EXPLORING DIGITAL CITY WITH PHYSICAL INTERACTIONS

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Abstract. The purpose of this work is to develop needed interaction techniques for understanding the context of a digital city. In this paper, we present a framework in terms of three perspectives: information representation, physical interactions and media space design. We implement tangible media for physical interactions, allowing users to explore a digital city with respect to different positions in time-space in an interactive and intuitive manner. The time-space representation is mapped to physical media space. Our work is demonstrated in a digital 3D museum project for Tainan city in Taiwan.

1. Introduction

Significant efforts have been made in modeling the real world into digital cities located in World Wide Web for 3D information navigation. An important aspect of a digital city is to represent the historical context of the city whereby users can create a sense of understanding the development process in terms of time and space. Yet most of the digital cities are focused on cyberspace navigation or social interactions with avatars (Ishida, 2002), with less concern about the representation of time in context. In exploring a digital city, time is an important factor to aid users to gain an overall view of a city’s developing history. It is particularly so for modeling a city with rich historical characteristics.
We have undertaken a 3D digital museum project for modeling Tainan city in Taiwan. Tainan is the oldest city in Taiwan with more than one hundred statutory historical buildings in the district. The work presented is part of the 3D digital museum project. An initial focus of this project has been the development of digital cities supporting 3D navigation, and more recently for supporting physical interactions in the museum exhibition.

This paper describes work in progress for developing an integrated time-space digital-physical interactive environment supporting exploring the historical context of a digital city. A growing consensus is that the most desirable way to understand city history in context is to integrate timeline into digital city models. There has been several research works integrating timeline in virtual representation such as EMP project (EMP web site). In this paper, we present an alternative approach in modeling time dimension with physical interactions. The time dimension is useful in mapping the separated pieces of digital city information into holistic overview of the genuine physical space.

2. A Conceptual Framework

*Connectivity* and *interactivity* of information are the major criteria in developing the interface for understanding city history in context. In terms of connectivity, we aim to enhance the sense of the time continuity in our cognition for digital city. And for interactivity, we focus on the interaction between physical and virtual space.

In order to clarify the relations between the problem domains in this research, we provide a conceptual framework in terms of three perspectives: digital information, physical Interactions, and media space design. The relations are shown in Figure 1.

![Figure 1](image)

*Figure 1*. A conceptual framework of the physical interactions for digital city
3. Time-space Representation

A digital city can be realized in two dimensions: *time* and *space*. The model we described here is organized in a two-dimensional navigation interface structure; the horizontal dimension represents the historical timeline of the digital city while the vertical dimension is concerned with spatial information in terms of granularity of different levels of abstraction, e.g. city, district, site, building. In this structure, we are to weave pieces of the digital city models into a chunk of city information with both macro view and micro view accessibility. The time-space information model is shown in Figure 2.

3.1 TIMELINE

The timeline can be presented in two different kinds: milestone-oriented and range-oriented. To consider timeline representation, it is first necessary to identify milestones with respect to significant events that are related to the city development. In this work, we attempt to present a timeline in a range-oriented fashion such that the milestones are equally incremented in large scale. The alternative is to switch in both types according to the developing pattern of each city. What we want to achieve in this work is to dynamically “zoom in” and “zoom out” the proper scale of each equal-ranged timeline. The purpose is to enhance the accessibility to digital city information in different levels of abstraction. For better presenting the time-connectivity between city information from different granularity, a scale adjustable timeline for interacting with further navigation of digital city in this work is presented in Figure 2.

3.2 SPACE INFORMATION IN LEVELS OF ABSTRACTION

The city boundary and important geographical focal points of a city may varied in each historical city development stage. Our major concern is to explore how to switch the focus around the key area of the city with respect to its significant changes. Users should be able to fully explore into the proper levels of abstraction. For example, in the digital Tainan, the space context levels of abstraction in terms of display scale are:

1. peripheral
2. city
3. district / community
4. street / plaza / park / site plan
5. building / interior / landmark
6. furniture / art craft / detail design

and the media presented can be in text, 2D/3D drawing map, satellite photos, 3D modeling rendered image, physical models, photos, visual / audio data for special topics, etc.
Figure 2. A time-space model for digital city with multiple levels of abstraction

Figure 3. The two-dimensional time-space navigation structure for digital city
4. Physical Interaction Techniques

We have proposed a tangible user interface for exploring digital city with different positions in time-space. Through tangible user interface approach, users can access their interesting information concerning time and spatial factors simultaneously. The interaction can be achieved by manipulating the physical artifacts mounted on the operating bench. By shifting the physical timeline bar into a chosen age and moving the tabs along the bar to geographically control the scale of display area, the users can continuously adjust the information flowing with their navigation tour within the digital city.

To display spatial granularity with multi-scaled information in digital city, we proposed a zoom-able timeline for designated geographical spot, which was formerly picked by laser pointer from the map projected on wall. Then we can further link to other detailed information with versatile media presented. And for the purpose of “zoom in” and “zoom out” the scale of timeline, we proposed to reserve two button areas at the end of the timeline for activating the projector to adjust the scale of timeline.

Figure 4. The view of time-space dimensions is mapped to tangible interface in physical space
5. Media Space Design

The tangible time-space interactive bench that described in the previous section is embedded into the media space designed for exhibition. It can be setup in an ambient display environment and with multiple projecting surfaces for demonstrate better user interaction with different scales and views of information. After integrating this tangible user interface into the exploring of a virtual space, a new cognitive space is produced. With the timeline representation, we can easily shift our memory of digital city by articulating the physical timeline and we can move the space granularity tab to zoom in and zoom out for getting micro view and macro view of the city information. This way of manipulating information helps us to organize our time-space knowledge with more connectivity and to construct a holistic cognitive space between the physical and virtual spaces.

![Figure 5. A view of the media space in museum exhibition](image)

6. Conclusion

The proposed integrated time-space digital-physical environment seems to have advantageous capabilities not found in the conventional approach to digital city. The development of time-space tangible interface has just begun. A major underlying premise of this work is the need for physical interactions in exploring digital city in museum exhibition. The time representation appears to us to be the basis for digital city of the future.
Acknowledgements

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References


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