Evaluating perceptual visual attributes in social and cultural heritage web sites

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Abstract

Interaction with artwork collections can be made more effective by using creative web sites, applications or installations which support the user in the discovery process by using new search and browsing paradigms. Here we introduce some new image searching and visualization functionalities. We have exploited four perceptual visual attributes related to color to index the images: colorfulness, dominant colors, color moods and color harmony. These attributes are also used to display images in a 2D Map visualization to facilitate browsing of the retrieved results. In order to investigate the effectiveness of the implemented functionalities, we considered four different image collections of cultural heritage artworks, and, using the specifically designed MIDB portal, administered usability tests on a panel of subjects. The users performed different retrieval and browsing tasks. The analysis of the results of the tests shows that the users consider these new browsing and retrieval modalities engaging and useful on all the image collections evaluated.

Keywords: Perceptual visual attributes, social and cultural heritage, image collections, user interaction, searching and browsing.

1. Research aim

Museums and artwork collections on the web need methods and tools to navigate their catalogues and provide facilities for searching, browsing, clustering and visualizing different kinds of visual data and related information. The aim of this work is to present and evaluate some new image searching and visualization functionalities in the context of cultural heritage web sites. We have implemented content-based image retrieval tools that should be easily understood by users and that should help them to retrieve images based on visual attributes related to emotions and perceptions. We have also introduced different visualization tools including a novel, "Map"-based one. We want to investigate if these new functionalities indeed make the exploration of image collections more effective and engaging for the users. The investigation is based on established usability tests that consider different aspects of the users experience. The quantitative and qualitative results will help us to devise new interaction modalities.

2. Literature review

A number of collections of art objects are made available on the web with the purpose of making the contents of museums and other public or private organizations accessible to the general public in preparation for, or in place of, an actual visit. The museum itself, such as the Metropolitan Museum of art[1], the National Gallery of Art[2], the British Museum[3] and the Louvre[4], is accurately reproduced with the opportunity for the user to virtually visit its rooms, showcases and bookshops virtually. Sometimes objects collected on the web are not visible in single museums or galleries, but are located in many places (e,g, the WEB Gallery of Art[5] or the Kress Foundation[6]); some others are gathered and preserved in archives, libraries and collections available only to the select few, usually experts and researchers of the domain (e.g. the Hairpin Museum[7]).

According to the works in [1, 2], several features are appreciated by virtual visitors in their utilization of digital collections. Five main clusters of design features have been found valuable for search tasks and engagement of users:

- Search/Browse
- Image manipulation
- Interactive features
- Aesthetics/Interface
- Usability/Site Architecture

In the papers, six art websites have been considered, in-

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[1] http://www.metmuseum.org/
[2] http://www.nga.gov/content/ngaweb.html
[3] http://www.britishmuseum.org
[4] http://www.louvre.fr/
[5] http://www.wga.hu/index1.html
[6] http://www.kressfoundation.org/
[7] http://www.hairpinmuseum.org/

cluding Google Art Project and Artsy. Google Art Project[8] is an online platform that makes high resolution artworks from museums all over the world, integrating Google tools such as Street View, Picasa, Maps, etc. The platform allows users to have virtual tours in hundreds museums to enjoy an ever increasing number of artworks in high resolution. Several features are available for users:

- Virtual Gallery tour
- Creation of users' own collections
- Video and Audio guided tours
- Educational tools
- Comparison between artworks
- ...

Artsy[9] is a web site containing 350,000 images of art, architecture and design by 50,000 artists ranging from historical, to modern and contemporary works, and includes one of the largest contemporary art online databases. Artsy is used by art enthusiasts, museum goers, students and educators to discover, learn about and collect art.

Art museums are increasingly aware that a correct use of the web can lead users either to return often to visit the site, or to physically visit the museum.
Tate and Tate Modern[10] are very active on the web, trying to provide their users with tools and systems that will stimulate them and lead them to visit the museum and the temporary exhibitions more often. Cooper Hewitt Smithsonian Design Museum[11] provides an adequate and coordinated web site with the message it brings: an interesting and modern site exploiting not only the textual descriptions associated with its objects, but also the color palette, using several color standards: Pantone, Crayola, CSS3, etc.

More generally, museum curators are aware that they should choose communication and navigation technologies that match the experience they want to offer their actual visitors.

Regarding applications designed to query and browse the museums archives, innovative tools can be exploited to manage different types of data. For example, in the case of image data, we can borrow from the fields of image analysis and content-based image retrieval to design applications with advanced functionalities. Image indexing is the process of automatically computing a compact representation (numerical or alphanumerical) of some attribute or feature of digital images, to be used to derive information about the image contents. One of the pioneering examples on image feature extraction is the work by [3] where the concept of colour histogram is introduced for image indexing. More complex and sophisticated general purpose and domain dependent indexing methods are being developed to cope with different image attributes. Some examples of low level and high level features can be found in [4, 5, 6, 7, 8, 9, 10, 11]. All these features can be used and integrated into a retrieval system allowing advanced searches on the digital archives to be performed.

