# Visual Interfaces for Opportunistic Information Seeking

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## Abstract

Visual interfaces play an increasingly important role in how we access, analyze, and understand information. However, most such interfaces do not support opportunistic information seeking, a type of behavior characterized by uncertainty in user's initial information needs and subsequent modification of search queries to improve on results. In this paper, we present a visual interface implemented using semantic fisheye views (SFEV) and discuss how we use a word ontology to expand search context, thus allowing users more opportunities to refine initial queries. After presenting the formalism of SFEV, we describe an application of this framework in image retrieval.

## 1 Introduction

Opportunistic information seeking (Bates, 1989) is characterized by the fact that users are initially unable to articulate their needs clearly. They must learn new vocabularies and domain knowledge as they interact with search results, an ontology, or both in order to refine query terms. Here we define a query as the focus of information retrieval. A context of a query is the set of semantically related terms provided by a word-ontology, or terms from the current search results. In both cases, it is desirable to visually reify (Furnas & Rauch, 1998) the current query and its context in the same interface so that users can opportunistically choose the direction of search. The more search foci they are able to see and pursue, the more chance they have for the most precise query formulation. We thus have come up with the following requirements for the visual opportunistic interface for retrieval (VOIR):

<u>Context + focus:</u> Users must be able to perceive other possible search goals while exploring the current one. This means that the interface should include what surrounds the focus of the user's current interest (context) as well as the focus itself. The visual emphasis of displayed items must be determined based on their *semantic distance* to the focus, thus providing a semantic context for information perception and exploration.

<u>Dynamic selection of focus and contexts:</u> The interface must be dynamic because the user's context shifts when their search goals change. Displayed items should follow this shift by recalculating their respective semantic distance to the new focus, and their relative visual emphasis in relation to current interest.

Multiple foci and multiple contexts: Information seeking is multi-directional with several search goals. One important user activity in exploring multi-directional search is to compare the results and detect patterns and evidences (visual inferencing). Therefore, the interface must be able to support several foci and their respective contexts. Users should be able to select any item or a group of items as a focus and any number of foci. The interface should display the corresponding contexts to allow distinction and comparison.

Flexible modelling of semantics: to explore several semantic relationships among data, a flexible mechanism must be used. That is, users must be able to define any type of semantic relationships they want, but guided by the system.

In this paper, we introduce semantic fisheye view as a general display method attempting to satisfy the above requirements for VOIR. We first describe the formalisms and various algorithms comprising a SFEV; the types of semantic relationships that can be modelled; and an applications of SFEV for opportunistic information seeking with images. We will then compare SFEV/VOIR to other visual interfaces for information retrieval (VIRI).

## 2 Formalisms of Semantic Fisheye View

Fisheye (also called "focus + context") views are interactive visualization techniques that balance local detail and global context by directly relating the visual emphasis of information in a representation to a measure of the user's current interest. The term "fisheye" is an analogy to the effect of a wide-angle lens, where the center of the image is in focus and objects are progressively distorted towards the periphery. Furnas introduced the concept of fisheye views as a method to interactively reduce the complexity of abstract data structures such as hierarchies and structured text, but suggested that the technique could be applied in any domain where a *degree of interest (DOI)* function could be defined (Furnas, 1986). His original equation is as follows:

$$DOI(x|fp=y)=API(x)-D(x,y)$$

Given the user's current focus, $fp=y$, the *degree of interest, DOI,* of every element $x$ is the difference between the element's *a priori importance*, *API*, and the *distance*, *D*, between the element and the current focus. The *API* is the importance of an object independent of any focus, and may be either specified (e.g., measured from user studies), or derived algorithmically from properties of the information collection (e.g., calculated from structural metrics). Although *API* is often static, it may also change over time to reflect user interaction (Bartram, Ho, Dill, & Henigman, 1995; Lokuge & Ishizaki, 1995; Ruger, Preim, & Ritter, 1998).

The *distance* function measures the "conceptual" distance between the user's current focus and each element in the collection. We have identified several different types of metrics based on the attributes and structure of the information, the user's task, and the history of interaction (Janecek & Pu, 2002). For example, (Herman, Melancon, & Marshall, 2000) describes a range of different structural metrics that could be used to characterize "conceptual" distance in graphs.

