THE PROTOTYPE OF DIGITAL CITIES ON LINE

A cognition-oriented approach for spatially metaphorical model

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Abstract. The cyberspace upon physical space forms a new spatial structure to increase the influence on the urban fabric and the concept of space in architecture. Today, digital cities are being developed all over the world. By using a city metaphor, digital cities integrate urban information and create public spaces. However, human how to entry into the new emerging digital cities, to percept themselves in around cities, and then taking shape the recognition of digital city forms? How do digital cities directly connect to physical cities and become an imaginable city? Therefore, we argue that a new spatial analysis theory must be established for digital city, comparing with theories of spatial cognition, to find the explicitly spatial structures and relations in digital city upon physical city. This paper studied by the viewpoint of cognition in order to propose a prototype of metaphor of digital city.

1. Introduction

What is a digital city? Generally speaking, digital cities, which are dynamic phenomena based on cyberspace technologies, are a platform/space for transforming the flow of information and interactive communication by using the city metaphor(Batty, 2001; Ishida, 2000; Ricardo and Jose, 2002; Wheeler et al., 2000). Today, the so-call digital cities have been constructed more and more in the online cyberspace by using the mediums as the city entrance of virtual forms(Jianyu et al., 2002). However, human how to entry into the new emerging digital cities, to percept themselves in around cities, and then to take shape the recognition of digital city forms?

We focused researches on the entrance space forms of digital cities. The design of digital cities is spatially metaphorical(Maher, 1999), because it relies on references to the physical environments based on cognitive maps(Chang

et al., 2002). According to the cognitive studies of virtual cities, Murray et al. (2000) indicated that people use the spatial experience in the physical environments to survey the interaction themselves in the virtual cities. Even more, Huang et al. (2002) pointed out the linkage of the online spatial experience to the physical space. Therefore, the design of digital cities has been emphasized on the basis of the spatial experience in physical cities.

The use of a consistent metaphor provides a sense of place that combines way finding and an awareness of the presence of others. We consider such designs of digital cities from a representational perspective of cognitive maps in cyberspace. We examined the nature of the cognitive map – the beginnings of a cognitive map formed from one's early impressions of the environment one is in (YEAP and JEFFERIES, 2000). Two distinct paradigms have combined from our studies of what information is initially identified in a cognitive map.

The first, which we term a space-based approach, emphasizes making explicit the spatial semantic information of the current local environment. The basic concept is to describe each local environment as a semantic space of its own, void of anything, but which could be reminded by its name, its function, its structure and the surrounding in it(Maher, 1999; Olson and Bialystok, 1983). The second emphasizes making explicit the relationships between objects in the local environment and we call this an object-based approach. The basic concept is to describe the local environment by marking the relationship between visual objects in it. The early work of Lynch(1960) demonstrated that certain elements could be identified the legibility of visual experience in cognitive maps of urban dwellers. Among them the important ones being landmarks, paths and regions.

For both paradigms we examined the psychological literature to find support for the approach and the attempts of digital cities at implementing the idea in the virtual environments. Combining the both as a cognitive oriented approach to be the reference of spatial cognition. Then we studied the online digital cities to discuss the characteristics and distinctions of cognitive relationship of metaphorical design representation by using the reference, and to propose a prototype of the framework for the development of the representation of metaphorical design by cognition-oriented approach.

2. The conceptual model of cyberspatial cognition

Cognitive mapping research has traditionally focused on how humans navigate and acquire spatial information about real environments, such as cities (Lynch, 1960). However, only recently researchers have investigated how individuals learn to navigate through virtual environments and mentally represent those environments(Al-Kodmany, 2001; Chang, 2002; Chen and

Stanney, 1999; Kwan, 2001). The cyberspatial cognition approach in studying spatial structures of cyberspace and digital cities is an important access. Interestingly, the most studies of cyberspace and digital cities were influenced by the spatial knowledge of cognitive mapping(Al-Kodmany, 2001; Dodge and Kitchin, 2001).

