A NOVEL APPROACH FOR CBIR USING ELLIPTICAL HOUGH TRANSFORM

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ABSTRACT

In automated analysis of digital images extensive experimental work is conducted. The main objective in digital imaging is the interpretation of images. The most distinct method used is face detection. Face detection is important for several applications in face recognition. In this paper robust face detection technique such as Ellipse Hough Transform detection algorithm is implemented. This method does not require the evaluation of the tangents or curvatures of the edge contours, which are generally very sensitive to noise. No complicated mathematical computation is involved in the implementation and the required computational storage space is much cheaper .This algorithm uses a one dimensional accumulator which reduces the size of the accumulator and enables efficient storage. It also reduces computation and results in better execution time. An effective similarity measure, Bray Curtis method is proposed to compute the dissimilarity value between feature vectors of any images. The experimental results on the images results in effectiveness and robustness of the algorithm implemented. It also reveals that the strategy of distance measure outperforms the existing method of image retrieval.

KEYWORDS: *Edge detection, Shape Recognition, Elliptical Hough Transform, Similarity Measure, Content based image retrieval*

I. INTRODUCTION

The multimedia information systems involve a large number of images and videos; therefore it is essential for the accurate retrieval of multimedia contents from the database. Content Based Image Retrieval (CBIR) has many applications such as military services, architectural and geographical information. CBIR plays an important role in extracting appropriate features of the images from the database which describes their visual contents. Many researchers have been performed on the image retrieval system based on the shape. Shape based image retrieval is classified as two types, the counter based shape descriptors and region based shape descriptor. The counter based shape feature is extracted from the shape boundary points or the edges of an image such as curve corners, ellipse and line. For facial recognition the facial edge detection is considered important for image analysis.

Face detection is essential in various applications. It is pre-processing for face recognition, surveillance system and video conferencing and retrieval in content based image processing system. It is an essential aspect of image processing system. It depends on the color images, gray scale images also based on the background, rotation changes and different illumination. The edge detection is to identify areas of an image where a large change in intensity occurs. The changes are based on the physical boundary and the main purpose of the edge detection is to show a line drawing of a scene from an image of that scene. Here the important feature is extracted from the edges of an image (e.g. curves, corners and line). Mainly edge detectors are use to extract the spatial features in image processing. Edge detectors are used in pre-processing stage to obtain image points or image pixels. In some cases missing points or pixels on the desired curve is caused due to the imperfection in either image data or edge detector. These problems are addressed by Hough Transform (HT). A HT is used for the identification of lines in the image; later it was used to identify position of arbitrary shapes, circles or ellipses. The main task of a standard HT is defined as a mapping between the two dimensional image spaces and the five dimensional parameter space. The length of the major axis, minor axis, the coordinates of the centre point of the ellipse and the orientation of the major axis with respect to the x axis is considered to be the five parameter.

In the image space each data point is mapped onto specific cells of the five dimensional accumulators. The associated parameter cells are chosen so that the curve which defines these parameters passes through the data point. All the data points of the image considered and the local maxima of the accumulator correspond to the parameter of the ellipse which are detected in the image. Since the requirement for the five dimensional accumulator causes storage and computational constrains, many algorithm were considered to minimize the complexity of computations. Some of the algorithm considered was Fast Ellipse Hough Transform (FEHT), Randomized Hough Transform (RHT) and Probalisitic Hough Transform (PHT). FEHT was proposed by E.L. Zapata[1]. This method resulted in better execution time, but was affected by image noise. Xu et al[2]. argues the benefits of RHT, his papers shows the detection of line and circles. This method cannot be used for curves expressed by equation which are nonlinear with respect to parameters, which includes ellipse. Robert standard Mchaughlin[3]. compared RHT with SHT and PHT and found high accuracy in RHT but the speed of RHT was dependent on the number of edge pixels. The main contribution of this paper as follows: Extracting of elliptical edges from images by implementing EHT is proposed. The main difficulty of HT is its high computation complexity which is overcome by using EHT. The feature matching strategy is conducted between images, an effective method known as Bray Curtis is applied which is observed to be more efficient than Euclidean distance. This paper is organized as follows: Section2 provides the proposed system architecture. Section3 presents the Derivation EHT parameter and algorithm. Section4 presents Bray Curtis similarity measure to compute similarity value. Section 5 shows experimental results and performance. Section 6 provides conclusion.

