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REVIEW FOR COLLABORATION IN INFORMATION VISUALIZATION INTERFACES FOR MULTI-DEVICE CO-LOCATED SYNCHRONOUS

Hemant Narottam Chaudhari[*1]
[*1] M.Tech(Software Engg.), Lecturer, Computer Engineering Department, JCEI'S Jaihind Polytechnic Kuran, Tal –Junnar, Pune, India.
Email:-hemantch11@gmail.com

ABSTRACT

This paper describes the Review for collaboration in information visualization Interfaces for Multi-device Co-located Synchronous. It is the possible differentiations of collaboration along time and space. Collaborators can be the people working together using interactive graphics on different computing devices, such as large-displays, laptops, smartphones etc., and working at the same time and in the same place, which means co-located or distributed in different places, cities or even countries. They can work synchronous or asynchronous, which is the basis for many web applications or required when group members are in different time zones.

The design of digital systems for co-located synchronous collaboration around information visualizations poses challenges that have not been considered in single-user information visualization systems. In information visualization, it is not yet understood (1) how people collaboratively work with visual representations of data and which methods they use to solve information analysis tasks as a team, and (2) how work on other co-located collaborative activities (e. g. collaborative photo sorting, document editing, and games) applies to the specific problem of collaborative data analysis.

Keywords: *Collaboration, Information Visualization, Multi-device Co-located, Distributed, synchronous.*

I. INTRODUCTION

Collaborative working is appropriate for a range of vital human activities. Shopping, learning, sport, science, engineering and even entertainment can all advantage from face-to-face collaboration and to many of us collaboration is simply the most natural way to do things. In general, it's well if more than one person can work on the same problem together. This is collaboration [1]. Information visualizations map huge amounts of data into a visual form. This is very useful because it is then possible use inherent human abilities to explore the data to find patters that would be difficult to identify through automated techniques [2].

With remote collaborative workspaces, Collaboration on co-located mobile devices shares certain characteristics. Even though physically co-located, the visual workspace and input modalities on mobiles remain separated. The yield, users have limited knowledge of the other's virtual footprint, activity or focus. This separation encourages loosely coupled collaboration and can lead to unnecessary overhead in the exchange of relevant information. The need for improved assistance for such settings can be best explained through a scenario [3].

The multiple displays and devices are interactive workspaces and several benefits and characteristics can be derived from that. The multiple displays provide physical spaces beyond one single virtual space enables users to:

(1) Increasingly utilize space as a resource for visual perception and spatial ability, (2) Extend the device they are currently using to any nearby devices as needed, with appropriate technology, (3) tap into the potential of different types of technologies for suitable tasks or data, and (4) collaborate more flexibly by satisfying the analytic needs of multiple users in a group through multiple devices.[4]

This paper is review of the feasibility of adapting information visualization techniques for co-located synchronous collaboration by considering how different aspects of information visualization design can be applied in a multi-device & multi-user environment. How to take benefits of interactive workspaces from multiple displays and devices.

II. COLLABORATIVE SCENARIOS

The broadly categorize collaborative scenarios according to where they occur in space (distributed vs. co-located) and time (synchronous vs. asynchronous).

These distinctions for systems or tools are not strict—systems can cross boundaries and could, for example, be used either synchronously or asynchronously, as pointed out by Dix et al. (1998) for the example of e-mail. E-mail can be used similar to a chat client in synchronous work or asynchronously in conversations that stretch over longer periods of time. Figure:1 shows several

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scenarios in which collaborative visualization can occur.

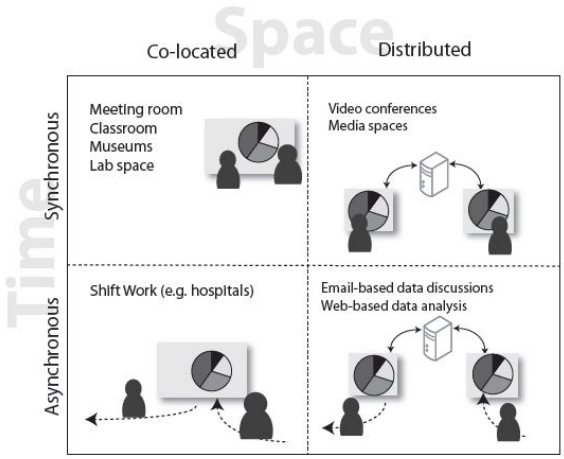

Figure: 1 Collaborative Visualization Can Occur In Many Scenarios Delineated According To Space And Time

