iBase: Navigating Digital Library Collections

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1 Introduction

The growth of digital image collections in many areas of science and commercial environments has over the last decade spawned great interest in content-based image retrieval. A great variety of methods have been developed to retrieve images based on example queries and techniques to elicit and utilize relevance feedback (e.g. [4, 5]). Often the systems provide a simple framework that permits evaluation of the method and are not intended as full-fledged systems ready to be used in a realistic setting. Also, comparatively little effort has been expended on devising efficient techniques to browse image collections effectively. The few notable exceptions [1, 3, 6] treat browsing internally as a sequence of queries and thus do not leverage the performance benefits associated with pre-computed browsing structures.

2 Our Approach

iBase has been designed to seamlessly integrate the paradigms of text-based search, content-based search with relevance feedback and a recently developed NN^k browsing technique [2] in a unified interface. NN^k browsing takes place along a pre-computed network consisting of images and their nearest neighbours with respect to different feature combinations. In addition to the NN^k approach iBase supports directory and temporal browsing and camera motion, Query by Example and relevance feedback search. It allows fast navigation across a collection, provides a viable alternative to search by example and has proved instrumental for our successful participation in TRECVID [7]. The iBase system is being run successfully on media content from London's Victoria and Albert Museum collection, TRECVID and a personal photo collection from Imperial College London.

The GUI provides each access method with its own tabbed panel. Integration is achieved by building the interface around the notion of a focal image. The user selects an image as the focal one simply by clicking on it. The current focal image is highlighted in each panel and all panels are updated to show results with respect to the new

focal image thus ensuring consistency across all views. For example, the NN^k panel shows the nearest neighbours of the focal image, the Content Viewer panel shows an enlarged view of the focal image while the temporal panel (bottom of Figure 2) shows the temporal neighbours of the focal image.

3 Running the Demo

The system has been developed as a web application consisting of a Java applet and a servlet running inside Apache Tomcat. To run the client application a computer with Java runtime and Internet connectivity is needed. Figure 1 shows the client application comprising of 8 tabbed panels. The user starts by selecting the required content collection and features from the 'Collection Settings' panel.

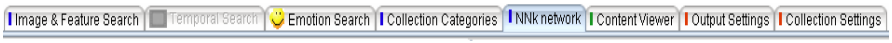

Figure 1: iBase Client Tabbed Panels

The user has a number of options for searching through the collection, they can select the 'NN^k network' panel to view nearest neighbour images (Figure 2), select a category (directory) or search based on Temporal or Emotion information. The NN^k network allows the user to browse the connected neighbours of **all** images in the collection. As the user interacts with other areas of the system (through an image search for example) **any** selected image will have its NN^k neighbours displayed here.

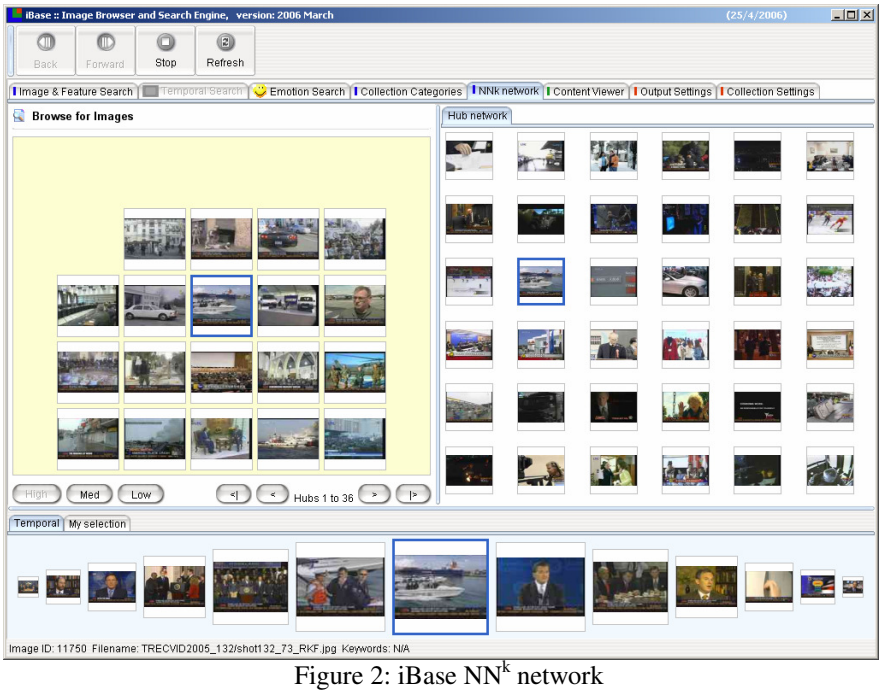

Figure 2: iBase NN^k network

To the right of Figure 2 the 'Hub network' shows the 36 most connected images in the collection. Left of Figure 2 shows the NN^k of the current focal image and controls for browsing the hub network. Exploring the hub network provides an additional search approach for the user.