[8] `http://https://www.google.com/culturalinstitute/project/art-project`
[9] `http://www.artsy.net`
[10] `http://www.tate.org.uk/`
[11] `http://www.cooperhewitt.org/`

3. Design of the MIDB portal

Understanding the audience is a key element in the design of the web site we want to create, user-centered and insight driven. We present here the MIDB portal designed to easily guide users in the discovery of the materials of their interest through the use of a hierarchical filtering paradigm of the relevant information. There is a wide range of reasons behind the visits to an artwork website, from research to looking for inspiration or remembering with emotion a previously seen artwork. Moreover, visitors have different levels of art knowledge: therefore the required information and content may vary. Requirements analysis has focused on a grid of features such as aims, users, data, devices, places of use, functionalities, etc. Our web site, that can be visited at the URL `http://database.itc.cnr.it/image_dbase/home_page.php`, offers a two step search interface, with a faceted query refinement: in this way navigational and direct searches are integrated to leverage the best of both approaches. The interface is kept simple, allowing to cross different key searches and different ways to show results.

The portal allows for querying, navigating and browsing four different archives, related to social or cultural heritage collection of images. The four datasets are:

- Good 50x70 ("GOOD")
- Archivio di Etnografia e Storia Sociale ("AESS")
- Painting 91 ("PAINT")
- Museum of Contemporary Photography ("MUSEUM")

Good 50x70 is a database of campaigns of social communication, based on an international social communication project which addresses some of the critical issues in todays world, such as Aids, child mortality, environmental damage, violation of human rights, underdevelopment, war, violence against women, etc. The name of the initiative comes from the size of the media (50x70 cm posters). The Good 50x70 database is organized in specific social topics (briefs), sponsored by charities (LILA, WWF, Greenpeace, ...) who identify themes to raise awareness of those problems and to promote change. To further promote awareness, the posters can then be re-used, for example on bags or t-shirts, in non-profit activities. Currently, the available data is composed of some 12,000 digital files containing poster images, grouped year by year and briefs, associated with some textual information, such as poster

description, author name, country, brief, tags, and so on, uploaded by the poster authors directly.

AESS archive is a database of Intangible Cultural Heritage of the Lombardy Region. It mainly contains popular traditions handed down generation to generation, such as traditional fairs, popular songs, and customs [12, 13]. In this project the AESS dataset refers to 24,616 photographs documenting intangible cultural heritage: e.g. pictures of puppets, food, festivals, masks, parades, etc. grouped by year and UNESCO categories, and associated with the title of the image, location, data, author(s).

Painting91 dataset [14] consists of well-known paintings by famous artists ranging from Vermeer to Chagall, from Bosch to Matisse with basic information such as author, artist categorization, and style classification. The data set consists of 4,214 paintings from 91 different artists.

Museum of Contemporary Photography in Cinisello Balsamo, Milan, has collections consisting of over one million and 800 thousand photographic works - prints in black and white and color images, slides, negatives, videos, installations - taken by about five hundred Italian and foreign authors. It contains the most significant examples of contemporary photographs and constitutes a significant cross-section of photography after World War II to the present day. A part of its collection has been cataloged, according to the Italian ICCD (Institute for Central Catalogue and Documentation) card layout, inserted in a database and provides the user with an online search of images, according to the author, the content, the place and date and the fund to which it belongs. In this project, the whole dataset, that consists of 46,210 images, has been integrated, together with information on the author, title, genre, etc....

For each dataset a different database, sharing the same structure - the MIDB data structure -, has been created and automatically populated, containing information about the images (photographs, posters, artworks and intangible cultural reportage). The simple model contains both textual information inserted by cataloguers and mood descriptors automatically extracted from the images as described below. The engine has been implemented being able to automatically populate the database, taking data from the four original websites.

The portal has been designed to allow the different types of users identified to query, browse and navigate in a simple, usable, interesting way, being aware that they use the website differently and even use some of the same features of the site differently. In particular we considered users from the general public who are interested in finding images, using different query strategies, and creating "galleries" of images taken from the various datasets. The portal's requirements for each category are:

- support users that want to discover the material of interest, by giving easy searching tools, able to search among both text and image features.
- allow designers, creative and general digital visitors, to create galleries and download images to reuse them. This functionality is not described in this paper.

According to [1], the users of a museum web site, in evaluating and judging it, are affected by the availability of features such as innovative methods for querying and visualizing, and tools for storing, downloading and manipulating images, besides its aesthetic appearance. To meet the needs of the different types of users, various methods of search on the texts or the pictorial features have been introduced, as well as innovative ways of displaying the results, as described in detail in the following paragraphs.

In Fig. 1 the logical schema of the MIDB system is represented. At the top the four datasets are represented from which the information is extracted: this is the input of the population engine; its output is the MIDB database. The MIDB search engine is the core of the system and is characterized by the following innovative features:

1. browsing and advanced browsing;
2. different search modes, both on text and on pictorial, emotional and aesthetic characteristics automatically extracted from images, as described in the next paragraph;
3. data display modes: list and thumbnail, or mapped on a Cartesian plane, in which the user dynamically chooses which attributes to put as x- and y-axis;
4. ability to refine the query through the same search filters.

