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Investigation of the Characteristics of Sequential Landscape Elements using Images for Historical Space

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Abstract

This study was performed based on a sequential landscape investigation method of the best-known Buddhist temples in Korea to determine its characteristics through the comparison of the applied data acquisition method and the quantitative data of employed elements. The major objectives of this study can be determined as follows: first, consideration of the sequential method using image data; second, configuration of a subjective site and investigation of its environments; third, examination of landscape elements using images produced using normal and fish eye lens; and fourth, suggestion of a direction that investigates the characteristics of sequential landscape using a manner of visual perception through the comparison of the characteristics of landscape elements. Finally, a method that approaches the objective in the aspect of the visual world rather than the sequential approach in the visual field was summarized.

Keywords**:** Sequence, Visual world, Visual field, Visual Perception

1. Introduction

The Gestalt theory has been largely mentioned in studies of the visual perception in human being since the mid-20th century and has been as a recent trend in many urban and architecture studies. Furthermore, urban space analyses have been applied based on visual perception theory owing to studies of Kevin Lynch and Philip Thiel. Moreover, the subject has been verified and evaluated in various aspects by several other researchers in this field.

On that account, this study investigates the characteristics of sequential landscape constituents related to 'Changes in visual perception experienced by the motion of human being'. In addition, this study focuses on the investigation of the characteristics of landscape using camera images, which are known as an excellent method in the aspect of cost and time savings when

compared to other methods. Photographing using normal and fish eye lens is a representative method for obtaining such camera images.

This study attempts to clarify the sequential characteristics of such images through applying an analysis for the sequential landscape constituent of these images. 360° panoramic images, which can be used in certain sequence studies, show a limitation in public uses due to the specialties in its camera and lens(Note 1). The visual category, as mentioned above, is a sequential experience method determined by Gibson and Philip Thiel through their concepts of a visual world and a visual field. Additionally, sequential studies on urban spaces have been conducted based on their studies(Note 2).

The following sections address the characteristics and differences in landscape constituents occurred due to the difference of approach methods from the two categories of visual perception. Later, future studies the knowledge gained from this study we act as a guideline in characteristics comparison of sequential landscape between regions or countries.

2. Examination of conventional studies and positioning of this study

There can be no doubt that the history of studies on factors that affect the human's visual perception can be traced back to an early period of time. Human visual perception can be understood through a process of simple deduction that estimates thought ability in judgments from experiences or personal interests before it is verified through certain specific academic studies.

As mentioned above, the systematization of such theories, [A study on the origin of the visualization of human being] was performed in the Greek age of Socrates, Platon, and Aristoteles. However, most of these theories are close to deductive studies that are based on philosophy and have been developed as a type of experimental study by Bacon (1561~1626) and Descartes (1596~1650) in the 16C.

Then, it becomes a field of scientific psychology by Wundt and others in the 19C (Kim, 1981 ; Rita et al., 2002) and that took affects in fields of architecture, urban, and landscape in modern and contemporary ages.

The Gestalt theory that is extended in the area of life spaces becomes a chance that proposed a direction to visually read urban spaces, many that were done by Gibson, Kevin Lynch, and Philip Thiel. In particular, Philip Thiel who had proposed a presentation displaying continuous experiences as a tool of space design and tried to verify its reality as a manner of record for the changes in space forms by symbolizing it.

As noted above, the theory that has been largely quoted as a direction related to the visual factor of human being is the Gestalt theory in which the most widely used data is image data that represents a three dimensional space as a two dimensional space.

Although drawing, figure, map, and other materials were used in the period, digitalized data and images have been used as generalized materials in this

civilized age. Studies on the investigation of the characteristics of landscape using this image data increased since the 1970s in Japan (Takei et al., 1971; Oyamada, 1973).

The investigation methods of the characteristics of landscape can be classified as scene landscape and sequential landscape methods, according to the configuration of viewpoints. In the case of the scene landscape, objects are viewed from a fixed viewpoint. In a sequence landscape, objects are perceived with the addition of time, speed, and direction for a target scene.

If the scene landscape grasps detailed figures based on instantaneous captures, the sequential landscape method is a study that digests figures based on continuous changes (Fig.1). In order to investigate such continuous changes, it is necessary to develop a direction that provides the next stage. Various methods have been used for the purpose including the development of new tools (Kim, 2007).

In Asian countries, 'Investigation of the state of continuous changes' studies it is still limited in some spaces for shopping mall, exhibition area, road, and street space in Korea. In Japan, although there are some cases that investigate historical spaces as same as this study, it shows only some few cases compared to other areas. Thus, it is necessary to endeavor to escape limitations (Takei et al, 1971) in the selection of target sites(Note 3).

3. Introduction of subjective sites and study methods

The objective of this study is to verify the sequential characteristics of space. Previous study (Kim, 2007) provided a viewpoint configuration method according to the physical conditions of subjective sites (Fig.2).

Furthermore, this study attempts to prepare a guideline that uses data in the investigation of the characteristics of sequential landscape constituents through an acquisition process of image data. First, this study determines major historical spaces in Korea that are regarded as important sites in the aspect of culture and leisure in urban life as