It is very important for the potential for greater scalability of group oriented analysis to partition work not only across time, but also across space. And that the scenarios of collaboration and presentation across both time and space are nowadays becoming very common in business. The team members are at the same physical location means that Co-located work. This can be for a short time, because the members traveled to a common location, but also permanent, because the members are at a common site. An important technology for the co-located collaboration in information visualization was the development of bigger displays like display walls or interactive tabletop displays, because visualizations often need a lot of display space to be readable and useful.

Distributed collaboration can provide an infrastructure without duplicating the costs and efforts.

Example telephony, meeting room conferencing, desktop video and audio conferencing, chat rooms for text interactions, file transfer or application sharing.

Synchronous means that the collaborators work at the same time on a project or a solution and can speak directly with each other either face-to-face or for example by audio or video connections.

When the team members collaborate asynchronous, they are working at different times.

III. DESIGN COLLABORATIVE VISUALIZATION

The investigation on the design of an application to help a group of users find a hotel with a large display and several smartphones or equivalent mobile devices, the next stage was to relate user requirements to individual design decisions.

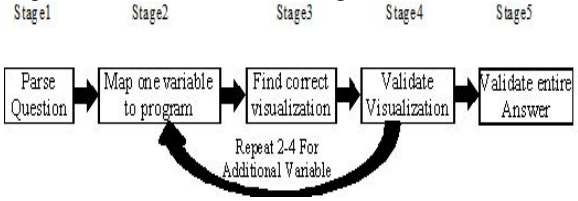

Figure:2 The Collaborative Visualization Process

As shown in figure:2. The five stages from parsing the question over mapping the right variables to finding the correct visualization and then validating the visualization and the entire answer. The stages four and five are more important for the collaboration, because here the members discuss and validate the solution together.

A. Visual Mapping

The visual mapping of information visualization determines how data tables are mapped to visual variables such as spatial displacement, size, shape and color. This transforms raw or processed data to visual structures and determines the form of the visualization.

Due to the different displays of a multi-device multi-user environment, different visual mapping have a number of reasons.

The HotelFinder application we can see a case for both complimentary and consistent visual mappings. The users can select hotels on their mobile according to the price and the number of bedrooms using a scatterplot view and use a map on a large display that discovers the location of the apartments. The large display could also contain a higher version of the scatterplot for people viewing without a mobile device and it would be useful if the map could also be accessed from the mobile devices when the users move away from the large display to go to out and view the actual properties. The equivalent views on different devices are as consistent as possible to avoid unnecessary additional cognitive load.

B. View Transformations

View transformations, also known as data brushes, are individual selections made on the visual structures of the data. For example, if one of the students in our HotelFinder case-study wants to highlight or select a particularly interesting group of hotels and show this to the rest of the group, this selection is a view transform.

The question is how to coordinate selections on different device displays. Different options are:

1) *Independent displays*: This option means that each device display responds independently to user interaction through its own interface and there is no coordination between displays. This reduces the

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possibility of conflict between user-selections since users need to actually be interacting with the same device for any conflict to occur. The problem is that there is less capacity for sharing and if a user wants share a selection made on their own device, they would need to repeat the selection on the main display.

2) *Complete coordination*: This means that any selection made by any user appears on all devices immediately. The problem with this approach is the capacity for conflict between user-selections. For example, if a user is in the middle of forming a selection and another user makes a selection this could be distracting or confusing, especially in the case of a hard selection where the elements they select could unexpectedly disappear.
3) *Coordination on main display*: This means that selections made on mobile devices are sent to the main device but not vice versa. In this case any conflicts between user's selections will affect only the main device and not personal mobile devices. Users can share selections on the main display but cannot view another user's selection on their own personal mobile device.
4) *Commands to send and retrieve*: In this configuration users can choose to send selections to the main device or retrieve selections from the main device to their personal devices. This adds an additional step for each user if they want to share a selection but offers more control over what is shared and what is kept private.

