Research on the Visualization for Analyzing City Changes

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Abstract. *To perceive such changes of city space visually, a three-dimensional (3D) city space model is effective. The use of buildings in a city space is complex, reflecting the number of stories, and the number of stories in many cases. Furthermore, environmental parameters, such as opening a shop developed for conditions of the location, the existence of a building which is easy to divert to some other purpose, a managerial layer, and the whole country, is closely related to city change. A city change can be analyzed from various perspectives if such information can also be accumulated and displayed. If it is expressed in two dimensions, it will be restricted, but if expressed in 3D, the use situation of city space can be grasped quickly. Commercial 3D GIS software is useful for visualizing such a 3D city space model while referring to attribute information. However, such software is expensive and its use is restricted.*
For this study, highly extensible 3D modeling software is used to develop a technique for visualizing city spaces using its attribute information. Then the developed script is applied to an actual city model in Japan.
Keywords: *City Analysis; Urban design; 3D-model; City Visualization.*

Introduction

Cities are always changing. The process of city change occurs concomitantly with social trends, users, building use, building renewal, and rent payments. For example, stores catering to young people on back streets separating conventional busy shopping and amusement distric from residential areas are becoming more common in Japan. Busy shopping and amusement distric which show prosperity centering on young people are newly forming in neighborhoods with existing busy shopping and amusement distric. Nevertheless, they have a different charm from that of existing busy shopping and amusement distric. What is the spatial representation of the process that is changing such new busy shopping and amusement distric? For example, what relations does change create in an area as the city changes according to an area's use? What relation pertains between commercial space and residential space? Moreover, what kind of relation pertains between city changes and changes of street space?

A 3 dimensional (3D) city space model is effective for visual perception of such changes of city space usage. The usage of buildings in a city space is complex, reflecting its size, location, and the number

of stories in many cases. Furthermore, environmental parameters, such as opening a shop developed for a certain location, the existence of a building that is easily converted to some other purpose, a managerial layer, and the whole country, are closely related to city change. City change can be analyzed from various perspectives if such information can be accumulated and displayed. If it is expressed in two dimensions, it will be restricted, but if expressed in 3D, the use situation of city space can be grasped quickly. Commercial 3D GIS software is useful for visualizing such a 3D city space model while referring to attribute information. However, such software is expensive and its use is restricted.

For this study, highly extensible 3D modeling software is used to develop a technique for visualizing city spaces using its attribute information. Then the developed script is applied to an actual city model in Japan.

City Visualization Using 3D City Model

Some tendencies exist for visualization of a city using a 3D model for urban design, or research of city analysis. First were development and evaluation of visual simulation techniques using VR technology; such studies used CAVE and other methods. Subsequently, simulation studies using city data and GIS data were undertaken by Gohnai et al. In such studies, a Web-GIS system and city data were used to perform an advanced simulation. Cooperation with real-time simulations, such as VR, and their use in workshops have also been undertaken recently.

However, a research approach to create results of a city investigation using simple 3D software has not been reported.

It will become easy for students of various computer environments and those interested in city planning to use a technique if the result of city investigation can be treated using simple 3D software. Moreover, if functions supporting visualization as a result of city investigation are suitably extensible to a program, its use will spread. Therefore, use of simple 3D rendering software that can extend visualization of city investigation is considered.

City Changes Investigation Which Paid Its Attention to Public Resort Space

Recently in urban areas of Japan, stores for young people have come to be aggregated in gaps and back streets and towns, which are somewhat separate from conventional public resort spaces. Examples are increasing in which prosperous public resort spaces used by young people are newly formed in previously undesirable areas. Two or more common features, such as being newly formed in places only 5–10 min walking distance from existing public resorts, are apparent for such new public resort spaces. Attention was given in this study to differences of advancement of the formation of public resort spaces in areas surrounding a central city area. Changes of public resort spaces were assessed using the following investigation items. First, the following three items were examined from the perspective of change of a street, a building, and space use.

Street space including building

The position of street space, such as the location of a building accompanying advancement of the public resort space formation, width of the street and the change of the residential site rate were investigated.

The low layer, the medium-rise and high-rise building distribution

It is presumed that it is necessary to grasp space characteristics of a town, having paid attention to the building scale. In addition, we classify buildings with three floors or fewer as a low layer. The middle layer includes buildings with 4–9 floors. The upper layer includes those with 10 or more floors.

Distribution situation of commerce, business, and habitation spaces

The changes occurring throughout the whole town can be investigated by observing changes of space

use for spaces of three types: commercial, business-related, and residential. Changes of a town that have taken place are readily apparent in relation to changes of space allocated to each use.

Business conditions relating to commerce
While forming public resort spaces, the tendency for expansion of commercial space and changes in business conditions should be clarified.

Development Environment of System

SketchUp and Ruby, 3D model creation software programs, were used to mark changes of city space in 3D. SketchUp is a sketch-like 3D software program that is widely used for construction design processes; it can use Ruby scripting. Ruby is a script language with the following features, which are currently supported by SketchUp4.

Ruby is an object-oriented language. Moreover, various class libraries are attached as standard. It is possible to carry out a class definition in a program dynamically. Moreover, it is open software. It was made available to the public for open use in 1995; anyone can receive it and develop it freely. Using Ruby scripting, 3D visualization of a city space model is simplified by depicting the attribute information related to a building.

System Configuration

Setup of Data Format
The results of an investigation of the city described above yielded the following information.

