INVISQUE: Intuitive Information Exploration through Interactive Visualization

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Abstract
In this paper we present INVISQUE, a novel system designed for interactive information exploration. Instead of a conventional list-style arrangement, in INVISQUE information is represented by a two-dimensional spatial canvas, with each dimension representing user-defined semantics. Search results are presented as *index cards*, ordered in both dimensions. Intuitive interactions are used to perform tasks such as keyword searching, results browsing, categorizing, and linking to online resources such as Google and Twitter. The interaction-based query style also naturally lends the system to different types of user input such as multi-touch gestures. As a result, INVISQUE gives users a much more intuitive and smooth experience of exploring large information spaces.

Keywords
Information seeking, search, interactive visualization, user interface, design principles

Classification Keywords
H5.2 User interfaces (Graphical User Interfaces)

General Terms
Design

Introduction

Results from search queries are traditionally laid out in a list format, where the data can only be ordered in a single dimension. Also, the format often relies on users having to scroll through the data (or proceed through several pages). Users can lose their train of thought when searching through lists and come to the problem of "What was I looking for?".

INVISQUE (INteractive Visual Search and Query Environment) was developed to overcome the problem of list-based searches. The novel aspect of the system is a non-conventional yet innovative user interface, which facilitates rapid and continuous iterative searching while keeping visible the overall context of the search. This concept would also provide opportunities for discovering relationships within the data and create opportunities for the users to find unanticipated related information [1].

Related Work

Over the years different concepts of multi-dimensional information visualization and direct manipulation of data have been implemented. Combining multi-dimensional visualisations and dynamic queries is not a new concept. Ahlberg and Shneiderman ([2], [3]) visualized search results using 2-dimensional scattergrams and provided sliders to filter the data. HomeFinder [4] used dynamic queries and sliders for user to control visualization of multidimensional data. More recently Stasko et al., [5] developed a system (Jigsaw) that provides multiple coordinated views of document entities emphasizing visual connections between entities across the different documents. INVISQUE combines the information visualization concepts mentioned above with a modern visual interface and emerging interaction technologies.

Design

INVISQUE is designed around a metaphor of physical index cards on a two-dimensional infinite 'canvas' workspace. Although this is a departure from the traditional 1-dimentional list-style interfaces, the cards still present basic information such as title, description and keywords (see Figure 1).

Index Cards

By default, the index cards are ordered and presented in both the x and y axes. The attributed that ordered depend on the search domain, and can be set by the user. In the example of searching for journal articles, the y axis can represent the number of citations and the x axis can represent the date of publication. If we were searching for film showing times at a cinema, the y axis can represent the rating for the movie and the x axis can represent the show time. This method allows users to view two levels of ordering, something that is not seen in traditional list-based searches.

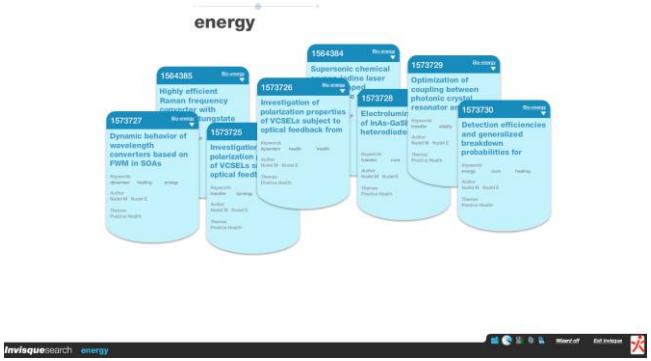

Figure 1. Search results screen showing 'index cards' with bibliographic information.

Figure 2. Drilling down into an index card to see the content of the document.

By clicking on an index card, users are able drill down to find more information. In the case of a document search, users can view the content of the document (see Figure 2). If searching for films, then users could drill down to read a synopsis or watch a trailer. INVISQUE is designed such that the information appears in the foreground, meaning the user never leaves the workspace. This helps to maintain the context of the search.

Clusters

Rather than relying on static text boxes for input, INVIQSUE allows the user to start a new search anywhere on the canvas. This is done simply by clicking on the white space and typing in the search term.

Each set of search results are grouped into a cluster. The infinite canvas allows users to visualize multiple searches (or clusters) simultaneously (see Figure 3). This is a step away from traditional tabbed-browsing,

Figure 3. Multiple search results grouped into clusters. The active cluster (the focus) is opaque while remaining clusters (the context) are semi-transparent, layering the information presented to the user.

and allows users to make visual comparisons between multiple search results.

Although we are only in a 2D space, the use of transparency creates a series of layers (see Figure 3). The active search (or cluster) is opaque, giving it the impression of the closest layer and, therefore, the main focus. Remaining clusters are semi-transparent, giving the impression they are in the background, providing context to the active search.

Any attributes on the index cards can be used to progressively modify searches. For example, by selecting a keyword on one of the index cards, it highlights and brings to the foreground all cards across different clusters with the same or related keyword, quickly revealing further possible relationships. Highlighting the links through the use of transparency negates the need for linking lines, thereby reducing clutter while still being able to direct the user's attention.