II. PROPOSED SYSTEM

The query image is provided as input by online image retrieval process from the database. Features are extracted from the query images by EHT method. The detected elliptical images are superimposed onto the original image and edge mapped. After that the system measures the similarity between feature set of the query image and the image stored in database. Then based on similarity the system sorts the relevance and the result is provided.

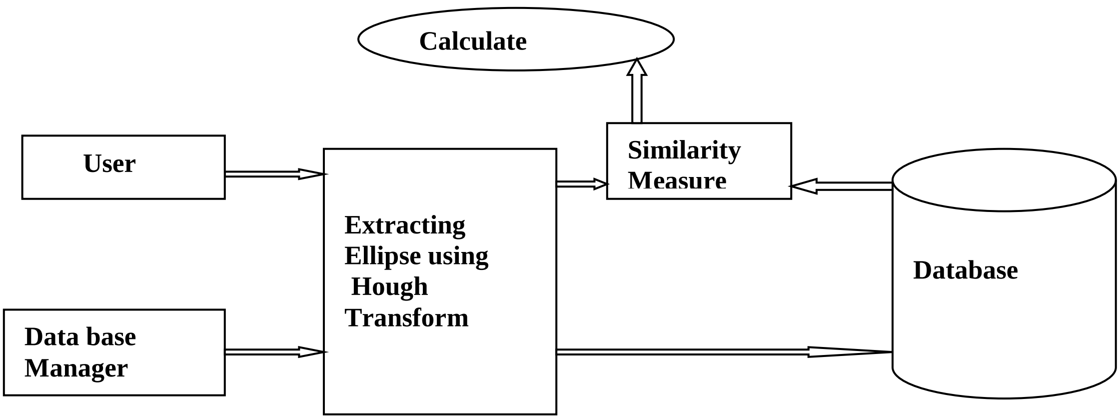

Fig 1: Block Diagram of the proposed system.

Steps involved

(1) Store all edge pixels in a one dimensional array.
(2) Clear the accumulator array.
(3) For each pixel *(x1, y1)*, carry out the following steps

(4) For each other pixel *(x2, y2)*, if the distance between *(x1, y1)* and *(x2, y2)* is greater than the required least distance for a pair of pixels to be considered then
(5) From the pair of pixels *(x1, y1)* and *(x2, y2)*, using equations (1) to (4) to calculate the center, orientation and length of major axis for the assumed ellipse.
(6) For each third pixel *(x, y)*, if the distance between *(x, y)* and *(x0, y0)* is greater than the required least distance for a pair of pixels to be considered then carry out the following steps from (7) to (9).
(7) Using equations (5) and (6) to calculate the length of minor axis.
(8) Increment the accumulator for this length of minor axis by 1.
(9) Loop until all pixels are computed for this pair of pixels.
(10) Find the maximum element in accumulator array. The related length is the possible length of minor axis for assumed ellipse. If the vote is greater than the required least number for assumed ellipse, one ellipse is detected.
(11) Output ellipse parameters.
(12) Remove the pixels on the detected ellipse from edge pixel array.
(13) Clear accumulator array.
(14) Loop until all pairs of pixels are computed.
(15) Superimpose detected ellipses on the original image.
(16) Carry out the Bray Curtis distance similarity measure for matching strategy
(17) End.

III. ELLIPSE HOUGH TRANSFORM PARAMETERS AND ALGORITHM

Consider the ellipse shown in Fig. 2a. Let point *o* be the center position of the ellipse and (o_x ,o_y) denotes the coordinates of point *o*. Let α and β be defined as the half-lengths of the major and minor axes respectively. Denote the angle, the major axis made with the *x*-axis as θ. For any arbitrary ellipse, if values of $\{o_x , o_y , \alpha, \beta, \theta\}$, then it is easy to define this ellipse.

