A User-Centered Interface for Querying Distributed Multimedia Databases[*]

Isabel F. Cruz
Kimberly M. James

Worcester Polytechnic Institute
Department of Computer Science
100 Institute Road, Worcester, MA 01609
{ifc, beez}@cs.wpi.edu

ABSTRACT

Facilitating information retrieval in the vastly growing realm of digital media has become increasingly difficult. Delaunay^{MM} seeks to assist all users in finding relevant information through an interactive interface that supports pre- and post-query refinement, and a customizable multimedia information display. This project leverages the strengths of visual query languages with a resourceful framework to provide users with a single intuitive interface. The interface and its supporting framework are described in this paper.

Keywords

Multimedia Querying, Customizable User Interfaces, Distributed Database Access

1. INTRODUCTION

With increasingly diverse user populations and available technologies on the World Wide Web, the value of reliable searching and information navigation mechanisms is becoming more widely recognized. To facilitate accurate retrieval of information, search interfaces must combine powerful search and refinement capabilities with simple views so as not to overwhelm users.

Delaunay^{MM} combines a simple interface with the advanced refinement and customization features offered through visual querying, to provide users with a unique interface for query specification and refinement, and for displaying the multimedia objects that are the answers to the queries [1,2]. These objects are laid out in virtual documents that are user-specified. Our current work focuses on increasing the usability of the user interface to Delaunay^{MM}. To this end, we have introduced significant changes to both the previous interface and the underlying framework [1,2], which we describe in this paper. The current prototype was developed in Java.

2. USER INTERFACE

The Delaunay^{MM} user interface is comprised of four components that work in tandem to provide users with the requisite features. This interface is supported by an architecture, as discussed in Section 3, that passes information on to the interface modules. The primary modules support query specification and the display of the results, shown in Figures 2 and 3, with query refinement implemented by the intermediate modules. Each module transparently operates with its respective architectural component to provide powerful functionality via a simple interface.

2.1 Query Specification

On the initial screen (see Figure 2), the query keywords are specified and optional fields for customization are available. Keywords are entered as text, as in most engines, but unlike in most, the Boolean operators are provided. The operators are laid out to prevent their incorrect use and to eliminate the need for users to understand Boolean query construction.

The optional fields allow users to select the maximum number of objects to return, desired information sources, predefined page template (Section 2.3), type of objects to display, and level of interaction. Objects are of type text, image, audio, or video. Users that have saved searches may also select to return to their previous search results.

The defaults provided offer the most powerful customized interface for finding the smallest number of relevant results from all available sources and object types, using a comprehensive results display interface. If users select the advanced features, they are able to create their own interface using the visual querying methods previously developed [1,2], and refine their queries based on the attributes of the target information sources.

2.2 Query Context and Refinement

To increase the number of relevant results and decrease the query execution time, a pre-query refinement option, the Search Assistant, is provided. This assistant shows users the context in which their keywords are found using an ontological representation. This representation allows users to understand the context of their queries, while also relaying structural information about the available resources.

Post-query refinement is provided when the number of returned results exceeds the number selected at query submission time. The refinement interface displays all returned objects in the left column and associated information in the right. This information includes the object in full, for example, displaying full text for text objects and object metadata, such as ownership information and associated keywords. Through this interface, users may select representative objects to use for refinement, similar to a collective "More like this option", or to use in creating the virtual page.

This interface's strength is in its ability to display all search results and in allowing users to select the objects that are of interest to them, thus effectively facilitating user-centered refinement. These pre- and post-query refinements are not performed when users select to use the advanced refinement options.

2.3 Virtual Document Display

The virtual document display is used to present users' query results in a single format that users can browse without leaving the Delaunay^{MM} site. Delaunay^{MM} also supports a "Go to Web Page" option, which allows users to go to the original web page. This presentation method preserves the context of retrieved information, while optionally allowing users to view the original web page [3].

Pre-defined templates are designed based on task and user types. For example, the student/researcher template seeks to preserve the relationship between objects, as found on their owning pages, in order to provide complete sets of information. On the other hand, the comparison templates seek only to provide users with the returned objects positioned side by side, so that they may be compared to one another as they are traversed.

Users may also save ("bookmark") their query results. This option is particularly useful when the refinement features are used to derive the query results, because subsequent queries are created by Delaunay^{MM} based on the selected refinement objects, which are not visible to the users.

