Structured Display and Browsing of Documentary Information: VIBE in Action

Robert R. Korfhage and Bambang Parmanto
Department of Information Science
University of Pittsburgh
Pittsburgh, PA 15260
korfhage@lis.pitt.edu

Abstract

Traditional information retrieval systems present the user with a very limited view of the document database, erecting a barrier to information at the same time as supplying the user with information. In this paper we present a graphical interface, VIBE, designed to eliminate this barrier and present the user with more complete access to information.

Introduction

Traditional information retrieval systems have been designed with little concern for the presentation of information to the user. The result is that most such systems present the user with a list of documents that supposedly satisfy his or her information needs. Such a list neither shows any structural relationships among the documents, nor provides the user much help in the event that the list is unsatisfactory. A more graphically oriented display of the system output can provide much information that is of value to the user.

Several designs for visual interfaces have been proposed [Chang, Crouch, Fowler et al., Korfhage, Lin et al.], each focusing on a different structural aspect of the information to be displayed. One characteristic of most such systems is that the display itself is relatively fixed. Beyond changing the query the user has little control over the display. Another aspect of many such systems is that the user, as in traditional retrieval systems, asks one query at a time.

This presentation focuses on a visual display system, VIBE, developed by researchers at the University of Pittsburgh and Molde College, Norway, that seeks to give the user more control over the display [Olsen et al.]. The system is based on two distinct ideas: that the user should be able to present several reference points to the system in addition to, or in place of, the query; and that the retrieved documents should be displayed as icons whose arrangement reflects structural relationships among the documents. The user controls the display by placement of the reference point icons, as well as by choice of the reference points.

VIBE

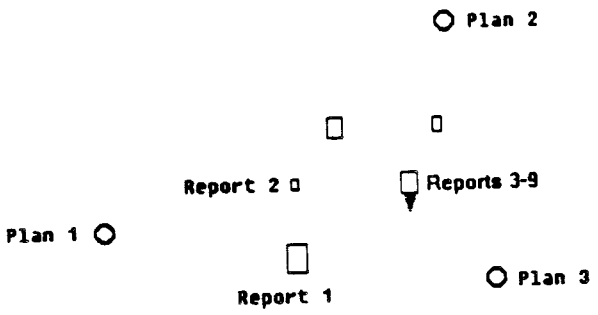
The VIBE display assumes that the user presents to the system one or more (preferably at least three) reference points consisting of weighted or unweighted key terms. Typically the reference points may include a traditional query, a user interest profile, or known documents. The user can simultaneously present two or more queries, focusing on different aspects of the data. Alternatively, the user may

decide to dissect a query, presenting each key term as a separate reference point.

These reference points are represented by circular icons, called POIs (points of interest), placed at will on the display screen by the user. The user can at any time add or delete POIs, or move them to other locations on the screen. As this is done the display adjusts automatically to accommodate the new icon configuration.

Each document in the database is evaluated for its similarity to each of the reference points. The similarity function used in the VIBE prototype is a simple one, the count of common key terms. However, any similarity function can be used. Any document that bears a similarity to any of the reference points, above a user-defined threshold, is displayed. Normally this threshold is set at zero, thus displaying any document that is at all related to any of the reference points.

Each document is represented by a rectangular icon, whose size is determined by its highest similarity value vis-a-vis the displayed POIs. The position of each document in the display is defined by the centroid of its similarity values. In the figure, Report 1 is related only to the POIs labeled Plan 1 and Plan 3; Report 2 is related to all three POIs, but only weakly to Plan 3. In addition, Report 2 is perhaps rather insignificant, as shown by the small size of the icon. Reports 3 to 9 all have the same relationship to the three POIs; the presence of multiple reports is indicated by the lines under the rectangle. (In the VIBE display only the POIs are normally labeled.



The user has a high degree of control over the display, being able not only to define each reference point, but also to determine and change the positions of the POIs, thus altering the display to make it more informative. As the POIs are moved or changed, the documents adjust to the new configuration, maintaining the centroid paradigm of the display. Moving the POIs may organize an apparently random set of documents into clearly defined clusters. This action may also result in an apparent cluster of documents resolving into two or more clusters, whose images were overlaid in the original display. In addition, outlying documents that belong to no cluster are clearly shown.

A number of different graphical functions are also defined to aid the user in interpreting the display. Primary among these is a "lens" function that enables the user to "open" each document icon to determine the database record underlying the icon. The document content is then displayed in a separate text window. For a textual document this will be the title, abstract, and as much of the full document as is in the database. (The text window is scrollable.) For a business or numerical database document, the display will show the field values in the database.

