

## VISUALIZING BITS AS URBAN SEMIOTICS

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**Abstract.** Geosemiotics, defined as the study of meaning of placing signs in the material world, concerns the interaction of spatial, individual, social, and cultural contexts. Mobile technology, enabling spatial awareness successfully, has turned our living space into coordinates to broaden geosemiotics study. With interdisciplinary perspectives, there is an emerging potential to integrate the study of mobile spatial interaction and geosemiotics and we address several open issues of geospatial applications in this paper. Since indexicality is the focus of geosemiotics study, we focus on digital indexicalities referring to physical space. Physical indexical signs are usually set by government or organizations rather than individuals, and therefore we propose a new concept to place personal indexical signs in the physical space with mobile devices and augmented reality technology. Overlapped onto the physical world via visual, iconic, and metaphorical methods, what these unique personal semiotics bring is a living space with novel urban landscape and geosemiotics.

**Keywords.** locative media; geosemiotics; augmented reality; ubiquitous computing; mobile spatial interaction.

## 1. Introduction

As the computing becomes ubiquitous in our daily lives (Weiser, 1991), our concept of spatiality has gradually changed and reconstructed under the influence of emerging technology in urban space. In our environment, technology-enabled intelligence becomes more and more ambient in this decade. Coded space defined by Dodge and Kitchin (2004) is dawning in the urban space by the accessibility of ubiquitous wireless network and pervasive mobile technology. Consequently, changes in sense of space and place (Cresswell, 2004; McCall, Ghellal and Rothauer, 2007) in the context of technology development are surely worthy of our attention.

To understand space and place nowadays, we think that geosemiotics, mobile technology, and cyberspace are important aspects in this emerging field. Desktop computers with Internet connection have made people immersed in the cyberspace at a fixed location. Interaction and interface study of cyberspace generally assume that participants are in front of separate desktops at different locations. On the other hand, geosemiotics argues that the meaning of texts and signs can only be interpreted in the social and physical world in which they are located. Probably the most significant technologies to bring cyberspace and geosemiotics together are wireless mobile technology, global positioning system (GPS), and augmented reality (AR). Through these enabling technologies, it is very possible that cyberspace participants become embodied social actors and vice versa.

Cyberspace, essentially decontextualized, has to give careful considerations to the spatial interaction as geosemiotics emphasizes. That is, contexts in social action become significant and necessary in designing future cyberspace. Similarly, geosemiotics can not evade the cyberspace while mobile services are ubiquitous.

Using signs is usually a good way to remind and guide people in the space and the study to set “signs in place” is a part of geosemiotics research (Figure 1). Geosemiotics consists of three sub-systems (Scollon and Scollon, 2003): interaction order, visual semiotics, and place semiotics. Discourses in place



Figure 1. Semiotics in the Material World: (left 3) Traffic signs and (right 2) Indexical signs.

have suggested that social action is the intersection of these three sub-systems. For example, an embodied social actor might simultaneously experience interaction order (e.g. talking, meeting, and walking with friends; shopping alone), visual semiotics (icons, posters, signs et al.) and place semiotics (situated building, landscape). However, when a virtual world overlaps or annotates a physical space, geosemiotics research becomes somewhat complicated than ever. We'll investigate the aspects of geosemiotics and propose issues when cyberspace is considered in section 3.

In this paper, we are interested in virtual semiotics authoring and representing in the context of urban physical space. Through augmented reality technology, we superimpose three-dimensional computer graphical models of signs onto the material world, and enable users to create and place personal indexical signs in the virtual space which is aligned to the physical space. By collecting semiotics, we might mosaic a personal urban landscape.

## **2. Related Work**

To regard mobile spatial interaction (MSI) as situated social action, we'll review related works with geosemiotics perspective. Instead of investigating thoroughly and academically, we attempt to explore how geosemiotics can provide a framework and what it can't. We believe that this will reveal much valuable research to be done in the future.

### 2.1. INTERACTION ORDER

Central to the production and interpretation of discourses in place, interaction order is social interaction when people are together (Goffman, 1971). Generally, location-aware applications can evoke different level of interaction, which is defined as 11 units of interaction order from singles to celebrative events. MSI with public displays or public maps (Holleis et al, 2007) highlights the interaction order, in which people are encouraged to interact at the location of events. When interaction methods such as pointing and touching are provided for mobile service discovery (Költringer et al, 2007), or small widgets can indicate available services in the immediate environment (Guinard, Streng and Gellersen, 2007), new behaviors are created in public space.

Although location-centered design makes location a new dimension of mobile experience (Sacher, 2007) rather than location-based or location aware designs, it is not necessary to promise social interactions. Interaction-order centric design would contribute to design levels of social interaction, from none to intense.

## 2.2. VISUAL SEMIOTICS

Visual images also contribute to the production of meaning of social action. Visual semiotics concerns about how visual images represent the action in real world, how images index the real world where they are placed, and how social actors index images in real world to perform their social presentation. Most of MSI systems designed visual signs in the cyberspace to facilitate locative media editing, navigation, mobile service discovery, and so on. That is, visual images in cyberspace, instead of physical space, are most commonly designed for mobile actors to be indexed to perform their social presentation. *RelateGateways* (Guinard, Streng and Gellersen, 2007) provided visual widgets on the screen of devices to remind user nearby available services.