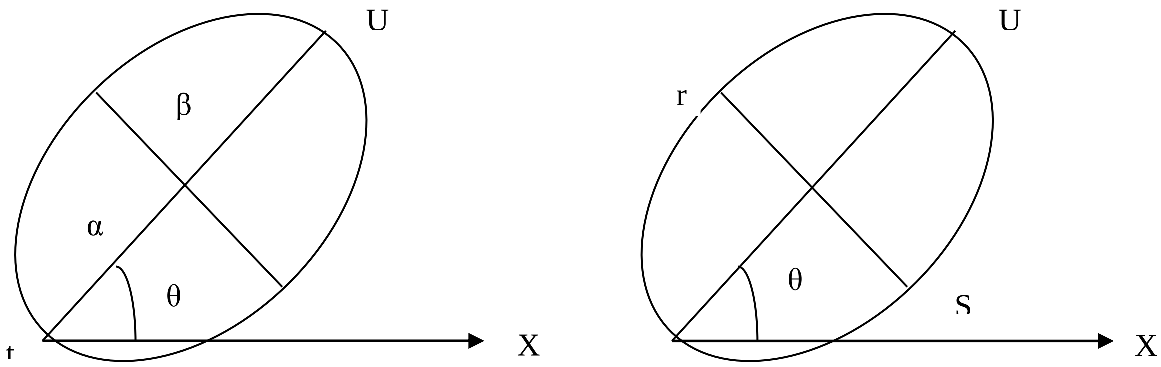

Fig. 2. a) Arbitrary ellipse in which point *o* denotes the center position of the ellipse, α and β denote the half-lengths of the major and minor axes respectively and θ defines the angle the major axis made with the *x*-axis. b) Another representation of the ellipse of Fig. 2a in which *lt,u* and *lr,s* denote the major and minor axes respectively.

Next consider the same ellipse now presented in Fig.2b. Let *lp,q* denotes a line segment whose end points are point *p* and point *q*. In this case, *lr,s* and *lt,u* denote the minor and major axes of the ellipse respectively. Suppose the edge points *t* and *u* of this ellipse is available from the image. Therefore by using (*tx, ty*) and (*ux, uy*), we will be able to derive the values of *{ox, oy, α, θ}*. Since only the half-length of the minor axis β is unknown, the remaining edge points of the image to vote for β. Consequently, only the half-length of the minor axis should be voted, hence it requires a one dimensional accumulator.

3.1 DERIVATION OF ELLIPSE PARAMETERS

Consider an arbitrary ellipse shown in Fig. 2. Denote the foci of the ellipse as points *w* and *v* and the center position of the ellipse as point *o*. Given the values of (*tx, ty*) and (*ux, uy*), we can readily derive *{ox, oy, α, θ}* as follows:

$$ox = \frac{tx+ux}{2} \tag{1}$$

$$oy = \frac{ty+uy}{2} \tag{2}$$

$$\propto = \sqrt{\frac{(ux-tx)+(uy+ty)}{2}} \tag{3}$$

$$\theta = \tan^{-1}\frac{(uy-ty)}{(ux-tx)} \tag{4}$$

Proceed to derive the half-length of the minor axis β. Let point k be an arbitrary point on the contour of the ellipse. Since points w and v are the foci of the ellipse, therefore the sum of the lengths of line segments lw,k and lk,v can be calculated by equ. (5)

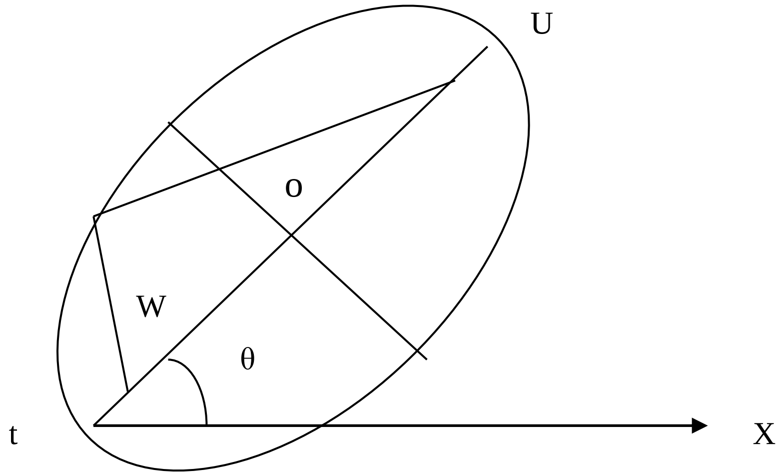

Fig. 3. a) Arbitrary ellipse in which points *w* and *v* denote the foci of the ellipse and point *o* denotes the center position of the ellipse.