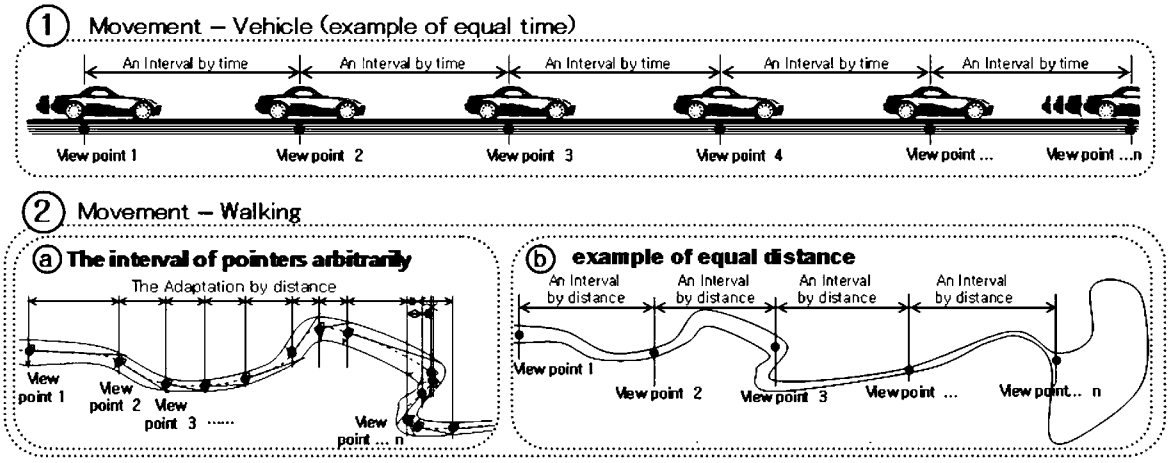

Fig.1. Patterns of sequence landscape through the means of movement

subjective spaces. This study also considers relative importance and representativeness in the aspect of reputation and importance in such spaces for the subjective of comparison.

Three representative treasures Buddhist temples in Korea were selected as subjective spaces. The subjective section that shows the highest frequency of visitors was determined from the parking lot to the main temple. Experiential movement in sequential landscape for each temple is based on walking sequences. (The introduction of historical and geographical sites was mentioned in the previous study (Kim, 2007). Thus, this study will introduce it briefly) (Fig.3) (Table.1).

The lengths of the approach road in the subjective spaces were determined as 1,799m (HAEIN), 1,715m (TONGDO), and 1,327m (SONGGWANG) respectively. In addition, a method 'that determines the interval of pointers arbitrarily' was applied as a viewpoint0configuration method(Fig.4).

The eye-stop that affects the viewpoint configuration for these three sites are (1) curved, branched, and bended roads; (2) changes in the ground level; and (3) appearance of buildings or objects. In addition, the average standard