On the other hand, visual signs or tags in physical space for mobile users are getting attention. Väikkynen et al. (2006) proposed to visualize hyperlinks with expressive visual icons in physical space. Also, spatial interaction methods for mobile service discovery (Költringer et al, 2007) and mobile map interaction (Väikkynen et al, 2006) were facilitated by placing visual signs. Thus, it is more spatially intuitive for mobile users to act as well as social actors in material world.

To provide visual signs physically or virtually has to be concerned, since it will determine how people act as embodied or virtual social actors in different spaces, respectively.

## 2.3. PLACE SEMIOTICS

In addition to the two sub-systems above, all the things in the environment contributing meaning to a place, such as urban landscape, buildings, installations, climate, and so on, construct the third sub-system, place semiotics. In MSI applications, public displays, maps, and installations are usually placed in the physical space to form place semiotics. Moreover, digital 3D objects (Cheok et al, 2006) and graphical visualization (Sant, 2006) sometimes aligned to the physical space by AR technology, also bring forth novel landscape. *Trace* (Sant, 2006) system was designed to record the traces of mobile participants in the urban space. The personal mobile device would show different landscapes according to the situation of the accessed hotspot when a mobile user walked around.

Place semiotics is an aspect of how people interpret social actions by surrounding environment. Both physical space and cyberspace could be considered as environment to emplace place semiotics. To design MSI applications, we suggest noticing the dimensions of interaction order, presentation of social action, visual signs, place semiotics, for both embodied and virtual social actors. Usually, these dimensions might depend on how the

action is designed. For example, if we wish to design a system with highly embodied social interaction, then, physical installation in public, task with intense level of social conversation, and vivid graphic icons might be the best combination.

Geosemiotics discourses also suggest that social action is a process of selection among many semiotics systems which are dialogical with each other. Therefore, how to provide available semiotics systems for choice in an event would be an alternative perspective for MSI design.

#### 2.4. EXAMPLES OF EMERGING SEMIOTICS

To visualize the transmission of digital information in the wireless network, Mixed Reality Lab proposed FNVN (Free Network Visible Network) (Cheok et al, 2006). This research visualized the flow of digital information as urban landscape and successfully overlapped public digital space onto public physical space. A visual marker was used to represent a network access point and then with a webcam and mixed reality technology (Kato and Billinghurst, 1999), people could understand the relationship between digital information network and situated physical space. However, the indexicality and the context-dependency of semiotics were not mentioned. Therefore, the interaction orders of FNVN were “singles” in both physical and virtual space, and its visual semiotics included physical markers and digital representation of data flow. The only place semiotics of FNVN was the augmented scene in cyberspace to help mobile users interpret the event.

### 3. Issues of Geosemiotics with Cyberspace

We address some open issues when geosemiotics encounters cyberspace.

#### 3.1. INDEXICALITY BETWEEN SPACES

Instead of simple indexicality from physical signs to material world, at least four possible indexicalities can be observed: physical signs to tangible world, physical signs to virtual world, virtual signs to virtual world, and virtual signs to tangible world. We concern how to smoothly bridge these types of indexicalities.

#### 3.2. INDEXICALITY CONFLICT

The meanings of indexical signs usually vary according to the context in which they are placed, and therefore, an indexical conflict might occur when a sign is

set out of place. Similarly, semiotics with the four possibilities above would surely inherit the conflict problem and further exaggerate the context-inconsistent situations.

### 3.3. EQUIPPED AND NON-EQUIPPED ACTORS

What is the difference between the abilities of interpretation of equipped and non-equipped participants in social action? What is the interaction order when an embodied non-equipped actor encounters an equipped one? How can we extend the 11 interaction units when cyberspace is considered?

### 3.4. FRONTSTAGE AND BACKSTAGE

Goffman (1959) defined frontstage and backstage in our daily presentation. What will happen if we consider cyberspace available in our daily presentation? Should MSI consider these two stages?

### 3.5. CODE PREFERENCE

When interpreting visual signs in material world, we follow rules of code preference to filter preferred code in multiple codes. As the cyberspace appears in the daily action, can we design effective virtual semiotics with proper preference of code to interpret?

## 4. Design Concepts

Annotation in the real world is surely important nowadays as well as ever. In the analog age, people might use post-it notes or write directly on the tangible object. However, digital technology can enable people to annotate physical objects by a simple mechanism of sensors and readers. Our research is toward enabling dynamic editing of annotation (Figure 2-a, b). Our living material world is full of annotations, and some of them are indexical signs and deliver their own messages at the place where they locate. The importance of the indexical sign is the possibility to transfer the abstract meanings into the meanings in the material world. Therefore, if an individual wants to bring messages or instructions into the physical space, she/he probably will post indexical signs at specific locations (Figure 2-c).



