ESTABLISHING A METHOD TO CONSTRUCT PEDESTRIAN NETWORK IN DOWNTOWN AREA

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Abstract

This study aims to present how the pedestrian network in downtown area was constructed utilizing space syntax, and how that process was applied to design the form of the plaza. The construction of pedestrian network utilizing space syntax was accomplished by observing pedestrian behavior. However, it needed a new method other than the existing axial line construction method. This was due to the downtown area where city hall plaza is located was a roadway with crosswalks and pedestrian stoplights, and there was a need to develop a new construction method for the pedestrian network that utilized the existing axial line. In this study, the axial line construction method was developed in consideration of the following: 1) whether or not the axial line could be framed separately on a road where pedestrian sidewalk and the traffic lane were not physically separated; 2) a way to recognize crosswalk "depth" according to the existence of traffic lights and its construction; 3) a way to distinguish the crosswalk "depth" recognition considering visibility and its construction; 4) a way to construct pedestrian network developed on top of the method to recognize the "depth" of underground passages and underground spaces. This study will be able to provide a significant method of constructing and analyzing the pedestrian network in complex downtown area.

Introduction

There are generally two kinds of methods to evaluate pedestrian environment. The first is a qualitative evaluation of pedestrian environment using a checklist, and the second is a large number of studies done on a pedestrian environment evaluation model that comprehensively considers the factors related to walkability. However, the focus of these methods is mainly on evaluation in accordance with particular routes of movement. The studies on pedestrian network (e.g., Hillier et al., 1993) that use space syntax techniques have greatly contributed to learning about the effects of street network and pedestrian features. However, the existing methods of establishing an axial line in space syntax method is lack of accurately reflecting pedestrian behavior. Specifically, in downtown areas where space is in complex ways, existing methods need to be improved through

careful observation. In this context, this paper aims to present a method that uses space syntax to establish a pedestrian network in complex downtown area, and how it was used to design the form of the plaza. In other words, this study attempts to develop a method of creating a space syntax pedestrian network model in densely used downtown space by observing how pedestrians perceive space and what patterns they follow in using space.

Figure 1:

