Blind-Folded Recognition of Bank Notes on the Mobile Phone

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1. Introduction

The identification of a bank note's value is a non-trivial task for the blind and the visually impaired. A popular approach adopted by many countries in order to facilitate the visually impaired, is the impression of a high-contrast, large-print region on their bank notes. Additionally, an approach used to facilitate the blind population is the impression of unique tactile marks on bank notes. However, even when tactile marks or different sizes (e.g. Euros) are used, blind and visually impaired people have practical difficulties in identifying them.

Therefore alternative methods and products for bank note recognition were proposed [1, 2, 3]. Even though they are mobile, unfortunately these don't recognize all bills of a single currency [1], cannot easily generalize to other currencies [1, 2] or are expensive and impractical for everyday use [3].

In this talk, we introduce a novel method for bank note recognition suitable for the blind that can so far recognize the Euro, Zloty and most of the US Dollar denominations. This method combines computer vision and pattern recognition techniques; it is fully portable and runs in real time on smartphones (symbian, windows mobile and iphone) with recognition speed 0.1 seconds. Furthermore, we have designed it such that is robust under different lighting conditions, and truly accessible to the blind by providing a "trainer" that helps the blind user to position the mobile phone over the correct side of the bank note. Finally, the output is read to the user by a screen reader which is always pre-installed in the user's mobile phone.

2. Method Overview

We briefly describe the method using as an example the Euro bank note recognition. In the case of the US Dollar, Polish Zloty or other currencies, the method is or can be adjusted accordingly.

Given an input RGB image (fig. 1, left), first we convert it to an intensity image (or gray scale image). A crucial step is the use of a novel adaptive segmentation algorithm to convert the intensity image to a black and white image. This algorithm allows the recognition of the currency's value under several different lighting environments (from very bright to near dark).

The algorithm is: Given the intensity image we traverse every line in the image and compute the maxima and minima of the line's intensity poly-line. Using these we create the threshold T=(Max+Min)/2 where, Max is the average of the maxima and Min is the average of the minima. Using T we split the pixels to two groups: If I>T the pixel becomes white, if I<T the pixel becomes black, where I denotes the pixel's intensity.

Figure 1. The left column shows three different input images. The right column shows the automatic detection of the number and the recognition outcome.

From the resulting black and white image (fig. 1, right), it is relatively easy to locate the horizontal and vertical boundaries of the bank note, use them to locate the bottom left corner of the currency's value which is used to compute the number's height. Using the number's height we estimate its maximum width. The recognition of the currency's value is done by intersecting the digits using vertical scan-lines that generate a unique pattern for each digit.

Every scan-line returns one of the following patterns B (1 intersection), BWB (2 intersections), BWBWB (3 intersections) or no intersections. The patterns B, W mean that there was an intersection with black pixels or white pixels, respectively. In addition for every intersection we save the number of pixels and the y-position of intersection. A no intersection pattern means white space and signals the end of a number. In addition, we can validate the intersections and disjoint the numbers if necessary (fig. 1, rows 1, 3). The patterns for the digits *one*, *zero*, *two* and *five* (that exist in Euro bank notes) are B, BW_1B, BW_1BW_2B, BW_1BW_2B, respectively. As the digits *two* and *five* produce the same pattern, we distinguish them by comparing the white pixel areas (A) of W_1 and W_2. When $A(W_1)>A(W_2)$, then the number is *five*. When $A(W_1)<A(W_2)$, then the number is *two*. Finally we reconstruct the number from the digits.

References

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