Geo-Spatial Context-Aware Visualization

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Abstract

Mobile computer systems equipped with wireless communication and sensor technology—such as mobile phones with cameras—have become widely available. Context information, for example the user's current location or their physical environment, plays an increasingly important role in simplifying the interaction between users and such mobile information systems. A generic framework for federating heterogeneous spatial context models is briefly described. The federated information serves as basis for the visualization of spatially referenced data. Visualization challenges include efficient rendering on mobile devices, automatic adaptation of visualization techniques to context information, as well as consideration of the quality of context in the form of uncertainty visualization.

Categories and Subject Descriptors (according to ACM CCS): H.5.2 [Information Systems Applications]: User Interfaces—Graphical user interfaces (GUI) I.3.3 [Computer Graphics]: Picture/Image Generation—Display algorithms I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Color, shading, shadowing, and texture

1. Introduction

Mobile computer systems, along with the increasing quality of wireless communication and sensor technology, have become a reality for millions of users. Applications on such mobile devices will be increasingly aware of context: they use and adapt to influences from the environment and display specific information depending on their context. Typical context information may include the current location of the user, their mode of activity, hardware capabilities of the mobile device, or physical parameters of the surrounding real world. Context-aware applications offer great benefits for users, easing the interaction with the mobile system and avoiding information overload by restricting displayed information to relevant data. Therefore, most applications will become context-aware in the near future.

2. NEXUS Framework

Similar to the World Wide Web, we envision an open conceptual and technological framework of a world wide space that facilitates integrating and sharing context information. Context information represents a collection of context aspects of stationary objects such as landmarks, buildings, and streets as well as mobile objects like automobiles or persons. In particular, context data can be time-varying: for example, sensors may deliver a continuous stream of data fed into spatial context models to establish the basis for context-aware applications. The key element of our framework is that the context models are federated in order to build a single large-scale context model resulting in a consistent and global view. The federation concept facilitates complex spatial queries as well as retrieving current model states, past or predicted future states, and continuously varying information. Privacy and security are ensured by protecting context data through application-specific and individualized views on data as well as personalized model access. Accomplishing these goals requires the interdisciplinary collaboration of many researchers. A large research project working in this direction is the DFG-funded Collaborative Research Center SFB 627 *NEXUS*. More information on NEXUS can be found on its web page[†] and the article by Hohl et al. [HKL*99].

3. Context-Aware Visualization

Context-aware graphical interaction with the federated spatial models poses particular research challenges for human-computer interaction, graphical interfaces, and visualization

[†] http://www.nexus.uni-stuttgart.de

specifically discussed in this talk. One issue is the restricted compute power of mobile devices, along with possibly unreliable network connectivity and limited battery capacity. Efficient local rendering on mobile devices in combination with remote rendering on render servers is a possible solution for this problem [SDWE03, MW08]. Here, aspects related to rendering techniques, load balancing and work distribution as well as wireless networks play important roles.

Another issue is the context-aware graphical display of information. Popular examples of context-aware visualization are Google Earth[‡] or Microsoft Virtual Earth[§], which show data in a spatial context. Our goal is to extend such geo-mashup desktop computer systems to mobile information systems based on generic context information (beyond just geo-referenced information) and heterogeneous data sources. To this end, the federation mechanism of NEXUS is utilized and integrated with the graphical interface in order to access data using a consistent and integrated view. Based on the context and the semantic information of the data to be visualized, an appropriate visualization technique is automatically chosen. Here, even advanced data visualization approaches, including volume rendering or flow visualization, are supported. Since some context information, such as the user's location or viewing direction, may change rapidly, a fast adaptation to context modifications is required [EKE08].

A third issue is the quality of data from the federated models. As input from various content providers and sources is combined, the federated models may contain inconsistent, incomplete, or unreliable information. Therefore, visualization of the quality of context data plays a crucial role.

The presentation focuses on future challenges in context-aware geo-spatial visualization, especially on open questions regarding uncertainty visualization and scalability of visualization techniques in large, heterogeneous environments. Finally, I briefly discuss target applications that range from mobile personal information systems all the way to systems that support experts analyzing flow simulation data [EKE08] or applications in the technical environment of a smart factory [WJE*05].

References

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‡ http://earth.google.com

§ http://www.microsoft.com/virtualearth