IV. CO-LOCATED

The co-located collaborative information visualization systems. The information visualization design advice, co-located collaboration advice and the combination of both. The structure is adopted from which divides into hardware and system setup, designing the information visualization and designing the collaborative environment. It is only an overview, because every application has different visualization and interaction requirements. For example some applications need simultaneous visualization and interaction on the same data across more surfaces requires various displays to show different perspectives of the same scenario.

A. Hardware and System Setup

The display size and the available screen space are very important and are often a problem, when you want to display a large dataset. When the number of group members grows, you also need a bigger display, so that the viewing and interaction area is large enough and gives adequate access to all users. When the members want to work parallel and in an acceptable distance from each other, there should also be enough space to display multiple copies of visualization.

There are a lot of configuration potentials with advantages and disadvantages. On the one hand only on big display can be available, like a display wall or an interactive tabletop, on the other the team members can be connected with their individual displays. A combination is also imaginable, so that the users for example can control the representation on a display wall with their handhelds or laptops. Distinguish the possible connections of the visual elements on different displays. For example there can be a simple file transfer relationship, a synchronous co-related relationship with focused view or a pixel update in unison.

To support collaboration each collaborator should have at least one means of input. Most suitable are inputs that can be identifiable so that the system can give a personalized response. It is also important to coordinate synchronous interactions and the access to shared visualizations and data sets.

The display resolution also plays an important role for the legibility of information visualizations. When the display has a low resolution it could be necessary to re-design the representation, so that for example

Text and color are displayed in proper style. Furthermore "interactive displays are often operated using fingers or pens which have a rather low input resolution".

The processing power of the system should also be considered well. Even if the implementations were designed carefully for efficiency, the system is supposed to display several information visualizations that interact with at the same time. This probably needs a lot of capacity and should work without much delay to avoid interferences for the users.

B. The Information Visualization

Many of the known design guidelines for single-user system will still apply for the use in collaboration. But new questions to answer are for example if certain representations will be better adapted to support small group discussions or if various representations help the users in their different interpretation processes. It is known that people prefer different visualizations on large and small displays.

Capabilities to freely move interface items is important for group interactions. "Letting users impose their own organization on items in the workspace may help collaborators create and

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maintain mental models of a dataset that contains several different representations". This also allows the users to build their own categorizations on the representations.

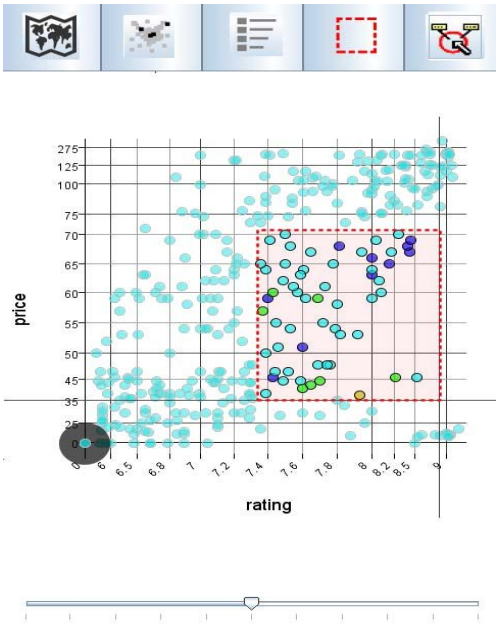
C. The Collaborative Environment

It is important that the users coordinate their actions with each other for successful collaboration. The workspace separating into shared and personal. The shared workspace with shared tools and representations is needed for the collaboration. A group can work together, discuss and analyze the visualizations. The data separately explore is necessary to the personal workspace. The personal workspace even divides in public and private.