Study scope and pedestrian volume observation points

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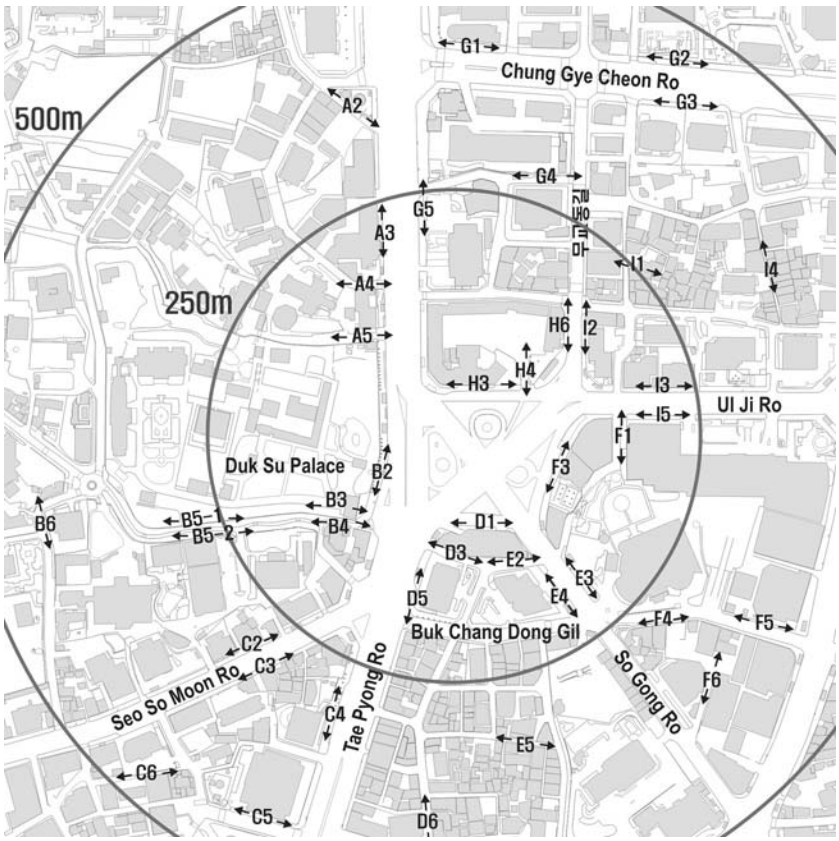
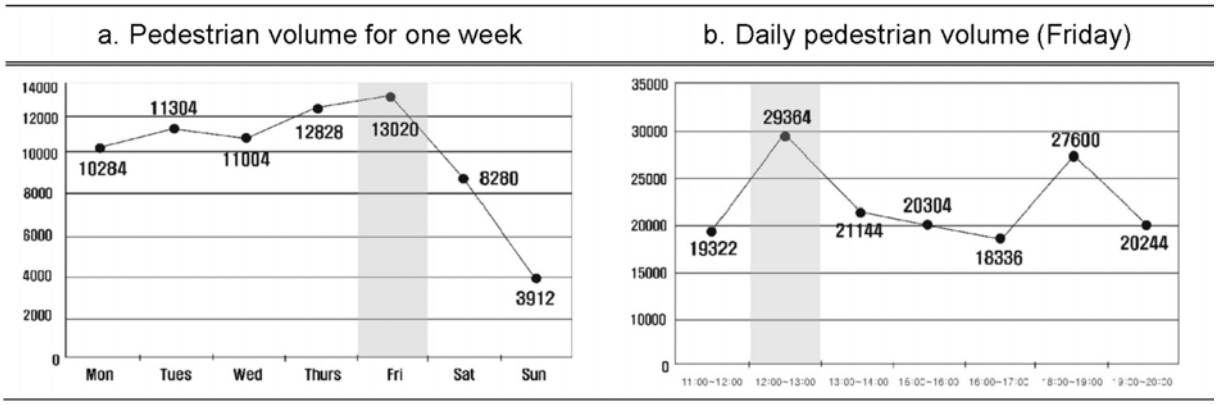


First, a space syntax pedestrian network on the surrounding areas of People's Plaza is established, and the pedestrian network is analyzed. Second, the way pedestrians use space in places such as the streets, crosswalks, and underground is observed. Third, space syntax model of pedestrian movement network is established through the process of verifying and calibrating the model, using as standards the established pedestrian network space syntax model and the observed correlations between pedestrians' space use patterns and space syntax variables.

Analysis of the Current Pedestrian Movement Characteristics

The People's Plaza in front of Seoul City Hall, which is the subject of this study, is a historically symbolic space. Along with the emergence of automobiles, this plaza functioned as a rotary for automobiles. Then a change occurred in 2001 to reform the People's Plaza into a space for pedestrians. In order to grasp the current pedestrian features around City Hall, the pedestrian volume within a 500m radius is observed. The survey of pedestrian volume will be used as basic data in analyzing the current pedestrian features of this area, and in predicting the pedestrian features after the completion of People's Plaza. All the space that accommodate pedestrian traffic in the areas surrounding City Hall are surveyed, and pedestrian volume is observed by randomly selecting 71 gates from among them. Observation was done for five minutes during each hour from 11am to 8pm. The pedestrian volumes at underground and crosswalks with traffic lights were surveyed for the surrounding areas of City Hall.



