# Retrieval of the ornaments from the Hand-Press Period: an overview

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## Abstract

*This paper deals with the topic of the retrieval of document images focused on a specific application: the ornaments of the Hand-Press period. It presents an overview as a result of the work and the discussions undertaken by a workgroup on this subject. The paper starts by giving a general view about digital libraries of ornaments and associated retrieval problematics. Two main issues are underlined: content based image retrieval (CBIR) and image difference visualization. Several contributions are summarized, commented and compared. Conclusions and open problems arising from this overview are twofold: 1. contributions on CBIR miss scale-invariant methods and don't provide significative evaluation results. 2. robust registration is the open problem for visual comparison.*

initial trademark heraldry

**Figure 1. Some ornaments**

| name | size | type | period |
|---|---|---|---|
| BVH[‡] | 8 000 | * | $16^{th}$ |
| Fleuron[§] | 6 500 | * | $17^{th}$ |
| Mouriau[¶] | 1 800 | * | $18^{th}$ |
| Môriâne[‖] | 1 500 | * | $18^{th}$ |
| Impcat[**] | 1 300 | trademark | $16\text{-}18^{th}$ |

**Table 1. Databases of ornaments**

## 1 Introduction

This article deals with the topic of document image retrieval. During the last 25 years, many work has been done on this topic dealing with the retrieval of official forms, maps, drawings, correspondences, etc. We focus here on a new application: the retrieval of ornaments from the Hand-Press period (Figure 1). The Hand-Press period runs from around 1454 (approximate date of Gutenburg's invention) to through the first half of the nineteenth century (when mechanized presses started to appear). The particularity of this period is the use of block of wood, with a relief carving on it, to print the ornaments.

With the growing of interest in the cultural heritage preservation in the 2000s, a large work of digitization of historical collections has been carried out. Nowadays several databases of ornaments are available and continue to grow, the Table 1 refers the most known. These ornaments are extracted from the whole digitized pages, using full automatic or user-driven segmentation methods [9], or recorded independently.

Historians next employ thesaurus to index these images. They first record the individual instances of ornament occurrence in order to identify the individual blocks. Next, they use a subject-specific classification system, like Iconclass[1], to describe the identified blocks. This identification is also very useful to date the books and to authenticate outputs from some printing-houses and authors [7]. Indeed numerous editions, published in the past centuries, do not reveal their true origin on the title pages. Fictive or misleading addresses are legion. Historians rely then on the

[*] The authors' names appear in the alphabetical order.

[†] http://www.informatik.uni-augsburg.de/heron/
[‡] http://www.bvh.univ-tours.fr
[§] http://dbserv1-bcu.unil.ch/ornements/scripts/
[¶] http://www.ornements-typo-mouriau.be/
[‖] http://promethee.philo.ulg.ac.be/moriane/ornSearch.aspx
[**] http://eclipsi.bib.ub.es/imp/impcat.htm
[1] http://www.iconclass.nl/

analysis of blocks to authenticate the books. These blocks were reused to print several books, be exchanged between the printing-houses or duplicated in the case of damage as illustrated on Figure 2. Their identification could help to authenticate books in addition to other information (paper and ink types, typographic practices of printers, etc.).

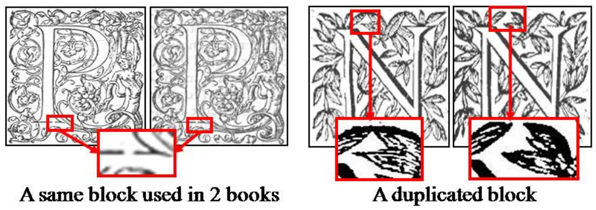


**Figure 2. Block identification**

The key problem today is the management of the masses of data. This makes a manual identification of blocks impossible. Automatic retrieval systems are the key component to do it. However, their development is a challenging task due to different open problems: degradation of images (old age, lossy compression), scaling invariance (various resolutions), complexity (masses of data), scalability (high number of block class), etc. In the last 12 years several contributions have been proposed on this topic dealing with two main aspects: Content Based Image Retrieval (CBIR) systems and visual comparison methods. CBIR systems aim to retrieve similar images (i.e. produced by a same, or by a duplicated, block) using image comparison techniques. Once images are retrieved, the final goal is to determine if two printings come from the same block, and to make a relative dating between them. Such task can not be achieved automatically, due to the need of contextual information to do it (about paper, ink, degradation level of printings, presumed printing-houses and authors, etc.). Historians are then required to determine it, they could be greatly helped by automatic methods of image difference visualization. Such methods display difference maps between images in order to highlight weak variations difficult to detect visually.