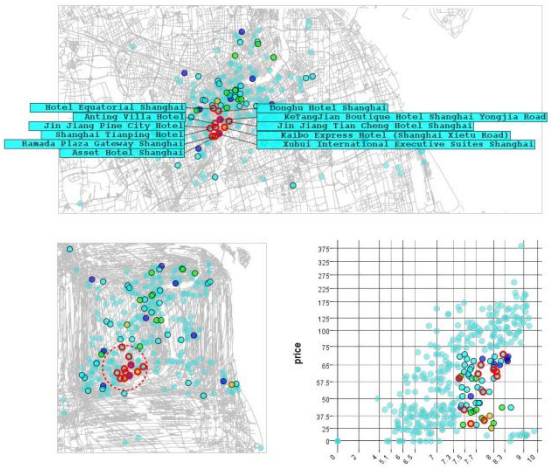
A smooth interaction is very important for an effective work. The system should be easy to understand and control. "Changing the view or the visualization parameters should be designed to require as little shift of input mode as possible and as little manipulation of interface widgets and dialogs as possible".

V. APPLICATION

The HotelFinder case study allowed to developing the prototype application shown in figure: 3.



a)



b)

Figure:-3. The HotelFinder Interface for Multi-Device Co-located Synchronous Collaboration. Mobile touch-screen display (a) with coordinated large display with motion detection control (b).

This shows the mobile display interface with the scatterplot view selected. Buttons on the left hand side allow the user to choose between eccentric labeling and box selection, or move from the scatterplot view to the details view or map view. The box selection is being used to select some Hotels with a reasonably low room fee and a higher user rating. When hotels are selected in either the scatter-plot or the map view other hotels are greyed out in all views so as to focus on the user selection. The slider on the right hand side allows the user to apply distortion based on the distribution of the data. This can be applied to have a better view of areas of the map or scatterplot where groups of hotels are normally too tightly clustered together. As the slider is moved, and the level of distortion changes, the points representing apartments gradually move to their new positions so as not to disorientate the user. Buttons along the bottom of the screen allow the user to first label then select a selection made by another user.

Figure: 3. also shows the large display interface. This includes the scatter-plot, map and detailed map on the same screen at the same time. The union of all user selections are highlighted all the users labels are shown in all views. This allows all users to label and select different hotels without conflicting with other users. The main map view is not distorted so as to give a better representation of geographical distance. This works well since the display space is normally big enough to distinguish between any hotels forming a tight cluster. The distorted map view can be used for a better view of hotels in the city center where the distance between places is smaller and less significant.

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TABLE 1. USER ATTITUDES TOWARD THE PROPOSED MULTI-DEVICE MULTI-USER INTERFACE

	Response Score	
	Yes	No
Would you consider using this type of interface in the future	87.0%	13.0%
I feel that this type of interface would	Average	SD
a. Improve the level of collaboration in the group	3.95	0.385
b. Help us make more democratic decisions	3.80	0.470
c. Help us make a more informed decision	3.97	0.409
d. Help us arrive at a better decision	3.95	0.381
e. Improve the experience of working together	3.91	0.411
f. Give us a better insight into the data	3.89	0.457

Responses are scored as follows: strongly disagree=0, disagree=1, neutral=2, agree=3, strongly agree=4.
SD abbreviates standard deviation

TABLE 2 . USER CONCERNS RELATED TO THE PROPOSED MULTI-DEVICE MULTI-USER INTERFACE

What are your biggest concerns for this type of system?	Response Score	
	Average	SD
Security	4.106	0.338
Privacy	4.200	0.458
Ease of Connection	4.015	0.433
Functionality	3.853	0.424
Ease of Use	4.166	0.365
Efficiency	4.106	0.338
Learnability	3.901	0.441

Responses are scored as follows: not a concern=0, a slight concern=1, a moderate concern=2, a serious concern=3, a very serious concern=4. SD abbreviates standard deviation.

VI. CONCLUSION

This paper described that the Review for collaboration in information visualization Interfaces for Multi-device Co-located Synchronous. Collaborative information visualization can be much helpful in the business and research world, where business people and experts are located all over the world and have to communicate and collaborate, both synchronous and asynchronous. Information visualization interfaces for co-located synchronous collaboration is understand with demonstration of a simple application for finding hotel accommodation. The application is demonstrate the power of information visualization interfaces when applied in a multi-user multi-device environment.

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