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SHAPE BASED IMAGE CLASSIFICATION USING GEOMETRIC –PROPERTIES

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Abstract - *This paper has classified shapes based on their geometrical properties. The shape properties are used to analyze the object dominant images such as area, perimeter, circularities, eccentricity, etc. In this work, the Discrete Wavelet Transform (DWT) method is used to remove the noise and compress the image. KNN (K Nearest Neighbor) classification technique is used to classify the object shapes such as square, circle, ellipse and rectangle. MPEG_7 dataset is used to evaluate the accuracy of the shape. It gives maximum accuracy for the given dataset.*

Key Words: geometrical properties, Discrete Wavelet Transform, K Nearest Neighbor, MPEG_7 dataset

1. INTRODUCTION

Digital image processing is an important area for the current scenario due to rapid growth in information technologies and World Wide Web because more images are stored in digital form. It is very important to define images in an effective way to improve automatic searching. The digital image is considered as a numerical representation of the image. The images can be collected in various ways, such as capture the image by the camera/various devices or download from websites. Image processing consists the operations such as image acquisition, segmentation, edge detection, morphological operation, feature extraction. These processes convert the original image into a digital image. This converted digital image is used to extract some information from original images, its each image pixels have particular value. It can be stored in an array format. Some of the applications of DIPs are pattern recognition, video processing microscopic imaging, image sharpening, image restoration in the medical field, remote sensing, transmission, encoding, and machine/robot vision.

Content Based Image retrieval (CBIR) is a technique where images are described by features such as color, texture, shape and combination of them. Shape is the fundamental visual features in CBIR. Various methods are discussed in its related works and are categorized into two: they are region based and content based. Content based shape techniques are used only boundary information, not considering the interior details. They include Fourier descriptor, Wavelet Transformation, Curvature scale space descriptor. Region based shape descriptor is used both boundary and interior details. Many recent research works are focused on defining new algorithms and feature extraction techniques are used to detect the shape of the objects with their properties.

This paper proposes a shape based image classification for preliminary shapes such as; square, rectangle, circle and ellipse. Geometrical properties are extracted for the preliminary shape images. KNN classifier is used to classify the given images. Classification accuracy is better than existing approaches. Section 2 elaborates on the recent research work in shape based image classification and feature extraction techniques. Section 3 provides the three types of properties; they are geometrical based shape properties, statistical based shape properties, margin based shape properties. Section 4 describes the implementation part and finally section 5 concludes the paper.

2. RELATED WORK

There are many approaches proposed based on shape based image retrieval using the Fourier descriptor and Wavelet descriptor. Xiaojun and Hongxing [1] have focused on the shape descriptor and they have specified two types of shapes such as global shape (Fourier Transformation) descriptor and local shape (Wavelet Transform) descriptor. The Gaussian fuzzy method is used to calculate the similarity measure. This method is novel and efficient to retrieve shape based objects, which is invariant to RST (Rotation, Scaling, and Translation). Woo Chaw and Seyed Hadi [2]. Have introduced the Fruits recognition system using color, shape and size feature analysis. Three combined feature analysis technique is used among various types of fruits and the final result gives 90% accuracy. Ehsan Nadernejad et al [3] have described different types of edge detection methods used to detect the objects and mainly focused to retrieve various matrices to the standard images.

Rajbhadur Yadav et al [4] have applied Fourier Descriptor (FD) and the Wavelet Descriptor (WD) technique. To find the shape feature vector value. Euclidean distance is used to measure the shape similarity. Wavelet Descriptor gives better performance compared to the Fourier Descriptor in this shape based classification they have identified in vehicular objects. In the year 2015 Cahya and Kohei [5] compared various contour extraction methods and Fourier Descriptor. EDs used to find the similarity matching between the query image and the database image. If the measured values are 0 (match to the query image) and 1(it means does not match to the query image). Shalu Gupta et al [6] have discussed various image features and they are global and local features. Feature extraction can be specified into four types of extraction such as Chord, diagonal, sub widow based, connected and nonconnected contour segment pixels. These techniques are used to extract image features. There are two classifiers used to classify the images. One is KNN and another is SVM. Finally KNN gives better accuracy than SVM.

