BACKGROUND ELIMINATION IN BANK CHECKS USING GREYSCALE MORPHOLOGY

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In this paper we propose a new method of background elimination in personal bank checks to facilitate machine recognition of user entered information. One of the key problems that affect the extraction of user entered information is the wide diversity of the backgrounds of checks. They have different patterns including scenes from nature, cartoon characters and sometimes even paintings. These backgrounds add artifacts, which are picked up by the pre-processing systems and produce errors in the later stages, culminating in erroneous recognition. This method does not require a pre-stored image of a blank check to be used as a template. Instead it generates a "pseudo template" from a filled in input image which is then used as a reference to eliminate the background. The input image is subtracted from the generated reference image. The result is then separated into foreground pixels and background pixels based on a relative threshold that takes into account the magnitude of the pixels.

1 Introduction

Automatic bank check processing is an area of active research and a number of papers [1] have been published on this subject. One of the key problems that affect the extraction of handwritten information is the wide diversity of the backgrounds of checks. Most authors have assumed that checks possess simple backgrounds or that their systems will receive checks that are already binarized. But modern personal checks issued by the different banks have different patterns including scenes from nature, cartoon characters and sometimes even paintings. Simple techniques commonly in use are inadequate for the purpose. Since elimination of the background is a critical step, it will directly affect the performance of all later processes.

A number of researchers have acknowledged this problem. Lui et al [2] in their work on Canadian checks with complex background use a local thresholding in combination with edge detection. Dimauro et al [3] describe two approaches for binarization of the bank check images to remove the background: global and local. In the global approach they take into account the pixels of the entire image whereas for the local treatment it is evaluated region by region.

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The paper by Okada and Shridhar [4] deals with extraction of user entered components from personal bank checks using morphological subtraction. They use a template, which is created from a blank check prior to the processing steps. This method gives excellent results but relies on computationally complex operations for image alignment and background subtraction. Another disadvantage is that it requires a pre-stored template, which, besides being impractical, is not always available.

In this paper we propose a method that produces results comparable to the pre-stored template based approach but generates the template from the input image. The process utilized by our method is computationally less expensive and does not require any special processing to align the template and the input check before background elimination.

2 Generation of the Pseudo Template

Okada and Shridhar [4] in their work on template based background elimination use a blank check as a template. Since the blank check and the filled-in check are scanned at different times it is not possible to ensure that they are aligned with respect to each other. Scanning also introduces differing amounts of geometric distortion in each. Hence the blank check cannot be used directly to eliminate the background from the filled in check. Since the geometric distortion is assumed to be linear, an affine transform is applied to the blank check to correct it. The resulting image is then subjected to a gray-level expansion process to produce the template.

We attempt to produce this template starting from a filled-in check. This template corresponds to the check image with the user-entered information and the machine printed text removed. Two assumptions are generally made about the background that are the key to its removal.

1. The background exhibits low contrast compared to the foreground.
2. The background pixels are generally higher in magnitude compared to the foreground.

Hence to eliminate the foreground and generate the pseudo template it is sufficient to eliminate the pixels that do not conform to the above assumptions.

To achieve this the input check image was subjected to a grayscale closing operation. Closing operation consists of dilation followed by erosion (all in grayscale space). The effect of the dilation is to fill in the crevices in the grayscale terrain and expand all the peaks. This is illustrated in Figure 2.

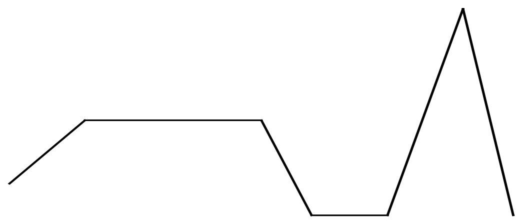


Figure 1. Cross-section of grayscale image

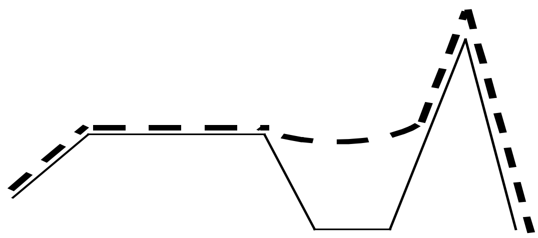
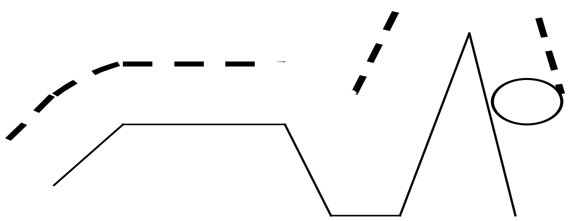


