PRiSMA: Searching Images in Parallel

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ABSTRACT

PRiSMA is an image search application for tablet and desktop devices intended to facilitate and promote the searching of images in parallel. With an intuitive user interface, users can branch their queries into multiple horizontal sliding strips to simultaneously explore different perspectives of large image collections (*e.g.* colors, geographical location or topic). Strips can be easily created, tailored, merged, and removed, allowing users to effectively perform multiple queries and manage the results in a dynamic and orderly fashion. With PRiSMA we aim to explore the potential and limitations of parallel image search from a user perspective.

Categories and Subject Descriptors

H.5.2 [**Information Systems**]: INFORMATION INTERFACES AND PRESENTATION—*User Interfaces*

General Terms

Design, Human Factors

Keywords

Parallel search, image browsing

1. INTRODUCTION

For most common image search tasks, traditional search applications like Yahoo![1], Bing[2], or Google[3], provide very good results. In many cases however, users must modify their queries several times, and do not always obtain satisfactory results [3]. With a greater or lesser success, several heuristics, techniques and interfaces have been proposed in order to improve image search. Acknowledging that some image search tasks require or benefit from several modifications of the initial query, we propose a novel approach by which users can simultaneously explore the result of multiple queries in a structured and orderly fashion.

In this paper we present PRiSMA, an image search application primarily designed for tablet devices, which allows users to explicitly perform multiple queries in parallel on large image collections. PRiSMA provides an intuitive and novel Graphical User Interface, which facilitates branching an initial query to simultaneously explore two or more result sets. As depicted in Figure 2, the results of each query are presented in a horizontal sliding strip. The interface allows users to easily create new strips, merge them, remove them and edit their associated query to modify the results of each query independently (see Figure 3). These functionalities, combined with traditional faceted search, allows users to automatically split the results by colors, geolocation or topic (*e.g.* Sports, Politics or Nature). Furthermore, PRiSMA also supports searching by image similarity, hence, users can create a new strip on the fly containing images which are similar to a user selected picture. Any such action can be done and undone without loosing the previous search results. In this way, users are encouraged to explore the image collection in diverse and complementary ways with little effort.

By facilitating the exploration of multiple queries in an orderly fashion PRiSMA can help users to: *1)* have a better grasp of the results space; *2)* diversify the results; and *3)* conveniently broad and narrow the search space, first by exploring alternative search paths to later focus only on those queries that provide better results. We envision three cases in which PRiSMA may be particularly useful: 1) in creative tasks in which users may need to explore diverse images within a given context while keeping a global picture of the results; 2) in educational settings in which users may utilize parallel search as a visual dictionary, where, with a single click, a term is shown in different contexts (*e.g* organizing the term "folk art" by location); and 3) in journalism/editorial work, where journalists and editors may benefit from the diversity of the results for identifying potential stories, for example, by comparing images of similar events (*e.g.* searching for images of riots in different countries), or comparing images from similar events in different periods in time.

The main contribution of this paper is a novel paradigm for image search that is based on allowing the user to dynamically create various searches in parallel. We present an implementation of this paradigm and discuss the results of a pilot study.

The rest of the paper is organized as follows. In the next

[1]`http://images.search.yahoo.com/`
[2]`http://www.bing.com/images/`
[3]`https://www.google.com/imghp/`

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section we discuss related work. In Section 3 we describe PRiSMA in more detail and in Section 4 we discuss the application evaluation. Finally in Section 5 we provide our conclusions and discuss future work.

2. RELATED WORK

With the growing popularity of tablet computers, an increasing number of commercial and research applications has been developed for mid-sized touch screen, mobile devices. Research efforts related to image search specifically for tablets include optimizing the use of the screen's real-state, which is typically limited in mobile devices [2], research into better organizing personal image collections [7], and exploring diverse location-based services [11]. To the best of our knowledge, however, no application has addressed the parallel *image* search paradigm we explore with PRiSMA, neither for tablet computers nor for desktop applications.

PRiSMA bares some similarity with mobile applications such as PULSE[4] or FLUDE[5] where users can browse through their news feeds in parallel, using horizontal sliding strips. Google's Image Swirl [5] arranges search results as a exemplar hierarchy, based on the images' visual and semantic similarity. Using a balloon-tree layout, users can navigate the clusters selecting different branches of the tree. Users can only explore one branch at a time, however, and cannot define different criteria for branching their search.