Site membership is required to allow the users to create their own collections of images, edit, rename, etc. The same search and visualization functionalities are also available for the collections.

4. Indexing images by visual attributes

Indexing images by visual attributes can be achieved in different ways. In the literature there is a plethora of visual descriptors (or visual features) that encode some image property such as color, texture, shape, patterns, edges, etc.... Some examples can be found in [15, 16, 17, 18]. Most of these visual descriptors are effective in the context of image retrieval since, to different degrees, they are able to describe the image contents. These descriptors are often exploited by information systems to retrieve similar images (e.g. [19]) used in the background by the systems in a transparent way with regards to the users. In fact, users find most of the visual descriptors difficult to understand : terms such as texture energy and phase are meaningless for the majority of users. Even color histograms carry little or no information for an average user.

For the purpose of this work, we need visual descriptors that can be easily understood by users, that can be associated with everyday terms, and that the user could be familiar with. Moreover, we need visual descriptors that can be helpful for content filtering and querying. So,

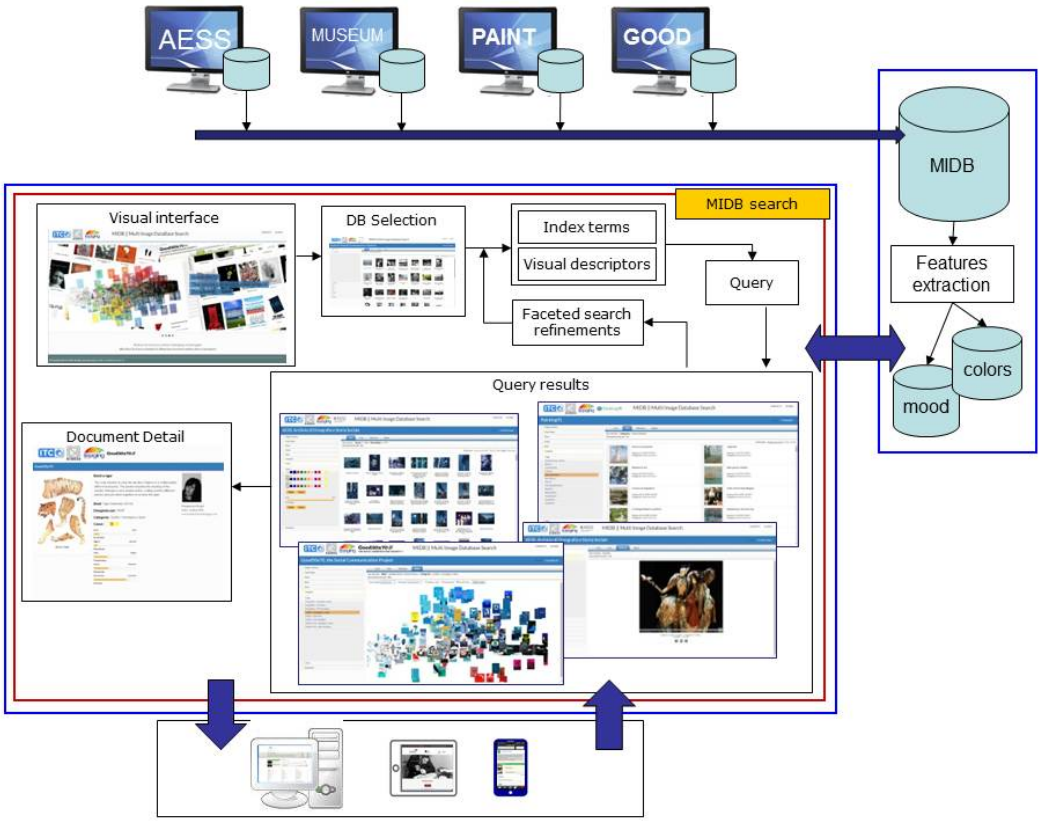


Figure 1: Details of the MIDB Portal schema.

