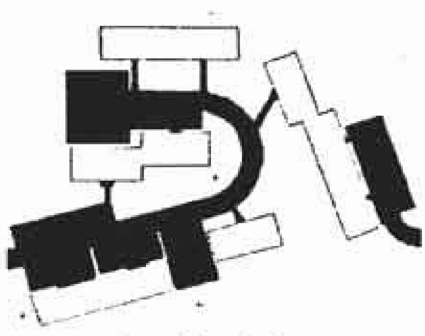


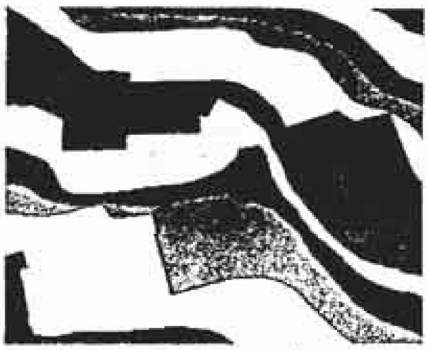
Fig. 2 Two settings for the case study

materials such as pavement, grass, and earth (Figure 3-a). If the site plan was drawn by a computer aided drafting (CAD) system, the vector data of lines could be transferred and directly utilized in the program. The data of land configuration of the site was similarly put into the frame memory with every one meter change of the land height identified by coded color on the display (Figure 3-b). Each of the trees and bushes in the site was recorded regarding its height, size of crown and location, and then put into computer memory (Figure 3-c).

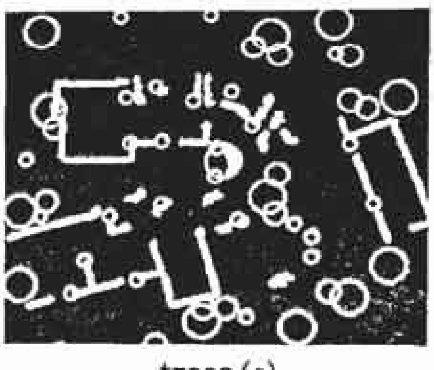
Fig. 3 Data of the site



site plan (a)



land configuration (b)



trees (c)

Measurement procedure

From the station point around which the visual state is to be assessed, a scanning line is drawn in each of the colored site plans on the display, and the land height, land covering materials and building heights along the line are identified by color code. With this data, a vertical section along the scanning line is drawn on the other plane of the display. Using the tree data, a vertical section of trees cut along the scanning line is calculated and drawn on the above obtained section.

In this section, many scanning lines are radiated from the station point at eye level (1. 5 meters high). Each of the scanning lines extends until hitting the outline of sectional surfaces and reading color code to identify whether it is, for instance, paved ground, buildings or trees. At the same time, the length of the scanning line is calculated (see Figure 4). If the scanning line does not hit any surfaces within the equivalent of fifty meters, it is judged as going up to the sky.

The above operations are repeated by changing the azimuth of scanning line by five degrees until all directions around the station point have been assessed. Figure 5 schematically shows the result of these assessments. In this figure, each cell of the chart represents a result obtained by one scanning line, and each column of 29 cells represent all results for one section of one direction, thus it has a total of 2,088 cells for all directions.