1. Block (Change of Road Width and Residential Site Rate)
2. Building Scale (Low Layer, Middle Layer, Upper layer)
3. Building Use (Commerce, Business, Residence, Vacant lot, etc.)
4. Business Condition Composition in Commerce

Regarding results of an investigation described above, the past situation and the past present situation were created using housing map data or the field survey. Specifically, the outer line of a building and a block created with Draw software are input into SketchUp through a DWG file. Next, the description method of Table 1 was taken for attributes of each building. Those attributes were the building position for every investigation year, the scale, use, and business condition composition.

Developed Script
The Ruby script used for this study was developed; it realizes the flow presented in figure 1.

1. Opening of an Excel (Microsoft Corp.) file. The Excel data including the name and attributes of a building are opened; they are read into the arrangement.
2. Matching of a building name and a layer name. A model is operated when data that agree with a layer name are read in a Ruby script.
3. Model creation for each story. In accordance with contents to be visualized, the color according to the use for each number of stories is assigned. According to the number of stories, it repeats creation of a 3D model for every layer of a building.

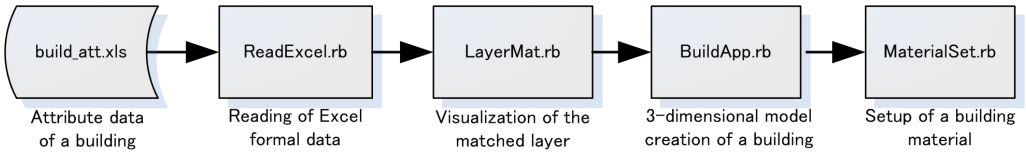
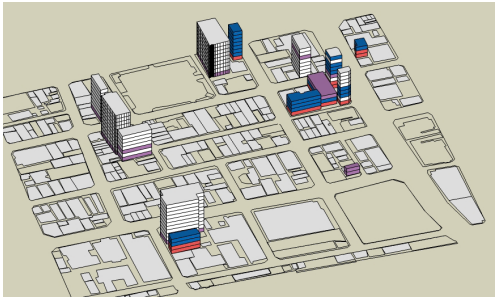


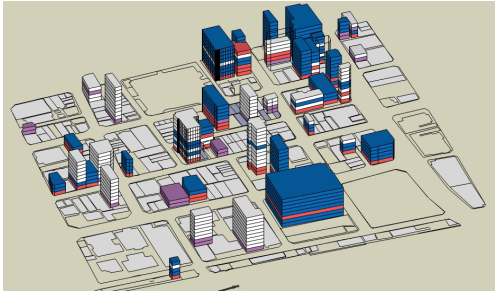
Figure 1
System flow

System Verification

Secular change was apparent in Minami-Senba in Osaka, Japan and two public resort spaces of Minami-Horie. The object range of Minami-Senba was 200 m × 300 m. The object range of Minami-Horie was 400 m × 350 m. Each public resort area was analyzed to ascertain the degree of mixture of commerce and business, especially here.

Regarding Minami-Horie, it showed the form presented in figure 2 and figure 3. The independent commercial floors, the independent operation floors, and mixed floors of commerce and business represent the degree of mixture of commerce and business.





Buildings in which commerce and business are intermingled on one floor are few. It turned out that such a mixed function type building of commerce and business in South Horie has a boundary line of commerce and business inside it.

Regarding Minami-Senba, it showed the form portrayed in Fig. 4. The independent commercial floor, the independent operations floor, and the mixed floor of commerce and business show the degree of mixture of commerce and business.

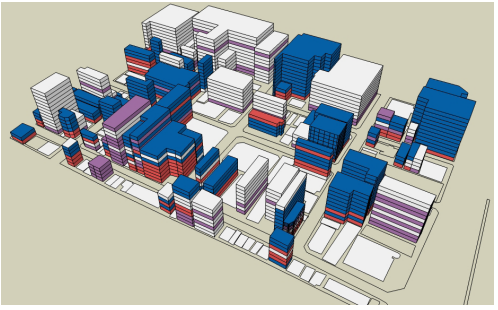


Figure 4
Mixed function type building of the commerce and business in 2005

Figure 2
Mixed function type buildings of commerce and business in 1994

Here, the use of each floor of the mixed function type building of commerce and business is investigated. A building with a floor on which commerce and business are intermingled was found. On another floor, commerce and business were separated entirely.

Conclusion

SketchUp and the Ruby script were used to develop a technique for visualization of attribute information. Furthermore, the developed script was applied to an actual city model. By developing such a tool, data from analyses of city changes were created easily. This tool can greatly facilitate education and investigation related to city planning through visualization of city models, such as city changes, which can be made easily and illustratively using 3D software.

Figure 3
Mixed function type buildings of commerce and business in 2007

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Table 1
Description of building attributes

Building name = Layer name											
Investigation year	Area name	Block number	Building number	Number of stories	Use application						
					1F	2F	3F	4F	5F	6F	7F
07	ms	01	01	05	01	01	20	20	30		

Table 2
Use application of building

Use application		id
Commercial use	Café, Teahouse	01
	Restaurant, Dining-room	02
	Tavern, Bar	03
	Fashion, Apparel	04
	Furniture, miscellaneous goods	05
	Beauty parlor, hairdressing, cosmetics	06
	Play institution	07
	Life related institution	08
	Hospital, Pharmacy	09
	School	10
	Art gallery	11
	Other use	12
	Two or more commercial use	13
Use of business		20
Use of a houseing		30
Mixed use	Use of commerce + business	40
	Use of housing + business	50
	Use of housing + commerce	60
	Use of housing + business+ commerce	70
Other use	Garage, Warehouse	80
	Religion	90
	Parking lot	91
	Vacant room, Vacant lot	92