In order to identify the object similarity matching, shape based image retrieval method is used to Rehman et al [7] in the year 2016. It gives better results in CBIR Application. Wavelet Transformation is a signal analysis method and has the advantage of multiresolution analysis. Pallavi and Megha [8] is applied this technique to face recognition and found that WT gives better accuracy. ED is used to calculate the similarity between the query image and the database image. Prochazka [9] has focused on image restoration using Wavelet Transformation. Signal decomposition includes Discrete Wavelet Transformation and Discrete Fourier Transform. Two dimensional object recognition system is determined in the year 2018 by Kamlesh Kumar et al [10].WT is applied and orthogonal functions are identified. Finally low pass filter and high pass filter are applied. It is proved that WT gives better accuracy to identify objects.

3. SHAPE BASED IMAGE RETRIEVAL

Content Based Image Retrieval (CBIR) is the application of computer vision technique to the image retrieval problem, the problem of searching digital images in a large database. The research analyses the content of the image rather than metadata such as keywords, tags or descriptions associated with the image. The term content refers to color, shape, texture or any other information that is derived from the image itself.

Some researcher has proven that the objects are noticeable based on their visual appearance/features. Among these features shape is the most important property for recognizing objects. In this section, geometrical based properties are used to extract shape representation that is invariant to translation, rotation, and scaling.

The images are collected for our work is only object dominant. Shape based properties are extracted from the original image base on geometrical properties. Region props functions are used to measure the image region properties and it recognizes the image shape. The basic image identification properties are extracted, such as area, bounding box, centroid, convex area, convex hull, convex image, circularity, eccentricity, equivalent diameter, euler number, extent, extrema, filled area, filled image, image, maxferet properties, minferet properties, major axis length, minor axis length, orientation, perimeter, pixel index list, pixel list, solidity, sub-array index. It can be considered as the feature vector values. The geometrical based feature is the powerful representation of the image shape recognition.

The black diagram of Figure 2 presented the overall shape detection such as image acquisition, preprocessing, feature extraction, feature vector generation, classification and shape detection which are given below

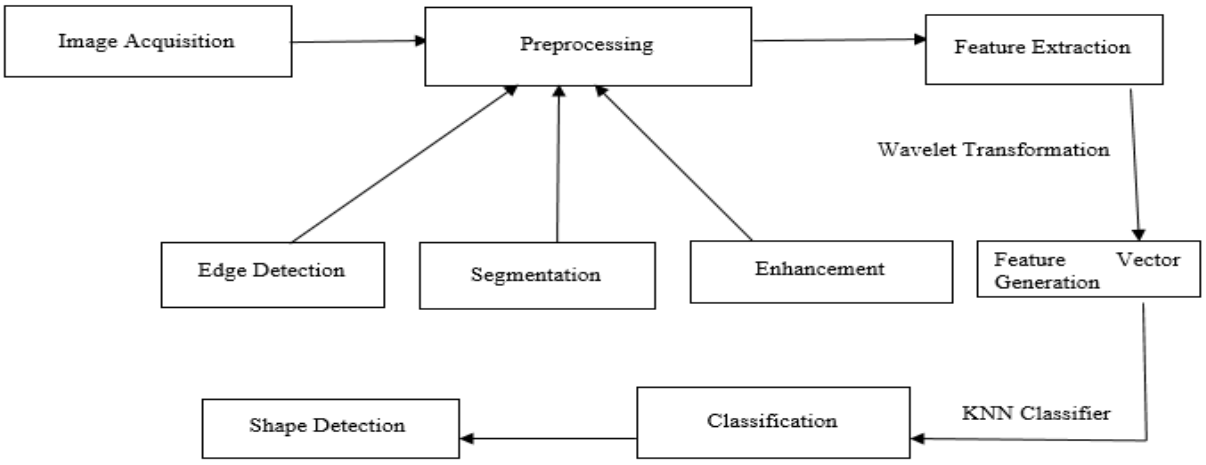


Figure1. Black diagram of shape detection

In this proposed work focused on geometrical based feature values. Image features are based on three types such as geometrical, statistical, margin based features. Which are as follows:

3.1. Geometrical Based Features:

Shanmugavadivu et al [11] in the year 2012, have proposed 7 geometric based properties, 2 margin based properties for shape based image retrieval applications.