3. ARCHITECTURE

The necessary user interface information is provided by well-defined middle layer components. These components are assumed to have access to the following information:

1. Ontology/structure of information repositories.
2. Object metadata.
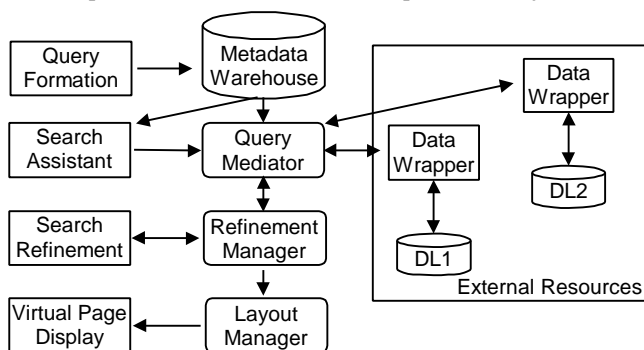3. Spatial and contextual relationship between objects.

Figure 1: Delaunay^{MM} Architecture

3.1 Metadata Warehouse

The metadata warehouse is a resident resource that provides Delaunay^{MM} with the metadata and structure associated with the information repositories. After the keywords are submitted, the metadata warehouse is consulted to determine in what context the keywords are found in the information repositories. A virtual ontology that represents globally the context of the keywords is subsequently built. This virtual ontology is displayed to the user via the Search Assistant for further selection. It is important to note that this resource only provides information about the contents of the information repositories and not their actual contents.

3.2 Query Mediator

The query mediator is the crux of the interaction, with the external resources supporting both the pre- and post-query refinement options. It sends and receives query information to and from the data wrappers for individual repository access.

The pre-query option uses the virtual ontology provided by the metadata warehouse, which includes information repository specifics, to determine which external resources to query. The query mediator then takes the results returned from these resources and passes them to the refinement manager.

When the refinement manager is utilized, the query mediator is again used to facilitate post-query refinement. Using the queries passed to it from the refinement manager, it accesses the appropriate information resources and returns the results to the refinement manager. It further determines when resources may be excluded from searches based on the representative refinement objects.

3.3 Refinement Manager

After receiving the query results from the query mediator this component determines whether further refinement is needed by means of the user's selected number of objects to return. If the number returned is greater than the selected one, it passes the objects to the search refinement interface allowing users to select which objects to use for refinement or virtual document creation.

If refinement is selected, using the metadata associated with each object and a refinement algorithm, the manager creates, on the fly, a new query to send back to the query mediator. This new query combines the attributes of all representative objects.

3.4 Layout Manager

The layout manager creates the virtual document, as selected by the user, from the returned query results (see Figure 3). Currently, fixed-coordinate templates are used to determine the layout, but constraint-based mechanisms will be incorporated to generate the layout dynamically.

4. USABILITY STUDY RESULTS

In December 1998, 34 students participated in the first usability study of the new interface and architecture. This study focused on three components: the intuitiveness of the new interface, the applicability of the approach to querying vast data resources, and the identification of flaws in the approach and interface. The

overall results of the study supported the approach and interface, suggesting minor changes that would significantly increase overall usability.

For this study, users were asked to use Delaunay^{MM} to submit two queries to various digital resources and to create their own virtual page template using the original application [1,2]. Each query used different Delaunay^{MM} attributes to tailor the interface to the specific task. Once finished, users were asked to complete a 40-question survey in which they either affirmed or negated statements about each aspect of the interface. Two users were monitored to confirm that the study's usage scenarios and survey questions were fair. All other users performed the study over the course of a week for 30 to 45 minutes at their leisure. A detailed discussion of the results is available elsewhere [4].

The overall results of the study were very positive. Of the respondents, 59% were expert web searchers having high confidence in their searching capabilities, and all others were average. All respondents noted that they are typically successful in finding information on the Internet, with most (88%) finding the necessary information within submitting a few searches. In response to the statement: "I would prefer this interface to existing search interfaces.", there was a close split between positive and negative responses (36% and 40%, respectively). Many of the users commented that the response time of this approach was too slow. This slow response time is a result of the need to transfer multimedia elements, as opposed to hypertext, over the Internet. Ultimately, for expert web searchers response time is a key usability factor [8], thus the interface was not regarded as highly by these individuals. We are currently investigating the optimization of the transfer of multimedia objects in response to different kinds of queries in Delaunay^{MM} .

5. RELATED WORK

There are several projects underway that directly relate to our work in the following areas: interface design [11,13], query definition and submission [9,10,12], ontological development [5,6,15], database mediation [7,14], and data warehousing [16].

6. CONCLUSIONS AND FUTURE WORK

Delaunay^{MM} offers a unique user-centered approach to querying multimedia information repositories. The approach has been validated by a usability study, with another planned in the immediate future for a wider variety of users, including inexperienced ones. The framework and interface of Delaunay^{MM} offer a basis for fusing together existing efforts in digital library and in distributed multimedia databases research. This framework can be extended to support World Wide Web applications.

There are several areas for future exploration: ontological incorporation, intelligent mediation, multimedia retrieval optimization, and query tracking and reuse.

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Welcome to DelaunayMM

Figure 2: Delaunay^{MM} Query Specification

Figure 3: Delaunay[MM] Student/Researcher Virtual Document
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