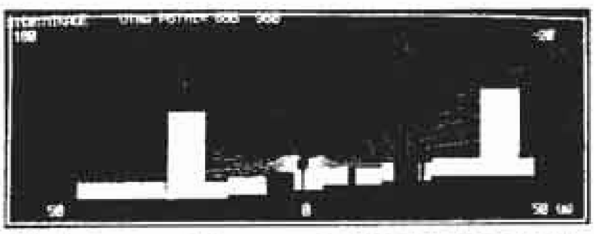
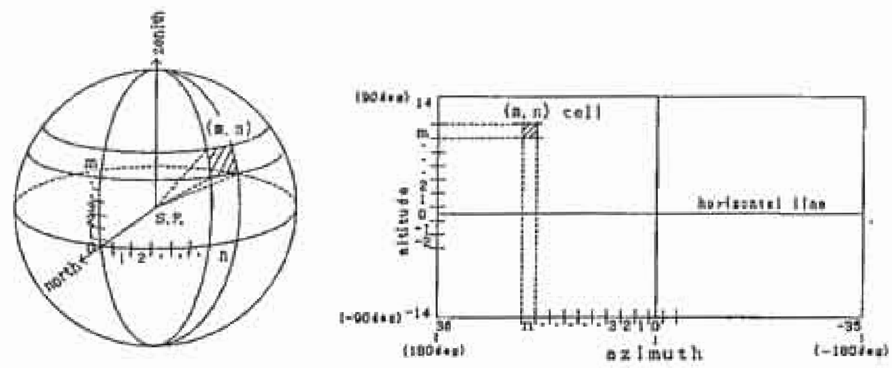


Fig. 4 A process of the measurement (analysis of a section)

Several numerical measures were extracted from the charts to examine possible implications relating to human perception of a place. A ratio of total area of solid angle for each visible component (RVC) was calculated from the chart showing the array of components (see Figure 6-a), and a measure of visible spatial volume (VSV) was represented by a mean radius of a hemisphere which is equivalent to the volume



(1) Ratio of Visible Component of "x" (RVCx):

$RVCx = n_x / N$

n_x: number of cells identified as component "x"

N : number of all cells (29 x 72 = 2088 cells)

(2) Visible Spatial Volume (VSV):

$$\log VSV = \sum_{m=0}^{14} \sum_{n=-35}^{36} \log L_{mn} / N_h$$

L_{mn}: length of visual line pointing (m,n) cell

N_h : number of cells of horizontal and upward directions (15 x 72 = 1080 cells)

Fig. 5 Operational definitions of the measures

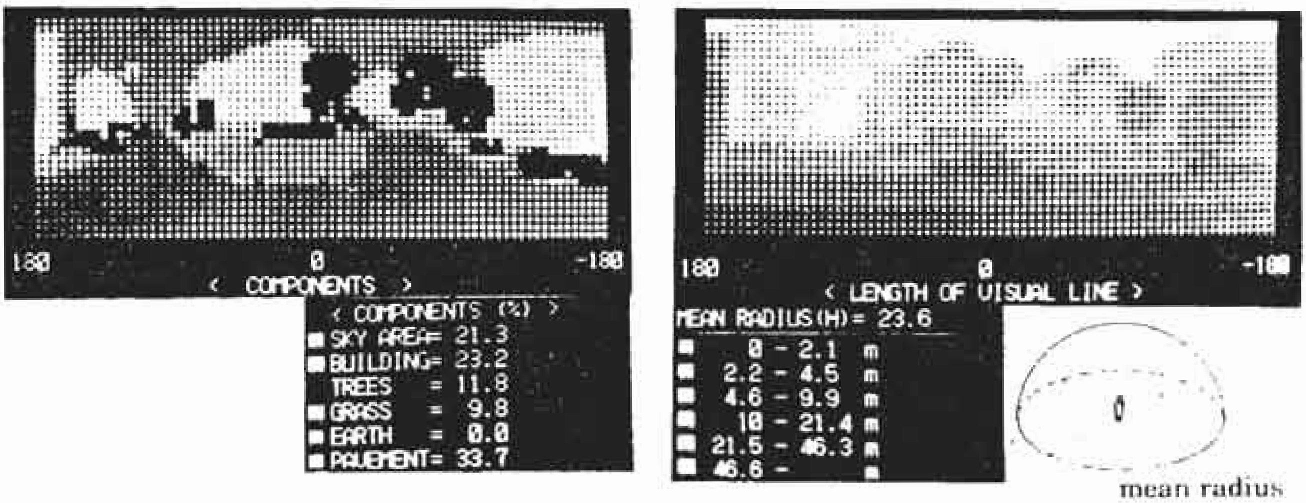
formed by integrating the visual lines above horizon of various lengths (see Figure 6-b).