The term parallel browsing has been used in the literature [4] to indicate that one navigation session may involve the exploration of a number of topics at the same time, usually through the use of the Browser's tabs, or by opening multiple windows of the Browser. When users search in parallel [8] they thus have to switch tabs or windows, so the search is not actually *simultaneous*. Furthermore, as opposed to PRiSMA, results in different tabs or windows are mutually agnostic, allowing for repetition in the results. PRiSMA is useful when users need to compare search results, for which, given no better option, users may place two windows side-by-side [9].

PRiSMA makes use of faceted search [10], image clustering using the image metadata [1], and allows for similarity searching based image-associated tags [6].

3. SEARCHING IMAGES IN PARALLEL

PRiSMA facilitates and promotes the exploration of image collections from different perspectives as it allows users to branch an initial query into two or more queries and follow their results on the same screen. As depicted in Figure 2 PRiSMA places the results of each query in a horizontal strip. Users can browse the result in each strip by sliding their finger over the touch screen. Strips can be scrolled simultaneously or independently, which allows users to perform two modes of exploration, the former being a more general exploration, possibly more convenient on an early stage of the search, while the latter allows for a more detailed search, where the user can focus on a single result set.

Strips can be easily created, reordered, edited (as depicted in Figure 3), removed, and merged. This allows users to initiate new concurrent searches, facilitates the comparison of results, enables query modification, discarding of non-relevant search paths, and combining of two or more queries[6].

PRiSMA allows searching of the image collection by *tags*, *colors*, geographic *location* and by *topic*, where the topic of an image is given by a taxonomy of over 140 terms including categories like Nature, People, Celebrities, *etc.*. To illustrate a simple use case of parallel image search, let us suppose that a user who is preparing slides for a presentation searches for "information overload." After some browsing, she may think that adding the keyword "funny" might render more interesting results. Now, rather than initiating a completely new search, the user can branch the query by adding the term "funny" and continue browsing the two results in parallel.

As depicted in Figure 3 *colors*, *location* and *topic* can be used for traditional faceted search on a single query. More interestingly, however, PRiSMA allows automatically branching of any query into the multiple values of the se-

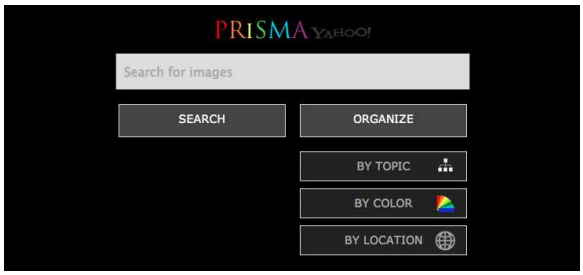

Figure 1: A screenshot of the search panel. Users can perform a simple search or branch the query by *topic*, *color* or *location*.

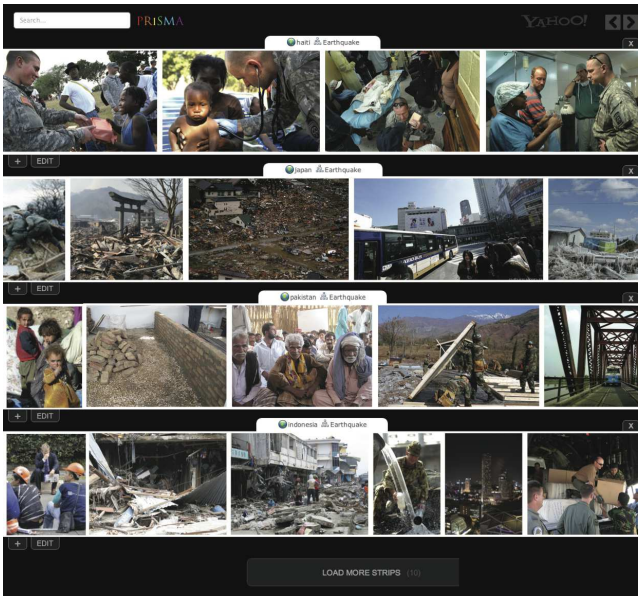

Figure 2: A screenshot for the results of the search for the keyword Earthquake organized by location. When automatically branching a query, the application opens up to 4 new strips. A button allows users to load more strips, or conclude the expansion.