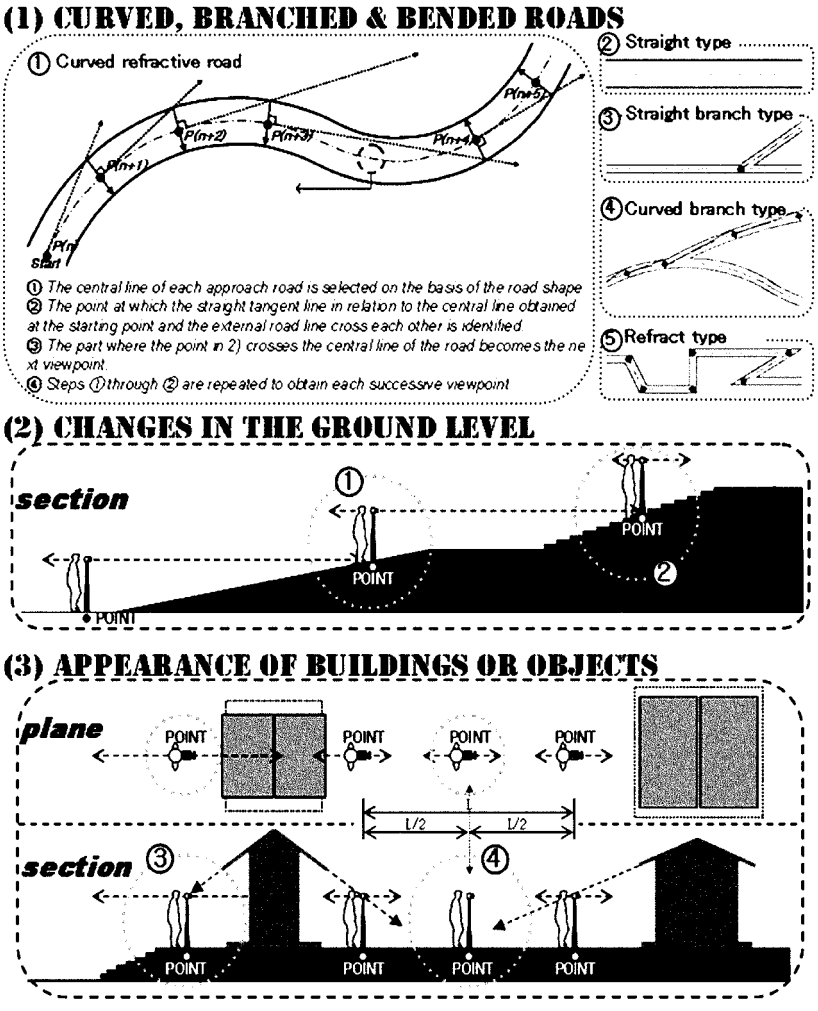

Fig.2. The plan and section of the Viewpoint Setting method

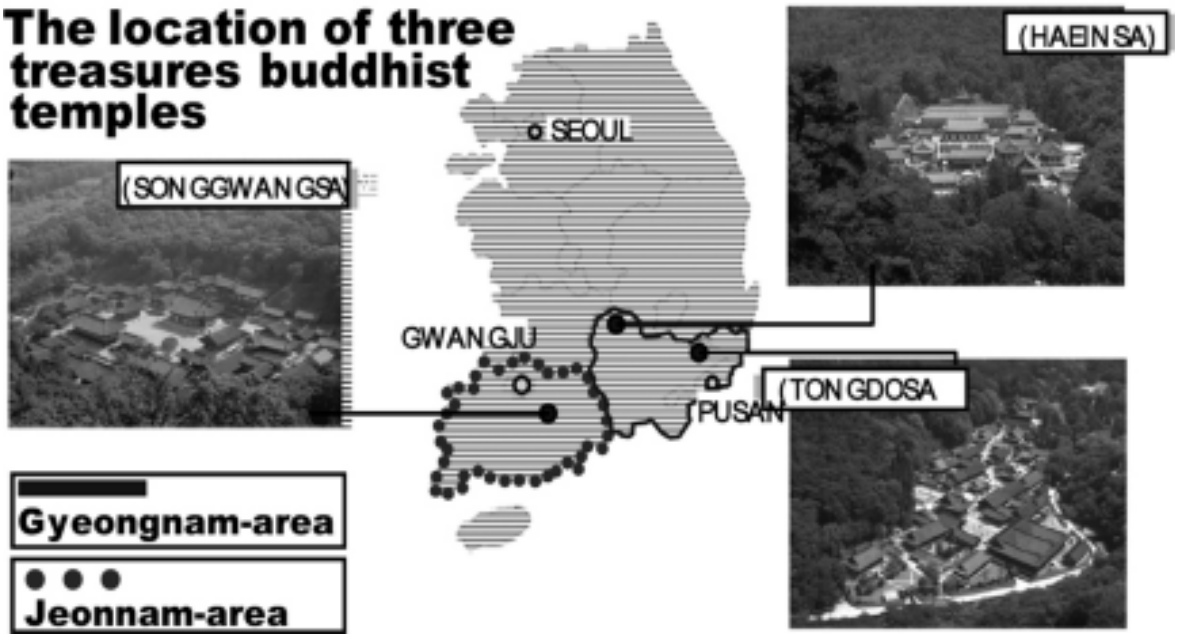

Fig.3. Site of Three Treasures Buddhist temples

	HAEIN	TONGDO	SONGGWANG
TEMPLE	Located in Habcheon Gun, Gyeongsangnam Do, Hae-in Buddhist Temple is said to have been built in the third year of King AejangwanG's reign (802AD) over Silla. One of the best-known Buddhist temples in Korea, the temple stores various Buddhist texts in its Daejanggyeongpanjeon.	Located in Yangsan, Gyeongsangnam Do, is said to have built in the fifteenth year of Queen Seondeok's reign (646AD) over Silla. Also one of the best-known Buddhist temples in Korea, the temple stores the "Jinshin sari" of Buddha. It is also famous for a staircase named Geumgang Gyedan.	Located in Suncheon, Jeollanam Do, Song-gwAng Buddhist Temple was first built under the name of 'Gilsang-sa' during the last days of Silla (late in the 10th century AD). Also one of the best-known Buddhist temples in Korea, the temple is famous for the array of reputable and respected Buddhist monks it has produced.
DISTANCE	1799m	1715m	1327m
CHANGE OF HEIGHT	98.6m	20.9m	54.4m
VIEWPOINTS FOUND	63point	40point	47point

Table.1. Site Overviews

deviations of the circulation axis caused by changes in the shape of such approach roads were investigated as 32.41, 22.93, and 19.54 for HAEIN, SONGGWANG, and TONGDO respectively. Also, changes in the ground level were recorded as about 98.6m, 54.4m, and 20.9m for HAEIN, SONGGWANG, and TONGDO, respectively.

The continuous viewpoints in each section were verified as 63, 40, and 47 points for HAEIN, TONGDO, and SONGGWANG, respectively. An image data acquisition method that uses a

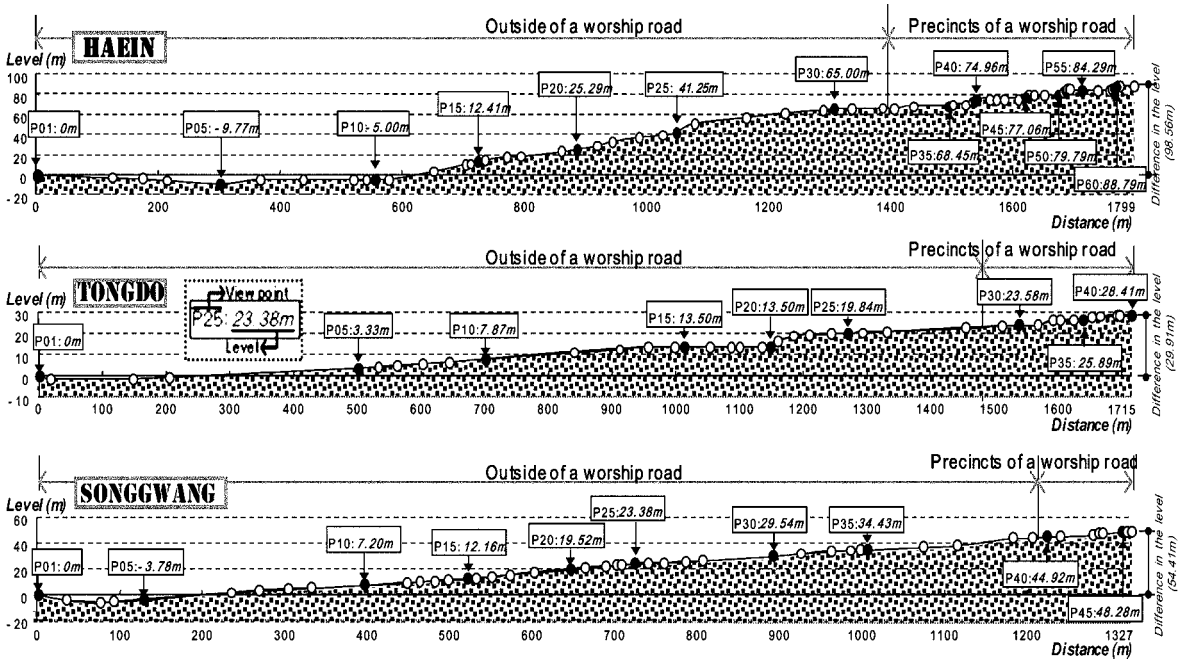

Fig.4. Change of Earth level and Generation of Viewpoint in Sites (non scale)

camera to take images from configured viewpoints was applied by considering operability, site reproducibility, and cost. In general, studies on the visual perception demonstrated by using the Gestalt theory have been performed by Lynch, Gibson, Thiel, Kazuhiko Miyauji, Hideke Shimizu, and Nobuyosi Fujimoto.