Results

The program was applied to a sequence of station points along a typical path in both of the two sites. Figure 7 compares the results of twenty consecutive points five meters apart. Site-A, which was judged as "monotonous" and "artificial", has very little variation in terms of the visible spatial volume and ratio of visible components. Its average visible area of trees occupies less than ten percent. As for site-B, it was quite varied in both of the measures, and an average visible area of trees exceeds thirty percent. These numerical measures well represent the impressions of the place.

The Accuracy of the Measure

The above results were obtained by using a simple model created in the computer memory, and the density of scanning lines are rather coarse. The accuracy of the obtained measures are, therefore, examined against the actual view



(a) RVC (b) VSV

Fig. 6 An example of the results of the assessments

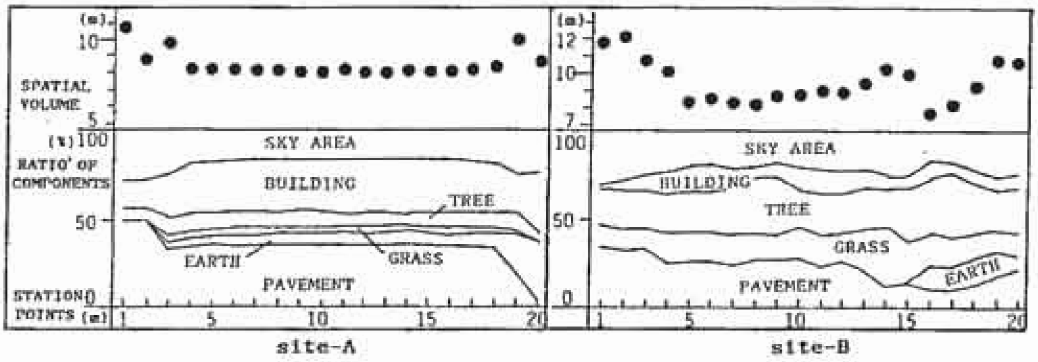


Fig. 7 Sequential profiles of visual information of the two settings

of the site. Figure 8-a was drawn from a photograph taken on site using a hemispherical projection (fish-eye) lens, and Figure 8-b was drawn using the data generated by the computer for the same station point. The area of components of both graphics were measured and compared. Figure 9, which compares eight different scenes, shows a correlation diagram with a regression line. The high correlation coefficient (0.95) indicates the good accuracy of the measure obtained by the computer generated chart.

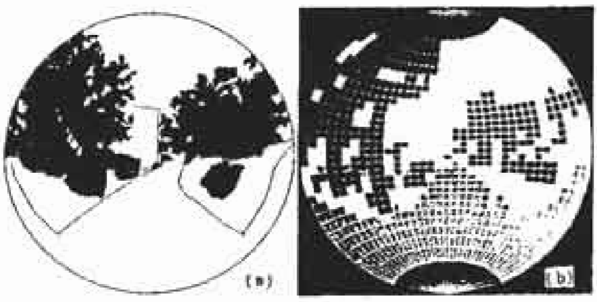


Fig. 8 Hemispherical Projections

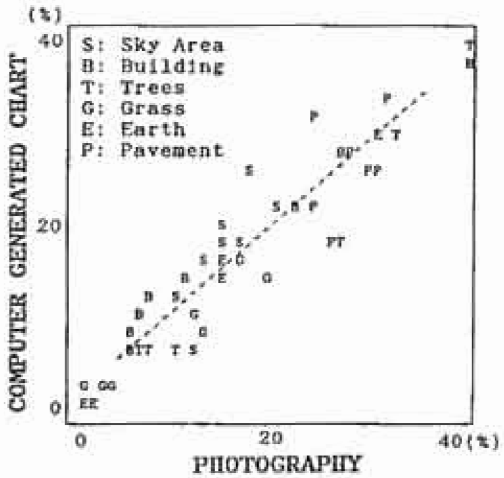


Fig. 9 Area of components by two different means

AN EXPERIMENTAL STUDY

In order to examine quantitative relations between human responses and the measures obtained by the program, nine simulated landscapes of housing neighborhood were assessed.

