The Effect of Query Type on Subject Searching Behavior of Image Databases: an Exploratory Study

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Image retrieval, searching for images, search behavior, image database searching.

1. AIMS

The objective of this study is to investigate how different types of queries affect searching behavior in an image retrieval system. Understanding how query types affect search behavior will in turn lead to improved indexing of images.

2. BACKGROUND

The explosion of the World Wide Web has facilitated the proliferation of digital image repositories and has exponentially increased the access to collections of digitized images. As a result image management and retrieval has attracted increased attention. In addition, an increasing number of image collections are being digitized and made available for retrieval by end subjects. Early research pointed to the need for textual description in combination with visual resource browsing tools [1][9]. Today, much research is focused on the technical aspects of image indexing and retrieval, using a variety of approaches with algorithms, e.g., [3][7], and AI techniques, e.g., [11]. Some approaches are based on the images themselves (content-based retrieval) and others on the text in images or around images (concept-based retrieval).

Despite all these research activities little attention has been paid to the subject side of image retrieval, especially to fundamental

issues such as the image attributes that are important for retrieval, the characteristics of subjects' queries for images, and the lack of theoretical background for the design and evaluation of image databases [5][12].

Our approach is based on the idea that it is desirable to base the design and evaluation of image databases on an understanding of image seeking and searching behavior of subjects [6]. To date, only a few studies have attempted to analyze this behavior.

The research presented examines the effect of query type in subject searching behavior of image databases. Previous attempts to uncover image categories included the analysis of queries that were successfully answered by archives or libraries [1][4], submitted to a photo-stock company [6], and the examination of seeking and searching behavior in controlled experiments where subjects interacted with images that were selected for them by the researchers [8][10]. Although obvious, the notion that the way subjects look for images depends on the purpose for which they need the image, was never tested before Jorgensen's study[8]. Fidel [6] proposed that retrieval tasks might affect searching behavior. As a result, each retrieval task may require its own interaction mechanism, such as relevance feedback, and measurements of retrieval performance. For example, it might not be useful to measure recall if a person is looking for a piece of data in an image, such as the shape of the windows in a certain building. In such a case, once the answer is retrieved, it is immaterial how many other images that could have answered the request have been missed. On the other hand, it might not be useful to measure precision in situations in which relevance criteria cannot be expressed verbally but can be determined once the subject views retrieved images, as is the case when one looks for a picture of a rose with unusual colors.

This implies that it is useful to study image retrieval by tasks first, before trying to find general metadata, interaction mechanisms and performance measurements. Therefore, this study examines searching behavior in an experimental setting to uncover attributes that are useful for retrieval of images.

3. METHODOLOGY

For this study three types of requests were created based on the framework developed by Fidel [6]. This suggests that retrieval tasks, or queries, occur along a spectrum starting with the Data Pole, which involves retrieval of images for the information the images include, and ending with the Objects Pole, which concerns the retrieval of images as objects of their own merit. The study selected one request at each Pole, and a third one in-between. The three questions were:

Q1: Find a castle in Ohio. What is the color of its window frames? *(The Data Pole)*

Q2: Find a picture for the homepage of the homeowners association of Seattle. *(The Object Pole)*

Q3: Based on the images in the databases available to you how many sails would you say an average medium size sailboat has? *(In between)*

Thirty-four subjects searched the three questions one per week over a three-week period. To avoid searcher learning effect bias, which will skew the results, searchers were divided into three groups. Each group searched a different question every week, while all three questions were searched every week.

Data was collected from 89 searches via questionnaires. The variables examined were divided into categories that included: retrieval effectiveness, subject effort, subjective end-subject reactions, search process characteristics and term selection characteristics. Particular emphasis has been placed on analyzing the search formulation approaches, and the properties that make an image relevant to a question.

The questionnaire elicited subjects experience in searching images in online and manual systems, the Web, text databases and in the use of computers. The subjects' knowledge of the subject of each query was established on a five-point scale. They were asked to describe how they would put together a search on the topic, what their overall search approach will be, and to provide a detailed description of what they will do. Questions elicited information of how subjects assessed relevance of images, especially what attributes of the images were used in the decision process. For example, subjects marked if they examined: the object that was pictured, whether or not there were people in the image, the kind of people in the image, the kind of objects in the image, the artistic value or appeal of the image, the colors involved, visual elements such as shape or texture, the location in which the image was taken, what the image describes, what abstract concepts the image reflected, what was the content of the image, or what story did it tell, whether or not it reminded the respondent of another image, the respondent's own feeling towards the image, and whether the respondent used any other criteria. Finally, there were questions that elicited whether most relevant images expressed the answer exactly or required some interpretation in order to answer the question, and if the respondents felt that the images they selected gave a satisfactory answer to the question.

The study used the CONTENT image database system [13]. Despite its name, CONTENT is a concept-based system, that is a text-indexed multimedia database system. Text descriptions are used as indices for images and videos. Each defined field can have associated with it a dictionary and thesaurus. CONTENT has an application-programming interface (API) based on the hypertext transfer protocol (HTTP). Standard Web-based browsers such as Netscape can query CONTENT servers and customized CONTENT clients can be built to access multiple CONTENT servers.

The version of CONTENT used in this research is the one available through the University of Washington library system and includes images from a variety of collections.

4. RESULTS

Preliminary results showed that there was a difference between the questions with respect to several aspects. First, the factors subjects used to assess the relevance of the results for each query were different. For Q2 (on the Object Pole), they used "the kind of people in the image," "the artistic value or appeal of the image," "the abstract concepts the image reflected," and "my own feelings towards the image" much more frequently than for the other two queries.

On the other hand, subjects were least certain that the relevant images they retrieved for Q2 expressed the answer exactly. While only 13% agreed with the statement for Q2, 33% agreed for Q3 and 19% for Q1. In addition, only 18% of the subjects felt that the relevant images retrieved for Q1 (on the Data Pole) required interpretation in order to answer the question, while 67% felt this for Q2 and 63% for Q3.

Question Q3, the one between the Data Pole and the Object Pole, displayed very distinct characteristics. On average, it required the smallest number of iterations (1.81 as opposed to 6.22 for Q1 and 6.17 for Q2). Similarly, it took on average the shortest time to search (12 min as opposed to 22 min for Q1 and 19 min for Q2). Although shortest to search, Q3 retrieved on average the largest number of relevant documents (24 as opposed to 6 for Q1 and 3 for Q2).

These very preliminary results indicate that research about the effect of the task for which an image is sought on searching behavior and relevance assessment is promising.

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