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Efficient Logo Extraction Method using Mountain Function in Gridding Technique

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Abstract: Document processing is an important area of image processing field. The paper presents a new technique for the extraction of logo/trademark images from the documents like receipts, bills, faxes and letters. The simple technique presented uses a gridding method along with mountain function to extract the desired logo images. The technique can extract multiple logos from a document. For checking the performance of the method a new logo database has been formed. The assembled database is the first most comprehensive database present on the internet**.**

Keywords: Document Processing, Logo Detection, Logo Extraction, Mountain Function.

INTRODUCTION

In the area of image processing and computer vision, the document image processing is a very important field. In document image processing the logo/trademark recognition systems can be employed in banks, companies and organization. These systems can increase the efficiency of the departments by increasing the sorting speeds of receipts, faxes, bills and other financial documents. The recognition of the company logos can be helpful in selecting the proper category of the document. The most important step undertaken by logo recognition systems is the proper extraction of logos from the documents. Without proper extraction of the logos from the original images the recognition systems are useless. The extraction of logos from the original documents is difficult because logos are complex as compare to other image objects. Logos may contain complex structures, drawings, texts and a combination of both drawings and texts. Very little work has been done in this important area. **(Fig. 1)** shows the abstract of document sorting system.

(Seiden, *et al.,* 1997) developed a system for logo extraction which uses top-down hierarchical X-Y trees. The method uses sixteen statistical features from these segments and then ID3 algorithm (Quinlan, 1992) is applied to extract the probable logo from a document. The algorithm can perform efficiently without the constraint of any specific database or location of the logo in the document.

In the paper a new technique for logo extraction has been proposed. The technique uses mountain function along with gridding scheme to extract the desired logo. To check the performance of the system a new comprehensive logo database of 1500 images has been assembled.

Section 1 introduces the paper. Section 2 describes the Logo Detection method employed in the system. In section 3 the newly formed logo database has been discussed. Section 4 presents the recognition rates obtained by performing different tests on the logo database. Section 5 concludes the work.

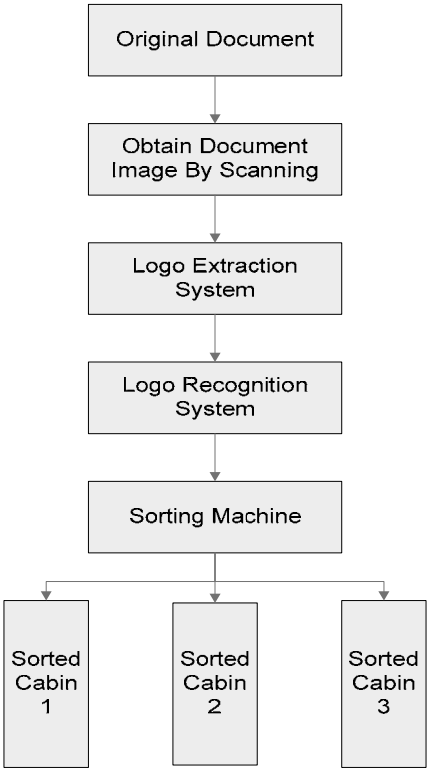

Fig. 1. Document Sorting System

MATERIAL AND METHODS

LOGO DETECTION

The logos present in a document are quite different from ordinary text. Usually the logos in the documents are more spatially compact than ordinary texts and non-logo regions. Due to their complex graphics it is relatively difficult to extract a logo from a document image. Let 'D'be the document with size IxJ, to be checked for logo presence and extraction. In the first step the binary image of the document containing logo has to be obtained. By doing this the system can differentiate between the foreground and the background area of the document image. In the paper OSTU algorithm (Otsu, 1994) has been used to obtain the binary image. The OSTU algorithm method is one of the best known methods to obtain binary images. The document containing logo is gridded to form small grid boxes of size nxm, where the total number of grid boxes is $T = \frac{I \times J}{n \times m}$,as shown in the figure. To detect any portion of the logo 'L' in any arbitrary grid box g_i , where i=[1, 2, 3, …, $\frac{I \times J}{n \times m}$] the spatial density of the grid boxes is calculated. If g_i is an arbitrary grid box and c_k is the center of the grid box, where k =[1, 2, 3, …, $\frac{I \times J}{n \times m}$] & $1 \le c_k \le$(mxn), then the spatial density of the grid box g_i can be computed around the center c_k , by using the mountain function F(c_k) (Pham, 2003) as:

