ICONOGRAPHIC WEB IMAGE CLASSIFICATION BASED ON OPEN SOURCE TECHNOLOGY

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Abstract

This paper presents a method to classify images in a WEB service based on Open Source technology to increase the usability of the system, particularly to users with disabilities or "non-expert" users. In addition with this implementation, we have studied new methods to search images on Internet with a semantic approach and the relationship between the size of the screen and the quality perceived by the user as other important parameter to improve the usability of a WEB image system. The WEB service programmed will allow us to validate (or no) two main hypotheses:
(H1): An iconographic system to classify images increases the usability of interfaces where we can look, index or find those images. This point is very important to approach the technology to users with disabilities, but it is necessary to consider the particularities of every disability and how the system can adapted to them.
(H2): The technical data of the image and the action of visualization them, are closely connected with the quality and the emotion perceived by the user. If we can find the optimum relationship among the technical characteristics of the image and the distance or size of the screen, we can optimize the emotional information of the image that remains reflected in the user and the interaction with the system.

Keywords: Image Indexation; emotional usability; 2.0 Web; Open Source Technology, semantic searching.

1. INTRODUCTION

When we began this project, we decided to develop an adaptable system, easy to use, and easy to replicate in other platforms like mobile phones. Through an Open Source technology we have developed a WEB page to evaluate and search images, one system that in this moment we are migrating in a mobile system.

Why do we use the Open Source technology? Because it is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, and lower cost [36].

One of the most important attribute of this work is how we use different systems based on O.S. to make a system to evaluate the emotional behaviour of a user and to improve the semantic searching of image in Internet.

Previous studies in the field of Internet accessibility demonstrate us that the two more important characteristics than any web page or image system has to have to be it is the use of images and icons in its navigation [21]. Also, it's important to recognize that if we understand the type of user who is working with a system (statistically as well as emotionally) we will be able to offer adapted answers to the same one, reducing the erroneous results and optimizing the degree of satisfaction.

In the field of the image indexing there is a great amount of studies centred on the automatic extraction and classification of the image. On the other hand there are many works (in the field of the psychology) that remark the importance that the subjective behaviour of the user have in any action. This is another strong point implemented in this work, in which from the subjective classification of emotional parameters of an image, a classification tool is provided it depending on users and their appraisals. Our system proposed, is compatible with the main image storage systems based on metadata and it's easy to migrate with new image mobile systems like phones, PDA, etc.

2. IMAGE AND THE HUMAN FACTOR

The image is a superior form of communication [4]. It's necessary to study new ways to use it, and improve the use of it.

Image storing
In this field we can find multiple proposals of image classification. Most of them are based on the elementary theories of data distribution contained in an image developed along the 90's decade [1, 6, 8, 14, 17], where the authors have proposed automatic methods that allowed us to extract the mentioned descriptors ("CBIR systems" or Content-based image retrieval methods).

At this point we have to reflect the importance of user's role: We should take into account the user that makes the search: where he/she comes from, age, sex, and education, with or without disabilities or type of disabilities. Why do we need to focus in the role of the user and not in the image? Because the type of user conditions the result of the classification and the research of images, as we will be able to see later.

Image perception
In a psychological area, we find works centred on evaluating the differences of perception in function of the user [18] as well as depending on the type and amount of emotions that the image provokes in the mentioned viewer [11]. We can find cultural differences how the user assigns different descriptors [16]. The emotional interpretation of the colours can influence directly on the emotions generated in the process of perception [13] and for this reason we believe that's very important to find the best way to store them (the emotions). The cultural language limits the classification of the images and in general, of any element, because words or usual descriptions are different from one place to another and still sharing a language and a geographical zone it is easy to find different senses for a same word. This limitation of language conditions the inclusion of descriptors within an image. The system proposed is based on a classification through icons and improves the classification scheme because it makes the origin of the user independent, since the system only stores a numeric value assigned on each icon.

It's very difficult to define the meaning of emotion, but there is a consensus that the emotions can differ and can be measured them [2, 20]. Centred in the field of psychology and neuropsychology the main study of how the user reacts in front of an image is the IAPS (International Affective Picture System[1] [19]), revised and replied in several studies to check out its validity within diverse cultural frameworks [3].

