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A STUDY ON SHAPE SIGNATURES FOR FOURIER DESCRIPTOR

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ABSTRACT

"Visual information plays an major role in computer vision applications", because an image contains rich amount of information. In this paper, set of shape signatures that are used for shape based image retrieval by Fourier Descriptor (FD) is investigated. The shape signatures are one dimensional feature vectors extracted prior to FD is applied. The different signatures are centroid distance, area function, Angular function, Angular radius function etc. found from existing work. In addition with existing shape signatures,a new shape signature Multi-Triangle AreaRepresentation (MTAR) proposed in this paper. The experiments are conducted on MPEG-7 Dataset images. The effectiveness of MTAR is compared with existing shape signatures and observed that MTAR preserves local and global characteristics of the shape.

1. INTRODUCTION

Now days,visual information plays a major role in our society, it will play an increasingly pervasive role in our lives.Thus it provides the necessary opportunity for us to use the feature of images. The knowledge will be useless, if one can't find and use it. In the, how to search and to retrieve the images that we interested with facility is a major problem: it brings an importance for an image retrieval system. A visual feature of the images provides a description of their content. Content-based image retrieval (CBIR), shown a promising mean for retrieving images and browsing large images databases. The problem of image retrieval plays a remarkable role in the fields of analysis and pattern recognition.Increasing amount of real-world image data to be processed and stored, the development of powerful retrieval method has become a central task also in various in computer vision applications. The goal is to find similar objects from large and often distributed image collection[2]. The aim of the content-based image retrieval (CBIR) is to find similar object from the database accurately as possible.

Shape description divided into two types,region-based and boundary-based techniques. Region-based methods consider the whole area of an object. Different moments, including for example Zernike moments are popular descriptors such as circularity, eccentricity, convexity, principle axis ratio, circular variance and elliptic variance. Here only boundary based image retrieval technique is used for retrieving images from dataset images. In CBIR systems, one of the issue is to answer the questions.' Which of the database images contain the most similar shapes to the query image?' This method of image retrieval is called shape similarity-based retrieval. In this kind of image retrieval, the aim is to find similar shapes from the database as accurately as possible. On the other hand, the classification accuracy (effectiveness) of a descriptor is not an adequate measure for its usefulness in the retrieval of images. Becauseofthe increasing number of on-line retrieval solutions. In retrieval, the computational efficiency of a particular descriptor is generally dependent on two issues: dimensionality and matching procedure. A recently introduced multimedia standard, MPEG-7, has set several principles are good retrieval accuracy, compact features, general application, low computational complexity, robust retrieval performance and hierarchical course to fine representation. These principles were used as criteria in the study of Zang and Lu, in which common shape - description techniques were reviewed [7]. Another review of the art in shape description techniques, here Fourier descriptor is used as a descriptor for retrieval of images.

2. RELATED WORKS

Shape is the most important feature for recognition of objects in an image. There are two classes of techniques in shape based retrieval systems. Region based techniques and boundary based techniques. A region based technique uses whole shape region but a boundary based technique only uses boundary points of shapes in feature vector extraction. Region based techniques often involve intensivecomputations and fail to distinguish between objects that are similar. Thus boundary based techniques are more efficient than region based techniques. Several number of techniques have presented that are based on boundary of shapes.

Curvature scale space image:

*SadeghAbbasi*proposed that *Curvature* scale space (CSS) image representation along with a small number of global parameters is used for this purpose [13]. The CSS image consistsof several arch-shape contours representing the inflection points of the shape as it is smoothed. The maxima of these contours are used to represent a shape. In this method shape retrieval is efficient, but it has some problems when mirror image comes in database.

Shape Retrieval Using Fourier Descriptorswith Different Shape Signatures:

In this work,Dengsheng Zhang and Guojun Lu, they build a Javaretrieval framework to compare shape retrieval usingFDs derived from different signatures [5]. Commonissues and techniques for shape representation andnormalization are also analyzed in the paper.Fourier transformation on shape signatures iswidely used for shape analysis,there are also somerecent attempts to exploit it for shape retrieval.Before applying Fourier transform on the shapesignature, shape is first sampled to fix number ofpoints theshape boundary or the shape signature of objects andmodels must be sampled to have the same number ofdata points. A smaller number ofsampled points reduce the accuracy of the matchingresults, but improves the computational efficiency.

Affine Invariant Feature Extraction for Optical Recognition:

Melody Z.W. Liao, Ling Wei, W.F. Chen in Affine invariant features of images, named the new polar normalized histogram (NPNH) [6].The feature of an image is extracted from a polar histogram bins originating from centroid of the mass to all other points in it with 5 bins for r and 24 bins for T.However, the traditional normalization is rotation variant since it normalizes the image only on two directions:vertical and horizontal. Thus the normalization of the image with different divergences on two directions is different from the normalization of its rotation. The NPNH is a simple, affine invariant and powerful distance in object recognition.

