COMPRESSION OF BANK CHEQUE IMAGES BASED ON LAYOUT KNOWLEDGE

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ABSTRACT

In this paper a scheme for bank cheque images compression based on layout knowledge is proposed. The layout structure of the cheques is analyzed and the non-essential parts are located. These parts, said, the background and the printed information are eliminated from the original image. The resulting image contains some noise that are eliminated by a filtering operation. The image is enclosed to eliminate some no informative parts. The final image has only the filled information. The digitized image can be easily reconstructed by restoring the filled information and summing it with background and printed information. The proposed compression scheme is tested by Brazilian bank cheques. Comparisons with other compression schemes, shows that the proposed scheme performs significantly better in terms of the compression efficiency, maintaining the visual quality.

1. INTRODUCTION

In Brazil, personal cheques are widely used perhaps more than cash and credit cards. According to the Brazilian Bank Association, 344 millions of bank cheques are monthly processed. After processing, the cheques are stored for legal and operational purposes. Currently, the financial institutions rely on the microfilming techniques for saving bank cheque images. Unfortunately, the information search and retrieval are slow and expensive because the operation is still performed manually. In literature we have found computer-aided compression techniques which claim good compression efficiency for document images [1-4]. These methods process bank cheques equally without considering their particular characteristics in terms of essential and non essential information. In this paper we describe our investigation on the layout characteristics of the Brazilian bank cheques, identifying the components such as background, lines, fields, printed information, position of the components, etc. Based on these characteristics we design an efficient scheme which eliminates all non-essential parts, maintaining only relevant informative parts. The digitized image can be easily reconstructed by an inverse operation similar to the above one.

The organization of this paper is as follow. Section 2 describes the analysis of the bank cheque layout structure. Section 3 describes the design of the compression scheme using the particular characteristics of the layout. The method for non-essential parts elimination is detailed in Section 4. Section 5 deals with the digitized image reconstruction. The experimental results and performance comparison with other compression schemes are presented in Section 6. Finally, conclusions are stated in the last section.

2. LAYOUT ANALYSIS

Brazilian bank cheques present a complex layout with variations in color, background patterns and stylistic characters, but all have standard size measuring approximately 171 mm by 75 mm. Each 300 dpi 8-bit digitized bank cheque may require as much as 1.8 MB memory space. Fig. 1 shows a digitized Brazilian bank cheque image.

In order to achieve the maximum compression efficiency we have studied the structure of bank cheque layout and performed a division in terms of the information characteristics. The patterns appeared on a bank cheque can be classified into four categories: *background pattern*, *fixed printed information*, *variable printed information* and *filled information*. Fig. 2 illustrates the abstract division of these information categories. *Background pattern* refers to the cheque's colored background pictures and drawings. *Fixed information* regards the financial institution's name and identification numbers, and printed lines on the cheque. *Variable printed information* consists of all information with respect to the agency and the customer's personal information on the cheque. Finally *filled information* represents the information introduced by the bank's customer, such as the worded amount, the digit amount, the date, the city's name, the payee's name and his/her signature. Note that the filled information can be either handwritten or printed by an automatic printing device such as typewriter or computer printers.

Figure 1: The image of a Brazilian bank cheque

The next section will describe how these particular characteristics of the information presented on the bank cheque are used for the design of our compression scheme.

3. THE COMPRESSION SCHEME

We have found that the fixed printed information and the background patterns are similar for every customers' cheques from the same bank. As a consequence, it is not necessary to maintain this information for every cheque. Instead, only two sample images (the fixed printed information and the background patterns), common to all cheques, should be available. On the other hand, the variable printed information should be carefully saved because it contains distinctive information of each cheque such as customer's personal information, cheque serial number and other processing codes. Finally, the filled image contains important and essential information for cheque processing. In general, the filled information require relatively small memory space. In this work, the filled information is a binary image.

A digitized bank cheque image may occupy as much as 1.8 MB memory space. Therefore, it is advisable to eliminate the redundant information, said, background patterns, fixed and variable printed which we considered redundant. This approach is perfectly plausible since all bank cheques issued by the same bank possess a common background and fixed printed information patterns. As a consequence, relatively no additional memory space is required because only one background and fixed printed information image is needed to be saved, however, can be used by every customer.

In the next section we describe with more details our proposed method for eliminating the background patterns and the printed information from the original image.

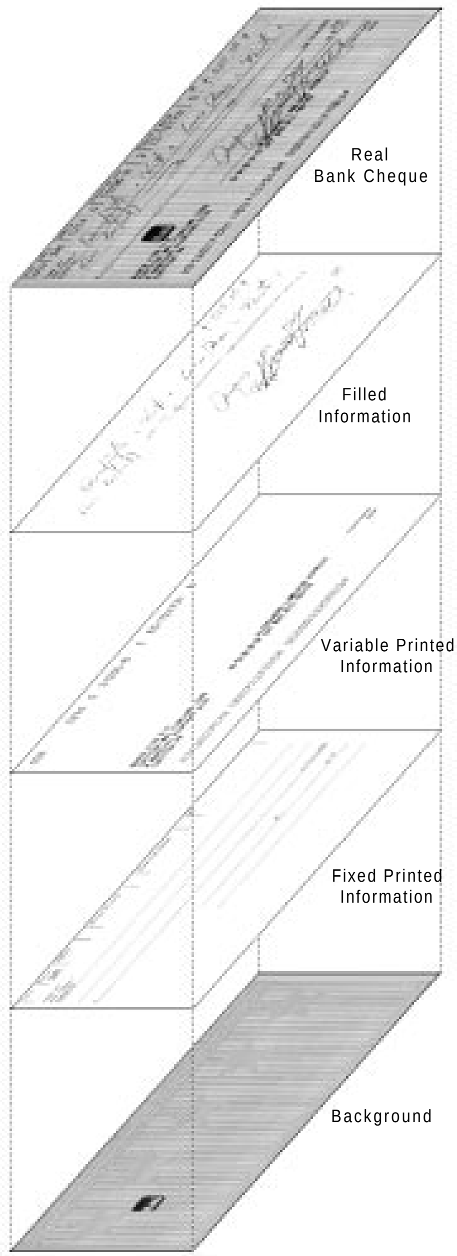

Figure 2: An abstraction of information division.