In a previous paper we generalized the fisheye view paradigm to model multiple semantic contexts as combinations of weighted distance metrics (Janecek & Pu, 2002):

$$DOI_{context} = f(API, w_i, dist_i)$$

We also described a prototype for browsing the structural, content and task-based relationships between information in a tabular display of a flight itinerary.

# 3 A prototype for exploring an annotated image collection

We have developed a SFEV for information seeking in a large database of annotated images (56000 images). This prototype allows the user to explore the collection at both the image content (annotation) level and the semantic concept level. First, each image has a caption and a set of, on average, 25 keywords (a vocabulary of 28000 unique keywords over the entire collection). Second, we use WordNet (Miller, 1995), a large network of semantic and lexical relationships between words, to disambiguate and extend the keywords associated with each image.

To create a semantic fisheye view integrating these two models of the collection, we have defined a *DOI* function that combines the similarity measure of the vector space model with the path distance between senses in WordNet. We linearly scale image size to reflect *DOI*.

In the interface, the user's focus may be a keyword in the image collection, a concept in WordNet, or one of the images. The distance metric used to create the fisheye view changes depending on the type of the focus. As the focus changes, the images in the collection are dynamically resized to reflect their similarity. This visual feedback allows the user to immediately evaluate the effectiveness of their query.

Our prototype supports these basic user information-seeking tasks:

- Search by key word, concept or image
- Query expansion by adding terms learned from keyword list appearing in retrieved images
- Query expansion by adding terms learned from related words found in WordNet
- Query refinement by adding more keywords or selecting the specific sense of the keyword in WordNet.

## 3.1 A scenario

A user is exploring a collection of images. Initially her query is very vague: "horse". Since images usually have few words describing them, matching based on keywords can only return images with the word "horse" or some variation of that word in the annotations. In Figure 1 we see the set of images and keywords that contain "horse". The largest images directly match the animal "horse", but the results are very non-homogenous, also containing images of waterfalls ("horseshoe falls"), a monument to the Native American chieftain "Crazy Horse", and fish ("horse-eye jacks"). By navigating through the set of similar keywords, she can immediately see the related images. For example, selecting "horse shoe" reveals the images shown in Figure 2. Although she can browse through the images and see their annotations, this doesn't enable her to easily learn the different types of horses that she could have images of.

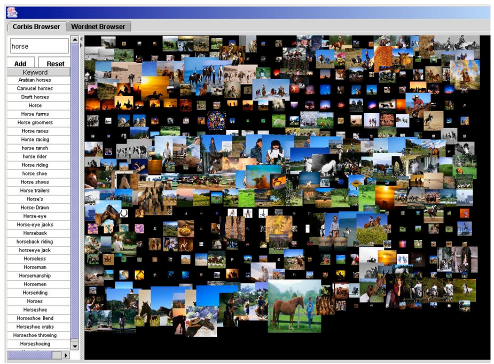

**Figure 1**: Images retrieved by SFEV using keyword 'horse.'

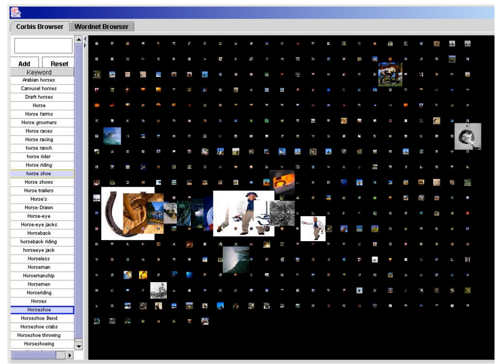

**Figure 2**: 'Horse shoe' is selected as the focus in SFEV.

She decides to look at the concepts related to "horse" in WordNet. Following the relationships between words, she can browse through different types of horses, such as "pintos", "Arabians", and "bays," and immediately see relevant images. Of course, searching for any of these words individually would return pictures of beans, people, and bodies of water. However, including the context of these concepts in the search for images, we clearly see results that are semantically relevant.