Lynch's analysis of the city rested on an object-based approach: landmarks and routemarks knowledge, to image the physical city form as the mental map, as cognitive processes of spatial knowledge. Lynch provided a theoretical framework for studying cognitive maps, urban form, and the spatial relationships of cities. This included an exploration of how citizens visualize city spaces. With regard to Lynch's mental map, the researches of cognitive psychology consider it as mental representation of spatial knowledge, referring to memory area and visual information processes. Because of the limitation of memory capacity, human use the simple strategy to abstract the information of landmarks, not clear visual symbol, to remember the spatial information(Solso, 1995). Siegel and White, 1975, state that the developmental progression of a mental map is from landmarks to survey map (P'eruch et al., 2000)?

Based on the Spatial Cognition Triangle -- sensory, spatial knowledge and behavior, Krieg-Bruckner et al. (1998) state that the mental map of human is formed from the hierarchical relationships of spatial knowledge, dividing by navigational behavior, as a space-based approach mapping the object-based approach to perform an entirely spatial concept. According to processes of navigation, the hierarchical taxonomy of a mental map involved three sub-processes to perform the Visual coding and Whole-Body coding of spatial information: working memory of egocentric coordinate, long-term memory of landmarks and long-term memory of position. Cyberspatal researches had indicated that human behavior in cyberspace bases on certain similarities with spatial behavior in the physical world(Kwan, 2001). Both above-mention approach about spatial learning, cognitive mapping, and way-finding behavior are helpful for understanding the cognitive experience of human in cyberspace and physical space.

We examined our mental representations of spatial knowledge include information about spatial relationships as the object-based approach and about how to navigate as the space-based approach in our environment. The main types of spatial knowledge, spatio-cognitive ability, have two: survey knowledge, learned from maps, and route knowledge, gained from navigating through the environment (Medin et al., 2001).

When we perceive the world, the external-input stimulate the sensory memory and decompose into verbal and visual elements to convey to working memory, then to select from there elements to save into long-term memory and perform the mental map of spatial knowledge(Atkinson and Shiffrin, 1968). With this background on spatial knowledge and cognitive cyberspace,

we described a conceptual model to understand cyberspatial cognition before discussing different digital cities (figure1). We drew this theoretical and conceptual model from results of our other researches between cognition and space.

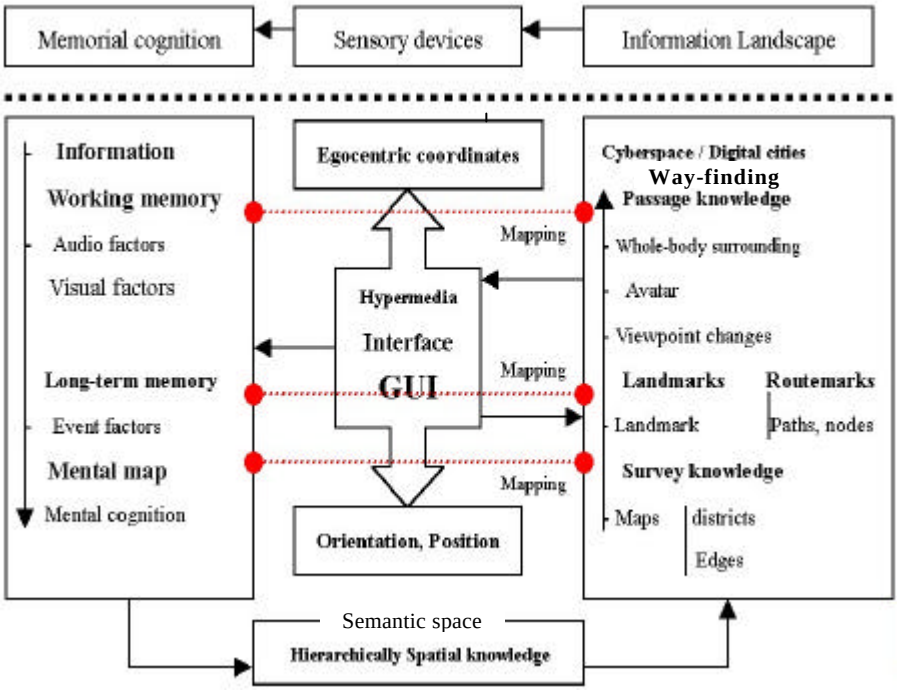

figure 1. The dual interface of space and cognition between digital and physical cities.