$$\sqrt{(\boldsymbol{ky}-\boldsymbol{wy})^2+(\boldsymbol{kx}-\boldsymbol{wx})^2} + \sqrt{(\boldsymbol{ky}-\boldsymbol{vy})^2+(\boldsymbol{kx}-\boldsymbol{vx})^2} = \mathbf{2}\boldsymbol{\alpha} \tag{5}$$

Where

$$\boldsymbol{wx} = \boldsymbol{ox} - \cos\boldsymbol{\theta}\sqrt{\boldsymbol{\alpha}^2+\boldsymbol{\beta}^2} \tag{6}$$

$$\boldsymbol{wy} = \boldsymbol{oy} - \sin\boldsymbol{\theta}\sqrt{\boldsymbol{\alpha}^2-\boldsymbol{\beta}^2} \tag{7}$$

$$\boldsymbol{vx} = \boldsymbol{ox} + \cos\boldsymbol{\theta}\sqrt{\boldsymbol{\alpha}^2-\boldsymbol{\beta}^2} \tag{8}$$

$$\boldsymbol{vy} = \boldsymbol{oy} + \sin\boldsymbol{\theta}\sqrt{\boldsymbol{\alpha}^2-\boldsymbol{\beta}^2} \tag{9}$$

Therefore given an arbitrary point on the contour of the ellipse, can derive the value of β using eqns. (5)-(9) as follows:

$$\boldsymbol{\beta} = \sqrt{\frac{\boldsymbol{\alpha}^2\boldsymbol{\delta}^2-\boldsymbol{\alpha}^2\boldsymbol{\gamma}^2}{\sqrt{\boldsymbol{\alpha}^2-\boldsymbol{\gamma}^2}}} \tag{10}$$

where

$$\boldsymbol{\delta} = \sqrt{(\boldsymbol{ky}-\boldsymbol{oy})^2+(\boldsymbol{kx}-\boldsymbol{ox})^2} \tag{11}$$

$$\boldsymbol{\gamma} = \sin\boldsymbol{\theta}\,(\boldsymbol{ky}-\boldsymbol{oy}) + \cos\boldsymbol{\theta}\,(\boldsymbol{kx}-\boldsymbol{ox}) \tag{12}$$

ALGORITHM

1) The derivation is the fundamental of the ellipse detection algorithm.
2) First consider every pair of edge pixels of major axis of a hypothetical ellipse.
3) Calculate the values of {O_X, O_Y, α, θ } of the hypothetical ellipse using equation {1-4}.
4) The outer edge pixels are used vote one, the half length of the minor axis β of the ellipse.
5) For each hypothetical ellipse, calculate values of α and β to compute the circumference of the ellipse.
6) An ellipse is detected if the number of the edge pixel that vote for the ellipse is greater than Relative vote x
7) Circumference of ellipse, where 0< Relative min vote min ≤ 1.
8) In this aspect set Relative vote min =1 since it will give detection of an ellipse only if all the counter points of ellipse can be found.
9) In parallel implementation each slave processor investigates the feasibility of the parameter of subset of hypothetical ellipse.

IV. SIMILARITY MEASURE

Bray Curtis is an effective similarity measure which computes the similarity between images. It is considered more effective than Euclidean distance measure. In Bray Curtis method the distance provides normalized similarity value and it is evaluated as summation of the absolute difference divided by summation of the absolute addition therefore their value lie in the range [0, 1]. This results as feature with higher magnitude will not dominate with lower magnitude, whereas Euclidean similarity measure does not normalize the feature value. The feature exhibiting higher magnitude dominate feature of the lower magnitude. The Bray Curtis similarity measure is given as:

$$d_c\,(Q,D) = \frac{\sum_{i=0}^{n} fi(Q)+fi(D)}{\sum_{i=0}^{n} fi(Q)-fi(D)} \qquad (13)$$

where ***$f_i(Q)$ and $f_i(D)$ represent feature vectors of t he query and database images respectively.***

4.1 Measurement of Retrieval Performance

The evaluation test is performed using two measures i.e. (P) and (R) rates to evaluate the retrieval performance. Precision and recall are inversely proportional to each other as (P) reduces (R) increases. For the test t image we calculate precision and recall in percentage as

$$\mathbf{P} = \frac{\boldsymbol{nt}}{\boldsymbol{Tt}} \times \mathbf{100} \;\;, \;\; \mathbf{R} = \frac{\boldsymbol{nt}}{\boldsymbol{TD}} \times \mathbf{100} \qquad (14)$$

Where ***nt*** represents the number of similar images retrieved from the database. ***Tt*** represents the total number of retrieved images. ***Dt*** represents the number of images in the database similar to the test images t.