Figure 3 shows how a user can add an image to their search. An image query can be created or expanded by right clicking on **any** image displayed by the system and adding it to the query. Using this approach the user can provide the system with relevance feedback on their information need. External images can be chosen as query, too.

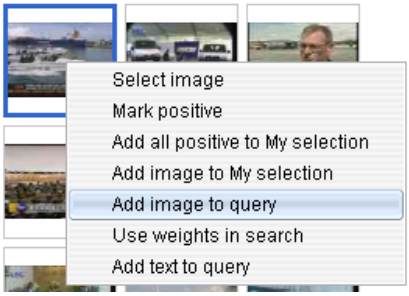

Figure 3: Adding a query image

Figure 4 illustrates a search using the image selected in the previous section. The users query image(s) are shown in the 'Search images' section on the left of the screen with the search results shown on the right. The user can further refine their query by modifying the feature weighting; this is achieved by adjusting the slidebars (shown just above the 'Search Now' button on the left).

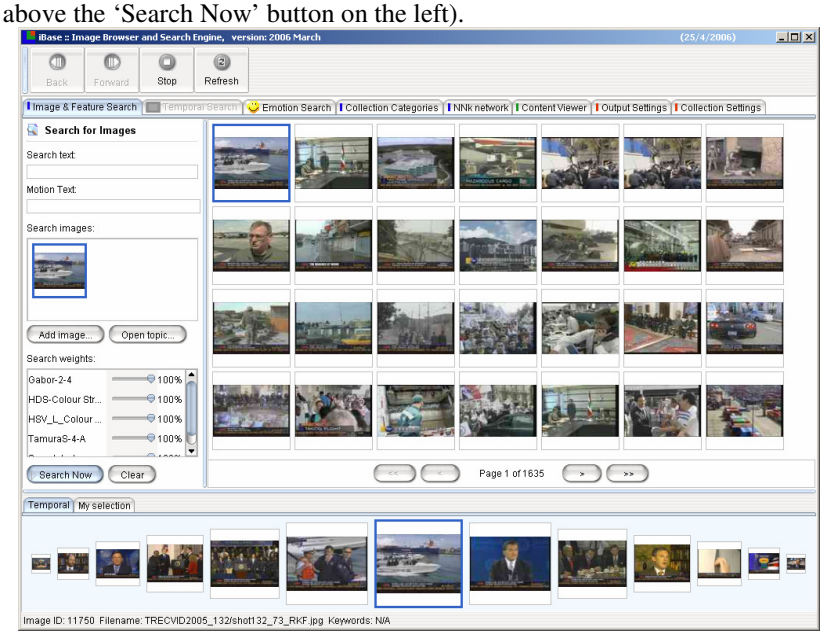

Figure 4: iBase Image Query Search

The temporal neighbours of any selected image can be seen at the bottom of Figure 2 and 4 while the directory structure of the collection can be browsed from the 'Collection Categories' panel. Both these options provide additional approaches for browsing through the collection.

4 Summary

It is this seamless combination of search and browsing, facilitated by the notion of a focal image, that *sets iBase apart* from other content-based images search engines: the NN^k browsing allows one to identify suitable images for search-by-example, the result of which can be browsed for other relevant material either by NN^k browsing or by temporal or directory browsing.

Additional importance is placed on the design of the GUI. By providing a tight integration of techniques and a rich set of user interactions, we aim to equip the user with substantial navigational power within a straightforward and intuitive interface. Several key concepts of HCI were maintained throughout the design process: (i) consistency (ii) responsiveness and (iii) system progress feedback.

The design of iBase is such that new search approaches that needed to be built into the system like camera motion, hub NN^k network browsing and human emotion feedback were done with relative ease. Demo: http://mmis.doc.ic.ac.uk/demos/ibase.html

References

1. I. Campbell. The ostensive model of developing information-needs. PhD Thesis, University of Glasgow, 2000.

2. D. Heesch and S. Rüger. NN^k networks for content-based image retrieval. In Proc. of ECIR pages 253–266. LNCS 2997, Springer, 2004.

3. Y. Rubner, L. J. Guibas, and C. Tomasi. The earth mover's distance, multidimensional scaling, and color-based image retrieval. In DARPA Image Understanding Workshop, 1997.

4. Y. Rui and T. Huang. Optimizing learning in image retrieval. In Proc. of IEEE Conf. on Computer Vision and Pattern Recognition, 2000.

5. Y. Rui, T. S. Huang, and S. Mehrotra. Content-based image retrieval with relevance feedback in MARS. In Proc. of IEEE Int'l Conf. on Image Processing, 1997.

6. S. Santini and R. Jain. Integrated browsing and querying for image databases. IEEE MultiMedia, 7(3):26–39, 2000.

7. D. Heesch, M. Pickering, S. Rüger and A. Yavlinsky. Video Retrieval using Search and Browsing with Key Frames. TREC Video Retrieval Evaluation, Gaithersburg, MD, 2004. Available at: http://mmir.doc.ic.ac.uk/www-pub/trec2003-nb.pdf.