(a) Equivalent Diameter:

Equivalent Diameter (ED) is used to compute the silhouette of image diameter that the region has the same area. It is given in Eq. (1)

$$ED = \frac{2*\sqrt{\text{Area}*\pi}}{\pi} \quad \text{.... (1)}$$

(b) Area:

The area can be determined by the actual number of pixels in the image region. Each pixel has different weights. This value differs from the binary image area and it is given below

$$Area = \pi * (\text{Radius})^2 \quad \text{... (2)}$$

(c) Major Axis length:

Major Axis Length can be determined to the Image pixel distance between the major axis endpoint and given by the relation. This property only supported for 2-D input label matrices. The result is to measure the object length and it is

$$Major\ Axis\ Length = \sqrt{\left((index1) - x(index2)\right)^2 + \left(y(index1) - y(index2)\right)^2} \quad \text{... (3)}$$

(d) Roundness:

Roundness can be determined by how to close of the object to the circle shape. The perimeter value determines the length of the boundary of the object. Which is given below

$$Roundness = \frac{(4*obj\_area*\pi)}{Perimeter^2} \quad \text{... (4)}$$

(e) Radius:

Radius can be specified in the half-length of its diameter. It is given below

$$Radius = \frac{Diameter}{2} \quad \text{... (5)}$$

(f) Compactness:

The ratio of the area of an object to the area of a circle with the same perimeter. The mean squared distance of the object's pixels from the centroid divided by the area. A filled circle will have compactness (CN) of 1, with irregular objects or objects with holes having a value greater than 1. It is given in eq (6)

$$CN = \left(\frac{2*\sqrt{\text{Area}*\pi}}{\text{Perimeter}}\right) \quad \text{... (6)}$$

(g) Elongatedness:

Elongatedness (EN) is the Ratio between the length and width of the object bounding box. The ratio value is between o and 1. It is given below

$$EN = \left(\frac{Area}{(2*maxRdius)^2}\right) \quad \text{... (7)}$$

(h) Eccentricity:

Eccentricity (ECT) of the image has the same normalized second central moments as a region. The range of the value between 0 and 1. Eccentricity value can be determined to the Ratio of the major axis length and minor axis length. Which is presented below

$$ECT = \sqrt{\left(1 - \left(\frac{minRadius}{maxRadius}\right)\right)^2} \quad \text{... (8)}$$

3.2. Statistical Based Shape Feature:

Statistical shape property values can be classified into three categories for further processing such as first order, second order and higher order. The first order describes one individual pixel (Average and variance). Second and third order shape properties are determined to the two or more pixel values are relative to each other. Statistical based shape property values are such as mean, standard deviation, RMS, homogeneity, correlation, contrast, variance, smoothness, kurtosis, skewness

(a) Mean:

The mean value can be determined to the sum of all image pixel values and divide by the number of an image pixel. It is given below

$$Mean = sum(A(:))/(r * c) \quad \text{... (9)}$$

(b) Variance:

Variance can be measured to the sum of all squared image pixels and divide the number of the pixel. Which are presented below

$$variance = sum(diff.\hat{}2)/(r-1) \quad \text{... (10)}$$

(c) Standard Deviation:

The square root of the variance value can be determined by the standard deviation. It is given below

$$standard\ deviation = \sqrt{\text{variance}} \quad \text{... (11)}$$

3.3. Margin based shape feature:

Margin based shape features are used to identify the boundary details. The margin based shape properties are such as convexity, the standard deviation of edge, shape index.