V. EXPERIMENTAL RESULTS

The main objective of the experiment is to demonstrate an effective proposed system. The experiment is performed and the solution is obtained by implementing MATLAB. This proposed system performs ellipse detection on the digital images. The edge maps for these images are extracted with the canny edge operator. Superimpose the detected ellipse onto the edge map. It is noticed that the algorithm not only correctly detects these two ellipse but also fit them with good accuracy. The similarity measure Bray Curtis method is performed in order to obtain better matching strategy in feature matching. Evaluation test is performed using two measures i.e. (P) and (R) rates. It also includes F measure and Elapsed time taken. The P and R rates are also estimated for noised images. The precision demonstrates the robustness and effectiveness of the proposed system which outperforms the conventional algorithms. The results are shown in Fig 4 and Fig 5.

INPUT IMAGES

RGB TO GREY

EDGE DETECTION

ELLIPSE HOUGH TRANSFORM

FOR DIFFERENT POSES OF INPUTS IMAGES

RGB TO GREY

EDGE DETECTION

ELLIPTICAL HOUGH TRANSFORM

Fig 4: Detection Using Ellipse Hough Transform In One Dimensional

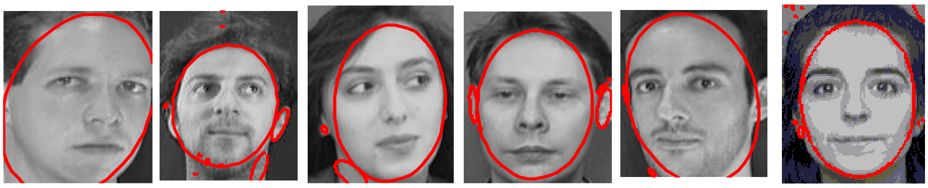

Table 1: Detection of Hough Transform

Recall	Precision	Fmeasure	Elapsed time
97.5000	98.0000	97.7494	0.114737 seconds

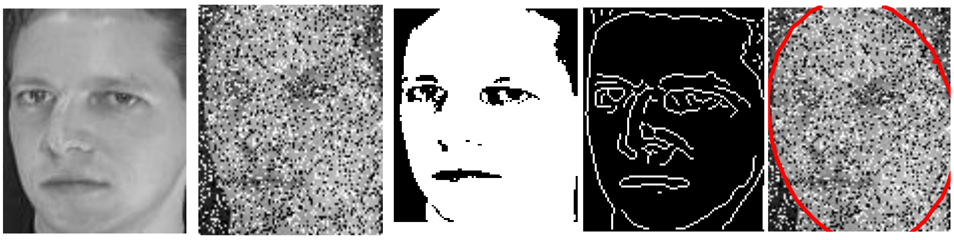

Fig 5: Noised image

Table 2: Detection of Hough Transform for noised image

Recall	Precision	Fmeasure	Elapsed time
97.5000	98.0000	97.7494	0.019258 seconds

VI. CONCLUSION AND FUTURE WORK

In this paper, the image retrieval method used is very effective than the existing method. It is implemented on the Yale data base and the method used here is elliptical hough transform. It uses one dimensional parameter this reduces the size and enables efficient storage, it also results in better execution of time compared to the ellipse hough transform based on five dimensional parameter. The similarity measure used here is Bray Curtis method which enhances the result compared to Euclidean method. The P and R rates are estimated also for noised images conclude better result. The F measure and elapsed time for the retrieval of images taken results in the robustness of the system and displays better accuracy. Table 1 & Table 2 exhibit the elliptical detection of Hough Transform. For the future work implementation of Elliptical Hough Transform on synthetic images and real time images will be taken into consideration. Furthermore the performance of Image Registration using Elliptical Hough Transform can be evaluated.

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