In particular, Gibson and Thiel et al. proposed an idea that there is a close relationship between sequential experiences and omni-directional angle (360°) around human being through the fact that "the objective of visual perception will not recognize the view in front of eyes but surroundings" and recorded continuous scenes according to the passage of time in their study(James, 1950) and writing(Philip, 1977). Gibson and Thiel determined the boundary of view angles as a visual field and a visual world and attempted to clarify the characteristics of the boundary. Also, they presented that the best expression on the boundary of view angles are from normal lens and fish eye lens.

This study will use the investigation of sequential characteristics in similar spaces between different regions for future study through applying the comparison and verification of both image application methods from this point of view. The images used in this study were produced using a camera, Nikon Coolpix-8800 fish-eye lens set and Canon 350D-28mm lens. By considering the conventional studies on the analysis of the characteristics of sequential landscape that mainly focus on the analysis of user's preference and satisfaction (Kim, 2004), this study attempts to clearly verify its appearance, occupancy, and type using the quantitative data of the landscape constituent in actual sites rather than such aspects.

4. Appearance characteristics for each element and the characteristics of continuous appearance

Objects recorded in the landscape constituent of the approach road in these three temples were about 43. These objects were classified as three characteristics, such as natural (A), artificial (B), and possible movement (C). Then, these characteristics were divided into 15 element types, such as A01~A04, B01~B09, C01, and C02(Fig.5).

For evaluating the influence of the landscape constituent on the visual perception, the results of the investigation of the appearance rate and its continuous appearance rate of elements were classified as three groups, low group (Ot), medium group (Os), and high group (Op) (Shinohara, 1982) (Note 4). The same method was used for the continuous appearance rate.

However, it was clear that there were some differences in appearance frequencies in the same category in both images. In addition, the correspondence rate for each viewpoint through the comparison of appearance frequencies showed that the elements of A03, A04, B03, B04, and B07 decreased higher in values than the average correspondence rate(Fig.6).

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It was due to the fact that images were too small to verify (fish eye images) and were missed in an angle of view. This study considered it as a factor of 'an obstruction of the verification of an appearance section' and named it "visual world missing (hereinafter called as Mvw)" and "visual field missing (hereinafter called as Mvf)", respectively.

Here, the Mvw and Mvf represented the total appearance rate (world or field)