Affine Invariant Ring Fourier Descriptors

In this work, **San-San Li, Yong-Dong Huang, Jian-Wei Yang**proposeda region-based Affine InvariantRing Fourier Descriptor (AIRFD) is put forward to extract affine invariant features [14]. A set of affine invariant closed curvesis constructed from the object. Prior to the extraction of features, the derived closed curves are parameterized to establish a one-to-one correspondence between points on the original closed curves and points on the closed curves of theiraffine transformed version. Consequently, these closed curvesare put on the image of the image, and pixels on these closedcurves are derived.It is efficient and used for shape classification.

Application of affine invariant Fourier descriptor:

P. Lionel EvinaEkombo, NoureddineEnnahnahi, Mohammed Oumsis, Mohammed Meknassiworked onContour-based descriptors are among the main approaches in content based image retrieval [15]. Most of these descriptors arebased on Fourier transform and use various shape signatures and retrieval methods. There retrieval rates are good, and they perform generally in speeded ways. Prior to feature extraction, the shape undergoes moment-based preprocessing in order to ensure affine transformations robustness. A double signature is computed from shape radiusand specific angles. Then, compute the coefficients of Fourierdescriptors, and with a specific similarity measure we get anefficient shape retrieval performance.

3. FOURIER DESCRIPTOR

Fourier descriptor is a descriptor which is widely used in contour based image retrieval. In FD the boundary line of a two-dimensional image is presented using some one-dimensional function. In this work, we propose a method for FD in shape based image retrieval. Fourier descriptor is computationally more efficientand accurate [7].

For a given shapesignaturesaredefined by a closed curve C which is represented by a one dimensionalfunction(u (t)), called shape signature. At every time t,there is complex u (t),(0<t<T), T is the period of t. Since u (t) is periodic, we have (u (t+ nT) = u (t)). The discreteFourier transform is given by

$$a_n = \frac{1}{N}\sum_{t=0}^{N-1} r(t)e^{-\frac{j2\pi nt}{N}}$$

The coefficients *an*, *n* = 0, 1…*N*-1, are used to derive Fourier descriptors (FDs) of the shape signatures [7] as vectors..

This paper focuses on presenting the existing approaches in FD for shape-based feature extraction. Usually, result of the descriptors are in the vector form. Shape descriptors should have the following characters

- The descriptors should be completely possible to represent the content of the information about images..
- The descriptors should be represented and stored . The size of vector must not exceed too large.
- The computation of distance between descriptors should be easier; otherwise the execution will take more time..

3. SHAPE SIGNATURES:

It is common to all Fourier descriptors that the boundary line of a two-dimensional object is presented using some one-dimensional function that is shape signature. Different shape signatures have been exploited to derive FDs, however, FDs derived from different signatures can have significant different effect on the result of retrieval [7].

4.1 CENTROID DISTANCE

Centroid distance function is simple and major method, which is a simple real-valued signature that is defined as distance between the boundary points (xk,,yk) and the object centroid (xc,yc)

$$r(k) = \sqrt{(x_k - x_c)^2 + (y_k - y_c)^2} \qquad (1)$$

For k=0, 1, 2… N-1, in which N is the number of the boundary points [7][8].

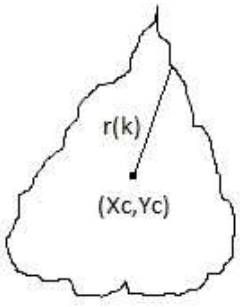

Fig 1: Illustration ofCentroid distance

4.2 Area function

An extension of this boundary function is an area function. Area function is defined as the area of the triangle formed by two boundary points and centroid in the object-centered coordinate system[7][8].

$$a\,(k) = \frac{|((x_k - x_c)(y_k + 1 - y_c)) - ((x_k + 1 - x_c)(y_k + 1 - y_c))|}{2} \qquad (2)$$

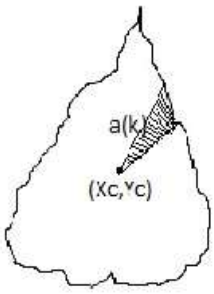

Fig 2: Illustration ofArea function

4.3 ANGULAR FUNCTION

Angular function is also real-valued signature i, which is based on the boundary curvature.This signature considers changes of directions in some boundary points of a shape [7][8].