Method

In addition to the two existing settings used in the previous case study, seven site plans which were systematically different in density of vegetation were created and scale models (1/250) of all sites including the existing ones were made. Stimuli of the experiment were slides of the models taken by a model scope (Fig. 10).

A total of forty-three subjects comprised of twenty-two male and twenty-one female students were employed in this experiment. A sequence of scenes along a typical path in each of the nine housing sites was presented to the subjects by a series of slides taken at ten consecutive points each ten meters apart. The task of the subjects was to rate each simulated landscape using a rating sheet which contained ten bipolar adjective pairs (Table 2). These adjectives which express the global impressions of a place were selected from the words obtained in the previous case study.

The program was applied to each of the nine sites and numerical measures of eight consecutive points along the same path as the above experiment were obtained.

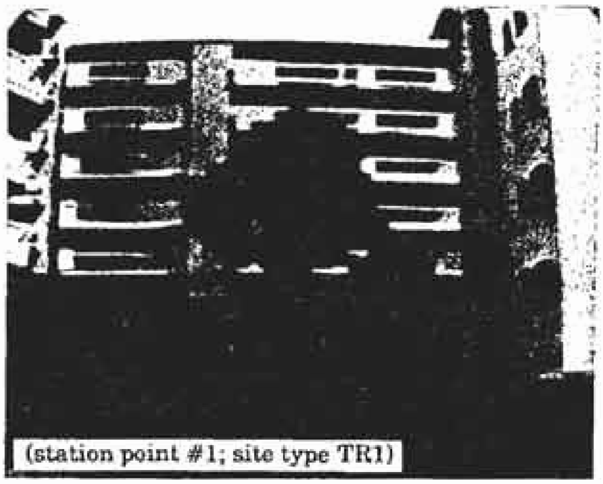


Fig. 10 An example of the stimuli

Table 2 Adjective pairs

1	monotonous	–	varied
2	natural	–	artificial
3	oppressed	–	open
4	bright	–	dark
5	pleasure	–	boring
6	ordered	–	disordered
7	unique	–	featureless
8	wet	–	dry
9	restful	–	restless
10	spacious	–	tight

Results

For each site, profiles of the visible area of components and the spatial volume were obtained as shown in Figure 11. From these data, the coefficient of sequential variation, which is an average difference between two consecutive measures divided by the mean value, was calculated.

Figures from 12 to 15 are part of the results which show the relation between the subjects' judgment of the landscapes and the average ratio of visible area of each component and the visible spatial volume. In the figures, the horizontal axis of the ellipse shows the standard deviation of the eight measures while the vertical axis indicates confidence interval (95%) of the subjects' rating.

Figure 12, which shows the relation between the judgment of "natural - artificial" and the visible area of greenery, suggests that greenery softens the negative impression of "artificial," but the positive impression of "natural" would not be enhanced by an increase of greenery beyond 15 percent. A reciprocal relation was obtained in the case of visible areas of buildings (Figure 13). The visible area of the sky is influential on "wet - dry" judgment as seen in Figure 14. A similar relation was obtained for the rating of "dark - bright." Figure 15 indicates that the visible spatial volume correlates well with "oppressed - open."