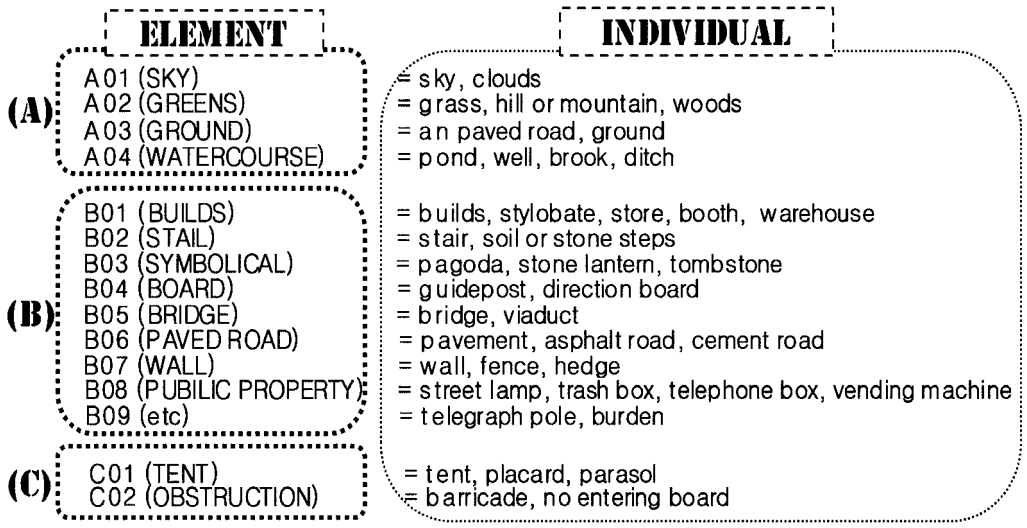

Fig.5. Classification of landscape element

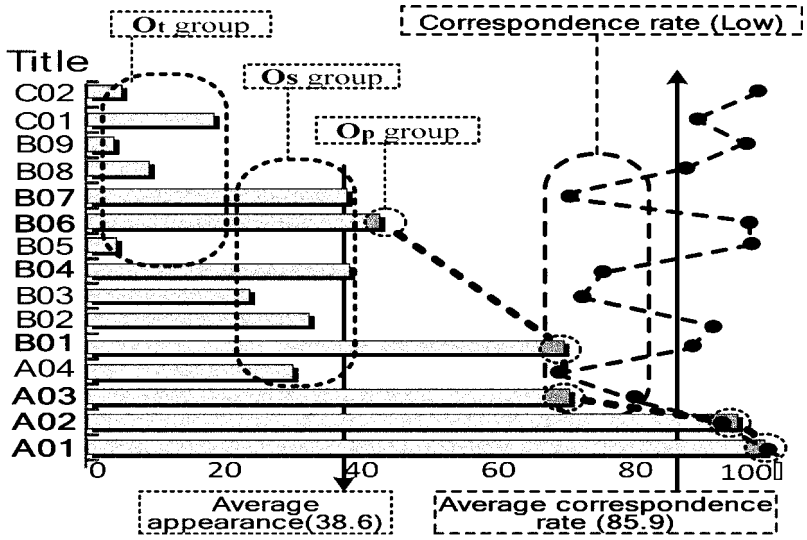

Fig.6. Appearance and correspondence rates for each element

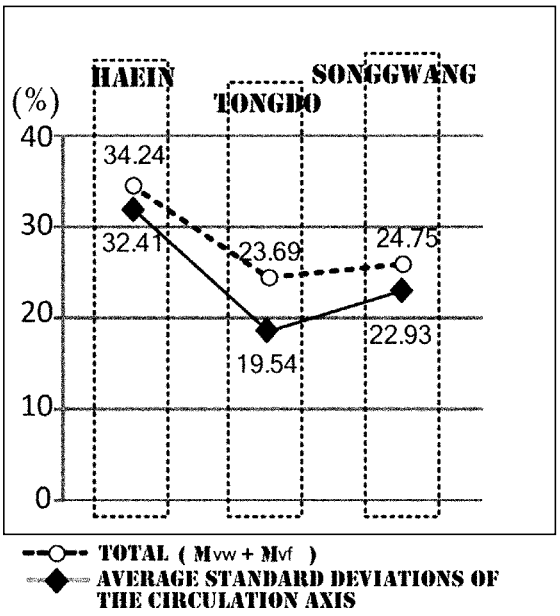

Fig.7. Total missing rates & Standard deviations of the circulation axis

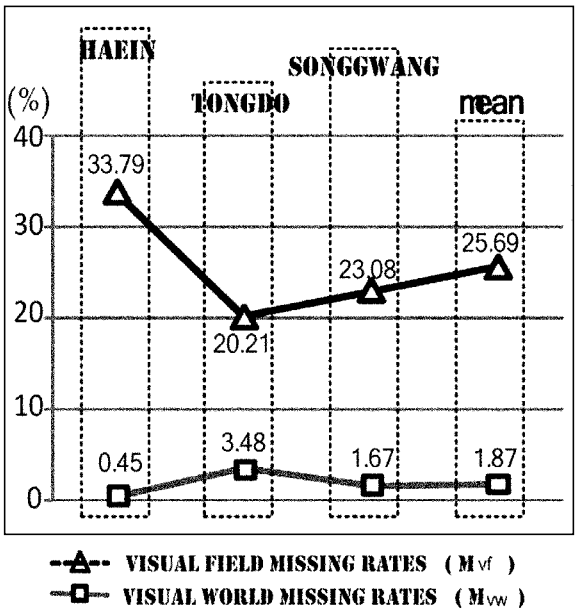

Fig.8. Visual field & Visual world missing rates

for each element in the total appearance rate (world+field) of landscape elements whereas HAEIN and TONGDO showed the highest and the lowest average value, 34.24% and 24.75%, respectively (Fig.7).

It showed similar differences to that of the standard deviation recorded in the change of the circulation axis for each site as investigated in the previous study. Whereas, the site that showed difficulties in the guarantee of desirable viewpoints due to the large variance of the circulation axis represented high missing rates of elements. The average Mvf rate (25.69%) was significantly larger than the average Mvw rate (1.87%) (Fig.8).

In addition, the Mvw occurred in the appearance of long and linear elements,

Normal lens				
title	H	T	S	Total
A01	59	40	47	146
A02	50	40	45	135
A03	20	29	40	89
A04	11	7	10	28
B01	43	24	33	100
B02	27	9	9	45
B03	6	15	0	21
B04	23	13	10	46
B05	2	3	0	5
B06	25	28	6	59
B07	20	9	13	42
B08	1	3	2	6
B09	1	0	0	1
C01	5	3	12	20
C02	3	1	0	4

Fisheye lens				
title	H	T	S	Total
A01	63	40	47	150
A02	63	40	47	150
A03	47	32	43	122
A04	26	16	20	62
B01	47	27	35	109
B02	33	9	10	52
B03	24	19	7	50
B04	37	16	16	69
B05	3	5	0	8
B06	34	28	7	69
B07	32	22	18	72
B08	11	3	7	21
B09	2	0	9	11
C01	10	6	19	35
C02	7	2	2	11

Table.2. Number of appearance for each element

FISH EYE LENS				RELATIVE FREQUENCY LEVEL	NORMAL LENS			
TITLE	PIXEL	RELATIVE FREQUENCY	CUMULATIVE SUM		CUMULATIVE SUM	RELATIVE FREQUENCY	PIXEL	TITLE
A02	68394	0.250	0.250	DOMINATE (Op)	0.320	0.320	83233	A02
A01	64277	0.235	0.485		0.495	0.175	45601	B01
A03	49957	0.183	0.667		0.639	0.144	37442	A01
B06	33968	0.124	0.791		0.764	0.126	32728	A03
B01	23979	0.088	0.879		0.869	0.105	27340	B06
B02	9945	0.036	0.915	ADDITION (Os)	0.911	0.042	10930	B02
B07	7463	0.027	0.943		0.940	0.029	7524	B07
A04	5042	0.018	0.961		0.959	0.019	4826	B04
B03	3420	0.012	0.973		0.974	0.015	3798	A04
B04	2812	0.010	0.984		0.985	0.011	2905	B03
C01	1470	0.005	0.989	CHANCE (Ot)	0.993	0.008	2063	C01
B05	1152	0.004	0.993		0.997	0.005	1203	B05
B08	836	0.003	0.996		1.000	0.003	726	B08
B09	577	0.002	0.998		1.000	0.000	0	B09
C02	428	0.002	1.000		1.000	0.000	0	C02

Table.3. Norm-referenced evaluation using pixel values

such as drain and fence, and the Mvf largely occurred in a regional circulation process section (for instance, a yard) or an extension area in viewpoints (HAEIN: HP-27; TONGDO: TP-17; and SONGGWANG: SP-35).

