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A SIMPLE BINARY IMAGE SIMILARITY MATCHING METHOD BASED ON EXACT PIXEL MATCHING

Mikiyas Teshome[1] Legesse Zerubabel[2] Kim Dong Yoon+

School of Information and Communication Engineering,

Ajou University, Suwon Rep of Korea.

Email{mykey@ajou.ac.kr [1], legessez@ajou.ac.kr[2] }

Abstract. Similarity matching between binary images has a lot to contribute to the image processing community. In this paper we propose a simple binary image matching technique based on the position of the pixel values in the images compared. When doing so we have limited our work to images not having a rotational variance. Our method, in addition to having a very simple approach, performs well beyond some methods proposed for binary image matching.

Key words: Similarity matching, binary image, Image retrieval.

1. Introduction

Binary images are one of the simplest kinds of images in the field of image processing. For these kinds of images, shape is the most dominant feature that can be used for retrieval purposes. It is obvious that the importance of determining the similarity between objects in images has proven to be very valuable in many application areas. So far, a number of methods, some of which quite complex, have been proposed for matching the similarity between binary images. In the work of Baudrier et. al. [2], an approach for a binary image comparison without feature extraction was presented. It used the windowed husdroff distance in a pixel adaptive way. In another work, Zhang [10] makes use of a shape matching method that compares binary images by transforming them into isotropic binary images. It then compares the shape similarity of the isotropic binary images. There are also methods like Curvature scale space [3,4], Shape similarity measure based on correspondence between visual parts [7], a technique based on wavelet representation of object contours [5] and others which were used for binary image matching.

In this paper, we present a new scheme to compare binary images based on a simple pixel matching technique. Section 2 gives a detail description of the proposed approach. In sections 3 the experimental result is presented .Lastly, section 4 summarizes the work.

2. Matching Method

For two binary images, assuming that they have the same resolution and same orientation of object(s) in the images, the most intuitive way to do a similarity comparison between the images will be to do an exact pixel by

+ + corresponding author. Tel.: +82-10-6680-2632 ; fax: + 82-31-219-1834
E-mail address: dykim@ajou.ac.kr

pixel matching. It is like overlaying two shapes one on top of the other and seeing how much of the shapes fit into each other. The part of the shape that is in excess is an indicator of how dissimilar the given shapes are.

An algorithm that, somehow, does the exact same thing is implemented in order to do a similarity matching between binary images. The matching is a two way process. In the first step, the algorithm scans through the query image and takes every foreground pixel (background pixels can also be taken) value and compares this with the pixel value in the database image at the corresponding location. If it finds the same value at the same position in the database image, this will be taken as a hit count. Otherwise, it will be taken as a miss count and finally the difference of the hit and the miss count is divided by the total number of foreground pixels in the query image. The result of this division gives a number that indicates how Similar the Query image is to the Database image (SQD). In the second step, the database image is scanned and its foreground pixel elements are compared against the query image as is done in the first step. This will give us a result that indicates how Similar the Database image is to the Query image (SDQ). Then the average of the SQD and the SDQ, Average Similarity Measure (ASM), is taken as a ranking measure for the retrieval process. Higher ASM value means higher similarity. However given a query image, it might happen that for two different database images Img1 and Img2, the average similarity measure for Img1(ASM1) might be greater than the average similarity measure for Img2 (ASM2) yet Img2 is more similar to the query than Img1. In order to avoid such a scenario we will discard all those images with negative SDQ or negative SQD values no matter how big their ASM is. By doing so, we can easily avoid all the false positives and improve the retrieval rate drastically.

The methodology described above is so simple and naïve that it will regard two images like in figure-1 as totally dissimilar just because one is linearly translated. So as to avoid this problem, an object (E.g. brick) in a given binary image is first translated to the center before commencing on the matching process. To accomplish this, the distance of the object in the image from the left (WL) and from the right (WR) are measured. Similarly the distance of the object form the top (HT) and from the bottom (HB) are measured.