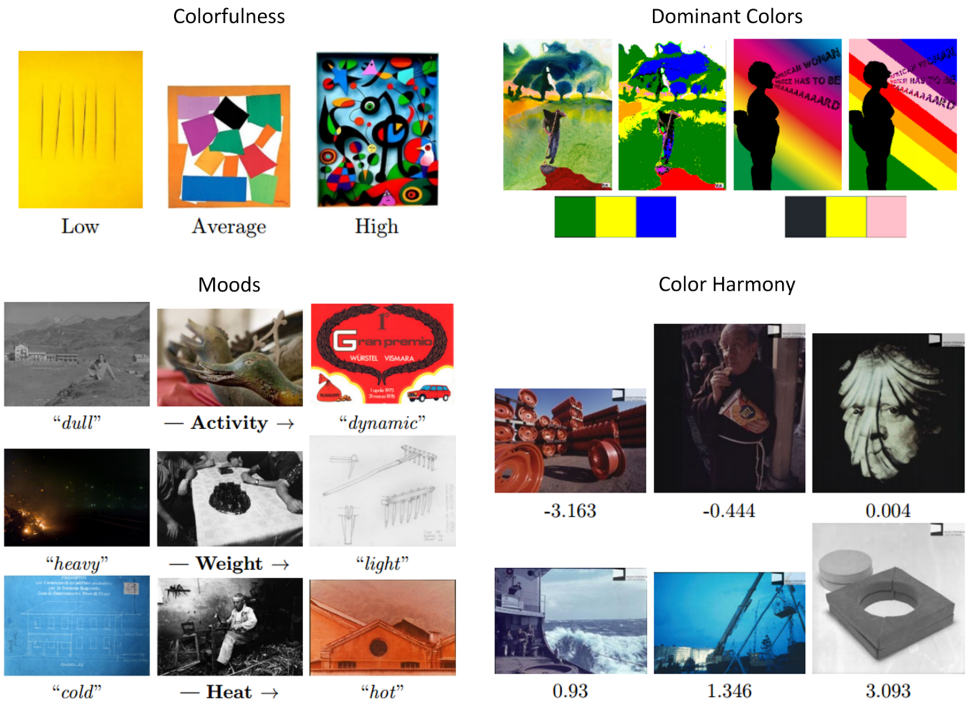


Figure 2: Examples of the four perceptual visual attributes used for indexing the images.

among the ones available in the literature, we have considered mainly descriptors related to color that clearly encode visually perceptive attributes. The list of descriptors considered is: colorfulness, dominant colors, mood features, and color harmony. These descriptors are meant to describe the image content from the emotional, impression, or feeling point of view and users can easily relate to them. We termed these descriptors "perceptual visual attributes". Specifically:

- the *colorfulness* descriptor is the number of unique RGB (Red, Green, Blue) color pixels present in the image. Figure 2 shows examples of images with increasing colorfulness values. The number of colors is a simple indicator of the colorfulness of an image and users can use it to select images with *"many colors"*, *"very few colors"* or any intermediate value using a simple slider.

- the *dominant colors* descriptor represents the amount of colors in an image. It is useful to retrieve images having the same set of colors. The set of dominant colors is computed using the color naming scheme proposed in [20]. Figure 2 shows two examples of images whose pixels are classified using the color naming schema along with their three most dominant colors.

- the *mood* descriptors aim at mapping the relationships between colors and human emotions. Since colors have a strong relationship with emotions we think that this attribute can be valuable in browsing the images. Here we use the mood color features extracted using the computational model proposed by Solli et. al [21]. Figure 2 shows some examples of images in our datasets ranked by emotion attributes. Semantic labels have been associated to the extreme values of each attribute. These labels are also shown in the user interface.

- the *color harmony* descriptor captures how a set of colors is perceived when those colors are seen in neighboring areas. In fact, some color may be perceived as either pleasant or unpleasant if viewed near each other. Figure 2 shows some examples of color harmony scores computed on images following the work by Solli et al. [22]. Note that the harmony score depends on both the color combination, and the color distribution.

5. Using the MIDB portal

The MIDB portal enables to navigate and search images using available query features inside each selected database. A population engine has been realized to extract original data from each dataset, leading to a common structure, the MIDB data structure, excerpt title, author,

Figure 3: Homepage of the MIDB portal. `http://database.itc.cnr.it/image_dbase`

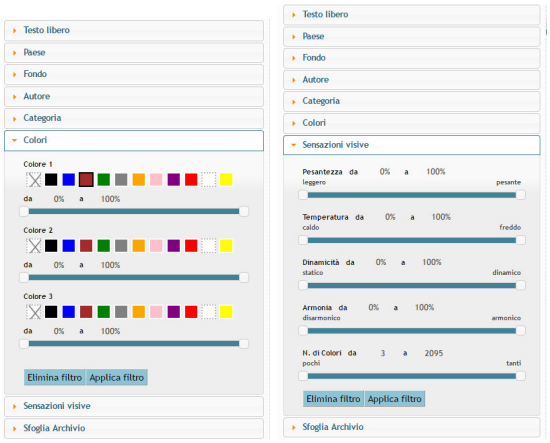


Figure 4: Perceptual visual attributes search: colors and moods sliders.

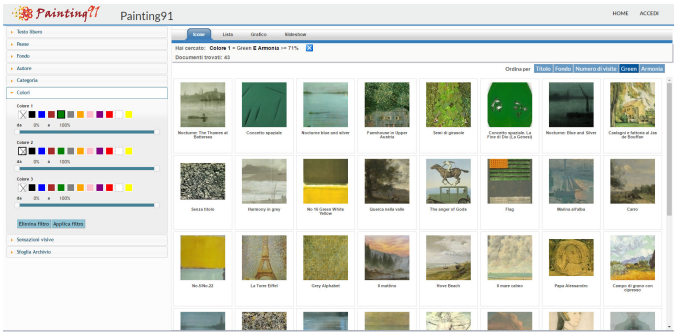


Figure 5: Query results: harmony and color ("green") features crossed.

