Quicklink: Managing Similarity Links in Cultural Heritage Archives on the Web

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ABSTRACT
The retrieval of visual information from large archives of images is a need shared by many application domains. In some environments, such as that of cultural heritage, the pertinence and quality of the information are elements of primary importance. Retrieval based on so-called low-level features does not guarantee these properties: the image alone of a cultural artifact cannot convey all the necessary information; it must be completed by a description, and by the historical and environmental collocation, that is, by an accompanying text. However, systems that retrieve images through text in a completely unsupervised manner have been seen to produce results that are not only unsatisfactory, but difficult to understand for even experts in the sector to understand.

We present here a web extension of Quicklink, a system which: retrieves images similar to a query image in large web archives of artworks by dynamically matching their textual descriptions, adapts its own behavior to user requests and presents the retrieval results in HTML pages, where the images are ordered according to their similarity degree.

KEYWORDS: Quicklink, image retrieval, information retrieval, perceptual/ conceptual similarity, similarity link, web art archives

OUR APPROACH
The images are retrieved by assigning them a value of decreasing similarity to a given query image, calculated on the basis of their descriptive texts, generally brief and relatively homogeneous in form and content, as the cards of an art catalogue usually are. When this similarity is found, the texts are connected by a link of the associative type.

The similarity model used is the conceptual "contrast" type, which considers similarity an intersecting of features, in this case, of terms. The basic idea is that the presence of terms common to two different cards indicates that these can be considered similar to each other. The possible links thus identified are a function of the number of terms present in the two cards, and have a "strength" of (0,1). Precisely, the similarity between two texts is defined by the number of terms in common in proportion to the total number of terms on the two cards. This model clearly suggested the use of Salton's well known formula [7, 8], to which weights could be added:

$$sim_{i,j} = \frac{2(w_i term_i \cap w_j term_j)}{w_i term_i \cup w_j term_j}$$

wi is the weight associated with the termi throughout the catalogue, as we shall explain below.

The results depend, obviously, upon the terms chosen for comparison. This choice can be made in two contrasting manners: automatically, using lists of stopwords, or manually, by having experts in the domain indicate the more significant terms according to certain criteria.

To this purpose, three dictionaries were created, the first automatic, the second controlled, and the third weighted and controlled [5, 6]. These dictionaries differ both in the way they are built and in their semantic content. Their performance was tested by expert observers, who were asked to evaluate the perceptual similarity of the images retrieved with respect to the query image. The Weighted Controlled Dictionary was found to produce the best results; therefore it was the one employed in the subsequent experiments. A taxonomy was also created, grouping the terms in categories, and these in turn in higher level categories, for a total of three levels.

The weight can be assigned automatically, on the basis of the number of times the term occurs in the entire collection, following well-established procedures of Information Retrieval (IR), or manually, considering the importance of the term in the domain, or in the collection, regardless of its frequency. The former procedure was used here: the greater the number of times a term appeared in the whole archive, the smaller the weight assigned it by default in the dictionary.

The value of the weights may vary from 0 to 1, with a granularity to be agreed upon on the basis of the archive dimension and variety.

A further procedure was designed to allow the user to assign a greater/lesser weight to some terms (or categories of terms) at query time, in order to express his specific interest.

RELEVANCE FEEDBACK

After a query, when the system presents the retrieved images, the user is allowed to progressively refine its response by applying the mechanism of relevance feedback [4] to indicate the images' pertinence or non-pertinence. The user selects one or more of the images retrieved by the system to serve as positive, or negative examples. Following the user's choices, the system temporarily increases or diminishes the weights of the involved terms, and then reapplies the similarity algorithm. To do so the system constructs an "ideal query", the terms of which are the union of the terms of the positive examples, with their weights modified as follows:

- the weights of terms common to the positive examples are increased by as many degrees as the times they occur, up to a maximum of 1;
- the weights of terms common to positive and negative examples are

decreased by as many degrees as the times they occur, down to a minimum weight of 0.

The weights of terms found only in one positive example remain unchanged. Moreover, a double change may leave the weights of the involved terms unvaried.

QUICKLINK ON THE WEB

The web site of Quicklink provides an intuitive and user-friendly mode of interaction.

The first screen shows 20 thumbnail images with their identification codes (Figure 1); the user may run through the entire archive in this manner. To see the card corresponding to an image, he simply clicks on it (Figure 2). He selects the image for the first query by clicking on the YES button. He can modify the weights of one or more categories by pressing WEIGHT increasing, or decreasing them by one, or more degrees; otherwise the default weights are kept. He then uses the SIMILAR button to have the system calculate the similarity of the textual card corresponding to the query with the cards of all the other images in the archive, showing the user the query and the 19 most similar images ranked in decreasing order and accompanied by their coefficient of similarity (Figure 3). Whenever he wants to, the user can click on the TERMS button to look at the terms and relative weights that have led to the current result (Figure 4). If the user is not completely satisfied with the results obtained, he can indicate examples he judges positive and those he considers negative (selecting YES or NO on the new display). With the FEEDBACK button, the system builds a new query, using all the terms present in the positive examples, increased in weight according to the frequency with which they occur in these examples and decreased in weight according to the number of times they appear in the negative examples. The new calculation of similarity produces a display of the 20 images that most resemble the choices made by the user (Figure 5).