Fig. 1: Bricks from CE-Shape 1 MPEG database

Afterwards values which will compensate the translation to the center can be calculated. Accordingly, the Vertical and Horizontal translation (VTrans & HTrnas) are calculated using following equations.

$$\text{VTrans} = (H_T + H_B)/2$$

$$\text{HTrnas} = (W_L + W_R)/2$$

After we obtain these translation values, every foreground pixel in the image is translated horizontally either to the right or to the left by HTrans and vertically either upward or downward by VTrnas. This translation technique is applied successfully on an image of irregular shape and images containing more than one object.

Occasionally, the query image might be a scaled form of the image in the database. In order to handle scale invariance, we adopted an image interpolation technique based on mathematical morphology proposed by Ledda et. al.[1]. We preferred this method because it removes unwanted artifacts in the scaled image making the edges smoother.

Optimization

In order to reduce the feature size on which the comparison is done, the pixels in a binary image are grouped using the pattern shown in figure-2. For each group of four pixels in the figure, an index which ranges from 0 to 15 is substituted and then the similarity matching is done based on only one of these indices.

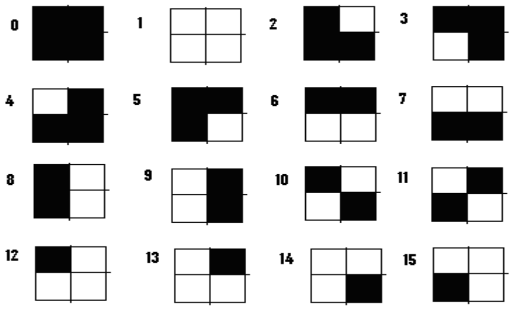

Fig. 2: Pixels grouped in four for optimization.

Considering the most frequent value in the images to be the background, the best results were obtained when the matching was done for either one of the first two pixel groups (all black or all white). However in some images the black and white pixels might be homogenously distributed which demands the matching to be done on the not fully black or on the not fully white pixel groups.

3. Experiment

Most experiments concerning binary image similarity matching are carried out on images from MPEG CE-Shape-11 database. In this database there are 1400 images with 70 classes of various shapes. In our experiment we evaluated the performance of the system for similarity based retrieval using those shape images.

As a preprocessing step, the images to be compared are first brought to the same pre specified resolution. Then the proposed similarity measure is applied as described in section 2. Using each image as a query, we counted the number of relevant images in the top 40 matches as done in [8]. In the database, the maximum number of correct matches for a single query image is 20 and the total number of correct matches for the whole process is 2800. As shown in

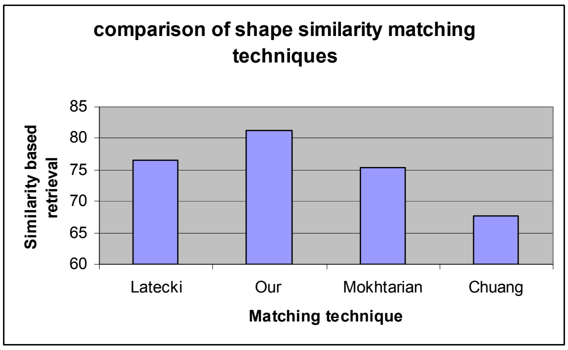

Fig. 3: Comparison with other methods.

Figure-3, our method was able to retrieve well above 2300 (82.5%) relevant images putting it above techniques like [7] which performed 76.5%, [3,4] which performed 75.4%, and [5] which performed 67.8%. However, as

[1] http://www.imageprocessingplace.com/root_files_V3/image_databases.htm

many of the natural scenes in images are where objects appear in their correct orientation, rotation invariance is not always required [6]. So, we did not take care of the situation where images might be rotated. Consequently 100 % retrieval rate was not possible as some of the images in the database are rotated.

4. Conclusion

In this work, a simple binary image similarity matching technique is presented. Experimental result showed that our approach obtains a similarity based retrieval rate of 82.5%.Whereas, Latick [7], Mokhtarian [3,4], Chuang [5] attained a retrieval rate of 76.5 %,75.4%, and 67.8% respectively. As good and simple as our approach is, it fails to detect the similarity between an image and its rotated version - which remains to be our future work. Despite this fact, the method can be applied for the retrieval of different kinds of binary images.

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