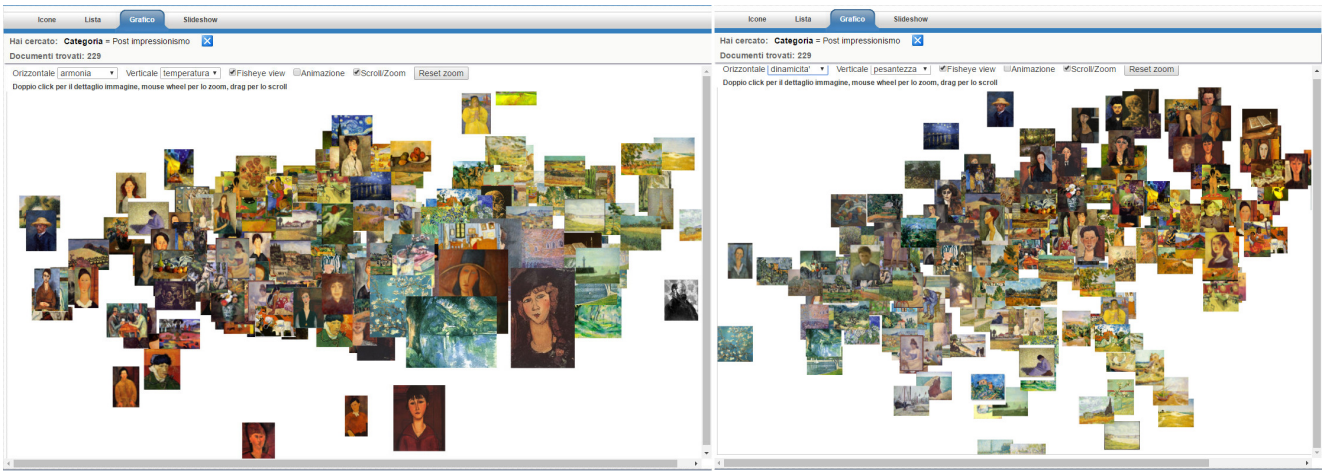


Figure 6: Query results: "Map" output mode, two examples.

description, category and location, as well as the link to the image file and to the original resource.

Such textual data are imported into the MIDB database, and completed with values related to colors and visual attributes, obtained from image analysis, as described above.

From the MIDB home page (Fig. 3) it is possible to navigate between the four available databases: each one is introduced by its name and the number of documents it contains in the carousel presentation, thus allowing the user to select the set of data he prefers.

Different means to retrieve the images have been designed and implemented:

1. standard text, such as Country, Fund, Category, already indexed in relation to database contents;
2. free text, extending research on all text fields of the data structure;
3. perceptual visual attributes search, which make it possible to intersect values based on colors, moods and harmony values.

In Fig. 4 visual attributes search tools are displayed: colors, moods and harmony sliders have a percentage representation, while number of colors slider goes from the minimum to the maximum number of colors resulting from all images. Color selection can be performed in a two-step way: first the user has to choose a color, then he can define a color amount using the related slider. It is possible to choose up to three colors to be found in the images, the desired amount being specified for each.

Text, color and mood keys can be crossed with each other in any desired manner, as shown in Fig. 5, and can be disabled by selecting the option *"All"*, available for textual keys, or using the *"Reset"* command available for color selection and scroll sliders.

Once a query has been executed and the results shown, users can perform a refinement step, using any further combination of the features present on the left of the screen.

Query results are displayed in the central section of the page in one of the following modes:

1. Icon, where each document retrieved is displayed by its thumbnail and sorted by title;
2. List, with more textual information than icon;
3. Map visualization exploits image visual parameters to position each image resulting from a query in a Cartesian plane, where the horizontal and vertical axes can be selected and combined by the user. Fig. 6 shows two examples of map output for the same search *"Category = Post Impressionism"*: the map on the left shows the *harmony* value on the horizontal axis (i.e. discordant vs harmonic images) and the *heat* value on the vertical axis (i.e. cold vs hot images), while on the right example the horizontal axis is the *activity* value (i.e. low vs high saturated images) and the vertical axis is the *weight* value (i.e. dark vs light images). The zero value is on the bottom left;
4. Slideshow mode enables a detailed image view, showing each image in a bigger format.

The user can change output show mode using two different command categories:

- commands to change how the results are shown, alternating between Icons, List, Map and Slideshow.
- commands to change to what extent the results are sorted: standard sorting modes are according to Title, Fund and Number of visits, to which colors and perceptual visual attribute keys are added when they are used to make a query, as shown in Fig. 7. Title and Fund apply alphabetic sorting while others sort images from highest to lowest value of the key.

Users can select each image resulting from a query to open a detailed panel, where all textual information available, together with perceptual visual attribute values, is shown. An example can be seen in Fig. 8.

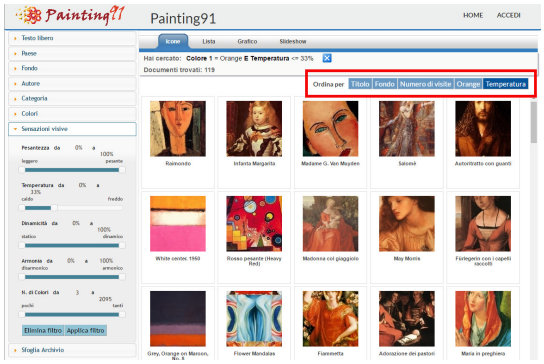


Figure 7: Query results: results sorted by heat attribute.