[4] http://www.pulse.me/
[5] http://www.flud.it/

[6] In the current implementation, queries are combined via an OR operator.

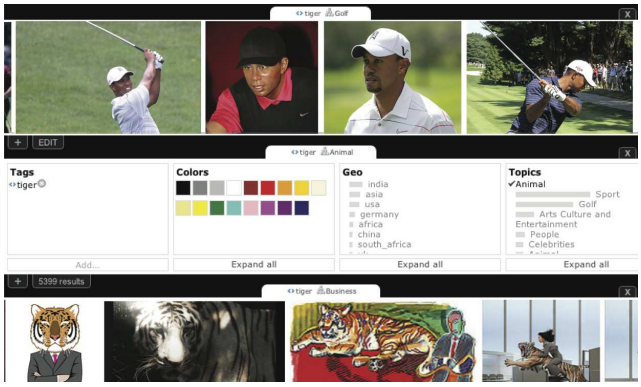

Figure 3: A screenshot of the Edit panel of a strip. Each strip can be edited individually. Users can add or remove tags, select one or many of the available facets or request to branch the query by all the values of the facets.

lected facet type. Thus, for example, a user searching for images of "bus" may branch the query with a single click (see Figure 1), to obtain multiple strips organized by *topic*, *color* or *location*. Figure 2 depicts the result of branching the query "earthquake" by *location*, while Figure 3 shows the results of branching the query "tiger" by *topic*. This functionality is particularly useful in an initial stage of an exploration where users may want to diversify the results to help them clarify the scope of their search. An important side effect of diversity is the promotion of creative and serendipitous search. Thus returning to the "information overload" example, if the query is branched by *topic*, as expected, the user will obtain images of "information overload" in the context of *Technology* or *Business*, but also under less obvious topics such as *Cheerful*, *Travel* or *Food & Drinks*, which may help in finding more original images.

It is worth noting, however, that while PRiSMA may promote diversity, it does so in an organized fashion. Strips with diverse but uninteresting images are easily removed by the user. In other words, PRiSMA provides a principled way by which to broaden and narrow the search space, recognizing the benefits of expanding the exploration in an initial phase, but also the need to focus the search at a latter stage.

In addition to the above mentioned features, PRiSMA supports searching for images by similarity, based on the images' associated tags. Thus at any moment, by tapping on the bottom-left corner of an image, a new strip is created containing images similar to the one selected by the user. Because image similarity is explored firstly as a secondary query, obtaining weak results is not critical, since the user can easily remove the created strip and continue exploring the image collection by other means.

While PRiSMA is mainly intended for tablet computers, it also runs on desktop computers. The application is fully implemented using HTML5, with javascript and PHP. In PRiSMA we use a large collection of several million stock photo images. Since we use stock images, most photographs contain rich and clean metadata. In particular, features like image location and colors are already given by the images' tags. The search by image similarity is currently based only on the images' tags. Given the quality of the image metadata, simple queries over the selected image tags renders fair results.

PRiSMA may be used for a variety of use cases, including simple entertainment (*e.g.* searching for celebrities in different contexts or locations), more creative uses which may involve searching for concepts, as in the case of "information overload," and for content-based search, where organizing the results by colors may be particularly useful. Suppose a user wants to explore images for the term "forest" for creative/inspirational purposes. In order to expand the search the user may select to view "forest" branched by location. The user may then have strips with images of forests from the USA, Japan, UK and Canada. The user could then decide to further branch the query "forest" in Japan by colors. With only three taps on the tablet computer, the user may obtain images for japanese forests in the colors: green, white, red and pink.

Journalists and editors may also benefit from PRiSMA. By visualizing the results of different queries in the same screen users can easily compare the results in order to construct a narrative. Searching, for instance, for concurrent events in different locations (as in Figure 2), may help users identify similarities and differences useful for building a story. PRiSMA is at an early stage of development and it is firstly intended to help us explore the pros and cons of searching for images in parallel. Our initial concern when initiating this exploration was related to the inherent complexity of performing multiple queries and seeing the results in parallel. In the following section we present our first pilot study exploring the benefits and disadvantages of such paradigm.