In the case of the original IAPS system, the emotions are grouped into three variables: "Valence" or level of happiness; "Activation" or level of excitement (also called Arousal) and "Dominance" or level of control sensation[2]. This system is defined as an effective method to check out abnormal behaviors and emotional dysfunctions in several types of users [12, 15] (Figure 1):

Figure 1.- 2D emotional representation. IAPS [19]

3. WEB IMPLEMENTATION

Metadata Overview
We can find a great amount of information about all type of archives and data in general (metadata). This type of information can describe electronic resources or physical elements. The most important systems are:

- **DC** (Dublin Core Metadata Initiative) [24].
- **IFLA** (Metadata Resources for Digital Libraries) [25].
- **MCF** (Meta Content Framework) [26] for presentations.
- **IMS** (Instructional Management Systems) [27] for education and learning methods.
- **MPEG-7 and MPEG-21** (Multimedia Content Description Interface and Multimedia Framework, respectively) [37] for multimedia archives description.

And the specific methods to describe images are:

- **IPTC Header** [29]: (Information Interchange Model). This system is used by the AP (Associated Press) to describe the contents of the image besides the author rights.
- **Exif** [30]: (Exchangeable Image File Format), it is a standard for storing interchanges information in image files, especially those using JPG compression.
- **MPEG-7/21** [37]: Developed by the Moving Picture Experts Group, for describing the multimedia content data.
- **XMP** [31]: The Extensible Metadata Platform developed by Adobe is a labeling technology that allows us to embed data about a file. One interesting thing is that system allows working with JP2 or JPG2000 format.

Also, other system more dynamic to store information about an image is to use extensible data base to store the images and their metadata. This process allows us to store a large list of information about the image and also allow us to include this information in several languages, with synonymous or descriptions. Those systems increase the usability and the learning process of the WEB, because every user can adapt the classification and the research to its attributes or language. This dynamic system is the methodology that we have implemented, and we can find two basic implementation models: The first one is based in Microsoft technology, easy to program with this tools:

- HTTP Server – Internet Information Services [3]
- Program system – ASP o ASP.NET [4]
- Data Base – Microsoft SQL Server [5]

The second model is based in the Open Source technology and has the advantages of the Open Source philosophy, moreover a very easy work interface. The services necessary are:

- HTTP Server – Apache HTTP Server [6]
- Program system – PHP Hypertext Processor [7]
- Data Base – MySQL Server [8]

Our system was developed by using the second approach, because this technology is freely available at university and seems more dynamic and accessible that the first one. Our final system follows the next structure:

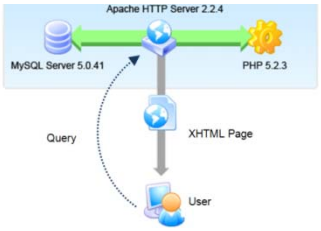

Figure 2.- Implemented Image Web Service

[1] Developed at the NIMH Centre for the Study of Emotion and Attention 1997. Florida University

[2] Nowadays we can find developments very close to the IAPS like Feeltrace, developed by Roddy Cowie (Queen's University, Belfast).

[3] http://www.microsoft.com/WindowsServer2003/IIS/Default.mspx

[4] http://www.asp.net/default.aspx?wwwaspnetrdirset=1

[5] http://www.microsoft.com/spain/sql/default.mspx

[6] http://httpd.apache.org/docs/

[7] http://www.php.net/

[8] http://www.mysql.com

Usability and adapted design

It is really difficult to find systems that combine usability and aesthetic beauty. Many designs are great, new and attractive, but when they are used we find a low level in its communicative and emotional character, in resume a low usability level. A design adapted to a concrete user together with the past experience (memory) of this user, it can generate more intense and long emotions than aesthetic design. For this reason it is very important when indexing or searching and image, that the system recognizes the concrete profile of every user.

Our system needs to be usable for the maximum amount of persons without adaptations or specialized designs [5, 7]: the key issue of a good design is to highlight the "low physical effort" in accordance to the adaptation to people with low training or with physical problems.

4. IMPLEMENTATION

The main characteristics of our system will be:

- Facility of use and easy implementation based in Open Source technologies
- Incorporation of emotional and subjective data into the descriptors of the image and a new model to investigate the relationships among the technical data of the image and the emotional affect in the user.

We have used the IAPS image system to make our system and the user test. We have divided the project into several phases:

- Replication of the IAPS system in a controlled universe.
- Incorporation of a measure for the "perceived quality", which allows relating the obtained data with the emotions perceived for every user.
- Replication of the system in multiple image visualization environments with a proposal of commitment referred to the file quality and the emotions associated with its visualization.

