

A Concept-Based Interactive Visualization Approach to Web Image Search

Enamul Hoque*
Memorial University of
Newfoundland, Canada

Orland Hoerber†
Memorial University of
Newfoundland, Canada

Minglun Gong‡
Memorial University of
Newfoundland, Canada

ABSTRACT

This poster presents a set of interactive features that support searchers in exploring and refining image search results. The system automatically discovers from within Wikipedia a number of related concepts pertaining to the given query, which are used to retrieve a diversified set of image search results via query expansion. A set of visualization and interaction techniques have been designed to support the searcher in exploring the broad range of images and their corresponding concepts, as well as in refining the query. Used together, these operations empower the searcher to take an active role in the image search process.

Index Terms: H.5.2 [Information Interfaces and Presentation]: User Interfaces—User-centered design; H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval—Search process

1 INTRODUCTION

Despite the increasing popularity of image search on the Web, the core interfaces of the top search engines have not changed much over the last decade. Given user-supplied queries, sets of search results are produced and organized in paged grids, ordered by their ranks. Such interfaces require that the searchers know how to describe their information needs, and support only a linear evaluation of the images within the search results set. Due to the frequent use of short and ambiguous queries [1], most image searches contain many irrelevant images distributed throughout the search results, making the activity of browsing the image set tedious, frustrating, and unpredictable. To complicate matters further, when searchers need to narrow down the scope of the search results to meet their specific information needs, the interface does not provide any support for refining or enhancing the query. As a result, searchers are responsible for manually refining their queries, which may be difficult for the casual user.

Recently, a number of different methods have been studied for exploring image search results. In Google Image Swirl, a large set of hierarchically clustered images are visually organized using a radial layout. Each layer of the tree is arranged radially around its parent, allowing the searcher to navigate from one layer to the next [4]. However, the number of images shown at any one time is limited by this layout. A variety of three dimensional visualization approaches have also proposed such as ImageFlow [3], that presents image results on a canvas where semantic features (e.g., relevance, related queries) are mapped to the canvas' spatial dimensions to allow seamless navigation through the semantic space. While, such 3D visualizations can be aesthetically pleasing, occlusion and irregular size of the images often cause important concerns.

This poster presents an alternative visualization approach for exploring the image search results and refining the queries. Our design is based on previous research that automatically discovers related concepts found in Wikipedia pertaining to an image search

query, and retrieves images through a query expansion process [2]. This results in a diversification of the image search results, covering a broad range of concepts when the query is ambiguous. The images within the search results set are organized based on their visual and conceptual similarity using a Self-Organizing Map (SOM) [5]. In this poster, we present the novel interactive visualization features that have been designed to take advantage of the conceptual information obtained through the query expansion process. In particular, the following interactive features have been incorporated within our system: concept-based focusing and filtering, which allows highlighting and filtering of semantically similar images; zooming and panning, which supports exploration within the image search space; and concept-based query refinement, which enables enhancement of queries based on concepts and/or example images.

2 IMAGE SEARCH INTERFACE

The image search interface consists of the following components: a Query Panel, an Image Search Results View, a Concept Hierarchy, and a Query History (see Figure 1). The searcher can initiate a new search by entering one or more keywords in the Query Panel. The system automatically expands the query based on concepts found in Wikipedia [2], and organizes the retrieved results based on their visual and conceptual similarity within the Image Search Results View [5]. Since more images are often retrieved than can be shown within the space available, only the most representative images from the organized results are presented. At the same time, all of the concepts used in the query expansion are presented in the Concept Hierarchy. These two components provide the searcher with a visual summary of the image search results and an overview of the concepts related to the query.

As will be described in the sections that follow, these components provide interactive features that support exploration within the image search results space, exploration within the concept space, and query refinement based on conceptual information and/or image examples.

3 SEARCH RESULTS EXPLORATION

Since the images within the Image Search Results View are organized based on both conceptual and visual similarity [5], a logical method for exploring within this image space is through pan and zoom operations. During the image organization process, each image is assigned a position in a grid based on its visual and conceptual similarity to its neighbours. Since more images will be retrieved than can be shown at one time, only those images that are most representative of their local region are shown at the top-level view. As the searcher zooms into an area of interest and more space is created between the images, additional images that were previously hidden are shown. At the same time, images that are distant from the focal point of the zoom operation are pushed out of the viewport. This interactive feature supports the searcher in visually identifying a region of interest, and then interactively zooming in order to show more images that are visually and/or conceptually similar.

The searcher can also interact with the Concept Hierarchy and the Image Search Results View in a coordinated way. By selecting any of the concepts within Concept Hierarchy, the images that were retrieved as a result of that concept are pulled to the front

