A study of Spatial Analysis using Space Syntax

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Abstract

The purpose of this study is to see how urban spatial configuration in Anyang city in Korea with Space Syntax theory which integrated into GIS modeling of Spatial Structure analysis. This study examines urban land use variation and urban spatial structure caused by a large development, such as a New-town project in 1990`s. The result of this study is as follows. Firstly, there is a drastic change of urban spatial structure caused by extensive development. Secondly, The changes of commercial land use patterns are caused by New-town project. Thirdly, The changes of urban spatial structure have mutual relations with the change of commercial land use patterns. In conclusion, it is found the potential of the Space Syntax approach within GIS, which should be of interest for many GIS applications.

Key words: GIS, Space Syntax, Spatial Analysis, Urban Spatial Structure

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I. Introduction

Spatial Analysis is one of the key features of GIS. In the last decade, much effort has been made in developing Spatial Data Analysis theories and methods for a better understanding and modeling of real-world phenomena (Fotheringham and Rogerson 1994, Timmermans 1997). So, it is largely recognised that GIS still needs an integration of new analysis and modeling methods of other field of study to achieve its goal as a general-purpose tool for geographic analysis(Goodchild, 2000).

Space Syntax theory has provided important computational support for the development of spatial morphological studies, in particular for the analysis of urban systems, with a considerable amount of empirical and case studies. It has been widely used for pedestrian modeling, criminal analysis, traffic, pollution control, way finding process and so on. Recently, Space Syntax theory provides a configurational description on of an urban structure, and attempts to explain human behaviors and social activities from a spatial configuration point of view(Hillier, 1997).

Space Syntax theory could provide an alternative spatial model for the representation of urban systems within GIS. So, integration of space syntax into GIS would stimulate researches about spatial analysis(Jiang and Claramunt, 2002).

The purpose of this study is to see how urban spatial configuration in Anyang city in Korea with Space Syntax theory which integrated into GIS modeling of Spatial Structure analysis. For this purpose, this study examines urban land use variation and urban spatial structure with analysis network of city road and distribution of commercial facilities of Anyang city in Korea which is developed by New-town project in 1990`s.

The remainder of this paper is organized as follows. Chapter 2 reviews studies of urban spatial structure analysis. Chapter 3 introduces the main principles of the Space Syntax theory. Chapter 4 examine Urban Spatial Structure Analysis with GIS and Space Syntax with case study of Anyang city in Korea. Finally chapter 5 draws the conclusions.

II. Spatial Structure

1. Urban spatial structure

Urban structure has been changed because of complex factor which consist of politics, economy, sociality and culture. City has grown from single function to multi function. There is vertical growth caused by higher stories and horizontal growth caused by outskirts development in city. The City center is the most central part of a city, where urban function of the business, commerce, administration and services is integrated. In Korea, most cities have grown on the basis of administrative controlling function such as City hall, municipal office and government

offices. As City grows older, there is reconstruction of urban structure such as re-development, New-town project(Alexander, 1987)

2 . New town development

A New-town is a settlement space that has been planned and built as a single project, including houses, shops, and factories, rather than one that has developed gradually. A New-town project is useful urban planning in big city to solve urban problem and to provide new houses. In Korea, there are two objectives of New-town project. The first objective is to support city of industrial complex such as Pohang, Ulsan city, The second objective is to solve urban problem and insufficiency of house such as Pundang, Ilsan city. These New-town development have an unexpected influence on urban spatial structure such as sudden land price rise, troubled development of suburb of city and so on. It is need to investigate spatial influence of new-town development and to modeling of urban spatial structure.

3 . Spatial Structure Analysis

Spatial Structure Analysis is to investigate characteristic of urban constituent element on urban space and to analyze of distribution of urban features(Freksa and Mark, 1999). Method of spatial analysis study is variable on the ground of each research area and described in Table 1.

Table 1. Spatial Structure Analysis type

Analysis type	Characteristic
Land Use Pattern	Land Use
Surface model	Land price, etc.
Spatial Statistics	Statistical Analysis
Spatial Morphology	Morphological Anal

These research methods are mostly qualitative analysis. To describe urban structure, three is some insufficiency about quantitative analysis. To make up for this weak part in the current Spatial modeling with GIS, Spatial Syntax theory is integrated in this study.