The catalogues of the Faenza International Museum of Ceramics form the principal part of the test bed. The study is part of the Italian National Research Council (CNR) project "Beni culturali: metodi e strumenti per la creazione di archivi multimediali nel settore della ceramica" (Cultural Heritage: methods and tools for the creation of multimedia archives in the sector of ceramics) developed at ITIM-CNR of Milan, in collaboration with IRTEC-CNR of Faenza [1].

CONCLUSIONS

The system, first designed as a stand-alone prototype, is presented here in its web extension. Some preliminary experimental results have been shown and commented.

Comparing Quicklink with CBIR systems, which use visual features for the retrieval of similar images seems to make little sense, especially since the choice to have Quicklink operate on the subjects – and therefore on the semantics of images specifically - produces results altogether different from those that can be obtained using low-level visual features. It appears

more reasonable, instead, to compare the feature category of color in the two approaches. This is what the authors intend to do experimentally in the near future.

What is in any case desirable is a complete integration of the two types of system. A first attempt in this direction is already in operation [2, 3]. It is a general purpose tool that uses automatic dictionaries, that reduce the semantic power of the terms, thus drawing the two methods closer together. The results to date are encouraging.

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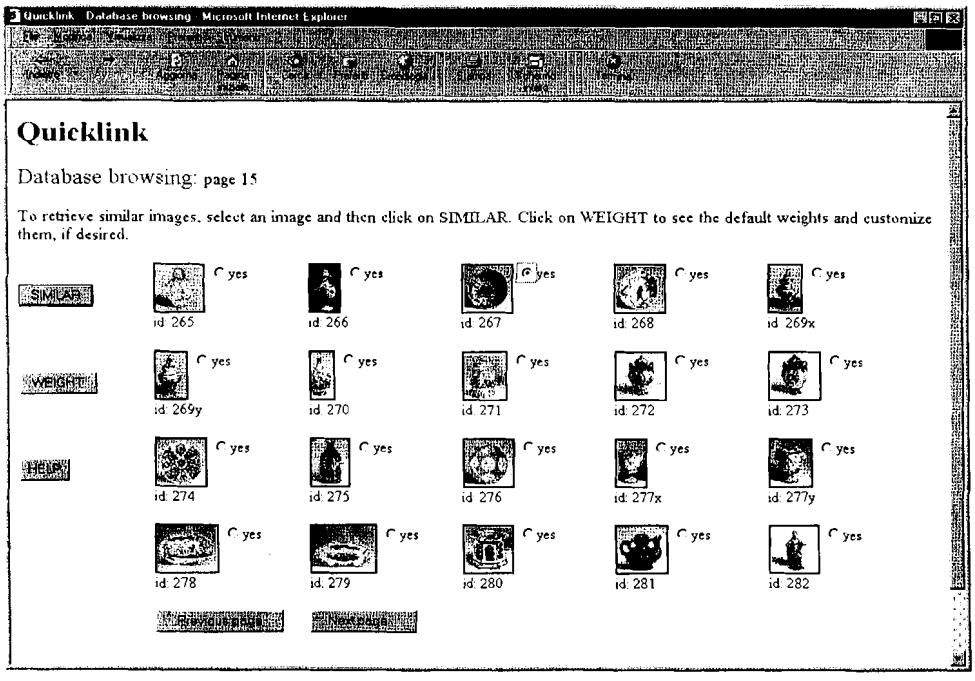

Figure 1: database browsing, with the initial query (id 267)