Regarding the sequential variation of components, the visible area of buildings among others can explain the rating of "monotonous -

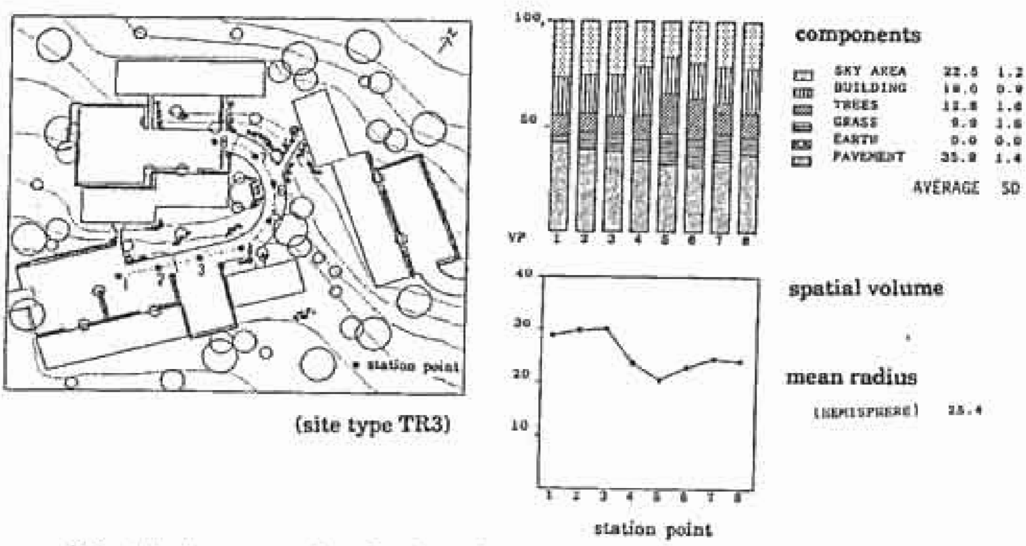


Fig. 11 An example of a site plan and a result of its measurement

varied" in the lower range of variation (Figure 16). The sequential variation of visible spatial volume was found to relate with "unique - featureless" (Figure 17) as well as "pleasure - boring. " In the above two figures, site-B, in which the direction of the path is frequently changed, was rated as more "varied" and "unique" than expected by the measures. This may suggest that a combination of measures is necessary for obtaining more clear relations.

As for the judgments of "restful - restless" and "spacious - tight," no significant relations were extracted probably because the present simulation method using slides was inadequate to elicit these feelings.

CONCLUSION

The data from the present empirical study generally supports the validity of the measurement of ambient visual information, and the