5. Occupancy characteristics for each element

Factors of landscape constituents that affect the visual perception can be varied according to the degree of occupancy beside the appearance frequency. In order to verify the occupancy of landscape elements for each viewpoint, the maximum pixel of HP-10 was A02 (625446Pixels), and the minimum pixel of HP-01 was B08 (32Pixels) from the results of the investigation of fish eye lens images (809480pixels) and normal images (798984pixels) produced from the same viewpoint(Note 5).

The route conversed values of the original pixel values for each element were used to minimize the difference between groups, and the results and occupancy rates were also classified as three groups (Table.3).Based on the

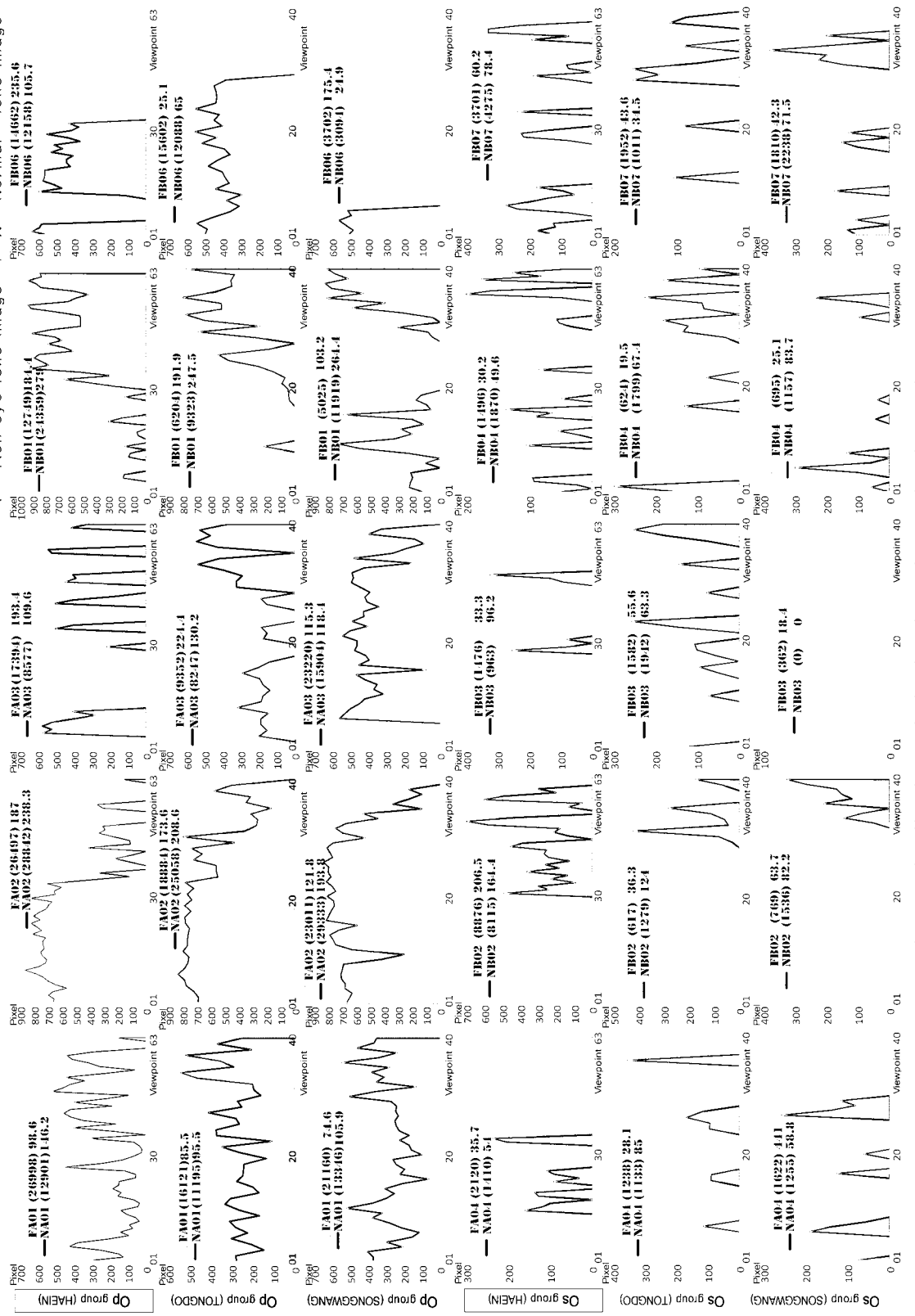

Fig.9. Distribution of pixel values for each Viewpoint

influence of the appearance and occupancy on the entire section or visual perception according to viewpoints, the elements of A02, A01, A03, B06, and B01 in the Op group can be classified as dominant landscape objects, and the elements of B02, B07, A04, B03, and B04 in the Os group can be classified as addition landscape objects. Also, the Ot group, which showed low values in the appearance and occupancy, can be determined as a type of chance landscape object.

In the comparison of the Op and Os groups that showed relatively large influences on the visual perception, the tendencies of ceiling and ground elements showed high values, such as A01, A03, and B05, in the aspect of a visual world, and the tendencies of screen elements, which show a front appearance tendency, showed high occupancy rates in the aspect of a visual field (Fig.9).0The visual world represented larger deviations than other side besides five elements (H06, H04, T03, S06, and S03).