We proposed a theoretical model of spatially metaphor of cognitive maps about way finding from physical environments that can be used to guide and map the design of navigational aiding in digital cities. While this general subdivision has been proposed before, the current model further delineates the way finding process, including the distinct influences of spatial information, spatial orientation, and spatial knowledge. With this specification of the way finding process, the taxonomy of navigational tools is then proposed that can be used to systematically aid the specified prototype of digital cities. If effectively applied to the design of a digital city, the use of such tools should lead to reduced disorientation and enhanced way finding in large-scale cyberspace. It is also suggested that, in some cases, this enhanced way finding performance may be at the expense of the acquisition of an accurate cognitive map and spatially metaphor of the digital city being transformed.

3. Mapping Digital cities

The concept of digital city is a representation of a real city on the Internet, offering citizens all kinds of information about the real city, as well as possibilities for communication and interaction(Ishida, 2000). A digital city can refer to systems that use the city metaphor, like virtual communities. We need to remark some different aspects of "digital city" to develop a better understanding of what meaning of digital city in our research. The studies of digital cities have three types from the perspective of physical space.

Defining the digital city

A. The flow of Information space
It is a social information infrastructure for urban life by sending and receiving information and interactive communication (Ishida, 2000). The information cities use a city metaphor and build the urban infrastructure of telecommunication to integrate people's everyday life and business on the Internet. They emphasized the information flows, just like: Singapore IT2000, Helsinki Arena 2000, e-Japan.

B. The simulation of Interface space
The virtual city had used an interface metaphor to information and services on WWW by computer-based for the user to get a real sense of being in an urban place, trying to build platforms to support community networking(Batty, 2001). Virtual cities provide an electronic hub of services, activities, information and people located at a single "place" on your computer screen, just like real cities are a focal point in geographic space(Dodge et al., 1997).

C. The interaction of co-existed space
It like as a new spatial structure of urban fabric, using digital telecommunications infrastructure and new digital media design to shape our future city, like so-call digital architecture, new urban spatial layout, in the new digital age(Mitchell, 1999). Recently urban planning emerges an initiatives which are trying to shape the articulation between urban built forms and digital interactions(Graham and Marvin, 1999).

The definition of digital cities has at least two meanings. The first, a digital city has transformed or re-oriented the physical city through digital technology as A and C. That of the city becoming more digitally-oriented, the physical and non-physical attributes of the city itself are changing(Mitchell, 1995). Second, the digital city is a digital representation or reflection of some aspects of an actual or imagined city as B. In ours studies, we concentrate

on digital representations and manifestations of cities, as the cognitive topography.

The system architecture of digital cities online

We visited five existing digital cities to analyze the system architecture of interface with the cognitive model (figure2). The following table had showed the results (table1). The analysis has some found the basic metaphor of digital cities, as the figure showing (figure3).

Table1. The system architecture of digital cities with the cognitive model.

Digital city	AOL digital city	Akihabara	VIRTUAL TUBIGEN	Digital city Kyoto	Activeworlds
Goal	The gateway of cities with urban information	Touring guidance of the city information	Simulating the representation of a real city	The interactive information for a city everyday life	Virtual communities
Interface GUI	Text, 2d images, 2dmaps	3d maps, landmarks, paths	3dvr	Text, 2d images, maps, 3dvr	Avatars, 2dmaps, 3dvr
Hierarchical spatial knowledge	Survey knowledge	Survey knowledge Maps districts Edges		Survey knowledge, Maps districts Edges	Survey knowledge Maps districts Edges
		Landmarks	Landmarks	Landmarks	Landmarks
		Routemarks	Routemarks	Routemarks	Routemarks
			Passage knowledge, Whole-body surrounding Viewpoint changes	Passage knowledge, Viewpoint changes	Passage knowledge, Whole-body surrounding Viewpoint changes
Hyper Media Support navigational behaviour	non	Orientation, Position	Egocentric coordinates	Orientation, Position	Egocentric coordinates Orientation, Position
Cognitive relationships	low	medium	medium	high	high
	Semantic space	object-based space	object-based space	Semantic and object-based space	Semantic and object-based space

Figure 2. The five existing digital cities online.

