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TOWARDS COORDINATION-INTENSIVE VISUALIZATION SOFTWARE

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Key words to describe this work: Visualization software, Exploratory Visualization EV, HCI, Coordination/model, Multiple Views, Linking, Visual Information Seeking.

Key Results: A framework for coordination in exploratory visualization based on multiple views. A prototype implementing the coordination model (these are the goals of the project)

How does the work advance the state-of-the-art?: A foundation for a coordination model which can be extended to support collaborative visualization.

Motivation (Problems addressed): To move from add-hoc approaches in coordination. Rapid exploration through correlation of visual and non-visual information across multiple views.

Introduction

Most coordination realizations in current visualization systems are "last-minute" ad-hoc and rely on the richness of the chosen implementation language. Moreover, very few visualization models implicitly consider coordination. If coordination is contemplated from the design point of view, it is usually only regarded as part of the communication protocol and is generally dealt with within that restricted domain.

Coordinated multiple views[1] are considered to be an efficient way of exploring [4]. A flexible model for coordination will ensure easy embedding of coordination in such exploratory environments.

This paper compares different approaches to coordination in exploratory visualization *(EV)*. We recognize the need for a coordination model and for that we formalize aspects of coordination in EV. Furthermore, our work draws on the findings of the interdisciplinary study of coordination by Malone [3] and others.

Coordination in exploratory visualization

Coordination is a subject that has been covered by separate disciplines but only recently that is has been established as an independent interdisciplinary science [3].

However, for a deep understanding of coordination in specialized fields such EV, context is important. For instance, in the context of cognitive psychology, the focus of coordination is on the interoperability of multimodal brain functions. In a volleyball game, the focus is on cooperation and synchronization so that all players act and react at the right time to receive, pass or hit to score points. In Petri nets the focus is on the mechanism for specifying and controlling interaction between workflow processes.

In EV often visual correlation is seen as the focus of coordination and thus limiting coordination to generally brushing and navigational slaving. Coordination in fact can appear at any level within the visualization process. A more generic definition of coordination is yet to be defined and formalized.

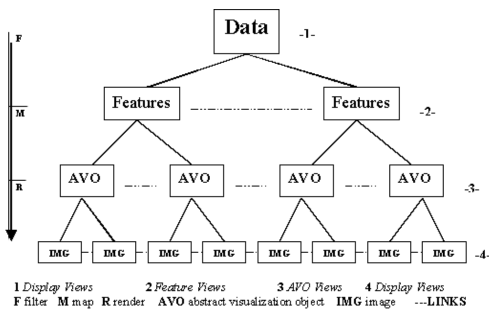

Figure 1 - Coordinated Multiple Views

[1] A view can be generated by tweaking control parameters at any stage in the visualization process.

The essence of ***Exploration*** in visualization is Visual Information Seeking where the emphasis is on rapid filtering, progressive refinement of search parameters, continuous reformulation of goals and visual scanning to identify results [1].

Thus, we define ***Coordination in EV*** as the management of dependencies between views to facilitate the visual information seeking. Indeed we regard interdependencies between views as higher value than the independent views themselves.

Challenges

Many issues in visualization such as synchronization, correlation of visual or non-visual information, occlusion, view explosion and multitasking could be more approachable if coordination was modeled. The challenge is for that model to avoid bias towards a particular data, navigation or communication paradigm. Effectively, it should be flexible, adoptable, and extensible. In a nutshell, the model should foster better exploration.

Coordination Features

We are interested in formalizing aspects of coordination in EV. These features include: the coordinated entities, the links between those entities, including properties such as type and scope, user involvement in coordination, the input/output mechanism to coordination and coordination realizations.

Coordination Approaches

Existing coordinations in EV can be ad-hoc or embedded. Ad-hoc coordination is the prevalent form and has no consistent pre-defined rules. For example, in figure 2, coordination relies on the Object Oriented paradigm in its design and implementation. Users discover coordination in the midst of exploration. Although add-hoc coordination is flexible within the developed environment it is difficult to export to other visualizations since coordination rules may be difficult to extract.

Embedded coordination is often a result of adopting a scheme for visualization. For instance Snap-together conceptual model for coordination [2] relies on the relational schemata, so joins between relations are links between visualizations. Thus, legitimate links are those that comply with the restrictions of the underlying paradigm.

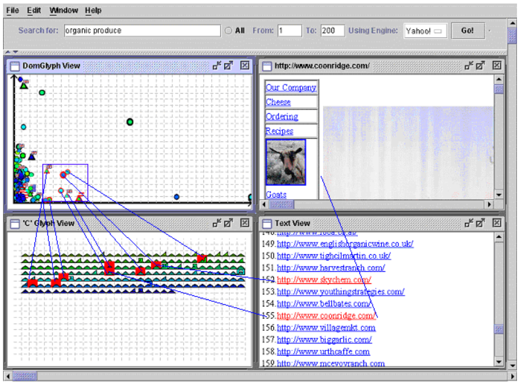

Figure 2 - An ad-hoc coordination example – Web Search Results Visualization [5]

Our aim however, is to produce an overt type of coordination model that is rule-based but independent from any underlying paradigm. Our framework combines various basic interactive activities to achieve new insight.

Conclusion

Coordination between entities is useful in EV if there exist an interdependency between those entities and if its purpose cannot be accomplished by a subset of those entities. Coordinated multiple views if designed carefully are beneficial to visual information seeking. We are working on a flexible coordination model that could be easily adopted by any visualization paradigm that supports exploration.

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