This paper proposes a complete overview of this work at best of our knowledge. It results from investigations done by the international research workgroup Calypod[2] dedicated to these problematics. It also reports the undertaken discussions during a one-day international workshop held in December 2007, grouping historians and computer-science people on this topic[3]. The rest of the paper is organized in two sections, 2 and 3, related to the problematics presented above: CBIR systems and visual comparison methods. Open problems and conclusions arising from this overview are discussed in section 4.

[2] http://calypod.free.fr/

[3] See the acknowledgment section 5.

| good + +<br>weak - - | Precision | Scale | Speed | Setting | Experiments | Specificities of images |
|---|---|---|---|---|---|---|
| Bigu'96 [5] | - | no | ++ | yes | 500 | no textured |
| Chen'03 [6] | - | no | + | yes | 50 | large |
| Baud'08 [2] | ++ | no | - - | yes | 68 | none |
| Dela'08 [8] | + | no | - | no | 2048 | none |

**Table 2. Comparison of CBIR systems**

## 2 CBIR systems

The first step, to identify the blocks, is to retrieve similar printings (i.e. ornament images produced by a same, or a duplicated, block). This task relates both to CBIR and image comparison fields. Indeed, two images must be compared with great precision to identify if they have been produced by a same block. The major difficulty, when dealing with the image comparison, is time complexity. This makes impossible to employ it within a CBIR system due to the number of comparison to perform. To solve this problem, the proposed systems to date for the retrieval of ornaments employ specific techniques to reduce time complexity [2, 5, 6, 8]. We will present and discuss all of them in this section. In addition to that, to support the discussion we compare these systems in Table 2 according to different criteria: speed and precision, is the comparison scale invariant, if the system needs a prior setting, number of images used for experiments and specificities of images to process.

In [5] the authors propose a system for the retrieval of fleuron ornament images. This system is implemented in the Passe-Partout portal[4] [7], that provides a web access to different databases of ornaments. Because the fleuron images are mainly composed of curvilinear lines, the authors employ orientation signatures to describe the images. The Figure 3. illustrates their approach.

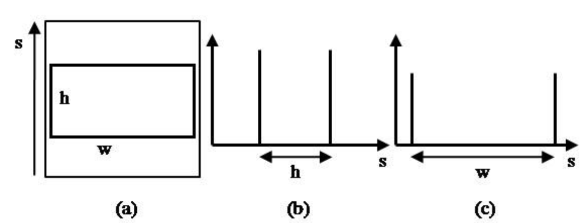


**Figure 3. Orientation radiogram of [5]**
(a) image (b)(c) radiograms 0°, 90°

For each pixel of an image Figure 3. (a), a linear symmetry vector is computed. In geometrical terms, this vector

[4] http://www2.unil.ch/BCUTodai/

corresponds to optimal straight-line fitted to the local power spectrum. Its orientation gives the dominant orientation of the local neighborhood. The obtained vectors are next used to build orientation images in predefined directions. Radiograms are obtained by projecting the corresponding orientation images along their pass orientations. Figures 3. (b) (c) gives examples of radiograms computed from the image (a). Fourier coefficients are next computed for each radiogram. The coefficient vectors are compared with an Euclidean distance to obtain similarity measures between the corresponding radiograms. This process is fast enough to be run online on large databases[5]. Its drawback is the scaling invariance. Symmetry vectors are obtained by local computation involving to use images at a same resolution level (around 200 dpi in Passe-Partout[4]). Another drawback is the specificity of the radiograms to fleuron ornaments. As an example, straight-lines are difficult to detect within images of initials, mainly composed of textures.

The system of [6] is employed for the retrieval of emblem images. In order to reduce the time processing of such a comparison, this system works with points of interest extracted from images. The global score of similarity will correspond to the number of similar points between two images, using feature vectors computed locally. The points are first extracted using a modified Harris detector. Then, Zernike moments are computed locally from each of them. These moments are compared using a maximum likelihood estimation and a $T$ threshold i.e. when the estimation does not overflow $T$ the two points match. To limit the number of comparisons, only the points having near coordinates (with a precision of 5 pixels) are compared. Figure 4 gives an example of retrieval result (b) using the query (a).