Users are also able to extract index cards of interest from across clusters to make a new user-defined cluster. This is done by drawing a continuous line that passes through each of the interested index cards. When the user stops drawing, the selected index cards are merged into a new cluster. We call this method *connecting the dots*, which is a gesture that translates well between both cursor and touch based interactions (see Figure 5).

Figure 4. The merging of two clusters.

Users can also easily invoke Boolean operations by dragging and dropping multiple results sets to create a super-set or intersection, revealing information that is common between the results. For example, in Figure 4 two clusters are being merged by dragging one cluster title on top of the other.

Themes

At any point, the workspace can be saved in its current state as a *theme*. This theme captures the related search terms, acts as a place holder for re-visiting the search, and provides a pre-defined environment for new users who want to perform similar searches.

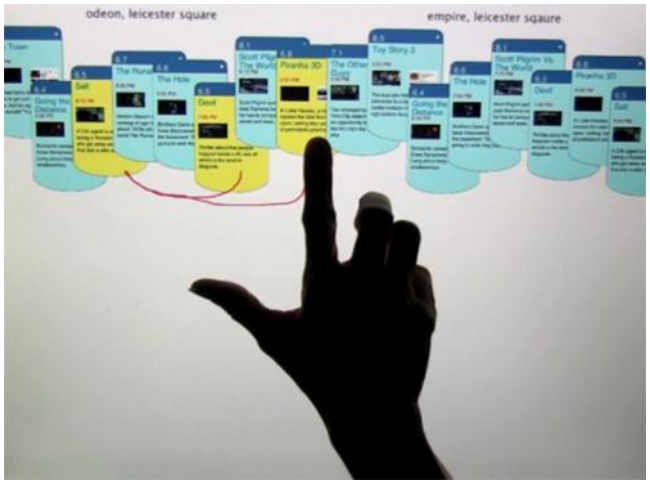

Figure 5. Selecting multiple index cards from two clusters by drawing a continuous line through them (connecting the dots).

User Interactions

Although INVISQUE was developed using a point and click interface, the interaction concepts work well with other interfaces. We see multi-touch as an emerging yet popular interface, and as a consequence INVISQUE has been designed with that in mind (see Figure 5).

The infinite canvas allows users to visualize searches beyond the boundaries of their display. Multi-touch gestures allow users to easily zoom and pan their workspace, and preventing the problem of *what was I looking for?*

The infinite canvas concept has the potential of being adapted and deployed into collaborative environments, enabling multiple users to search simultaneously. Users would have the ability to both visualize and interact with each other's search results and combine them with their own.

Implementation

At the time of writing, we would describe INVISQUE as a working prototype. The graphical user interface is connected to a MySQL database, and users are able to perform real time search and queries.

We are still developing INVISQUE, and are investigating the use of several platforms, as well as optimizing performance when accessing large data collections. We find that Flash provides the best visual output, with a well presented and polished feel, but performance drops when accessing large data sets. We find that Java performs much better for data retrieval, but lacks the final polish.

In the near future, our aim is to improve both the visual output and performance when accessing large data sets. We are also investigating mobile platforms such as Google's Android and Apple's iOS.

Domains and Audience

We have applied INVISQUE to several domains. The system was initially designed for document retrieval, helping academics search through journals and proceedings. We soon realized that INVISQUE could be applied to a variety of domain areas. In contrast to document searching, we have experimented with a cinemas and films data set, where users can plan what film to see and where.

In each of the above examples, the content of the index card was completely different, as well as the ordering of the axes and the drill down content. We

found, however, that even with such a contrast in the information presented, the search methodologies for both examples were similar.

Since INVISQUE is capable of providing an interface to many different domains, the potential audience will also be large and varied. The interaction concepts and search metaphors are simple and easy to understand, allowing anyone who wishes to perform a search or query to benefit from its use.

At the time of writing, we are also in the preliminary stages of evaluating the use of INVISQUE for high and low literacy users in the context of finding social service information. Our hypothesis is that the context layering will reduce premature search abandonment when compared to traditional hierarchical website layout.

Conclusion

INVISQUE aims to present the design for the next generation of information search and retrieval systems that would support semantic analysis and access to massively large data sets. The designs we have developed shows how we can visualize search results, how they need to be presented, and how their interactions need to be carried out.

We have moved away from the conventional list-style arrangement, and instead represent information by the use of index cards in a 2-dimentional space. The open canvas allows users to perform multiple searches while keeping the context of the complete search space.

The audience of INVISQUE will vary depending on the domain it has been applied too. While the initial concepts of INVISQUE were applied to document retrieval, we foresee it begin applied to many search domains.

In the near future we will be integrating and evaluating INVISQUE with a multi-touch interface. We also intend on testing performance with large data sets. Once we have established that INVISQUE is a robust and adoptable search environment, we aim to commercialize the product, making it available for public use.

Acknowledgements

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