$$F(c_k) = \sum_{p \in g_i \,\&\, p \neq c_k} \delta(p) \exp[-d(p, c_k)]$$

Where d(c_k ,p) is the distance between c_k and the pixel p, and $1 \le p \le$(mxn) & $p \neq c_k$. The function $\delta(p)$ is defined as:

$$\delta(p) = \begin{cases} 1 & if \quad p = active \quad pixel \\ 0 & if \quad p = background \end{cases}$$

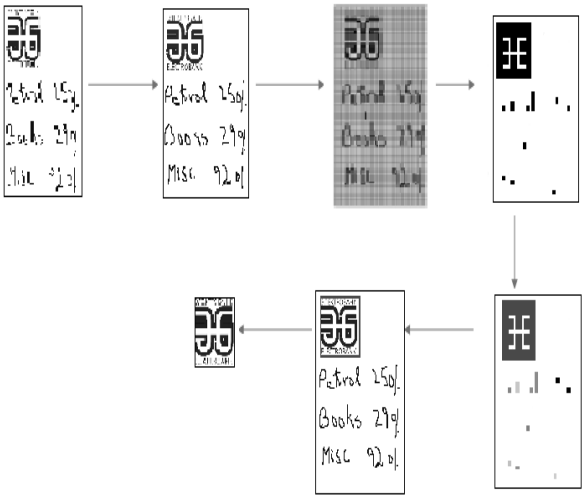

Fig. 2. Abstract of Logo Detection Model

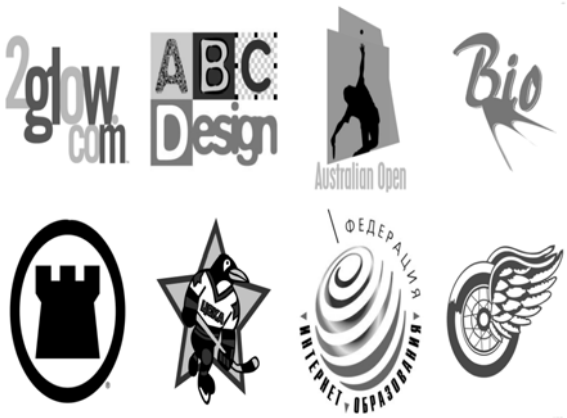

Fig. 3. Samples of Logos from FET, IIUI Logo Database.

Here the simple distance between the c_k and p, given by $d(p, c_k) = \sqrt{[x(p) - x(c_k)]^2 + [y(p) - y(c_k)]^2}$ has not been calculated in the grid box g_i , because it will

not calculate the compactness of the foreground region around the center c_k , properly. The mountain function $F(c_k)$ can find the compactness more efficiently by assigning higher weights to the pixels near to the center c_k . After calculating the mountain function of all the grid boxes, a threshold θ is applied. All the pixels of the grid box are assigned a constant value (preferably black), if the mountain function value for the grid box is greater than a specific threshold θ. If in any grid box the value of the mountain function is found below the threshold θ, the pixels of the grid box is assigned the constant value of the background (preferably white). The main objective of this threshold is to find the approximate positions of the desired logo. During the process, many locations may be detected which do not contain any part of the logo. These locations must be discarded by further processing on the document image. In the next step segmentation is performed on the document. All the grid boxes containing the logo belong to the same segment as the grid boxes with the same constant value tend to be connected. The document may contain other segments because many of the grid boxes may have higher mountain function value than the threshold θ, but they remain spatially spread in the whole document. At this point another location estimation threshold ∅ is applied by keeping in view the encountered size of the logo, present in the document. The aim of this threshold is to eliminate all false logo segments which do not belong to the original desired logo image. The segments with size less than the location estimation threshold ∅ are considered as the non-logo portions. The segments with size greater than the location estimation threshold are considered as logo/logos. It must be kept in mind that the document may contain multiple logos. In this case the system must extract all the logos in the document. **(Fig. 2)** shows the abstract of the logo detection model.