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Gate	Integration(3)	Pedestrian volume/hr
1	4.2117	1,178
2	3.9068	1,046
3	4.1976	1,035
4	4.1006	1,910
5	1.5715	149
6	2.9333	358
7	2.6889	612
8	3.2128	363
9	3.4978	622
10	3.6727	1,188
11	2.6360	543
12	3.2658	739

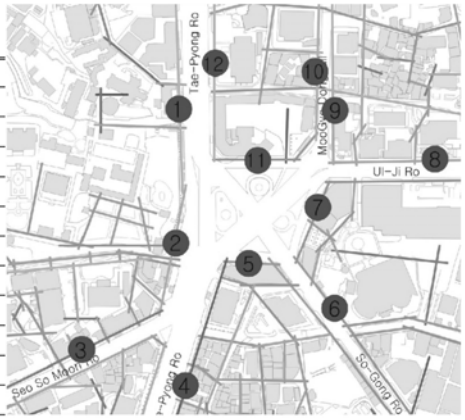

Table 1:

The observation results of pedestrian volume

Table 2:

The integration & pedestrian volume at major points

The Methodology of Establishing a Pedestrian Network

Pedestrian Spatial Network Establishment Method

Pedestrian network model according to the spatial recognition of crossroads

The pedestrian network model shown in Figure 2a is created using the above-mentioned method of establishing a space syntax model. The axial line is drawn up with the assumption that pedestrians recognize all crossroads as a different space. In the Figure 2a model, the space recognition behavior of pedestrians in moving from area to area involves the process of seeing four Depths that includes recognizing the crosswalk and the sidewalks on both sides as separate spaces. That is, the model creates an axial line with the assumption of pedestrian behavior in which a pedestrian goes through four directional changes to recognize in detail each of the crosswalk spaces. In order to verify the above pedestrian network model, space syntax analysis was carried out, and the results of regression analysis between Integration (3) and pedestrian volume is as follows:

$Y = 2.132+0.203X$; $R^{\wedge 2} = 0.278$

(Y=Pedestrian volume (Pedestrian/hour), X=Integration (3)

The results of verifying the network model according to pedestrians' space recognition of crosswalks show that t value is 3.97, and thus, Integration(3) can be considered an important variable in explaining the pedestrian volume; but because the coefficient determinant ($R^{\wedge 2}$) is 0.278, it is difficult to predict the current pedestrian volume.

A pedestrian network model that considers the separation of pedestrians and vehicles and the width of the road

The pedestrian network model in Figure 2b observed and added the possible pedestrian space that had been omitted in the map, and

modified the axial lines on the roads that were being used as mixed roads for both pedestrians and vehicles even though they were designated as roads with separate sidewalks and roads. The results of regression analysis of Integration(3) value and pedestrian volume for verifying the pedestrian network model, according to the pedestrian behavior in using space in accordance with the width of the roads and with whether or not the roads had separate sidewalks and roads, are as follows:

$Y = 2.11+0.212X$; $R^{\wedge 2} = 0.332$

The results of model verification show that the value of coefficient determinant ($R^{\wedge 2}$) is 0.332. That is, when a road that is designated with separate sidewalks and vehicle lanes has narrow sidewalks and low traffic, and it is being used as a mixed road by the pedestrians, that pedestrian behavior can be explained, but it also reveals that the hypothesis “pedestrians recognize crosswalks as another space” is not established here.

