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Stamp detection in scanned documents

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Abstract – The article presents current challenges in stamp detection problem. It is a crucial topic these days since more and more traditional paper documents are being scanned in order to be archived, sent through the net or just printed. Moreover, an electronic version of paper document stored on a hard drive can be taken as forensic evidence of possible crime. The main purpose of the method presented in the paper is to detect, localize and segment stamps (imprints) from the scanned document. The problem is not trivial since there is no such thing like „stamp standard". There are many variations in size, shape, complexity and ink color. It should be remembered that the scanned document may be degraded in quality and the stamp can be placed on a relatively complicated background. The algorithm consists of several steps: color segmentation and pixel classification, regular shapes detection, candidates segmentation and verification. The paper includes also the initial results of selected experiments on real documents having different types of stamps.

1 Introduction

From the strictly technical point of view, rubber stamping, also called stamping, is a craft in which certain type of ink made of dye or pigment is applied to an image or pattern that has been carved, molded, laser engraved or vulcanized, onto a sheet of rubber. The ink coated rubberstamp is then pressed onto a type of medium such that the colored image has now been transferred to the medium. The medium is generally a

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type of fabric or paper. This kind of stamping has not changed for centuries (in fact it is as old as writing itself) and it is supposed that it will not change in the close future.

Nowadays, when computer technology is present in various areas of life, the problem of computer crime is becoming more and more important. It covers both strictly electronic and traditional types of law-breaking. On the other hand, there are still many areas of life, where computers and digital media are employed only as tools and play just a supporting role. The most evident example of such domain is an area associated with official documents, identity cards, formal letters, certificates, etc. All these documents are being issued by formal authorities and are often in a form of a paper letter consisting of several typical elements: heading, body text, signatures and stamps which, from this historical point of view confirm its official character. In business environments, they are often used to provide supplemental information (date received/approved, etc). In other words, its main purpose is to authenticate a document which in many cases is a subject to forgery or tampering with help of modern computer means. In general, the process of forgery consists of the following steps: obtaining the original document, high resolution scanning, digital image manipulation and final printing. It is rather easy to recognize fake stamps, even if they are printed using ink-jet printers. This article addresses the problem, which is definitely not new, since the task of seal imprint identification on bank checks, envelopes, and transaction receipts have emerged from mid-1980s. On the other hand, reliable recognizing stamps in the documents is not trivial and has not been solved so far [1–3]. The most advanced method found in the scientific literature is described in [1], where the authors present a stamp detection approach, which treats stamps as regions with analytically shaped contours, however, these regions are limited to oval shapes only.

The general motivation of the research presented in this paper is a need of semi-automatic computer software that is able to analyze an image as wellas detect and localize different types of stamps in it. The application area of this kind of a system is broad, ranging form law-enforcement forces, law offices, official archives and any other stamp utilizing institutions.

2 Stamp characteristics

All stamps placed on paper documents have specific characteristics which are derived from the process of stamping, These characteristics (shape, complexity, typical patterns) evolved into de-facto standards. The analysis of the problem shows that there are two main groups of stamps having its distinguishable properties:

- official stamps mostly found on official documents,
- unofficial stamps used as decoration.

The first group (see Fig. 1) consists of regularly-shaped objects (ovals, squares, rectangles) with clearly visible text and mere ornaments. They are often coloured red or blue and do not cover large areas. On the other hand, the stamps in the second group (see Fig. 2) are more fancy, irregularly-shaped, with decorative fonts and complex patterns.

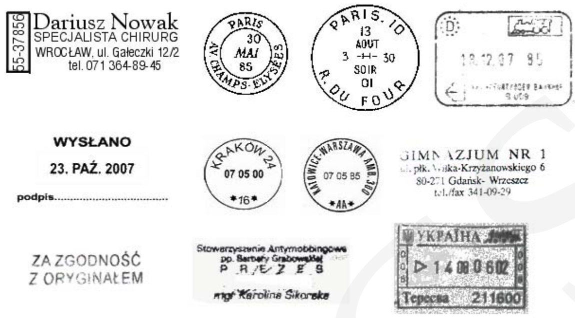

Fig. 1. Examplary official stamps.

Fig. 2. Examplary unofficial stamps.