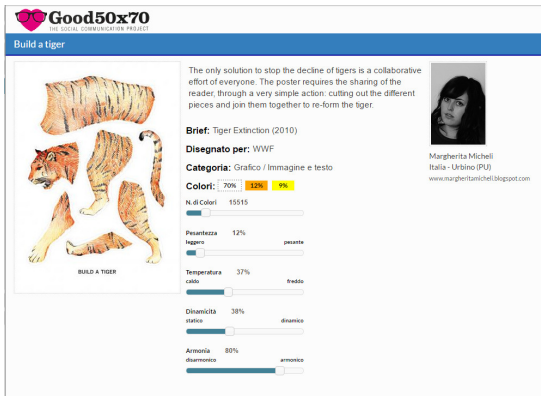


Figure 8: Image detail.

6. Evaluation

In order to measure how the users find the new functionalities helpful in achieving certain tasks, we performed a usability test involving several users. The test provides direct information about how people use our system and highlights problems with the site interface usage. There are several methods for testing usability, the most commons are thinking aloud, field observation, and questionnaires [23, 24, 25]. Another means is automatic observation through data logging, which involves statistics about the detailed use of a system. Usability testing recording software may be used to record the computer screen and the participant's voice and facial expressions during testing. This software can also facilitate tracking of user behaviours, including mouse clicks, keystrokes, and active or open windows. However, the purpose of our test is to evaluate whether the new features are perceived helpful and not an hindrance to the search. To this end we devised several tasks to somewhat force the users to use the new functionalities. With this aim, we administered questionnaires that are more informative for us than an automatic evaluation. Subjects were selected taking into account a broad range of ages, expertise and educational backgrounds covering the kind of expected users of a cultural heritage web site. Specifically, 48 subjects (Italian native speakers) were enlisted. Both males and females were included (45% males and 55% females). The subjects age ranges from 16 to 66 years old (37% below 26 years old, 30% between 26 and 45 years old, and 33% above 45 years old). Their backgrounds are variable: we have enlisted high school students, undergraduate students, researchers and retired people. None of the enlisted users have a specific notion in retrieval in image collection or image indexing using visual attributes. The number of subjects used in our test is in accordance with the guidelines proposed in [26].

Each subject conducted the usability test on a single image database (to avoid biases due to adaptation), under the supervision of one of the authors that explained the structure of the web site and the tasks to be performed, but without being actively involved in the test. The tasks were aimed at gradually introducing the subjects to the new functionalities while giving them a global overview of the whole system. The tasks we asked the subjects to perform are the following:

T1. Explore the system and the available search tools;

T2. Given a query, retrieve the information of a specific image using the Map;

T3. Search for the record of a given, printed, image (target search);

T4. Search all the images having the given visual attributes (category search);

T5. Freely navigate the image database.

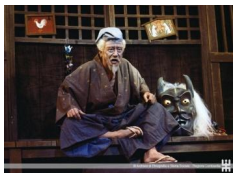
An example of the tasks given to users is shown in Fig. 9. The image reproduces the page with the tasks given for the "AESS" image collection. Similar pages have been created for the other three collections. As it can be seen, for Task 2 we asked the users to perform specific actions and to retrieve the displayed image in the Map mode visualization. Task 3 is similar to Task 2 but the instructions are less specific and only the generic goal is described. Task 4 is even less specific. For all these three tasks we required the user to fill a mini-report to ensure that he successfully performed the required tasks.

After the tasks have been performed, the subjects judge their experience by filling in a questionnaire. The questionnaire is reported in Table 1 and has been administered in Italian (here we report the English translation). It is composed of a series of statements related to different aspects of the experience, and the subjects were asked to express their agreement or disagreement on the given statement with a score taken from a Likert scale of 5 numerical values. The questionnaire is an adaptation of the System usability Scale (SUS) questionnaire developed by John Brooke at DEC (Digital Equipment Corporation) [27].

Our SUS questionnaire is composed of 20 statements: the first 10 statements correspond to the original SUS questionnaire (we label this set as SUS1-10), while the next

Task 1: explore the system and the available search tools

Task 2: *set the following filters*
"Free text = "**bunraku**" e "Activity >= 30%", show results using **Map Mode**, try different horizontal and vertical axis arrangement to find the image given on the right, then open image details and fill the table below.



Title	
Category	
N. of colors	
Color 1 (name and value %)	
Color 2 (name and value %)	
Color 3 (name and value %)	

Task 3: search for the image given on the right using the available filters, try to have it on the first page of results combining filters with sorting commands, then open it and fill the table below.

Title	
Category	
N. of colors	
Color 1 (name and value %)	
Color 2 (name and value %)	
Color 3 (name and value %)	

Task 4: search for images containing color portraits and fill the table below, try different filter combination and report your choices.

	First attempt	Second attempt
Number of images found		
Used filters		

Task 5: use the system to browse the collection

Figure 9: Example of tasks for the AESS database. We can also see the mini-reports that must be compiled by the users.