FORMATION OF FET, IIUI LOGO DATABASE

The only well known logo database available on the internet is UMD logo database (UMD, 2010), which contains single instances of 105 logs. The largest logo contains 182856 active pixels and the smallest logo has 17545 active pixels. For performing tests on the proposed system more comprehensive and huge database was required. For estimating the performance of the system a new logo database FET, IIUI, Logo Database (Naqvi, 2011) is assembled. The FET, IIUI, Logo Database is the first most comprehensive logo database available on the internet. The Logo Database contains 1500 logos/trademarks images collected from the internet. All the images are available in color PNG format. The resolution of the images is 800x800 pix which can be resized easily according to the needs. Only single instances of the logos are included in the database. The database contains all types of logos ranging from pure pictorial, pure text to mixed pictorial-text logos. All the logo images have a white background. The active area of the logos varies with smallest logo area 8954 pixels to the largest logo area 632820 pixels. For the ease of use the logo images are named as 1.png, 2.png, 3.png… 1500.png. The samples of the images are displayed **(Fig. 3)**.

RESULTS AND DISCUSSION

EXPERIMENTS

To check the performance of the method the FET, IIUI, Logo Database was used by introducing rotation, distortion, noise and inserting the logos in the documents. To place the logo images in the documents, resizing of the logos was performed. **(Table 1)** shows the statistics obtained.

Table 1. Performance of the system

Tests	Results
Test 1	96.66
Test 2	95.00
Test 3	96.53
Test 4	96.2
Test 5	95.00
Test 6	96.66
Test 7	95.33

The subsections elucidate the tests performed on the logo documents. Mostly 20x20 pixel grid size

was used. The logs were resized to different small sizes to fit in the documents.

Fig. 4. Sample Document from the Conducted Tests

Test 1: In the first test all 1500 logs were placed in blank documents. This test was conducted to test the performance of the system without posing much challenge to the system. The detection rate was recorded to be 96.66 %.

Test 2: In the second test the logos of different sizes were placed in bills, faxes and letters. In test 1 only the logo size was varied. In test 2 the size of the document containing the logo image was also varied. By inserting the logos in various sized bills, faxes and letters, more challenging environment was provided to the system for extracting the logo image. In this test the hand-written and typed objects were also present in the document. 95.00% detection rate was noted in this test.

Test 3: While scanning for processing, little rotations are commonly introduced in the documents. The logo extraction system must be robust against these rotations. To check the performance of proposed system against the logo rotation, logos were placed in blank documents after rotation. The proposed system is highly robust against the rotation of the logo in the document. To indicate its robustness the logos were rotated 0 to 360 degrees randomly, instead of few degrees. The detection rate obtained was 96.53 %.

Test 4: In test 4, the system was tested for more challenging environments. The logo images were inserted in the bills, faxes letters and receipts of various sizes, after introducing rotation of 0 to 360 degrees. The documents also contained hand-written and typed objects. The detection rate recorded in this test was 96.2 %.

Test 5: It is commonly observed that while scanning the documents little distortion may be encountered due to malfunctioning of the scanning apparatus. A good logo extraction method must have the ability to extract desired logo from these distorted documents. In test 5 the logo images were distorted before inserting them in the documents. It was seen that the system is robust to the changes introduced by the distortion. The recognition rate obtained in this test was 95.00.

Test 6: While using electronic machines the introduction of noise is a very common problem. The noise can affect the performance of any imaging system tremendously. Test 6 was performed by introducing Gaussian white noise of zero mean and 0.1 variance in the logo image. The detection rate obtained was 96.66%.

Test 7: Situations can arise where there can be more than one logo in the document. In these cases the logo extraction system must be capable of extracting both logos from the document image. In test 7 two logos of the same size were placed in the bills, letters and faxes of different sizes. In this test the extraction system was considered successful if it managed to extract both logos from the document image. The success rate in test 7 was recorded to be 95.33%

CONCLUSION

In the paper a method for extraction of logo from the documents has been proposed. The method used gridding technique along with mountain function to extract these logo images. To check the performance of the method FET, IIUI, Logo Database has been created. The database contains a variety of logo images. The performance of the method shows that the proposed technique is not only simple and easy to implement but is also robust to rotation and noise.

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