(a) Convexity:

The convexity value is 1 is the convex object. If the convex has less than 1 value have to the object it's considered to the irregular boundary. Convexity and shape index formula is given below

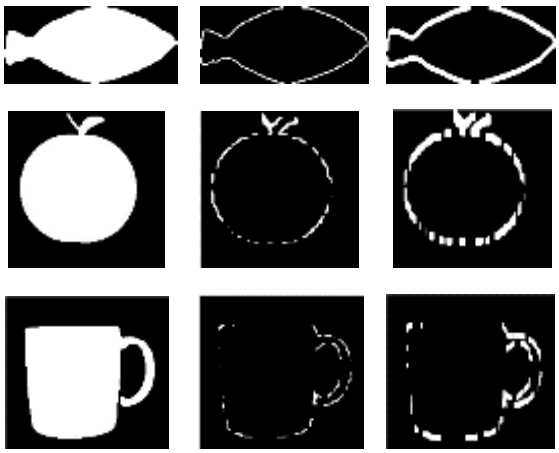
$$Convexity = \frac{Convexity\ Perimeter}{Perimeter} \quad \text{... (12)}$$

(b) Shape Index:

$$Shape\ index = \frac{Perimeter}{2*MaxRadius} \quad \text{... (13)}$$

4. IMPLEMENTATION

The MPEG-7 dataset and Matlab tool can be used for further processing. This dataset is used to analyze the images based on their shapes. The following diagram has shown some of sample images from dataset. Fig 3 (a) represents original image, (b) represents contour image and (c) defined silhouette image



(a) (b) (c)

Figure3. Sample images from dataset (a) Original image (b) Contour image (c) Silhouette image

In preprocessing includes such as image acquisition, segmentation, edge detection, image enhancement, noise removal, morphological operation. Gaussian filter method is used in DWT technique. It can filter the coefficient value and identify the exact image shape. The active contour method is applied to analyze the region of the image and it is processed more than 100 iterations to extract the boundary of the image. Sobel edge detection technique used to calculate the gradient of the image intensity within each image pixel. This method used to detect the edges of the input image and increase the brightness of their boundaries. The dilation operation is applied to further processing. Strel function used to find the nearest neighborhood pixels and dimensionality. This morphological operation reconstructs the image without any changes in its pixels and stored in a special format of decomposition image. The decomposition of an image is known as a silhouette image. DWT applied to remove the noise and filter the image. The resulting of the boundary classification are two classes such as internal boundary or global. In this proposed work DWT technique mainly used to compress the image.

Twelve geometrical shape features are extracted to evaluate such as area, area percentage, perimeter, minimum radius, maximum radius, equivalent diameter, compactness, elongatedness, circularity, modified circularity, eccentricity, thinners ratio. In table1, have presented each image is listed in the column and 12 geometric properties are listed in the row. Which is presented below

Table-1: Geometrical shape feature extraction

Image				
Area	65536	125172	262144	110760
Area per	0.4447	0.4488	0.3293	0.5233
Perimeter	2360.90	4363.67	8994.37	3620.68
Min_radius	0.5957	0.3746	0.6063	0.5308
Max_radius	0.5957	0.3746	0.6063	0.5308
Equiv_diameter	288.8651	399.2167	577.73	375.53
Compactness	0.3844	0.2874	0.2018	0.3258
Elongatedness	0.3133	0.7998	0.2240	0.4643
Circularity	86.0410	74.763	175.13	99.6657
M_circlularity	1	1	1	1
Eccentricity	0	0	0	0
Thinners Ratio	0.1478	0.0826	0.0407	0.1062

KNN classification technique is used to classify this work. Four types of shapes are classified in this proposed work such as circle, rectangle, square, and ellipse. This classification is based on the geometrical shapes of feature values. KNN classification technique give the 96% accuracy. Accuracy formula is given below

Classification Accuracy = (Images classified correctly/ All images classified)*100 ... (14)

Table-2: Degree of primitive shape of the object

Images	circle	square	rectangle	ellipse	Shape name
	0.65	0.35	0.40	0.39	circle
	0.59	0.68	0.41	0.39	square
	0.37	0.39	1.14	0.63	ellipse
	0.21	0.68	0.57	0.39	rectangle

5. CONCLUSION

In this research work, the proposed method recognizes the primitive shapes using geometrical based properties. DWT technique has been applied to compress the given input image and geometrical features are extracted using DWT. For experimental purpose MPEG_7 dataset is used and KNN classifier is applied for image classification performance of the proposed method gives 96% accuracy

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