This is a fundamental issue to define the features that can be employed to distinguish stamps from not-stamps and further between official and unofficial stamps. In this paper we focus on official stamps as they play a meaningful role in practical tasks.

The features which are used to describe stamps can be divided into two classes:

- spatial characteristics [5–8], including dimensions (proportions of dimensions), edge distributions, mean and variance of gradients, moment representation,
- colour characteristics [9, 10], which include colour distribution in HSV and YCbCr colour spaces.

Besides these features it is always profitable to use stamp templates (as simplified images) to verify the detection and recognition stage. It is worth noticing that we do not employ Hough transform [1] to detect circles, since we deal also with rectangular stamps.

3 Algorithm overview

The algorithm of processing is divided into two parts. The first one is associated with the learning stage, which is performed in the offline manner. Its main purpose is to obtain colour information related to the specific documents and stamps being used. It can also be used to collect stamp templates for verification purposes. The second portion of a system – actual working stage – performs the detection, localization and initial classification. Both stages are presented in Fig. 3. Detailed description of each block is presented below.

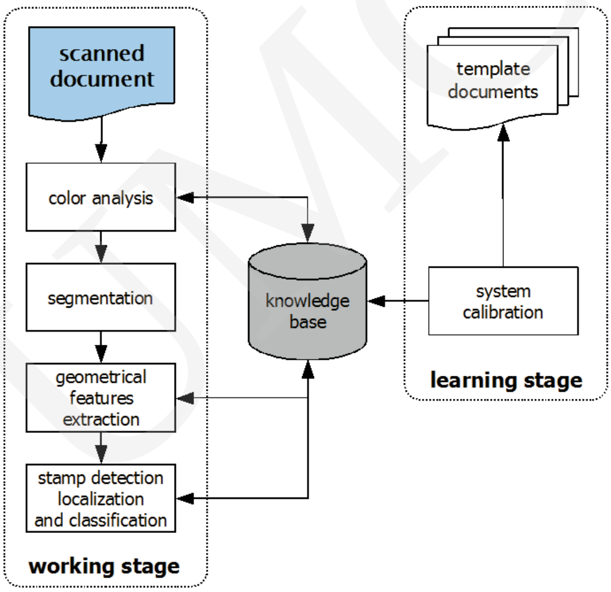

Fig. 3. General scheme of a system for stamp detection.

An input image has to be stored in a file with possibly lossless compression, high spatial resolution and full colour range (24bit RGB). First, it is down-scaled to obtain low resolution representation (256 x 256 pixels) used for preliminary detection. For the most popular red coloured stamps, the RGB image is then converted into YCbCr colour space. For a matrix which represents Cr channel we perform projections in horizontal and vertical directions. Sample projections for one of the test images are presented below, in Fig. 4. As it can be seen, the areas occupied by possible stamps are represented by the values higher than mean value (assumed to be a background value).

Next, the candidates for stamps are segmented and passed to the stage where the quasi-geometrical features are calculated. There are two general features used: width to height proportion and standard deviation of pixel intensities. In the case of stamps collected for the experimental purposes, the proportion of width to height should be not less than 1/3 and not more than 3. This prevents the situation where relatively narrow objects are accepted.

The standard deviation for template stamps represented as gray-scale values from the interval <0;1> falls within the interval <0.3;0.5>, hence the test objects should meet the same requirements.

Finally, the shape verification stage is performed using the nearest neighbour classification technique employing several templates. Each shape can be approximated using one of the two classes. In the offline stage we collect templates representing different typical shapes: round and rectangular. The feature space for classification is the build using simple spectral features obtained from the power spectrum calculated by means of two-dimensional Fast Fourier Transform (2DFFT) [11]. For each template we perform 2DFFT and extract a sub-matrix of 5x5 spectral elements related to low frequency components and based on these features build a searchable features space.