Thus, differences in occupancy rates according to viewpoints showed large variances due to the large deviation in the side of the visual field. The elements of A01 and A02 showed a uniform distribution for all sections, and the ramp of the temple where the value of A02 decreased represented an increase in the occupancy rate of B01.

6. Categorization of occupancy rates for each viewpoint

In addition, it is expected that the elements of A03, B01, and B06 showed a disappearance effect in some sections and that significantly affected the effect of perceptional transition for an experiencer. Then, it is evident that the elements of A03 and B06 contrarily occupied for each other. Furthermore, the elements of A04, B02, B03, B04, and B07 affected the detailed types of landscape constituents as a form that decreases the continuity a bit in a short period of time or through few times.

The influence of each image data on the characteristics of landscape can be evaluated using three different scales, such as Op, Os, and Ot. This study, however, performed a categorization process based on each occupancy rate under the hypothesis that the influence of each data on elements will be varied even though elements were in the same group as noted above. As a result, the primary group consists of three elements, Green (G), Paved Road (P), and Etc (E), from the visual world. The secondary group consists of eight elements, such as G1, G2, G3, G4, P1, P2, P3, and E (Fig.10).

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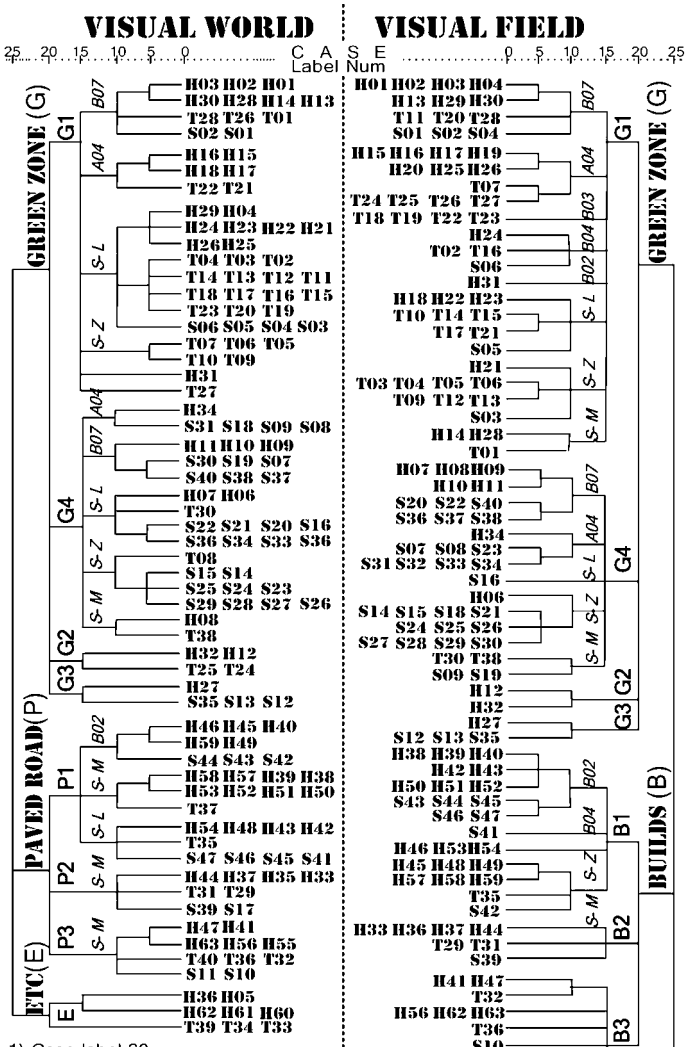
In the case of the visual field, the primary consists of three elements, Green (G), Builds (B), and Etc (E).The secondary group consists of eight elements, G1, G2, G3, G4, B1, B2, B3, and E. Although the number of type in the primary and secondary groups showed the same number, the Paved road was a dominant element in the visual world images, and the Build was a dominant element in the visual field images.

It was due to the characteristics of the visual field that shows a large response for the tendencies of front appearance elements and the characteristics of the visual world that represents an active response for the tendencies of ceiling and ground occupancy elements as mentioned in 4-2.

The images classified three and eight types of images in the primary and secondary groups, respectively, can be categorized as (Element name: a single appearance in the elements that show large occupancy rates more than 100 pixels); (S-M: a multiple appearance in



1) Case label 20
G1=(Green zone- Paved road),
G2=(Green zone- Builds),
G3=(Green zone- Sky),
G4=(Green zone- Ground)
P1=(Paved road- Sky),
P2=(Paved road- Green zone), P3=(Paved road- Ground), B1=(Builds- Sky),
B2=(Builds- Green zone), B3=(Builds- Ground), E=(Etc)

2) Case label 15
B07, A04, B02, B03, B04 = (A single appearance in the elements that show large occupancy rates more than 100 pixels)
S- M=(a multiple appearance in the elements that represent large influences more than 100 pixels),
S- L=(low occupancy rates less than 100 pixels),
S- Z=(no appearance in elements in the Os group)