$$\varphi(k) = arctan\frac{(y_k - y_{k-w})}{(x_k - x_{k-w})} \qquad (3)$$

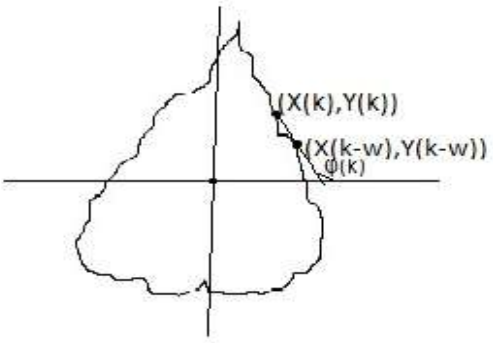

Fig 3: Illustration ofAngular function

4.4 COMPLEX COORDINATES

Complex coordinates also known as position function , which gives a point as a complex number on the complex plane[7][8]. In order to make this representation an invariant to translation, the position function is

defined as a displacement of the sample points from centroid point, such that

$$z\,(k)\ =\ (x_k - x_c) + j(y_k - y_c) \quad (4)$$

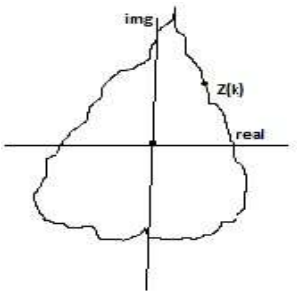

Fig 4: Illustration ofComplex Coordinates

4.5 POLAR COORDINATES

The feature vector of the signature polar coordinates at each boundary point (x_k,y_k) is a complex number. The real part is the distance between that point and the centroid point of the shape (radial distance)[7][8] is then applied in FD..

$$p\,(k)\ =\ r(k) + j\,\theta(k) \quad (5)$$

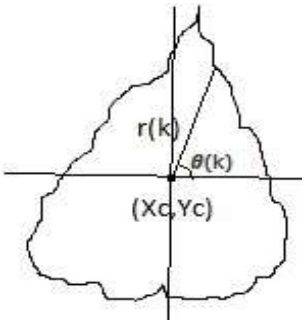

Fig 5: Illustration ofPolar Coordinates

4.6 ANGULAR RADIUS FUNCTION:

The feature vector of angular radius function at each boundary point is a complex number , that the real part is same as CD and the complex part is same as AF signature [7][8].

$$ARF(k)\ =\ r(k) + j\varphi(k) \quad (6)$$

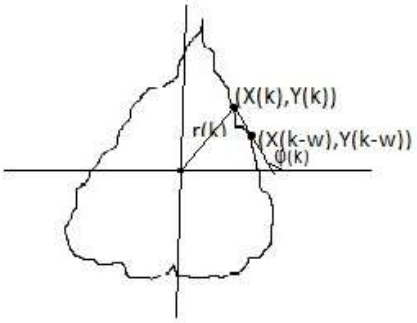

Fig 6: Illustration ofAngular radius function

4.7 MULTI TRIANGLE AREA REPRESENTATIONS(MTAR)

Multi triangle area shape signatures, In this method, an image boundary points are divided into three parts and first point of each parts are used to form triangle and also for second point and so on. Then area for each triangle is calculated using area function and then the resulting value is applied on Fourier descriptor and similarities between the images are shown.

$$\text{area} = \frac{1}{2} * \text{abs}((\text{x2} - \text{x1}) * (\text{y3} - \text{y1}) - (\text{x3} - \text{x1}) * (\text{y2} - \text{y1})) \quad (7)$$

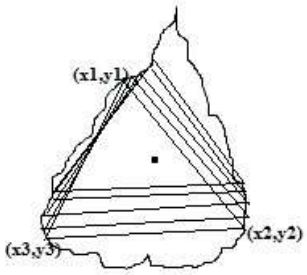

Fig 7: Illustration ofMulti Triangle Area Representation

5. DISCUSSIONS

As a kind of global shape description technique, shape analysis in transform domains takes the whole shape as the shape representation. The description scheme is designed for this representation. Unlike the spatial interrelation feature analysis, shape transform projects a shape contour or region into another domain to obtain some of its intrinsic features. For shape description, there is always a trade-o_ between accuracy and efficiency. On one hand, shape should be described as accurate as

possible; on the other hand, shape description should be as compact as possible to simplify indexing and retrieval. For a shape transform analysis algorithm, it is very flexible to accomplish a shape description with different accuracy and efficiency by choosing the number of transform coefficients.

6. CONCLUSION

In this work, we made a study and a comparison the methods of shape-based feature extraction and representation. The approaches of the feature extraction techniques were differed by their way of extraction. To make it easier the different signatures are introduced to extract the features of the image. Then the features extracted from the images are applied to Fourier descriptor and which gives a result as vectors. From this study , our proposed work considered to be have best retrieval performance when compared to other signatures. Based on the signatures, each signaturehasdifferent retrieval performance when they are compared. Each one has an efficient retrieval performance.

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