Figure 2. Grayscale dilation with a sphere



3 Detection of Foreground Pixels

Since the pseudo template is directly generated from the input check image there is no need for the computationally intensive stage for correction of geometric distortion. This also eliminates the need for an extra step for aligning both the images. This step can be achieved by applying grayscale subtraction of the check image from the pseudo template.
The closing operation would retain all the peaks in the input image and would smooth out all the depressions and crevices in the input image. The numerical difference between the template and input check image is nonzero for all points other than the local maxima points. It is maximum for points that are close to or at local minima, which are smoothed out during the closing operation.:

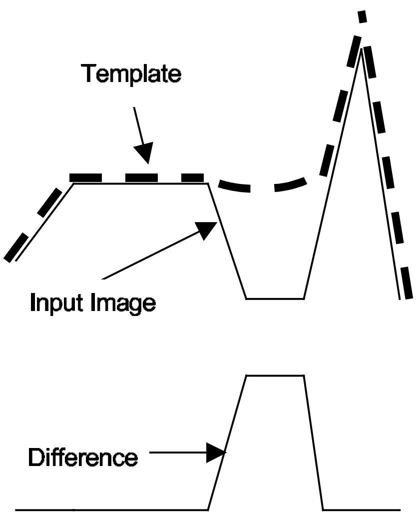


Figure 4. Difference image

Hence the magnitude of the pixels can be used as an approximate measure of confidence. The resultant image generated removes most of the background pixels. Some of them are not true foreground but are caused by variations in the intensity of pixels. Figure 4 illustrates the difference between template and the input check image.

4 Labeling of foreground pixels

The subtraction from the template results in the detection of good and bad candidates for foreground pixels. Pixels that are equal in gray level to the lowest point will be detected as foreground pixels with differing confidences because of the effect of the neighboring pixels, which affect the template. This is illustrated in Figure 5, which shows candidates produced by the detection process

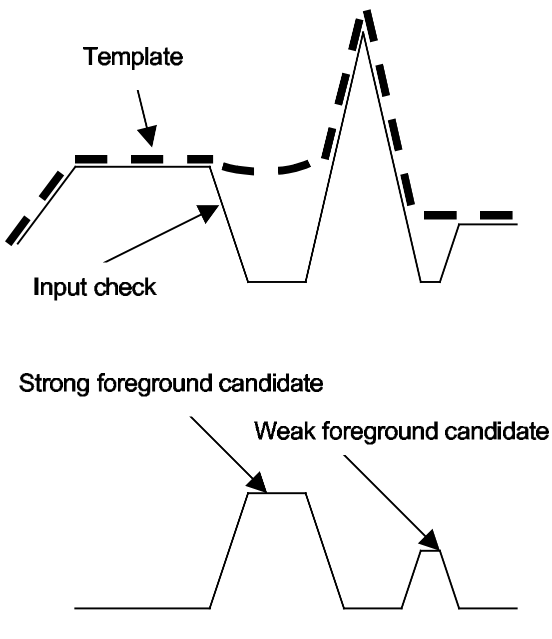


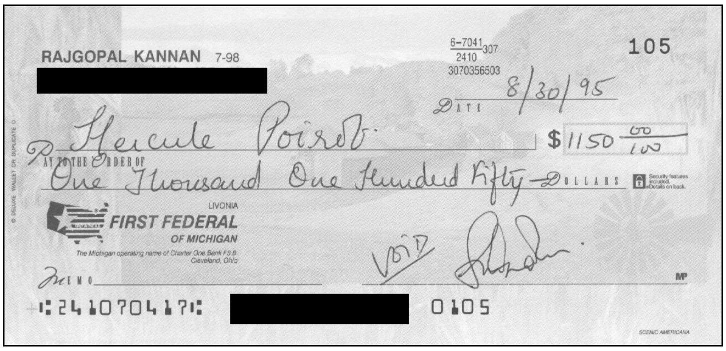
Figure 5. Foreground candidates

In order to minimize it a relative magnitude is used. The scaled magnitude of the detected pixels is the ratio of difference between the check image and the template and the pixel value of the template at that point. Since the template was calculated by the maximum of the window around the pixel there is no need to include the neighbors in the calculation.

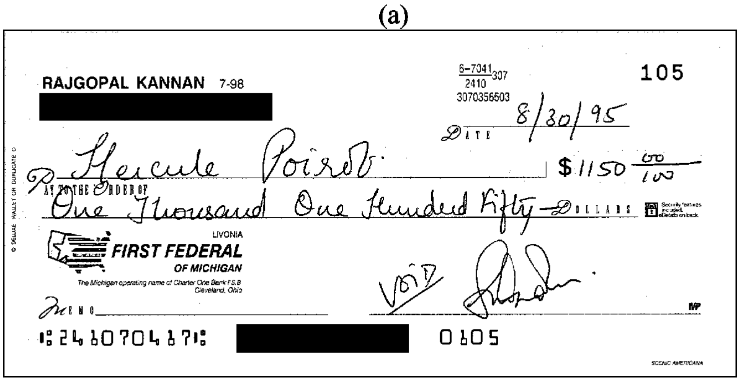
$C = \left| \dfrac{P_T - P_1}{P_T} \right|$ Where C is the relative magnitude, P_T a pixel on the template and, P_1 is the corresponding pixel on the input image