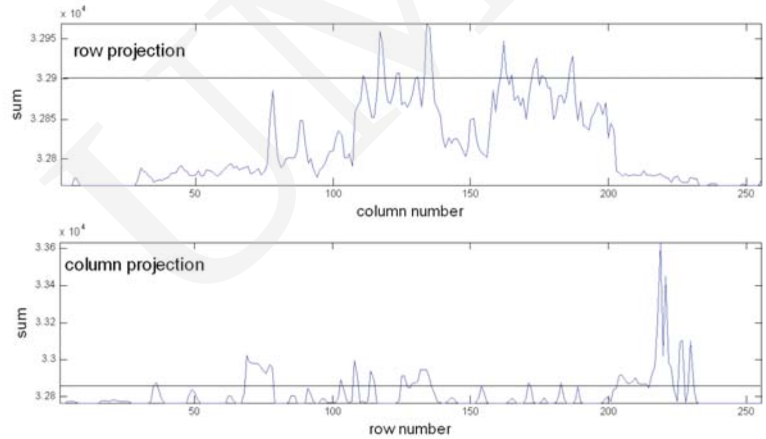

Fig. 4. Vertical (row) and horizontal (column) projections of a sample image.

In the verification stage, for each test image (which is supposed to contain a stamp) we calculate its 2DFFT spectrum and select its low-frequency components (5 elements for each dimension). Then we calculate the Euclidean distance to the center of each class and choose the class with the minimal distance. The following figure (Fig. 5) shows two examples of stamp recognition (verification). The most left image in both cases is a test image, whereas the rest five images are retrieved from the database as the most similar ones (respective distances in the feature space are shown above each image).

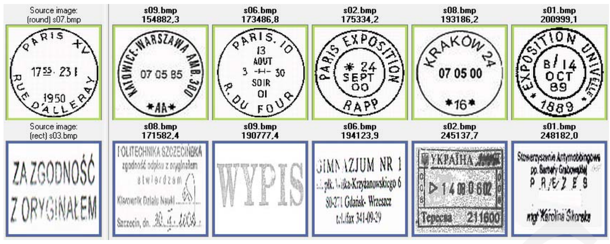

Fig. 5. Examples of similar stamp retrieval.

As it can be seen from the presented examples, round-shaped stamps are much more similar to each other than rectangular ones (distances in the first case are smaller).

The complete process of stamp detection, localization and verification is presented in Fig. 8. In this case (PhD diploma issued by Technical University of Szczecin), two potential areas are detected from which only one containing two stamps is passed to the verification/classification stage. One of the stamps was recognized as the round type, while the other was classified as the rectangular one.

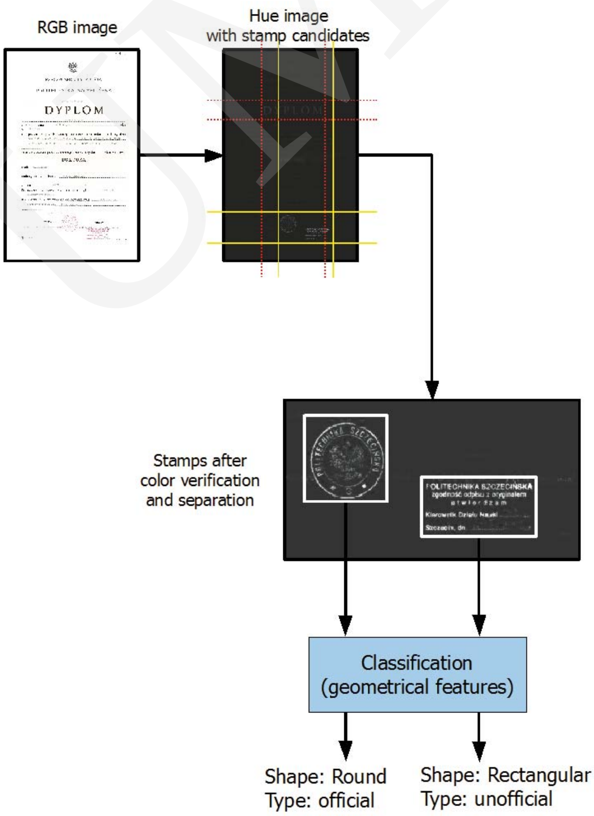

Fig. 6. Stamp detection scheme.

The process presented in the above figure can be employed to detect typical stamps that can be found in most official documents. Depending on the calibration stage, we can create knowledge base that is strictly adjusted to the documents being processed.

4 Conclusions

The developed algorithm was implemented as a working model in the MATLAB environment and tested on the images collected from different sources, including official documents from educational institutions, documents from private companies, passports and travel documents.

The ideas presented here can be employed in many different fields of digital document processing: as the input for electronic document interchange (EDI) software, in document issuing institutions, in law enforcement organizations, at the post office, etc.

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