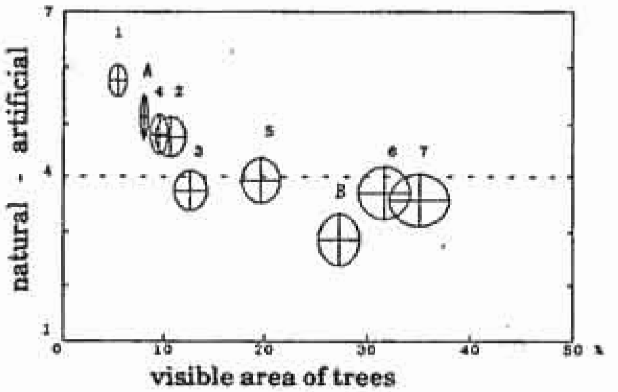


Fig.12

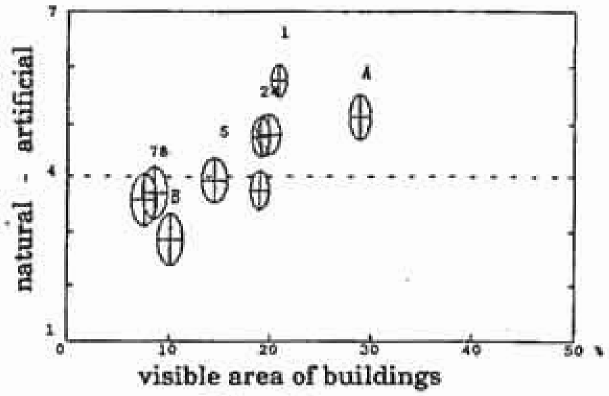


Fig. 13

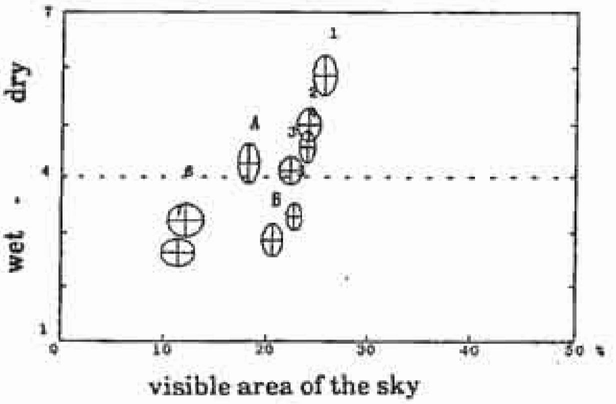


Fig.14

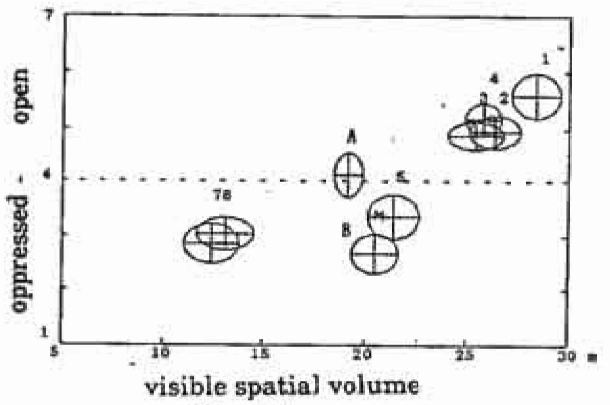


Fig. 15

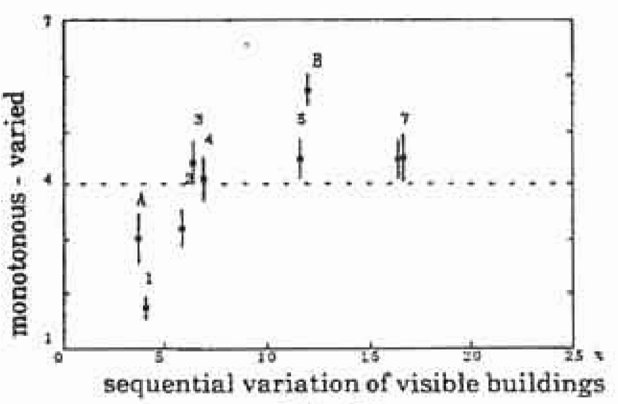


Fig.16

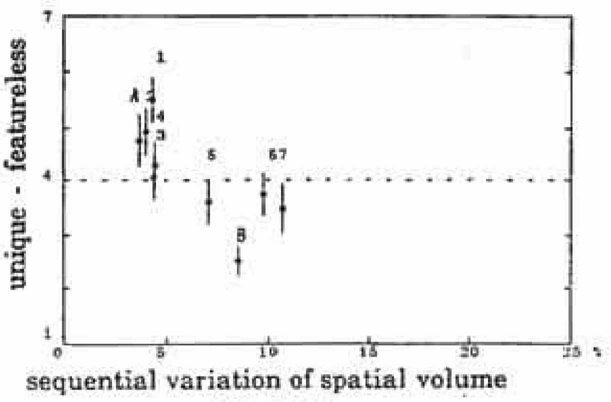


Fig. 17

numerical relations between some measures obtained by the program and human responses was clarified, although more detailed analysis is necessary to construct a explanatory system for predicting human perception of ambience of a place.

If the system is established, it would be a useful tool to assess the unbuilt environments for not only environmental researchers but also environmental designers. Although it may require some effort to establish the model by inputting the data of the site, once we have the model, it is quite easy to assess the visual state at any point in a proposed environment. Using a part of the data, it is also possible to produce a crude perspective drawing which can provide a view at any direction from the station point. If an environmental designer uses computer aided drafting (CAD), the model is obtained without extra effort, and he or she can easily and interactively use this system in the design process.

FOOTNOTE

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