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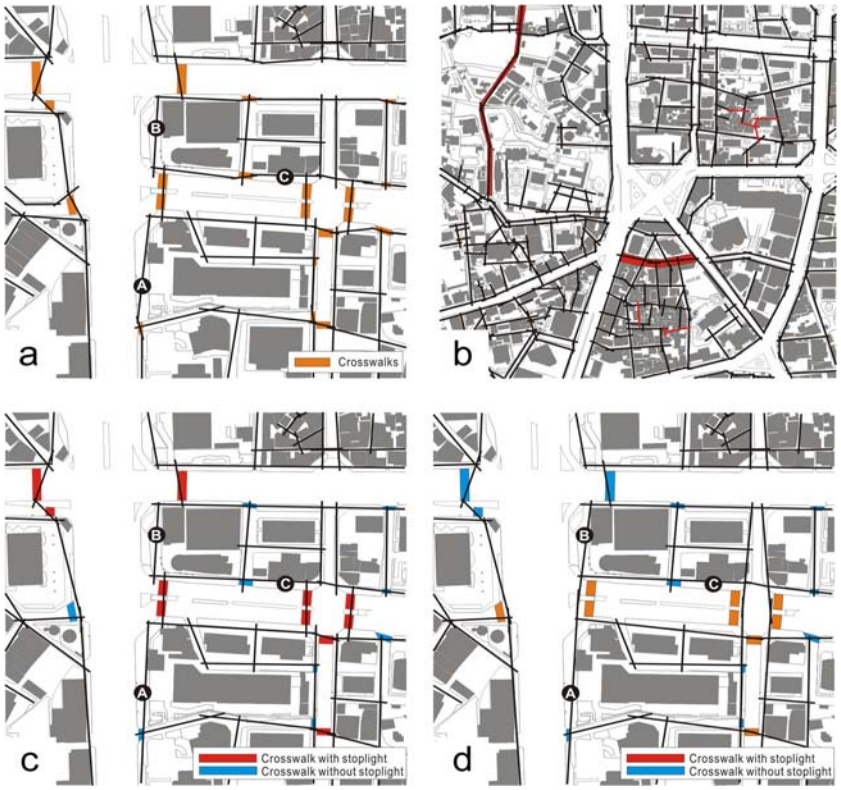
Figure 2:

The method of establishing pedestrian network according to space recognition behavior



A pedestrian network model that considers crosswalk traffic lights

Figure 2c shows a pedestrian network model that is created with the hypothesis that “pedestrians’ space recognition at a crosswalk change according to whether or not it has a traffic light.” An axial line was drawn up with the assumption that pedestrians would recognize a crosswalk as an independent space if there were a traffic light, and that if there were no traffic light, they would perceive the crosswalk as an extension of the sidewalk. In the existing models, the pedestrians go through three depths when they pass through a crosswalk without a traffic light, but in this study’s model, the axial line is drawn up so that the pedestrians in that same situation go through only one depth because they perceive the crosswalk without a traffic light as part of the sidewalk. The results of regression analysis on the pedestrian network that was modified according to an axial line drawing that changed depending on whether or not a crosswalk had a traffic light are as follows:

$Y = 1.897+0.263X$; $R^{\wedge 2} = 0.543$

The coefficient determinant ($R^{\wedge 2}$) is 0.543, and it thus can be described that crosswalks with traffic lights tend to decrease in their pedestrian network continuity and accessibility, whereas those factors are not decreased in crosswalks without traffic lights because pedestrians do not recognize those crosswalks as a separate space but see them as a part of the sidewalk.

Space recognition according to the location of crosswalk

The pedestrian network model in Figure 2d was created based on the assumption that "the location of a crosswalk affects the route of the pedestrian's movement." This model more actively reflects the behavior of pedestrian movement, and makes use of the tendency in all pedestrians to minimize their depth. The pedestrians' space recognition behavior, as shown in Figure 2d does not perceive crossroads that are visible as four depths, but rather, minimizes the depths and perceives them as one depth. It is an axial line creation method that shows the same space recognition behavior as when pedestrians are moving from area to area by passing through a crosswalk without a traffic light. The results of regression analysis for verifying the method of creating the modified pedestrian network according to the location of crosswalks are as follows:

$Y = 1.816+0.597X$ ($R^{\wedge 2}= 0.703$)

It shows a very high coefficient determinant. Accordingly, it can be seen that the behavior of pedestrian movement shows a tendency to minimize depth and the location of crosswalks affects the route recognition and behavior of pedestrian movement. Even when the crosswalk has a traffic light, if its location is situated within the visible range of the pedestrians' route and it is possible to access it without a change in direction, the crosswalk is perceived as an extension of the sidewalk rather than as a separate space.

