Collaboration around Wall-Displays in Time Critical and Command and Control contexts.

Abstract
The goal of this thesis is to investigate novel ways of interacting with wall displays, improving collaborative data analysis and decision support in time-constraint work contexts (time critical systems and command and control situations). With a focus on multi-user interaction with complex and multi-scale data, and collaboration awareness, this work will generate new interaction and visualization designs to better support data analysis and understanding.

Context
Wall-sized displays engulf viewers in large high-resolution information spaces and form intriguing environments for data visualization and monitoring due to several inherent benefits: (i) physical rather than virtual navigation affords a natural pan-and-zoom in the information space to see overview from afar and details up-close; (ii) an enlarged physical space in front of the display enables collaborative viewing; (iii) and millions of pixels support viewing large amounts of data.

Nevertheless, outside research, in a work context, wall displays are largely treated as big desktop monitors, both in the type of information we view on them and in how we interact with them. For example they often act only as summary and information sharing tools seen from afar (e.g. to enhance situation awareness), with interaction being nonexistent or limited to mice and keyboard. Thus the full potential of interactive large wall technology, such as high resolution or direct-touch interaction, is not fully leveraged, despite research work on interaction and visualization guidelines.

This lack of adoption is because we still need to understand (i) *what* information should be placed on wall displays (replicated information from personal screens, different information, or summaries); and *where* (how to layout the information); (ii) *who* interacts and updates this information (real-time feeds, a group leader, everyone); (iii) *how* to share and more generally interact with them (from a distance using mouse/keyboards or up-close using touch).

These general questions are hard to answer for all possible use cases, but insights can be drawn when looking at more specific situations, such as collaborative work around *Time-critical systems* and *Command and Control* situations. Such contexts include: emergency or time response & management, e.g. air-traffic control; critical infrastructure operations, e.g. public transportation systems, communications and power distribution networks; or the operations of large scientific instruments, e.g. particle accelerators and astronomical observatories. These domains already benefit from the use of wall displays as "monitoring" infrastructure, but not as yet taking advantage of their interactive capabilities.

Research Goals:
The goal of this thesis is to investigate novel ways of interacting with wall displays, improving collaborative data analysis capabilities and decision support in time-constraint work contexts (time critical systems and command and control situations).

Central to time-critical contexts of work is the notion of situation awareness, i.e., how workers perceive, explore and understand elements of the environment with respect to time and space, such as maps and data feeds from the field, and how they form mental models that help them predict future states of those elements. A major challenge is how to best assist users in constructing correct mental models and making informed decisions. This can be achieved by providing them with tools that help them to efficiently identify and correlate relevant and timely information extracted, within the *cooperative* nature of their work and the need for task *coordination*.

We envision situations where multiple workers have to interact with complementary views on the same data, possibly at different levels of abstraction. Central to many scenarios in time-critical systems are the tasks of: being able to explore data individually and as a group, decide which data to look at, combine or switch between representations of the data at different levels of detail, and merge data from multiple sources in a single representation. For example in natural disaster crisis management, experts with different backgrounds and their own resources, need to identify exposed areas at a regional scale, and draw security recommendations specific to smaller areas. Through new interaction and visualization designs, we can better support these tasks, by investigating *what* and *where* to show information to collaborating experts, and *how* to interact with this information to better support data analysis and understanding.

Current forms of multi-scale representations and navigation techniques are not suited to interacting with large amounts of data in a collaborative setting. A significant part of our research over the last eight years has focused on multi-scale interfaces, which let single users navigate large datasets at different levels of detail. We now want to push the concept of multi-scale navigation significantly further, extending it to collaborative setups.

Work Plan:

1. Review state of the art on critical systems in collaborative environments.
2. Gather requirements and tasks from experts on critical systems (user groups we are in contact with include operators of large telescope arrays and traffic controllers).
3. Design and implement prototypes of novel interaction and visualization techniques for multi-scale navigation in collaborative environments, with a focus on increased awareness.
4. Operationalize tasks performed in such environments and determine measures to optimize and test (e.g. efficiency, awareness, learning, etc)
5. Define and conduct user experiments to compare and evaluate the new techniques with respect to the identified measures.
6. Reinforce findings from user experiments through feedback sessions with expert users.

Skills/Interests

- Good knowledge of the foundations of Human Computer Interaction;
- Experience coding graphical interfaces (e.g., Java2D, OpenGL);
- Good level of English;
- Interest in time critical systems and collaborative situations.

Extra Information

As a platform for conducting this PhD, LRI is equipped with two interactive walls (WILD and WILDER), digital tabletops and other interactive devices (e.g. tablets, smartphones).

Supervisors

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