Fig10. Dendrogram by the categorization of for each image

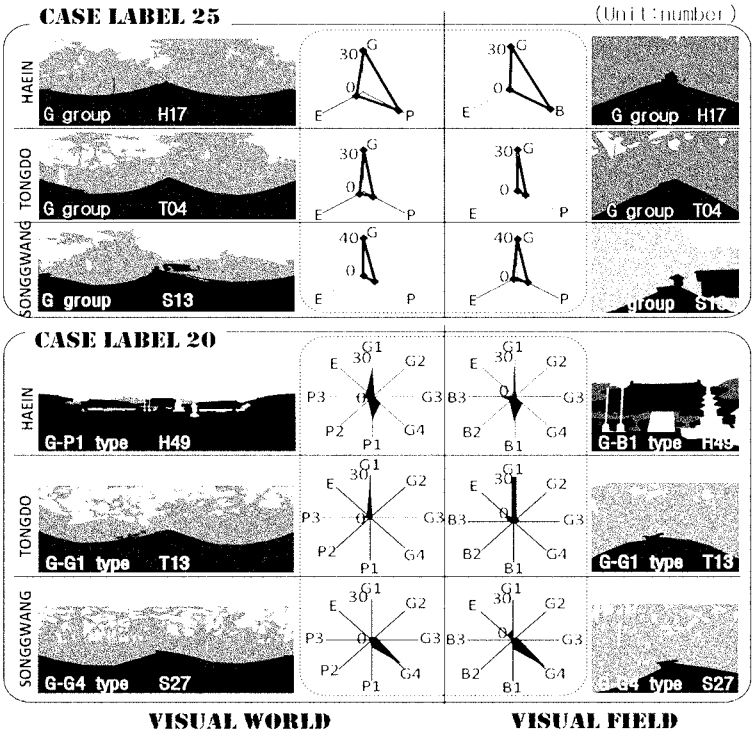


Fig.11. Dominant patterns & representative type images
(The number means quantity of each images)

the elements that represent large influences more than 100 pixels); (S-L: low occupancy rates less than 100 pixels); and (S-Z: no appearance in elements in the Os group) based on the occupancy rate of the elements (Os), which demonstrate low visual perception influences.

As a result, a category that consists of a total of 42 types in the visual world was obtained and a total of 52 types were obtained from the visual field. It shows that more analyses for the detailed types from the visual field increase the more number of group and that can be investigated as a major reason of the Mvf, which is the cause of temporal missing.

In addition, the primary group was largely influenced by G&P or G&B types in three treasures Buddhist temples, and the secondary group was dominated by 'HAEIN: G1-P1 or G1-B1', 'TONGDO: G1', and 'SONGGWANG: G4' types compared to other types(Fig.11).

7. Conclusions

The characteristics of sequential landscape elements appeared by the physical characteristics for three treasures Buddhist temples in Korea can be summarized as follows:

1) The landscape elements appeared in the approach road in these temples was classified as 15 elements according to their similar characteristics. In addition, it was possible to classify such elements as the groups of Op, Os, and Ot based on the appearance, continuous appearance, and occupancy rates. It showed the tendencies of Dominate Landscape object (Op), Addition Landscape object (Os),

and Chance Landscape object (Ot), respectively.

2) The element missing can be largely occurred in the Mvf that represents a circulation line and an extension area in viewpoints and the Mvw that shows an appearance in long and linear elements, such as drain and fence element. The average missing rate of the Mvf (25.69%) showed larger values than that of the Mvw (1.87%).

3) The tendencies of ceiling and ground elements showed large influences on the sequential characteristics in the visual world, and the tendencies of visual front appearance elements represented large influences on the sequential characteristics in the visual field.

4) The elements of A02 and B01, and A03 and B06 showed contrary occupancy rates for each other, and the elements of A03, B01, and B06 demonstrated large influences on perceptional transition effects.

5) In the type analysis, the primary and secondary groups classified as three and eight different group types, respectively, and that can be classified as 42 (the visual world) and 52 (the visual field) categories in the detailed classification by considering the influence of the elements in the Os group. In addition, to investigate the characteristics of sequential landscape, each characteristic in these two concepts can be summarized as follows:

Although a visual world image photographing method can cause a limitation in visual distances, it shows advantages in low missing rates, fast grouping speed based on type classification, and simple category types. However, in the aspect of the detailed verification of landscape constituents, although the visual field photographing method shows some advantages, it has some disadvantages in the investigation of regional characteristics for each landscape element due to the high missing rate compared to that of the method using fish eye lens.

As mentioned above, the most important thing in the investigation of the characteristics of sequential landscape is to grasp the flow read from the continuity. If the read of rhythm (flow) in music is a type of sequential tendency, the grasp of codes rather than the rhythm will be scene landscape.

Thus, in the sequential aspect of the investigation of landscape characteristics, the major objective is to read the flow of landscape elements as a large scope in a specific section. It is a method that approaches the objective in the aspect of the visual world rather than the sequential approach in the visual field.

As a result, the characteristics investigated from the results mentioned above can be used as a basic direction to compare future sequential landscape characteristics and to obtain data. In addition, it is necessary to perform more specific and clear studies on the guide of qualitative analyses aside form the quantitative analyses.

Notes:

1. Because a standard lens photographing method that has been known as the most similar way as the semi-fixed view angel of human being based on the conventional studies related to the investigation of landscape constituents can be largely used in various fields without any limitations in scene landscape and sequential landscape, it is verified that fish eye lens also used in some sequential landscape studies.

2. In the classification of visual categories for analyzing sequential characteristics, studies done by Ryuzo Ohno, Lee, Insung, Sa, YoungJae, and Lee, Insung were focused on the concept of the visual world by considering directions. Also, studies done by Nobuhiro Suzuki, and Choi, SukChang were close to the concept of the visual field by considering the direction of (100°^ÿ150°).

3. The meaning of 'limitations in the selection of subjective' presents the comparison of characteristics through the comparison of similar properties by differing countries.

4. Although Shinohara Osamu classified it into two classes, Primary and Secondary objects, according to the degree of influences of landscape objects in *'New System Civil Engineering 59'*, this study classified it three categories, Primary, Secondary, and Tertiary, to perform a more sophisticated analysis and that applies for individual appearance, continuous appearance, occupancy, and type analyses.

5. In this paper, HP means Viewpoint of HAEIN Temple, TP means TONGDO Temple's one, and SP means SONGGWANG Temple's one. Moreover, Continual View point which Extracted from the Site is HAEIN 63Point, TONGDO 40Point, SONGGWANG 47Point

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