Emotional Image Test WEB Page

We have developed a serial of web service with two primary objectives: Describing a data base to store the datum and programming the dynamic pages of the application through PHP and making use of the JavaScript language that executes itself in the machine of the user to endow with more comfort in the treatment of the datum and the visualization. As we can see in 3.2, our web server uses those services: Apache HTTP Server, PHP and MySQL. To make proves, in our local PC we have installed those services:

- Apache HTTP Server 2.2.4
- PHP Hypertext Processor 5.2.3
- MySQL Community Server 5.0.41

In the Internet public server, the software was previously installed and the versions of the services in function of the information commands[9] are:

- Apache HTTP Server 2.0.54
- PHP Hypertext Processor 4.3.10-22
- MySQL Server 4.1.1

[9] "phpinfo();" inside of a PHP file to know the Apache and PHP version, and "SELECT version();" inside a MySQL command to know the MySQL version.

There are some little differences between the software versions in the local machine and the public but it is not a problem because those changes don't need a change in the application code, in resume are compatible.

In our local machine we have installed Microsoft Windows Vista Home Premium, meanwhile in our web server we have a distribution of Linux based on Debian. The code will run without problem into the two systems because the systems make the translate function and we have the application and the operate systems in a different layers. This organization allows services to manage the execution of the application for every web request.

We have defined the navigation plan with an initial welcome page and to input the statistic datum. We have two example and explanation pages and after that, the test begins with a sequence of pages to see and evaluate the images and finally we show the final page, that informs us about the finish of the test:

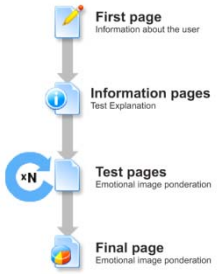

Figure 3.- Test on-line system

The main element of the test is one page that we repeat so many times as images that we want to evaluate. In this page we have to see the image and the icons to evaluate it.

Those buttons or icons replicate the SAM model from IAPS system. When a user makes a click into one category the system store the punctuation (9,7,5,3 or 1) and hide this category. This methodology allow to the user in only three "clicks" evaluate an image. To hide the category when we select an icon, we have programmed inside the PHP of the test page a little script in JavaScript to capture the value and hide the entire category. The information recollected with the clicks are transmitted with a POST form where the JavaScript validations in the client band writes the generated variable to the action page where are validated with PHP language before to be store into the database through SQL syntax.

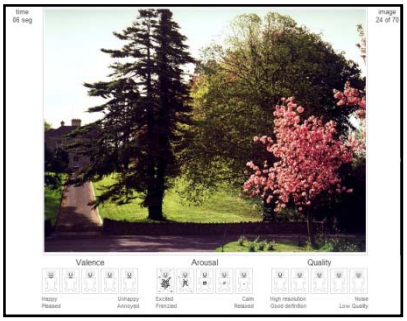

Figure 4.- Evaluation page: www.salle.url.edu/mid

To administrating the system, we have developed a Back-Office to active, create o delete a test, to view or download (in XML or XLS format) the results or delete the database. To generate the XLS file we have used a specific PHP module calls "CodePlex

PHPExcel 1.4.5. Production", available in Internet as free open license GNU LGPL[10].

The information store inside the database is put into three tables (user data, image evaluation and image information). In the next figure we can see and example:

Field Name	Field Type	Size	Precision	Not Null	Default	Comment
id	INTEGER	11	0	☑	Null	
name	VARCHAR	32	0	☐	Null	
surname1	VARCHAR	32	0	☐	Null	
surname2	VARCHAR	32	0	☐	Null	
sex	VARCHAR	6	0	☐	Null	
age	INTEGER	6	0	☐	Null	
birth_place	VARCHAR	32	0	☐	Null	
country	VARCHAR	32	0	☐	Null	
studies	VARCHAR	32	0	☐	Null	
studies_work	VARCHAR	32	0	☐	Null	
date_and_time	DATETIME	0	0	☐	Null	
place	VARCHAR	32	0	☐	Null	
set_number	VARCHAR	32	0	☐	Null	
distance_to_screen	VARCHAR	32	0	☐	Null	
screen_size	VARCHAR	32	0	☐	Null	

Figure 5.- Table1: "tester"

Image searching with semantic approach

In our implementation we have added a semantic dimension to the images to describe the associated emotions, but to obtain a correct search of images according to semantic criteria we will not have the categorization of emotions enough with the limited data base in what we have carried out. If we want to benefit and to study the different techniques of semantic search applicable to the field of the digital image we will have to use an images bank of an order of very upper magnitude.