The other graphical functions in VIBE are designed to display more fully the relationships between the documents and the POIs. A "star" function creates for each document individually rays pointing to each related POI, the length of each ray depending on the strength of the relationship. Coloring a POI automatically colors each document related to it. A "net" function creates the complete graph on the POIs, helping the user see which documents are related to any subset of them.

Another feature that has proven very useful is a "displacement" function. When this is turned on, any change in the display is shown as a line joining the former position of each document icon to its present position.

The system exists in two prototypes, running under X-Windows on a Sun and under Microsoft Windows on a PC. These two versions differ slightly in their display format. The Sun system utilizes multiple windows, displaying both text and graphics at the same time. The PC version was designed for a portable computer. The limited size of screens on such machines dictated a display that permits the user to toggle between the graphics window and the text window.

Uses of VIBE

While VIBE was designed with text documents in mind, it can be used with any data for which similarity functions can be defined. For example, it has been used successfully with demographic data representing 102 countries. When used with numerical data, the reference points are typically paired, representing minimum and maximum values of a given numerical datum. The data are further scaled to make all ranges compatible. If this were not done, annual salary data for example, with a range of 0 to perhaps 150,000, would completely dwarf age data with a range of 0 to 150.

When paired POIs are used in this way, the user is free to choose both, neither, or only one of each pair, and to place the POIs at will. An obvious tactic, if both POIs of a pair are chosen, is to place them on opposite sides of the display, thus expanding the display with respect to that particular characteristic.

Traditional retrieval systems may present the user with only twenty or thirty documents at a time, feeling that the user would be overwhelmed with a more lengthy display. VIBE is capable of presenting many more documents at a time, albeit as icons, raising the "information overload" question. Since the documents are displayed as icons rather than text, we do not feel that this is a significant problem. In an experiment with the Cranfield database we used the twelve terms of a query as POIs, and displayed the icons for nearly 900 documents. While the display was clear and understandable, we feel that this is perhaps an extreme case; more typically a user might use five or six POIs and adjust the threshold to display no more than two or three hundred documents. A set of controlled user tests is planned for the coming year.

Among the applications seen for VIBE are the following:

- ordinary text retrieval
- analysis of demographic or other numerical data

- sorting of electronic mail messages
- rough organization of data prior to detailed statistical analysis
- integration with geographic information systems in a crisis management situation
- organization and retrieval of image data
- determination of natural clustering among data
- applications in pedagogy, such as letting children determine their own organization of plants or animals
- organization of experimental data, such as that from medical experiments
- organization of investment information on the basis of several factors

Conclusion

As we move into an era of large full-text databases and image databases, it is becoming increasingly important to consider the manner in which data are retrieved and presented to the user. One aspect of this is the development of more sophisticated retrieval systems, that can do a much better job of matching the user's information need. Another aspect is providing more informative displays of the retrieved data. In VIBE we have focused on the latter. The underlying philosophy is that the user is really the intelligent part of the information system, and thus best understands the information need. Hence the user should ultimately be in control of the display. By allowing the user to define multiple points of view, and to arrange the display at will, we have taken a step toward providing this control.

Bibliography

Shi-Kuo Chang, Visual reasoning for information retrieval from very large databases. *IEEE Workshop on Visual Languages*, 1989, 1-6.

Donald B. Crouch, The visual display of information in an information retrieval environment. *SIGIR 86*, 58-67.

Richard H. Fowler, Wendy A.L. Fowler, & Bradley A. Wilson, Integrating query, thesaurus, and documents through a common visual representation. *SIGIR 91*, 142-151.

Xia Lin, Dagobert Soergel, & Gary Marchionini, A self-organizing semantic map for information retrieval. *SIGIR 91*, 262-269.

Robert R. Korfhage, *Information Retrieval in the Presence of Reference Points, Part 2*. Research Report LIS034/IS91002, School of Library and Information Science, University of Pittsburgh, March 1991.

Kai A. Olsen, Robert R. Korfhage, Kenneth M. Sochats, Michael B. Spring, & James G. Williams, Visualization of a Document collection: The VIBE System. *Information Processing and Management* 29, 1, 1993, 69-81.

Kai A. Olsen, Robert R. Korfhage, Kenneth M. Sochats, Michael B. Spring, & James G. Williams, Visualization of a document collection with hypertext links: The VIBE system. Submitted to a journal.