4. BACKGROUND AND PRINTED INFORMATION ELIMINATION

The background patterns and printed information elimination consists of the following operations: (a) position adjustment, (b) printed information generation, (c) subtraction operation, (d) filtering and (e) image enclosing. Next we describe each one of these modules.

Position adjustment

The position adjustment is fundamental for the success of the redundant information elimination operation. The algorithm is based on projection profiles. First we compute the vertical and horizontal projection profiles of the document image and locate the base lines. Using an adaptive algorithm, the skew correction and vertical and horizontal adjustments are performed achieving one-pixel precision.

Printed information generation

To segment the filled information from a bank cheque Yoshimura et al. [5] have suggested the subtraction of the image of an unused cheque image from the filled cheque image. A main drawback of this method is that, for each filled cheque, we have to maintain an unused cheque image sample requiring, therefore, a large amount of memory.

For each bank cheque, we generate a binary image which corresponds to the cheque image containing only the printed information (both the fixed and variable printed information), and uses it to eliminate the undesirable or redundant patterns. To generate a binary printed information image, we keep the following information in our database: position of the elements, font and size of each symbol, character and geometry object on a bank cheque. We have found that the average memory space needed for the printed information patterns is approximately 4 Kbytes.

Subtraction operation

To eliminate the background pattern from a bank cheque we subtract the stored background sample image from the real position-adjusted image, resulting in an image without background patterns. Next, we subtract this image from the generated image of printed information. Once performed the subtraction operation we have an image which contains only the filled information.

Filtering

We are rarely able to remove completely background patterns and printed information from a bank cheque image resulting in a neat image containing only the filled information. This problem is mainly due to the variations of gray levels in background information and no perfect position matches between images before the subtraction operation. Parts of the background pattern and the printed information that the algorithm fails to remove are generally characterized by isolated spots. To eliminate these residual noise we apply a morphological *erosion* operator using a 1 X 2 structuring element.

Image enclosing

The image enclosing method considered here consists of finding the smallest rectangle which is capable of covering all black pixels [6]. The size of an enclosed image containing only informative parts represents less than 8% of the original image size on the average.

5. IMAGE RECONSTRUCTION

To generate a digitized image from the stored and generated samples, we use a similar procedure applied before for redundant parts elimination. The image reconstruction consists of the following steps: (a) size restoration and (b) addition operation. Next we describe two modules that perform these two operations..

Size restoration

The size restoration corresponds the inverse processing used for image enclosing, that is, we simple restore the original size of the filled image, in order to normalize it with the other stored samples.

Addition operation

We add the stored background sample image with the filled image, resulting in an image with background patterns. Next, we add this image with the generated image of printed information. Once performed the addition operation we have an image corresponding to the original digitized bank cheque image. We have noted that the reconstructed image has the same characteristics of the real one. Fig. 3 shows the reconstructed image of a bank cheque.

6. EXPERIMENTAL RESULTS

In order to test the proposed compression scheme, two sets of experiments were conducted. In the first one we used a set of 200 real Brazilian bank cheques to perform a comparison with other compression schemes. For comparison purposes we consider the LZW scheme, the LZ77 scheme, the Huffman coding and the lossless JPEG scheme with prediction method "x". The performance factor, *compression efficiency* (CE), such as defined by Namuduri et al. [7], was used for performance comparison. The results of our comparison are shown in Table 1.

The second set of experiments considers the time-consuming involved in the compression and uncompression operations. We have performed the transmission of the compressed images files through by a 28.8 Kbytes/s link. The transmission and processing time required for these image files is summarized in Table 2.

Table 1: Comparative performance

Scheme	**CE**
Huffman	17.96
Lempel-Ziv	10.08
LZ77	17.37
JPEG 2	52.69
JPEG 5	61.52
JPEG 7	65.03
Proposed Scheme	93.78

Table 2: Average processing time (s)

Scheme	**Transm.**	**Proces.**	**Total**
Original	64.3	-	64.3
Huffman	54.2	9.4	63.6
JPEG 7	23.2	10.2	33.4
Prop. Scheme	4.6	24.7	29.3

7. CONCLUSION

In this paper we present a technique for image compression based on the document layout structure knowledge. We have analyzed the layout characteristics in order to locate and eliminate the redundant information. This approach eliminates non-essential information, maintaining only the informative parts for bank cheque storing purpose.

The performance of the proposed scheme is compared with other schemes. The choice of Brazilian bank cheques for testing the proposed scheme is merely due to the convenience. We believe that the proposed method can be applied to other cheques and documents based on preprinted forms with complex layout structure.

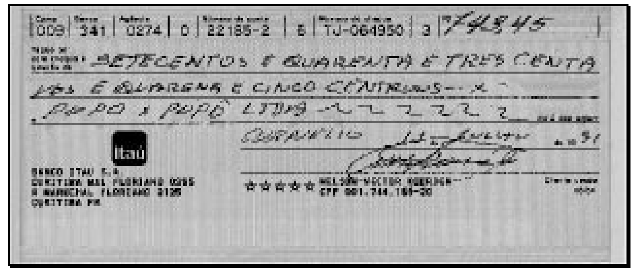

Figure 3: A reconstructed bank cheque image

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