#	Statement
1	I think that I would like to use this system frequently
2	I found the system unnecessarily complex
3	I thought the system was easy to use
4	I would need the support of a technical person to be able to use this system
5	I found the various functions in this system were well integrated
6	I thought there was too much inconsistency in this system
7	I would imagine that most people would learn to use the system very quickly
8	I found the system very cumbersome to use
9	I felt very confident using the system
10	I needed to learn a lot of things before I could get going with this system
11	The search for color is very helpful
12	Too many input/interactions are required to obtain acceptable results
13	The system user interface is easy to understand
14	It is difficult to repeat the same task twice (and obtain the same results)
15	I found it easy to combine multiple search keys
16	I thought there are too many tools displayed in the search area on the left
17	The search for mood is very helpful
18	I would prefer to use only the basic search functionality
19	I thought the possibility of change in the indices of graphic display is very useful
20	I thought the graphic display of many images is frustrating

Table 1: SUS questionnaire statements. Statements 1 to 10 are the original SUS statements (SUS1-10); statements 11 to 20 are our system specific statements (SUS11-20). We indicate the set of all the twenty statements as SUS1-20.

10 statements, devised in the same way as the SUS ones, are specifically related to our system (we label this set as SUS11-20). We label the whole set of twenty statements as SUS1-20.

Finally, in order to have more feedback about the new functionalities, we also interviewed each subject asking for the strongest and weakest points of their experience while using the MIDB portal.

7. Results and discussion

Almost all the users performed the five tasks within 45 minutes. From the analysis of the users' mini-reports, we found that out of the 48 users, only two failed to complete one of the tasks. Specifically, one user failed to locate the given image in the Task 2. When subsequently interviewed he stated that there were too many images on the Map and many images were hidden by others placed in front of them. We discovered that he neither used the zoom or scroll tools available in the Map page to better view the hidden images. We think that the instructions about these tools displayed on the top of the page (see Fig. 6) must be made more visible and clear. The second user failed to complete Task 4. He was unable to satisfactory combine different filters in order to retrieve the required images. He used only those filters he was mostly accustomed to: i.e. the text-related ones and the dominant color while ignoring the other, attribute-related, ones.

After collecting all the user questionnaires, we followed the standard procedure and normalized the scores in the numerical range 0-4 by subtracting 1 from the odd-numbered statement scores and by subtracting 5 from the even-numbered statement scores. All the scores are then summed up and multiplied by a proper factor to have, for each user, an overall score in the range 0-100. All user scores were then averaged to obtain a final global SUS score.

We have analyzed the responses of the sets of statements SUS1-10 and SUS11-20 separately as well as as a whole (SUS1-20). Moreover, we have individually considered the responses collected from each one of the four image collections ("AESS", "MUSEUM", "GOOD", and "PAINT") and the responses from all the collections ("ALL DB").

The results of this analysis are shown in Fig. 10 (left). Standard deviations from the average scores are also shown. As it can be seen, there are no relevant differences among the scores obtained from the four collections. This indicates that the proposed functionalities can be used in image collections having different content without any problem. Only the responses collected from the "MUSEUM" collection present a higher variability with respect to the other collections. By considering all the responses on the four collections, the average SUS score (SUS1-20) for our system is 72.4. If we consider the two sets of statements separately, we have an average score of 73.9 for the SUS1-10 statements, and 70.79 for the SUS11-20 ones. By plotting the SUS1-10 score on the acceptability scale devised by Bangor et al. [28], our system obtains an "Acceptable" score.

If we analyze the responses of each statement in the survey, we obtain the results shown in Fig. 10 (right). These values, also reported in Table 2, are normalized in the range 0-4 with high values corresponding to better responses. All the responses are above average. The statements with the lowest scores in the SUS11-20 set are 14, 17 and 20 that all belong to our system-specific questionnaire. Statement 14 indicates that the users feel that it is difficult to obtain the same results for the same task. This is mainly due to the use of range queries on colors and moods where small changes can lead to very different result sets. The low result of statement 17 ("The search for mood is very helpful") is due to the particular nature of the mood features. Users are not accustomed to having these kinds of search indexes in a retrieval system. Interestingly, for statement 17, young people gave the best scores compared to older ones. Finally, statement 20 ("the graphic display of many images is frustrating") highlights a limit of our Map visualization. When there are a lot of images to be displayed on the Map, browsing and navigation can be cumbersome and users became frustrated. This is mainly a software engineering problem. The development tools that we have used are not suitable to managing many images on a single page. With respect to the other statements, we have not found any significant difference in the distribution of the scores among the different users. What we have registered instead, is that elder people give more frequently scores around the middle value (i.e. 2, 3 or 4), and are less prone to give the highest or lowest scores. On the other hand, younger user emphasize their answers by often giving scores at the ends of the spectrum (either 1 or 5), and use less frequently the middle value (which we recall corresponds to a neutral answer).

From the responses to statements 4 and 10 a *Learnability* measure can be derived [29]. In our case this value is 6.77 out of a maximum of 8. This indicates that, given a minimum of time, users can easily learn to use the specific functionalities of our system.