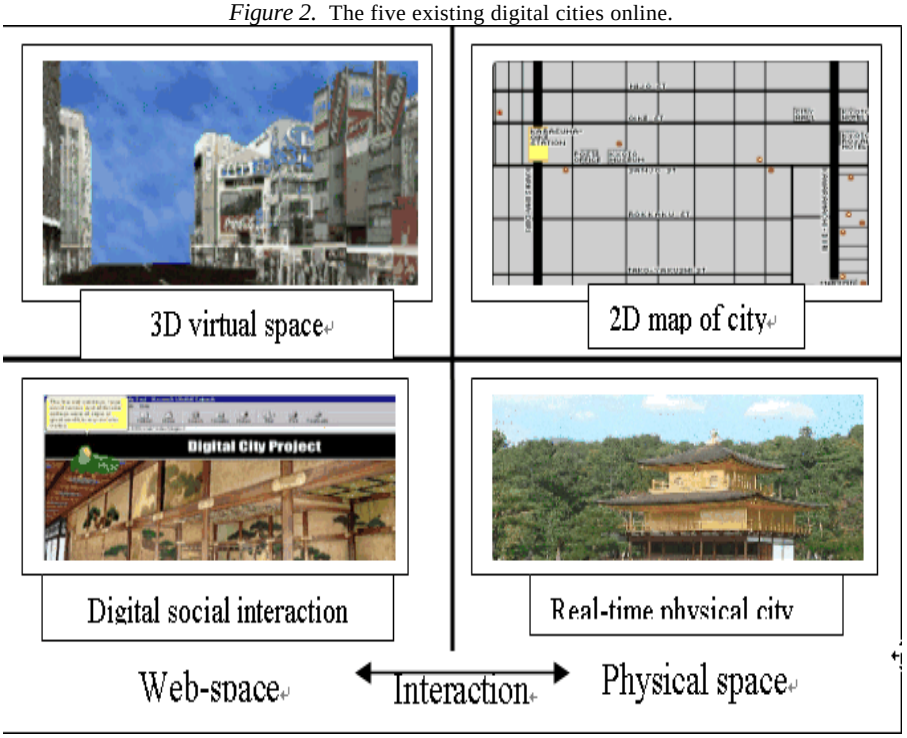

Figure3. The metaphors of the Digital City.

4. A comparative analysis of the prototype of digital cities

Based on an evaluation of way-finding studies in natural environments, this model divides the way-finding process into three main sub-processes: cognitive mapping, way-finding plan development, and physical movement or navigation through an environment(Chen and Stanney, 1999). We examined our mental representations of spatial knowledge include information about spatial relationships and about how to navigate in our environment. The main types of spatial knowledge, spatio-cognitive ability, have three level: survey knowledge, learned from maps, routemarks and landmarks knowledge, gained from navigating through the environment, and passage knowledge, perceived from navigating through the paths (Medin et al., 2001).

According to the cognitive model of navigation, we emphasized how the metaphor each relate to the city by spatial cognition and constructed the prototype of digital city:

A. The metaphor as physical paths, nodes, edges, districts, landmarks and routemarks. By using images, 2D maps, 3D virtual spaces and GIS to designate orientation and egocentric coordinates.

B. The metaphor as place representation, such as a map combined with time, where you can understand change, and combined with people. By using a real-time mapping data from the physical city.

C. The metaphor as whole-body surrounding, which is this continuity of interaction and change over time. By using chat boxes, the emotional symbol, the avatars and viewpoint changes. An avatar is the user's representation of their bodily presence in around the digital city in order to navigate and interact in it.

D. The metaphor as cognitive memory, and it is what we perceive in the representations of environments. By using the audio and event factors.

E. The metaphor as mental maps, such as survey knowledge. By using overall view of a place, like 2D, 3D maps and panoramic view.

F. The metaphor as interactive communication, which allow the social activity to give a real sense of life. By using the text and web cam to transform information and provide support for face-to-face social interaction for multiple residents and visitors.

5. Conclusion

This paper proposes a theoretical model of spatially metaphor of cognitive maps about way finding from physical environments that can be used to guide the design of navigational aiding in digital cities. With this specification of the way finding process, the taxonomy of navigational tools is then proposed that can be used to systematically aid the specified prototype of digital cities. If effectively applied to the design of a digital city, the use of such tools should lead to reduced disorientation and enhanced way finding in large-scale digital cities. It is also suggested that, in some cases, this enhanced way finding performance must can be at the expense of the acquisition of an accurate cognitive map and spatially metaphor of the digital city being transformed.

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