## 4 Future work

We implemented SFEV to satisfy several key requirements important to information browsing, exploring and seeking. Multiple foci are supported to strengthen SFEV's semantic emphasis by allowing related words to be used simultaneously for a query. We are currently exploring multiple foci in terms of discovering semantic relationships between two or more concepts to support opportunistic search. Furthermore, we plan to perform several user studies in order to validate our hypotheses regarding SFEV's role for providing a flexible and wide range of modelling of semantic information.

## 5 Related work: Visual Information Retrieval Interfaces (VIRI)

There is a long history of research on information exploration tools to help users formulate their queries and understand the relationships between collections of information, such as search results. For example, Scatter/Gather (Cutting, Karger, Pedersen, & Tukey, 1992) automatically clusters retrieved documents into categories and labels them with descriptive summaries. Similarly, Kohonen maps (Lin, Soergel, & Marchionini, 1991) cluster documents into regions of a 2-D map. The goal of these methods is to organize documents to help users more efficiently evaluate where they can find information that satisfies their needs. The problem is that when the goals of the user are ill defined and fluid, it is unlikely that any single organization will be satisfactory over time.

Semantic fisheye views (SFEV), on the other hand, are interactive techniques that modify an existing view to make semantic relationships apparent. This dynamic aspect allows the user to continuously refine or expand their goals by exploring these relationships. We propose that enhancing VIRI with SFEV techniques can effectively support the requirements of opportunistic search.

## 6 Conclusion

In this paper we described several important requirements for an interface to support opportunistic information seeking. We have presented a framework of semantic fisheye views, which are a type of dynamic display technique aimed at the uncovering of semantic relationships of data by exploiting users visual power for patterns. We then described an application of SFEV for finding images by exploring word semantics.

## References


Bartram, L., Ho, A., Dill, J., & Henigman, F. (1995). The Continuous Zoom: A Constrained Fisheye Technique for Viewing and Navigating Large Information Spaces. In *Proceedings of the ACM Symposium on User Interface Software and Technology* (pp. 207-215).

Bates, M. J. (1989). The design of browsing and berrypicking techniques for the online search interface. *Online Review, 13*(5), 407-424.

Cutting, D. R., Karger, D. R., Pedersen, J. O., & Tukey, J. W. (1992). Scatter/gather: A cluster-based approach to browsing large document collections. In *Proceedings of ACM SIGIR '92* (pp. 318-329).

Furnas, G. W. (1986). Generalized Fisheye Views. In *Proceedings of ACM CHI'86 Conference on Human Factors in Computing Systems* (pp. 16-23).

Furnas, G. W., & Rauch, S. J. (1998). Considerations for Information Environments and the NaviQue Workspace. In *DL'98: Proceedings of the 3rd ACM International Conference on Digital Libraries* (pp. 79-88).

Herman, I., Melancon, G., & Marshall, M. S. (2000). Graph Visualization and Navigation in Information Visualization: a Survey. *IEEE Transactions on Visualization and Computer Graphics, 6*(1), 24-43.

Janecek, P., & Pu, P. (2002). A Framework for Designing Fisheye Views to Support Multiple Semantic Contexts. In *International Conference on Advanced Visual Interfaces (AVI '02)* (pp. 51-58). Trento, Italy: ACM Press.

Lin, X., Soergel, D., & Marchionini, G. (1991). A Self-Organizing Semantic Map for Information Retrieval. In *Proceedings of the 14th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 262-269).

Lokuge, I., & Ishizaki, S. (1995). GeoSpace: An Interactive Visualization System for Exploring Complex Information Spaces. In *Proceedings of ACM CHI'95 Conference on Human Factors in Computing Systems* (Vol. 1, pp. 409-414): ACM.

Miller, G. A. (1995). WordNet: a lexical database for English. *Communications of the ACM, 38*(11), 39-41.

Ruger, M., Preim, B., & Ritter, A. (1998). Zoom Navigation. In T. Strothotte (Ed.), *Computational Visualization: Graphics, Abstraction, and Interactivity* (pp. 161-174). Berlin: Springer-Verlag.