III. Space Syntax theory

Space syntax is a method for measuring the relative accessibility of different locations in a spatial system (Hillier and Hanson, 1984). Space Syntax theory can be both considered as an alternative model of space at the cognitive level, and as a practical computational method for the analysis of urban structures and patterns. To estimate accessibility of spatial structure, it is need to execute Axial Analysis with Axial map. Axial Analysis is shown below in Figure 1(Jiang and Claramunt, 2002). Axial Map is composed of abstract space syntax graph of relationships between streets.
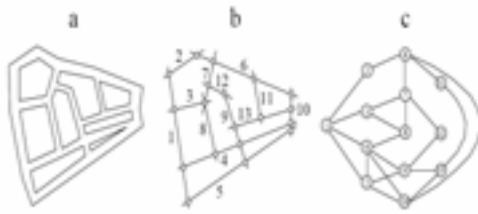
Figure 1. Process of Axial Analysis

There are important spatial property parameters in Axial Map graph. First of all, 'connectivity' is defined as the number of nodes directly linked to each individual node in the connectivity graph, The second parameter, 'control value' expresses the degree of choice each node represents for its directly linked nodes. The third parameter, 'integration' is a value which indicates the degree to which a node is more integrated or segregated from a system(Hillier, 1997). These parameters can be used to describe both local and global properties of a spatial configuration in the sense of integration or segregation.

IV. Spatial Analysis of Anyang

To see how urban spatial configuration of Anyang city in Korea which is developed by New-town project in 1990`s., Space Syntax theory is integrated into GIS modeling of Spatial Structure analysis. This study examines urban land use variation and urban

spatial structure with analysis network of city road and distribution of commercial facilities of Anyang city. It is shown Axial Map in Figure 2.

This study estimate important parameters of Space Syntax shown as Table 2.

Table 2 Parameter of Spatial Syntax

Road	Connectivity	Integration	Control	Remark
Pyungchon	13	237198	310278	Newtown

Figure 2. Axial Map of Anyang

Jungang	13	293264	299563	
Kyungsu	12	256024	366111	Newtown
Simin	12	32259	230706	Newtown
Heungan	10	240739	198728	Newtown
Kwanak	9	298694	109872	Newtown

In Road Network of Anyang city, Jungang Ro., Pyungchon Ro., Kyungsu Ro., and Simin Ro. are higher value in Connectivity and Integration parameters. These roads are mostly related with New-town.
On node of these roads, Commercial facilities are aggregated densely and these area has grown to City Center, especially in New-town shown as Figure 3.

In Anyang city, there is a drastic change of urban spatial structure caused by extensive development such as a New-town, which has induced concentration of Commercial facilities. As a result, The changes of urban spatial structure have mutual relations with the change of commercial land use patterns.
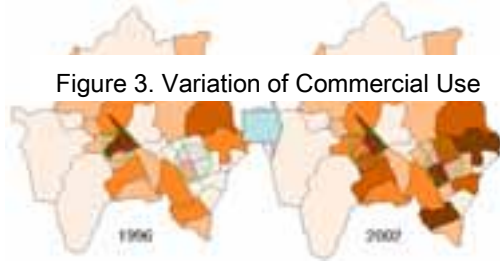
Figure 3. Variation of Commercial Use

V. Conclusion

It is need that GIS implies the integration of new analysis and modeling methods for Spatial Analysis. Space Syntax could provide an important experimental contribution to the analysis of urban structures.

This study investigate urban spatial configuration in Anyang city with Space Syntax theory and GIS. As a result of this study, there are quantitative analysis and qualitative analysis as follows.

Firstly, there is a drastic change of urban spatial structure caused by extensive development such as a New-town. Secondly, The changes of commercial land use patterns are caused by New-town project in Anyang. Thirdly, The changes of urban spatial structure have mutual relations with the change of commercial land use patterns. In conclusion, it is found the potential of the Space Syntax approach within GIS, which should be of interest for many GIS applications.

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