By analyzing the responses of the users to the interview, we found out that more than 95% of the uses consider the Map visualization one of the strongest points of the system. The second most voted useful functionality is the search by dominant colors. One of the weakest points is the slow responsiveness of the system when many images are involved. Moreover the terms used to describe the mood filters are considered not very descriptive. Users suggested adding some hints to describe better the significance of these terms and reduce ambiguity and subjectivity in their interpretation. In designing the system we purposely avoided adding these hints because we wanted to investigate the comprehensibility of the various visual attribute filters to the users. The results clearly indicate that notwithstanding the positive feedback about these filters, we need to pay more attention to help users to better understand their effect on the query in order to make the

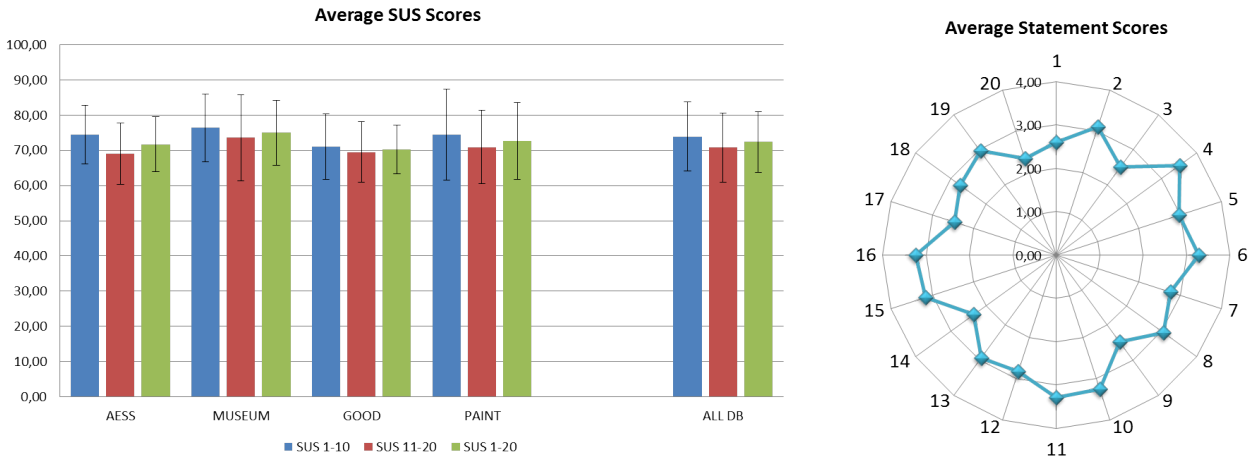


Figure 10: Average scores per image collection (left), and per questionnaire statement (right). Scores have been normalized as described in the main text. Numbers 1 to 20 in the figure on the left correspond to the statements in Table 1.

Statement	1	2	3	4	5	6	7	8	9	10
Score	2.60	3.11	2.51	3.51	2.97	3.29	2.77	3.06	2.49	3.26
Std.Dev.	±0.78	±0.74	±0.86	±0.66	±0.60	±0.83	±0.95	±0.93	±0.83	±0.78
Statement	11	12	13	14	15	16	17	18	19	20
Score	3.29	2.83	2.94	2.34	3.17	3.23	2.46	2.74	2.97	2.34
Std.Dev.	±0.76	±0.91	±0.80	±0.99	±0.61	±0.79	±0.93	±0.88	±0.74	±0.96

Table 2: Average scores for each statements in Table 1.

system more user friendly.

Finally, among the functionalities that the users suggested to add to the system there is the content based image retrieval to allow similarity search of the images. Furthermore, many users suggested to add the ability to perform "OR" queries. Currently, the criteria selected from the different filters are executed in "AND". Users suggested to add criteria from the same filter in "OR" to allow more flexibility. Making clear the different execution modalities in the user interface poses some challenges.

8. Conclusions

In this paper we presented the MIDB portal that integrates some innovative image searching and visualization functionalities, in the context of cultural heritage web sites. We have implemented content-based image retrieval tools, related to the emotional, impression, or feeling point of view, that should be easily understood by users and that should help them to retrieve images based on visual attributes related to emotions and perceptions. We have also introduced a novel, "Map"-based visualization tool. The MIDB portal has been tested on four different image collections related to social or cultural heritage. To evaluate the usefulness of the innovative tools, we performed SUS usability test and the results show an average score of 72.4, and highlight that 95% of the users considers the Map visualization one of the strongest points of the system. Mood features search evaluation results indicate that, although users are very interested and enthusiastic in their use, fine-tuning remains to be done to achieve significant results and in line with user expectations. Also, from a software engineering point of view some improvements are needed to overcome the slowness in the visualization of the Map of multiple images.

The preliminary results presented in this paper show that users find the proposed functionalities both useful and engaging. We plan to further investigate the functionalities by performing a long-term evaluation (both quantitative and qualitative) considering a larger ensemble of users. To this end we need to integrate within the MIDB site automated techniques to record and track the users' experience.

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