Nowadays there isn't evidence of web site systems that follow the recommendations of the semantic web page[11] where a great number of categorized images[12] are available. Then we will check for an alternative data base of digital imagery containing metadata. Some of these data bases are web services consisting of the share of images (Photo Sharing). Those provide users with tools to describe the images through labels or tags (key words), so that a great number of images show metadata associated of this type. There are four services of this type that contain a huge number of images with metadata, to be able to carry out our study:

- PhotoBucket [32]: Image sharing system with more than 3.000.000.000 images and 80 millions of users. This system allows semantic metadata in tagging format.
- Flickr [33]: Maybe the second largest image system in Internet. It allows semantic metadata in tagging format, "geo-location" metadata and Exif format. Also, it gives a Web Service API to obtain results.
- ImageShack [34]: Very similar to Flickr but without Exif format, and search API.
- Picasa Web Album [35]: Similar to Flickr with searches by group and the image contest.

We have selected the Flickr system because it provides us with the necessary tools to carry out requests and to extract the results in the format that is more comfortable for us (XML, for example). We will be able to use consulting requests while carrying out searches based on the metadata of those images that have some tags, technical datum of picture Exif, or coordinates of reference for the geo-location are already in the form of labels of semantic description from the contents. This service allows us having the possibility of making semantic image search with the Flickr API, Open-Thesaurus, Google Research Translate API, a Thesaurus simulation and Onthologies implementations:

Figure 6.- Front Office of the Web implemented.
www.salle.url.edu/mid/search

We can define our implementation in a functional level with the following figure:

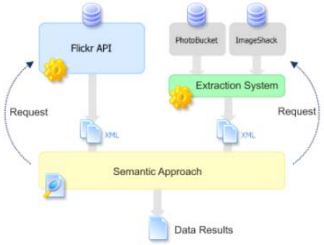

Figure 7.- Block diagram of searching with semantic approach

The results of the search are in XML format thanks to the Flickr Web Service API and to the extraction (parser) that will be get the results of the pages from PhotoBucket and ImageShack.

To probe the system we have programmed the server when we have made the "Image Metadada and Emotions implementation" with two PHP files in a directory called "Search", the first one to define the search approach (search.php) and the second one to show the results of the search (results.php). With those two files we will probe the different versions of the search with semantic approach:

- Case 1: Only with key words.
- C2: Key words with synonymous.
- C3: Key words with different languages.
- C4: C2+C3.
- C5: With a "geo-location" filter. (This case was studied only with Flickr system, the only ones that allow to the user put geo-location metadata into the image)

Next we can see an example of searching:

- C1-Keyword: "Universidad" (in Spanish)
- C2: "Universidad OR facultad OR escuela OR colegio OR seminario"
- C3: "Universidad OR university"
- C4: "Universidad OR university OR facultad OR faculty OR escuela OR school OR colegio OR college"

Results:

	Flickr	PhotoBucket	ImageShack
C1	48.273 images	1.023 images	19 images
C2	150.093 images	33.599 images	271 images
C3	1.051.441 images	Error[13]	191 images
C4	3.681.080 images	Error	2.653 images

Table 1.- Images results in function of semantic approach

[10] LGPL: Lesser General Public License

[11] Unicode technologies, URI, XML, RDF, OWL, SPARQL

[12] With RDF tags in metadata and onthologies.

[13] Technical limitation because we exceed the search parameters.

To study the C5, we have studied the number of images that contain geo-location datum. In our example, we have searching for the number of images that contain the metadata "universidad" and placed in Spain:

	KeyWord: "universidad"	Marked with "Geo-location"	In Spain
C5	48.273 images	6.516 images	178 images

Table 2.- Geo-location filter application

If we merge C4+C5 the results are:

	Results with 8 keywords	Marked with "Geo-location"	In Spain
C4+C5	3.681.080 images	412.838 images	212 images

Table 3.- Geo-location filter application with C4 condition

5. INTERACTION RESULTS

In the first phase of this study we have tested our system with an universe of 143 users, 67 women (26,3 years old average, S.D. 5,52) and 76 men (30,8 years old average, S.D. 5,47). In this phase, we show 60 images from the IAPS test 1. Every image was showed for 20" in a screen about 1.2x1.2m and the emotional results we can find them in previously papers [9].

In the second previous phase [10], we have substituted the "Dominance level" for another one called "Perceived quality", and the main contribution was to evaluate the relation between the image quality and the emotional response of the user. In addition to this phase we worked with our WEB test system and after the test the users were asked about the experience with three questions:

1. Q1: Do you prefer the hardcopy system or WEB?
2. Q2: From 0 (not easy) to 10 (very easy), score the system proposed to make the image classification.
3. Q3: From 0 (not easy) to 10 (very easy), score the system proposed to make the image searching.