(a) (b)

**Figure 4. Example of retrieval result of [6]**
(a) query image (b) $2^{nd}$, $4^{th}$ and $6^{th}$ results

Like this, this method reduces the whole complexity of comparison by considering only some points of interest. However, it is not scale invariant. Local templates are used at different steps of the process (with the Harris detector, to compute the Zernike moments and to compare point coordinates). Another problem of this method is the complexity of comparison. When the number of points becomes important, it could take time to match them together. At last, retrieval precision will depend a lot on the stability of detected points. As an example, smallest images will have less stable points. This makes the method more adapted to big ornament images, like emblems.

In [2] the authors propose an alternative approach to the previous ones. In order to make their retrieval process accurate, they use the full pixel information to compare images. However, to address the complexity problem related to such a comparison, they employ a multi resolution approach. The multi-resolution permits them to reduce the whole complexity of their process by reducing image sizes. A scaling factor (from $\frac{1}{1}$ to $\frac{1}{16}$) is determined in a semi-automatic way by an human expert, according to some training results obtained on the image corpus. The scaled images are next compared using a Hausdorff distance computed locally. This local measure results in a local-dissimilarity map including the dissimilarity spatial layout, and can be achieved within a linear complexity. In a last step, the authors employ a classification step based on a Support Vector Machine classifier to compute similarity scores between images. Figure 5 gives an example of computed local-dissimilarity map[6] (c) from two images.

(a) (b) (c)

**Figure 5. Local-dissimilarity map of [2]**
(a) image 1 (b) image 2 (c) dissimilarity map

The main characteristic of the method is a comparison of images without any feature extraction, a high precision is obtained about image differences. On the other hand, the method increases computation times and can't be used online. Scalability of the method is unknown as it is not tested on large database. The last point concerns scale invariance. As scale variations are not taken into account, variations in resolution will mislead the classification.

The authors in [8] employ also pixel information to compare the images. However, they propose to address the complexity by using a Run Length Encoding (RLE) of images. RLE encodes successive pixels of same intensity into a single object as illustrated Figure 6. (a). It is a lossless compression technic, but working from binary versions of images. In their experiments, they obtain a mean compression rate of $0.88$ on a database of initials. This reduces therefore the needed time for retrieval. Figure 6. (b) gives some examples of compression rates. RLE is used in a retrieval process working in two steps: centering and comparison. The centering computes $d_x$ $d_y$ offsets to align two images together, to make more accurate their comparison. The comparison next computes a distance between the two images

[5] The system can be tested from the Passe-Partout website[4].

[6] The bright parts correspond to low distances.

based on the common number of pixels detected in RLE, exploiting a specific algorithm.

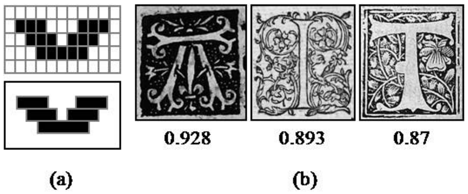


**Figure 6. Compression based retrieval of [8]**
(a) RLE (b) Some compression rates

The approach looks promising. The precision of retrieval seems quite good, through the RLE images are compared at a pixel level. In addition, the system is full automatic and employs none predefined setting to perform comparisons. However, distance between images is obtained with a simple pixel to pixel comparison, which is less accurate than the approach proposed in [2]. In the other side, processing times seem much more better, but they are still too long to use this system online. It can still be used off-line to index large scale databases within a reasonable time, which is already an interesting contribution. Another problem related to this approach is the scale invariance. It doesn't work with different resolution images.

## 3 Visual Comparison

Once similar images have been retrieved, the next step is to identify if printings come from a same block, and to make a relative dating. This task can not be achieved automatically, due to the need of contextual information (about paper, ink, degradation level of printings, etc.). However, it can be difficult for historians to notice visually the relevant differences between images (Figure 2). They could be helped in with automatic methods of image difference visualization [1, 3, 4]. These methods employ a two-steps process: a) images registration, b) difference visualization. None of the proposed contributions to date [1, 3, 4] studies deeply each of these two steps.

The system of Van Beusekom and al [4] is more focused on image registration. It is based on detection of interest points (centers of connected components), following by an affine deformation parameter optimization. It seems adapted to textual images. However, ancient ornaments studied here are small-size and textured images, with a strong information density. Online evaluations[7] show the failure of this method on some ornaments to be registered (Figure 7). Indeed, connected components of such dense images have often no signification, and then the extracted interest points are not reliable in this case.