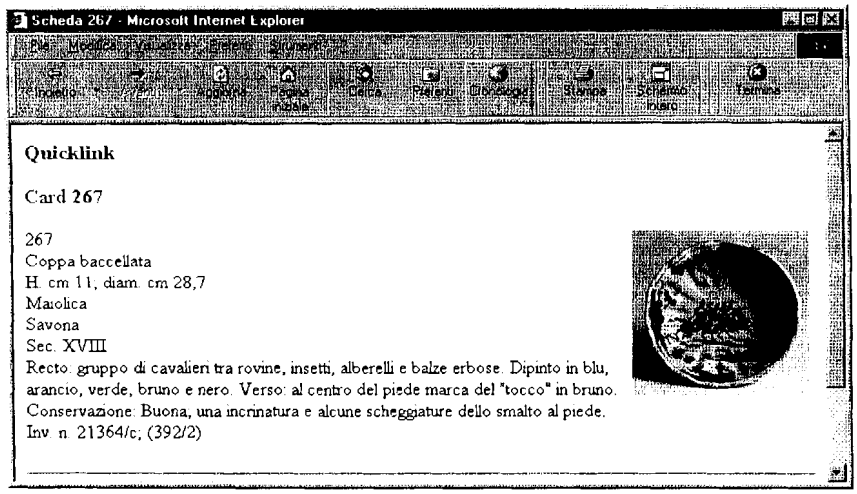

Figure 2: a card (card id 267) and its image

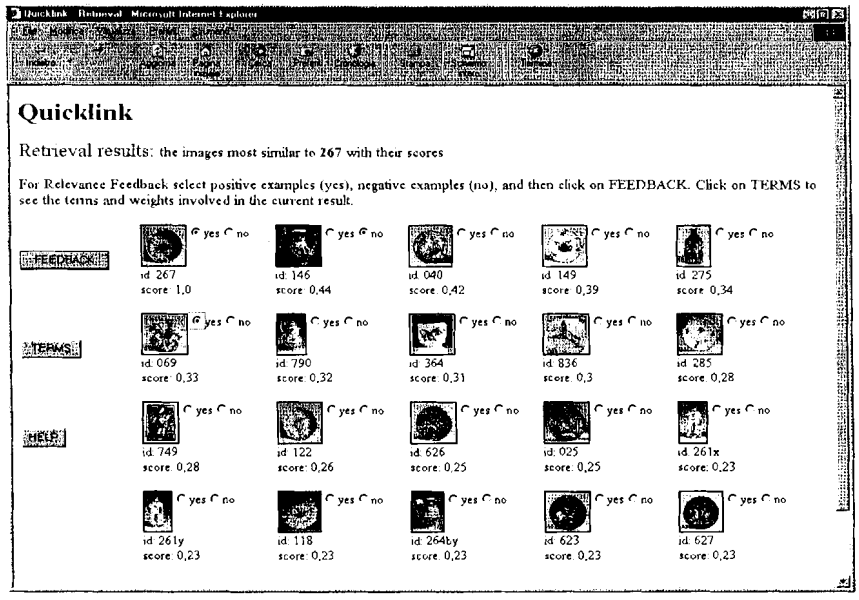

Figure 3: retrieved images as result of the query (id. 267), with positive and negative examples for feedback

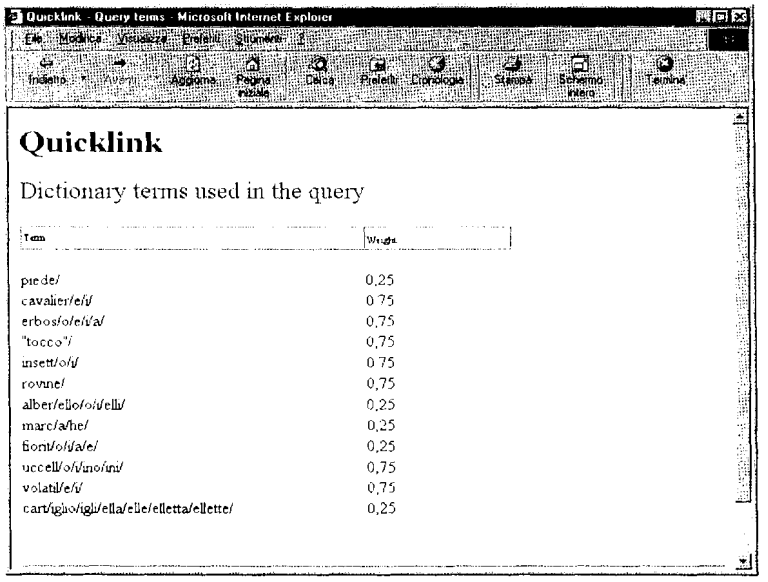

Figure 4: dictionary terms used in the query

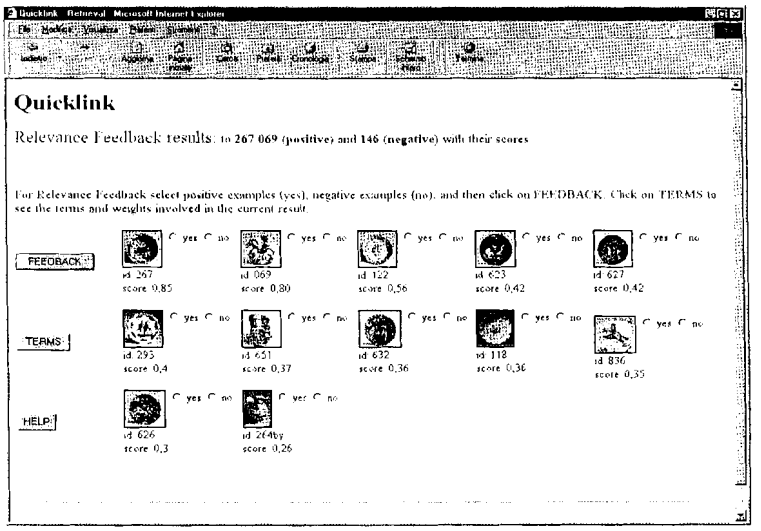

Figure 5: retrieved images as result of the feedback