A pedestrian network model
according to the depths of underground paths

The subject area for this study has many underground paths, and therefore, an examination of underground pedestrian network is needed. In this study's model of axial line creation, the depth of the underground exit of stairway, which was set as one depth, is assumed to be two depths in model 5. This is because in underground paths, it is assumed that pedestrians' space recognition will be more difficult, accessibility decrease, and at the same time, affect the pedestrian network on the ground.

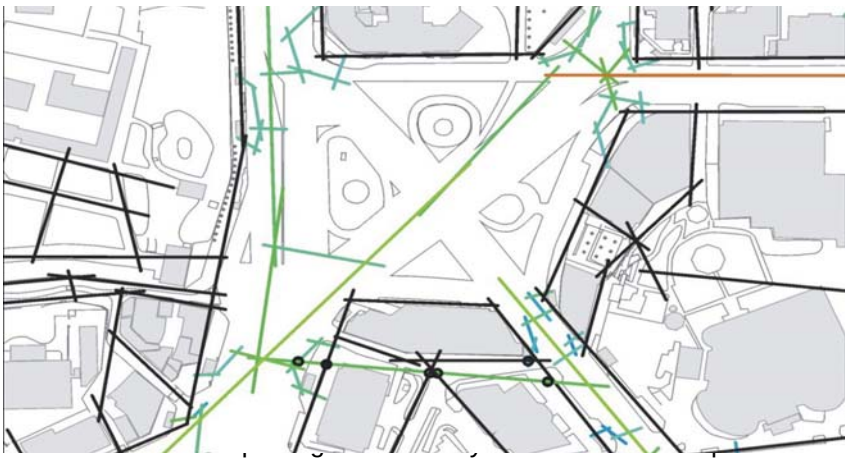


Figure 3:

The method of establishing a pedestrian network that reflects the depths of underground paths

network model that reflects the depths of underground paths are as follows:

$Y = 1.736+0.323X$; $R^{\wedge 2} = 0.710$

These results show that pedestrians in underground paths see them as places of low recognition and accessibility due to their many depths, but since pedestrians cannot reach their destination without the use of underground paths due to the features of the subject area, they use them in spite of their somewhat low accessibility. Accordingly, because the pedestrians have to use the underground paths even though their accessibility and recognition levels are low, it follows that those factors cannot significantly affect the pedestrian network on the ground.

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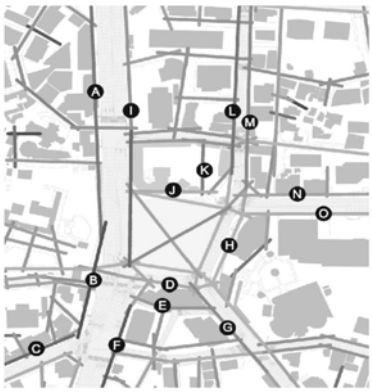
Table 3:

The integration & pedestrian volume at major points

a. Before People's Plaza plan	b. After People's Plaza plan
	

Conclusions

This study developed a method of establishing pedestrian network by considering the space recognition and behavior of pedestrians through a case analysis of the Seoul City People's Plaza plan. A method of establishing space syntax pedestrian network model in complex downtown area was formed according to the space recognition and space using behavior of pedestrians. The method of establishing space syntax pedestrian network was influenced by: whether or not axial line could be drawn separately as a mixed road used by pedestrians and vehicles, the depth recognition of crosswalks according to whether or not there was a traffic light, the difference of crosswalk depth recognition according to visibility, and the differences in the depths of underground space network. This study is meaningful in that it extracted important factors in the process of establishing pedestrian movement network, and then set up a method to establish space syntax pedestrian network model. This study aimed to develop a method of applying space syntax, but it also can be said that this study's elucidation of pedestrian space behavior is its more important contribution.

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