*e-mail: enamulp@mun.ca

†e-mail:hoerber@mun.ca

‡e-mail:gong@mun.ca

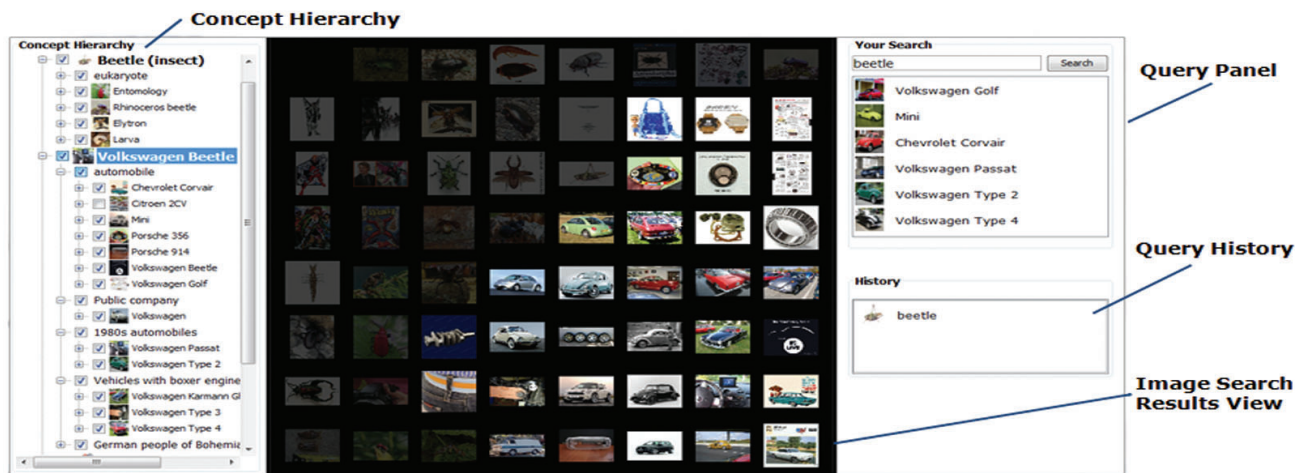


Figure 1: A screenshot of the image search interface, showing the results for the sample query *beetle*. The images are shown in the Image Search Results View based on conceptual and visual similarity. The Concept Hierarchy organizes all the related concepts of the query into a tree view. Selecting *Volkswagen Beetle* from the hierarchy causes images from this concept to be pulled to the front; other images are dimmed. The searcher can either choose a concept from the concept hierarchy or add a few example images into the Query Panel for further refinement. The Query History can be used to quickly reload past queries.

of the display (temporarily increasing their display priority within the image organization process); the remaining images are dimmed giving the focused images more visual prominence. Alternatively, by selecting any image within the Image Search Results View, the corresponding concept within the Concept Hierarchy is highlighted, and the other images that were retrieved as a result of this concept are pulled to the front of the display. In addition, the searcher can use checkboxes associated with each node in the Concept Hierarchy to filter the search results, removing the associated images from the display. This feature allows the searcher to quickly scan the names of the concepts, removing those that are not relevant to the intended meaning of the query. Together, these two features allow the searcher to quickly inspect a particular concept or image, evaluate the related images, and decide whether to keep the concept and associated images as part of the search results set.

4 QUERY REFINEMENT

Although, a searcher may start with a rather broad query, the interactive exploration features described above can assist in the identification of specific concepts and images that are of particular interest. The searcher may be interested performing one or more query refinement loops, with the goal of creating a query that is an accurate representation of the desired information need. This interactive query refinement process can be facilitated based on the concepts and/or example images.

As the searcher explores the Concept Hierarchy and the images associated with the concepts, a specific concept may be identified as a more accurate description of the information need. By right-clicking on the concept, it is placed in the Query Panel and a new search is initiated. The query is automatically expanded, and the retrieved images are organized and displayed within the Image Search Results View. This process allows the searcher to start with a vague query, and then refine it into something more specific based on the concepts extracted from Wikipedia. Concepts may also be discovered serendipitously, which are of interest to the searcher but are not particularly relevant to the current search activity.

Alternately, the searcher may discover a set of images that are relevant to their information need, and may wish to retrieve more images that are like these. By right-clicking on these relevant images, they can be added to the Query Panel. Upon clicking the search button, the system automatically finds the associated con-

cepts for the images within the Query Panel, and uses these concepts as queries. Unlike the previous approach to query refinement where query expansion is performed for a particular selected concept, this query refinement process narrows the scope of the query to just the images (and associated concepts) chosen by the searcher. As such, the query expansion process is not performed; instead more images are retrieved only based on the specific concepts associated with the query images. The images are organized and displayed within the Image Search Results View, and only the concepts that produced these images are shown in the Concept Hierarchy. From here, the search results can be explored, and further query refinement activities can be performed.

5 CONCLUSION

In this poster, we have outlined a set of novel interactive features that take advantage of the conceptual information about the images in order to explore the search results and refine the query. User evaluations are currently underway to examine the efficiency, effectiveness, and subjective opinions regarding such an interactive approach to image search.

REFERENCES

- [1] P. André, E. Cutrell, D. S. Tan, and G. Smith. Designing novel image search interfaces by understanding unique characteristics and usage. In *Proceedings of the IFIP Conference on Human-Computer Interaction*, pages 340–353, 2009.
- [2] E. Hoque, G. Strong, O. Hoerber, and M. Gong. Conceptual query expansion and visual search results exploration for web image retrieval. In *Proceedings of the Atlantic Web Intelligence Conference*, pages 73–82, 2011.
- [3] V. Jampani, G. Ramos, and S. Drucker. ImageFlow: Streaming Image Search. Technical Report MSR-TR-2010-148, Microsoft Corporation, November 2010.
- [4] Y. Jing, H. A. Rowley, C. Rosenberg, J. Wang, M. Zhao, and M. Covell. Google image swirl, a large-scale content-based image browsing system. In *Proceedings of the IEEE International Conference on Multimedia and Expo*, pages 267–267, 2010.
- [5] G. Strong, E. Hoque, M. Gong, and O. Hoerber. Organizing and browsing image search results based on conceptual and visual similarities. In *Proceedings of the International Symposium on Visual Computing*, pages 481–490, 2010.