**Figure 7. Ornament registration of [4]**

In [1, 3], the authors used a standard registration method, based on the equivalent ellipse computation thanks to the first image moments. This step is not well detailed in their papers [1, 3], where the visualization evaluation is made on pre-registered images. However, this method is well-known to be a few accurate, particularly for homogeneous images (where the ellipse is near to the circle).

Concerning difference visualisation, Van Beusekom and al [4] use a (simple) colored Pixel-to-Pixel Difference Map (PPDMap). In [1, 3], the authors show that the PPDMap is very sensible to perturbations (i.e. time degradations of paper pages, difference of digitization plate-forms, difference of pre-processing chains, etc.) and yields false alarms that hide the pertinent differences. They propose a visualization method based on a local Hausdorff-distance, resulting in a Local-Dissimilarity Map (LDMap) between images. They evaluate the correlation between the dissimilarities values in the LDMap, and regions of interest annotated by historians. It shows that the LDMap values reflect, only in part, the historian annotations. But the visualization purpose is to show to users all relevant differences in images, even those that are not visually noticeable.

In the frame of ornaments visual comparison, an interesting method has been developed for the step of difference visualization [1, 3], but it follows a registration step that is still problematic for nowadays methods [4]. Registration remains an open problem for visual comparison.

## 4 Open Discussions and Conclusions

This section reports discussions undertaken during the one-day international workshop held in 2007[8], arising from this overview. Today, several image databases of ornaments are available on the web and will continue to grow. The key problem is to index these images, it is almost impossible to do it manually today due to the masses of data available. CBIR systems, and methods of image difference visualization, are the key components to do it. However, their development is a challenging task due to different open problems discussed in this overview. Promising approaches have been proposed to date, but one has to admit that no system works

[7] http://demo.iupr.org/bruno/bruno.php

[8] See the acknowledgment section 5.

on heterogeneous and large size databases, with a reasonable time and a good precision. Thus, more researches have to be done, we present here some recommendations for future work resulting of our discussions.

Starting the hypothesis of a Digital Library using ready-to-use automatic retrieval and visualization systems, it seems a crucial issue in the future to design an architecture using two types of databases. A source database will contain the digitized images and the automated metadata. The ornament thesaurus will describe each image with metadata validated and controlled by human experts. In both cases these databases should be readable/writable from Internet for general users and experts, exploiting collaborative web platforms with control accesses.

CBIR systems are the components of utmost importance today, to help in indexing of ornament databases. It is an harder task, due to the required precision and the complexity needed for image comparison. Several issues have been explored in the literature including orientation signatures [5], points of interest [6], multi resolution & robust image comparison [2] and image comparison using compressed representations [8]. All these systems present tradeoffs between complexity and precision, and some of them could be dedicated to particular image corpora. In addition, none of methods is scale invariant. This constitutes a strong limitation, as resolutions of digitized images could vary a lot in digital libraries. However, invariant methods have been already in other application domains, resulting of an additional complexity impossible to integrate in a CBIR problematic. In all the cases, the lack of evaluation of these systems makes difficult the choice of a best-suited approach. Classification results have been proposed only in [2], and time experiments in [8]. Thus, one of the upcoming tasks for the research community will be to work on performance evaluation. Test databases of ornaments, with corresponding groundtruth, must be constituted and make available for future researches. This work must result in collaborative actions between historians and computer science people. Despite this direction, it seems already mandatory today to think about other ways of developing fast and accurate systems. Such systems will certainly require to use hierarchical approaches, combining high-level signatures (to limit the space solution) and low-level descriptions (for accurate comparison).

The visual comparison is a crucial point for the historians and automated comparison can help it. Nevertheless, even if some methods can produce visual comparison that highlights pertinent differences (for the historians), the visual comparison rests on a precise registration. For small, noisy, dense and textured images such as ornaments, the proposed methods seem inaccurate. Moreover, a fine registration which can be linear or non-linear, does not seem reachable soon. So we propose a user semi-supervised registration, e.g. based on the interest-point designation by the users. Even in this frame, the choice of the deformation space will require a lot of attention: it should fit the real-world deformations. This semi-supervised step offers an important challenge to raise the interest of automated visual comparison.

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