Toward Multimodal Interaction of Scatterplot Spaces Exploration

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Abstract
The latest generation of large vertically-mounted multi-touch displays bring new opportunities for solving visual analytics tasks. Due to their size, it is possible to visualise and collaboratively interact with high-dimensional datasets and multiple views (e.g., scatterplots, scatterplot matrices and parallel coordinates). However, using only multi-touch for input can be overly restrictive. Other modalities need to be considered to utilise the power of these screens fully. By adding natural language interaction, the user can directly interact with the visual analytics application from a distance. Incorporating eye-tracking can help narrow down what the user is looking at or is interested in. In this paper, some of the challenges of using multi-touch as input for the analysis of scatterplot spaces on large vertically-mounted multi-touch displays are discussed and addressed by proposing the incorporation of other interaction modalities.

Author Keywords
Multimodal; interaction; scatterplot; multi-touch; high-dimensional visualisation.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

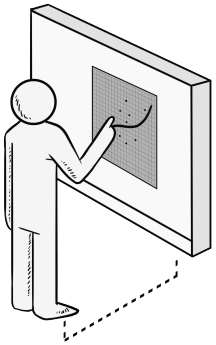

Figure 1: Interacting with the screen using multi-touch (up close).

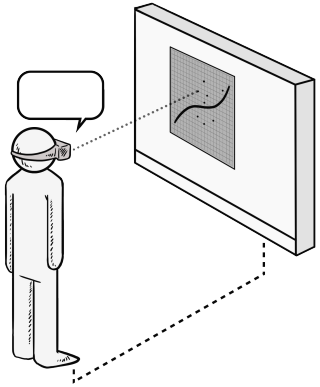

Figure 2: Interacting with the screen using eye-tracking and speech (distance).

Introduction

Large vertically-mounted multi-touch displays are a new medium for interactive visualisation of high-dimensional datasets. These screens can visualise a large number of records in multiple views and provide sufficient space for collaboration between multiple users. Figure 1 shows a setup of such a display. Due to the nature of touch screens, using multi-touch as the sole input modality can have some drawbacks, including the gorilla arm effect [2], having to be within touching distance of the screen, and not being able to reach all parts of the screen without stepping sideways. This paper discusses how these problems can be addressed by integrating other interaction modalities, such as gesture recognition (Kinect), eye-tracking, and speech recognition. Figure 2 demonstrates an alternative scenario, in which the user is using eye-tracking and speech to interact with the scatterplot.

Related Work

Research on combining multiple interaction modalities has a long history. In one of the earliest works, Wang [6] proposed VisualMan, a device and application-independent model to integrate various modalities including gaze and voice into a user interface.

Some researchers have begun to look at how to integrate multiple interaction modalities into visual analytics interfaces. Srinivasan and Stasko [5] presented Orko to explore the idea of using natural language interaction for network exploration. Shao et al. [4] suggested using eye-tracking as input for exploration of patterns in scatterplot spaces. They used eye-tracking to detect which plots have been inspected by the user to suggest the most dissimilar plot by a guideline. In other work, Chegini et al. [1] implemented an application in which two users can work together on a large vertically-mounted multi-touch display to explore scatterplot spaces and suggested adding other interaction modalities besides multi-touch, including eye-tracking to better utilise the large screen.

Multimodal Interaction for Scatterplot Spaces

Scatterplot matrices and parallel coordinates are two well-known techniques for visualising high-dimensional datasets. Shao et al. [3] proposed a way to interactively analyse scatterplot matrices using a regression lens. The user can select an interesting set of records in a scatterplot and the regression model for that subset of records is then visualised. Later, as shown in Figure 3, Chegini et al. [1] presented a similar application in which two users can collaboratively analyse a scatterplot side-by-side on a large vertically-mounted multi-touch display. While developing the prototype, the authors observed several issues:

- Using a vertically-mounted multi-touch display for long periods results in fatigue in the arms, the so-called gorilla arm effect [2].
- On a large vertically-mounted display, it is not possible to reach all places on the screen without moving sideways.
- In order to touch the display, users must stand within arm's reach.
- Such a display is potentially inaccessible to disabled users.

To address these issues, the multi-touch interaction can be augmented with both speech input and eye-tracking, resulting in the following benefits:

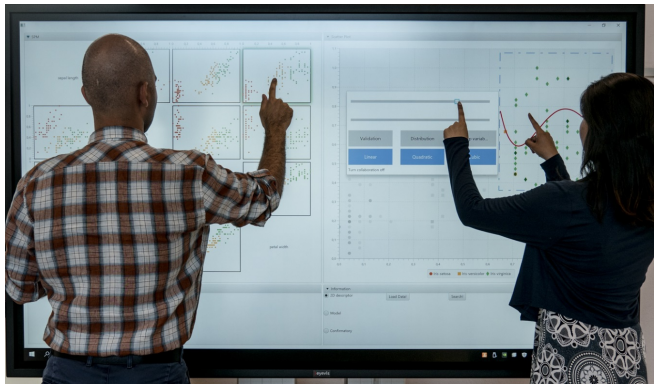

Figure 3: An example of solving visual analytics tasks on a large vertically-mounted multi-touch display.

- Selecting a particular scatterplot from the scatterplot matrix can be achieved by looking at the scatterplot of interest and issuing a voice command.
- Selection can potentially be achieved by fixing a gaze for a certain period of time.
- Voice commands (e.g., search or zoom) can be issued from further away.

Future Work

In the future, interaction modalities other than multi-touch should be added to the current system. Eye-tracking, natural language interaction and gesture recognition would all be desirable. The research will focus on solving collaborative visual analytics tasks using currently available modalities, not on creating novel modalities or interaction techniques.

References

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