The results of this navigation questions have been:

- Q1: The 100% of users prefer the WEB system.
- Q2: The averaged has been 8.22 S.D. 0,98. Some criticism was the size of the photo, the visualization time or the possibility to make changes in the evaluation and the possibility to put metadata at the moment of viewing.
- Q3: The averaged has been 6,76 S.D. 1,10. Some criticisms: No possibility to merge metadata descriptors with the perception classification, it's difficult to calibrate the search, and no possibility to view with more detail the image (zoom the image).

Moreover, we had worked with ten non-experts users or with motor disabilities. Those ten users have the following results to the test:

- Q1: 100 % prefer the WEB System.
- Q2: 8,7, S.D. 1.18
- Q3: 6,7, S.D. 1.10

In resume we can say that our system is easy to use, easy to learn and it improves the classification of image with icons. We need to improve the search system but we can affirm that the first hypothesis (H1) has been validated.

H2. Image-User Relationship

A part of the secondary hypothesis was developed in our previous study, and it was completed with the study of the influence that the distance between the screen and the user and the size of the screen has on the perceived quality, because as we have seen, it affects directly to the emotions [10]. Although the perception of the quality of an image will depend on every particular user, there are several recommendations that advise us about the optimum distance and height to see a screen (Figure 7).

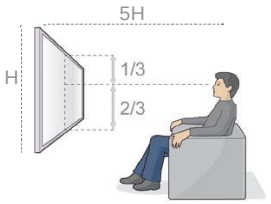

Figure 7.- Optimal visual distance and height on TV screen [22]

Some recommendations define the optimal distance is about 10 cm for each inch of screen diagonal. Also it's important the angle of visualization, because with angles upper to 30º we began to have bright and color loss, and of course quality loss. In this second hypothesis we have described an index of optimum visualization (IOV) as the result of dividing the diagonal distance in the screen among the distance between the user and the screen. Checking several recommendations we have obtained an average factor of 0.31 as the optimum rate of visualization[14].

For extreme values of IOV (i.e. very close or far away the screen), a natural trend is to perceive minor quality because we can't see the details in a far situation (It allows us to increase the compression of the image, reducing its size and therefore obtaining a better yield of the environment) or the pixels and errors of the compression are quite clear if in a close situation (we need to increase the quality of the image).

We have found that in order to obtain IOVs close to the optimum value (0.31), and whenever we intend to work with images compressed with the JPG2000 format, the compression rate shouldn't overcome values from 60 to 80% with respect to the original. Finally, and to highlight the perceived quality of the data depending on the IOV rate and the type of compression of the image, we present some results in table 2.

Men		Women		Image Type
IOV>0.4	IOV<0.4	IOV>0.4	IOV<0.4	
6.90	7.55	7,34	7,41	Jpg colour
6.97	7.83	7,50	7,87	Jpg2000 colour 80%
5.23	6.60	5,47	7,00	Jpg2000 colour 90%
5.77	6.19	5,98	6,49	Jpg B&W
5.83	6.70	5,92	6,52	Jpg2000 B&W80%
2.51	3.08	2,61	3,55	Jpg2000 B&W95%

Table 4.- Quality average depending on the IOV index.

The results seem coherent with the initial hypothesis that we have inferred. However there's a surprising result: the fact that the perceived quality, when dealing with men, is minor than in case of women.

[14] We have generated a IOV rate with different distances and screens by following the recommended links.

6. CONCLUSIONS

The user is the central element of our system. We have developed a WEB service based on Open Source technology to increase the usability of the system, particularly to users with disabilities or "non-expert" users. Every user is capable of reinterpreting the same image in multiple ways. The inclusion of modern tools like "Eye-Tracking" [23] technologies will allow us to discover if the composition of the image and its technical characteristics are important or relevant in the emotions transmitted to the user.

We have observed that a compression rate of 60-80 % when dealing with the JPG2000 format allows us to obtain results analogous to those with the JPG common standard. This fact brings us to recommend the use of the JPG2000 format since it allows a considerable reduction in the file size.

The distance to the screen, the size and its resolution are factors to consider in the visualization. They directly influence the generated emotions and, indirectly, the perceived quality.

We have made a new web system with a "highly usable" interface to evaluate and search images with different criteria: one closed system to work with the emotional data of the user and the image and other system to make semantic advanced searches using Google and Flickr.

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