Figure 2. (a) A digital indexical sign in physical space (b) Different digital indexical signs are possible (c) A poster with indexical sign

However, whether one is allowed to put signs in a physical space is much related to her/his power over the space. Besides, personal post with paper material usually implies limited and temporal usage of the space. As the digital space considered, we find that these problems might be partially solved to enable personal indexical signs to be posted at the associated location. Moreover, by visualizing digital information in place, our system makes users associate digital information and physical space, and thus lowers the crises of neglecting the situatedness and groundedness of signs on information highway (Brown and Duguid, 2002).

We consider the following elements in our research. In our research, we adopt field work methodology in our experiment. Users are asked to go to the real environment to experience the situation in which the virtual space is overlapped onto the physical space. In order to create novel digital landscape in the physical space, we use augmented reality technology. Thus, personal signs are overlapped on physical objects and the environment is augmented with semiotics. Moreover, we enable users to attach their personal signs in the physical space. We are especially interested in the indexical semiotics, because the interpretation of them is context dependent. By visualizing and interpreting within the physical landscape, new urban landscape will surely emerge. To signal our meanings to others, we usually use icons, indexes, and symbols. In stead of literal resemblance to the tangible objects, digital data are usually represented metaphorically since there is no physical form in digital object to be iconized (Figure 3).



Figure 3. Visualizing bits as (a) cubes (b) flows (c) radio waves

## 5. System Description

Our system architecture is shown in Figure 4. Mobile devices with camera are used to edit and view the signs in the urban space. We use MXRToolkit to recognize and track visual markers and then the digital graphics are overlapped on markers. According to the contextual landscape at a specific location, a mobile author (user A in Figure 4) can select appropriate indexical signs (presented as 3D models) and assign them to the corresponding marker at that location where she/he is situated. Further modification such as inserting and deleting 3D models or adjusting the orientation of models on the marker can be performed by updating database on the server.

On the other hand, readers in the physical space (user B in Figure 4) can subscribe indexical signs placed by different authors with RSS mechanism. With AR technology from arbitrary viewpoint, readers can check the indexical 3D models indexing to the same direction as set by the author. A mobile user can also join various groups to access those indexical signs. The benefit of subscription and grouping is that it is easier to manage the access to vast amount of digital information.

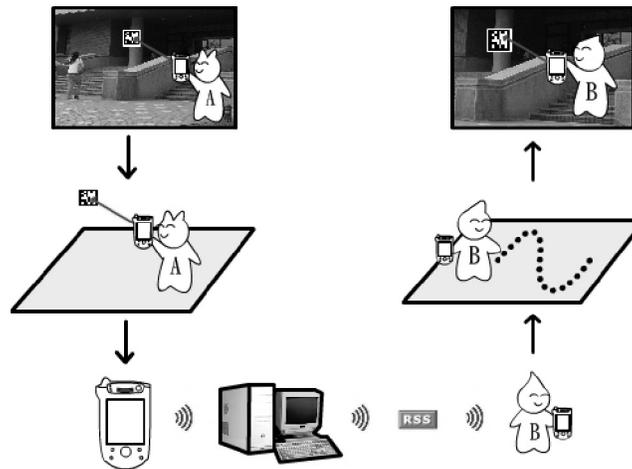


Figure 4. System Illustration

## 6. Experiment and Results

We have tested our prototype with experiments for preliminary study. One experimental group is assigned to perform the task of placing personal indexical signs at appropriate locations on our campus with our prototype (Figure 5). On the other hand, the control group is asked to do the same task with traditional

material such as post-it notes and posters, that is, no digital network or subscription mechanism. In our preliminary observations and interviews, members in the experimental group could get newly updated semiotics more quickly and the attached 3D indexical signs could be more precise than paper posters when indexing in the physical space. This group also reported that it was more flexible to use 3D signs authoring. On the other hand, since the control group was not allowed to use our prototype, members felt difficult to know the newly updated semiotics in the physical space. Moreover, posts by different members at a location would cause confusion. Also, paper material would suffer from damage.

Participants in the experimental group reported that authoring semiotics at a location was not as intuitive as posting on the tangible surface. However, personal semiotics is easier to publish and subscribe with digital technology.



Figure 5. A member in experimental group with our prototype

## 7. Conclusion and Future Work

Since the global positioning technology becomes pervasive and consequently, the geospatial web becomes popular, geosemiotics research turns into such a significant field that no one would deny its importance. However, geography, place/space research, urban planning, and geosemiotics seldom include the virtual space as daily phenomenon or landscape nowadays. In our opinion, technology not only frees the mobility of networked devices but also complicates the problems in geosemiotics. In other words, when mobile technology and augmented reality are included, geospatial web might amplify the scope of geosemiotics research.

Therefore, we propose personal indexical semiotics in virtual space as an emerging urban landscape. We also discuss differences between physical semiotics and virtual ones. Landscapes for personal space overlapped on material world are also possible. In addition to the preliminary observations, our future work is to test our system with quantitative evaluation for daily life in the urban space.

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