4. EVALUATION

For the pilot study we conducted individual interviews with eleven participants. We began each interview with a five minutes presentation of PRiSMA, both on a Tablet and a desktop computer. We then allowed participants to ask questions and use the application with no specific instructions and for as long as the participants wanted. We concluded the interview with a questionnaire. The interview took between 20 and 30 minuets, depending on the time participants spent with the application. The participants included 10 computer scientists and a professional graphic designer, aged between 25 and 40 years old (10 males, one female). All participants were familiar with image search and use it regularly: 3 of the participants search for images on a daily basis, 4 on a weekly basis and 4 participants search for images a few times per month.

For this first pilot study we were particularly interested in learning three basic things from prospective users: *1)* whether the inherent complexity of parallel search overshadows its benefits; *2)* what types of images users would search for in this kind of environment and *3)* to what extent users perceive this approach as both useful and novel.

Overall, the results of this pilot study were very good, much better than expected. Questions required participants to give a score between 0 and 10, being 10 the best option, unless otherwise specified. From our study, users had a very clear understanding of the general principles of searching in parallel with PRiSMA, with an average score of 9. The participants found the overall interaction to be very intuitive (with an average score of 7.5) and found no particular difficulty in simultaneously navigating through the results of the different queries (with an average score of 2.18, where

10 was "very difficult"). In summary, all participants were willing to use this application (with an average score of 8.5) and believed it was worth sharing (with an average score of 8.4).

Participants reported numerous uses cases in which they envisioned themselves using PRiSMA. However, a recurrent theme was the search for images which illustrate abstract concepts, generally in order to use them for slide presentations. Participants particularly value the variety of the results obtained when automatically branching the query over one of the available facets. Participants equally valued the structured presentation of the results which allowed them to keep the search focused. One of the users was particularly interested in the use of PRiSMA for news related searches, to be able to easily browse through multiple events in different locations, inline with the search depicted in Section 2. Other uses included entertainment (*e.g.* "*search for rare and ambiguous terms*"). Three users, including the graphic designer, thought PRiSMA was very good for inspirational purposes.

Participants were also asked to think of other applications with which they could equally resolve the above mentioned intended searches. Only two participants responded, one participant mentioned Flickr[7] while the other mentioned both Google Images[8] and Cooliris[9]. Nonetheless they both expressed a clear preference for the parallel search approach as it allowed a "*more focused search*".

To further evaluate if participants perceived PRiSMA as a novel and useful image search application, we wanted participants to compare PRiSMA with the use of the browser's tabs as way to perform parallel browsing. All participants stated that they make intensive use of the browser's tabs for searching and browsing in parallel (with an average score of 9.1). While they understood what makes the two options comparable, they recognized the two are very different (with an average score of 7.64), with a clear preference for searching images using PRiSMA over using multiple tabs (with an average score of 8.2). Users valued the possibility of seeing all results at once, in one single page. They also valued the fact that a query can be branched automatically by any given facet (*e.g.* colors, geographical location or topic).

5. CONCLUSIONS AND FUTURE WORK

In this paper we presented PRiSMA, an image search application intended to facilitate and promote searching of images in parallel. We have illustrated how, by facilitating the exploration of multiple queries in an orderly fashion, PRiSMA can help users have a better grasp of the results space, diversify the results and conveniently broad and narrow the search space. We have illustrated use cases of PRiSMA for creative, educational, and editorial use. Of course these examples should be further developed and tested. In this early stage of development our main concern was to learn from users on whether the inherent complexity of parallel search overshadows its potential benefits. To clarify this concern, we conducted a pilot study with 11 participants, obtaining surprisingly positive results. Users unequivocally deemed that the complexity was well justified. Of course future work should include a more rigorous and extensive study not only on the application's principles but also to evaluate the actual performance of the application. In future work we also intend to explore the use of other image collections with different characteristics (*e.g.* Flickr) and to try different search dimensions, for example time, but also source of the image. Both features would be particularly useful for journalists as they would be able to compare images across time as well as compare the results from different sources.

[7] `http://www.flickr.com/`
[8] `https://www.google.com/imghp/`
[9] `http://www.cooliris.com/`

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