5 Experimental Results

The sample set consists of 82 different checks scanned as grayscale images at a resolution of 200 dpi. 53 were filled-in using 12 different writers who were instructed to fill each check differently and the rest were blank checks. Due to obvious reasons some of the writers insisted on filling in handwritten information that is meaningless and cannot be used for further processing. The average size of the images is 1200 x 540 pixels at 8 bits/pixel allowing 256 gray levels. Figures 6 and 7 show two checks before and after processing by the proposed method. They are representative of the good results and bad results respectively from the sample set.



(a)



(b)

Figure 6. Simple Check Image (a) Before processing (b) after processing

Figure 7. Complex Check (a) Before processing (b) after processing

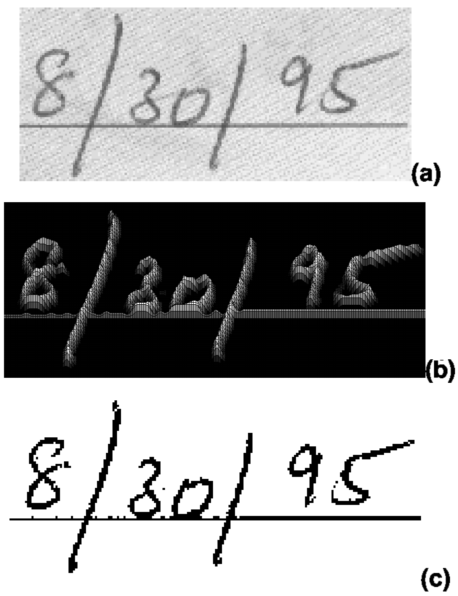


Figure 8. Simple Check Date field before processing (a) in 2D b) in 3D (c) After processing

Figures 8 (a) and (b) show the date field from the simple check image shown in figure 6 in 2D and 3D(after processing was done for clarity) respectively. Figure 8 (c) shows the same field after processing. Figures 9 (a) and (b) show the payee field from the complex check image shown in figure 9 in 2D and 3D(after processing was done for clarity) respectively. Figure 9(c) shows the same field after processing and figure 9 (d) shows the same field after binarization by global thresholding.

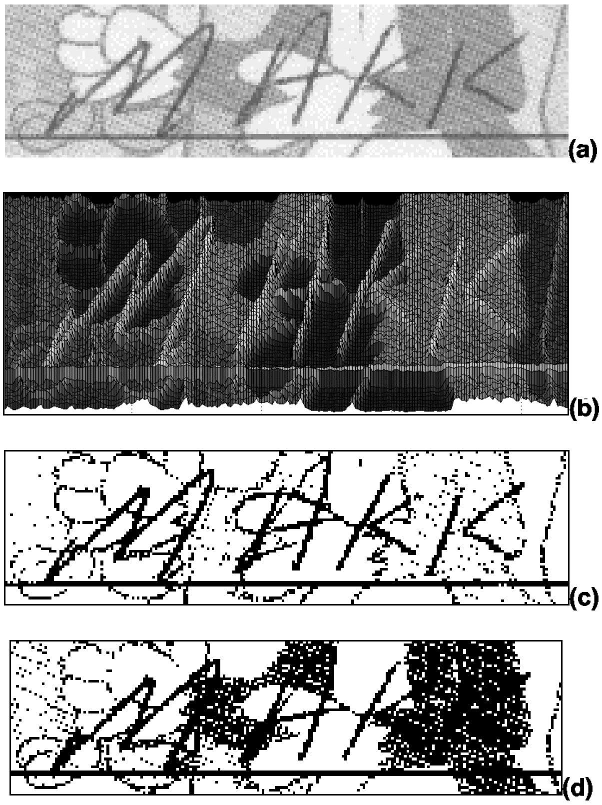


Figure 9. Complex Check payee field before processing a) in 2D b) in 3D and (c) after processing by proposed method (d) after simple binarization.

6 Conclusion

In this paper we have presented a technique for eliminating complex backgrounds from bank checks. The technique is very robust and does not require any tuning for individual checks. It has only one parameter the structuring element, which is set to a constant determined experimentally from training samples. As a result the method is very fast and produces good results for most images. In some of the images the procedure produced some artifacts as in 9. But compared to the methods like simple binarization the results are very satisfactory. The obvious areas for improvement are in speedups in the closing operation and suitable noise removal for artifacts. Work is still continuing in these directions.

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