Seethalakshmi D, International Journal of Computer Science and Mobile Applications,
Vol.2 Issue. 8, August- 2014, pg. 15-25 ISSN: 2321-8363

SHAPE BASED IMAGE RETRIEVAL FOR 2-D VEHICLE IMAGES

SEETHALAKSHMI D MCA., MPHIL,
School Of Computer Science, Engineering & Applications,
Bharathidasan University,
Trichy-23, Tamilnadu
E-Mail- seetha8390@gmail.com

Abstract: ***Content Based Image Retrieval (CBIR) is an emerging and developing trend in Digital Image Processing. CBIR is a technique for retrieving images on the basis of automatically-derived features such as color, texture and shape. With the large image databases, becoming a reality both in scientific and medical domains and in the vast advertising/marketing domain, methods for organizing a database of images and for efficient retrieval have become important. The current image retrieval systems for successful in retrieving image using keyword based approaches. Content based image retrieval aims for developing techniques with support effective searching and extracting from large image repositories. Identifying and representing the shape of object is very important for image retrieval applications. In this work, it has proposed shape based image retrieval for 2D vehicle images. We concentrated on single object vehicle image for image retrieval. Shape is the important and extract features of an image. The shape of the vehicle has been constructed and retrieved based on the query image. The performance of the proposed approach is compared with some of the recently approached similarity metrics such as Manhattan, Euclidian etc., Using these similarity metrics the classification process is been done. The experimental results of proposed approach are better Performance and increase an accuracy of image retrieval.***

Keywords: Shape, Image retrieval, CBIR, Shape descriptor, Geometric Shape Feature Descriptors (GFD)

1 INTRODUCTION

CBIR is the process of retrieving images from a database or library of digital images according to the visual content of the images. In other words, it is the retrieving of images that have similar content of colors, textures or shapes. Images have always been an inevitable part of human communication and its roots millennia ago. Images make the communication process more interesting, illustrative, elaborate, understandable and transparent.

The ability to retrieve by shape is perhaps the most obvious requirement at the primitive level. Unlike texture, shape is a fairly well-defined concept – and there is considerable evidence that natural objects are primarily recognized by their shape. Shape representation and description techniques can be generally classified into two classes of methods: contour-based methods and region-based methods. The classification is based on whether shape features are extracted from the contour only or are extracted from the whole shape region. Under each class, the different methods are further divided into structural approaches and global approaches

The goal of my research problem is to predict which shape features are distinctive and focus similarity retrieval on shape features. My approach is to compute shape descriptors for several regions of each predict their retrieval performance based on a training set of labeled descriptors, and then select only the most distinctive descriptors to be used during retrieval.

The rest of the paper is organized as follows. In section 2, discuss shape features descriptions and representation techniques. Then in section 3 describe proposed schemes of Shape Detection and Shape Based Image retrieval. Experimental results with accuracy tables are explained in section 4. Finally conclusion is made in section 5 followed by the references.

2 SHAPE FEATURES DESCRIPTIONS

This paper also presents an approach to retrieve images through an automatic segmentation technique. This allows us to get approximate information about the shape of the regions in the images. Shape description or representation is an important issue both in object recognition and classification. Many techniques, including chain code, polygonal approximations, curvature, Fourier descriptors and moment descriptors have been proposed and used in various applications.

Shape representation and description techniques can be generally classified into two classes of methods: contour-based methods and region-based methods. The classification is based on whether shape features are extracted from the contour only or are extracted from the whole shape region. Under each class, the different methods are further divided into structural approaches and global approaches. This sub-class is based on whether the shape is represented as a whole or represented by segments/sections (primitives). These approaches can be further distinguished into space domain and transform domain, based on whether the shape features are derived from the spatial domain or from the transformed domain.

A good shape representation feature for an object should be invariant to translation, rotation and scaling. For the purpose of image retrieval, a number of features characteristic of object shape, which is usually independent of size or orientation, are computed for every object of image database. Shape attributes techniques can be represented in two distinct categories: measurement-based methods ranging from simple, primitive measures such as area and circularity to the more sophisticated measures of various moment invariants; and transformation-based methods ranging from functional transformations such as Fourier descriptors to structural transformations such as chain codes and curvature scale space feature vectors.

. Global shape features are general in nature and depend on the characteristics of the entire image object. Area, perimeter, and major axis direction of the corresponding image region are examples of such features. Local shape features are based on the low-level characteristics of image objects. The determination of local features usually requires more involved computation. Curvatures, boundary segments, and corner points around the boundary of the corresponding image region are examples of such features

The feature extraction stage produces a representation of the content that is useful for shape matching. Usually the shape representation is kept as compact as possible for the purposes of efficient storage and retrieval and it integrates perceptual features that allow the human brain to discriminate between shapes. Efficient shape features must present some essential properties such as:

Table 2.1 Shape Properties and Descriptions

Shape Properties	Descriptions
Identifiability	Found Similar Shapes of Objects
Affine Variance	Constructed translation, Scales, Flips, Rotations, Shears
Noise Resistance	Strength of noise Couldn't affect the pattern
Statically Independent	Compactness of the Representation
Reliability	Deals with the same Pattern
Occultation Invariance	Some Parts are executed, Remaining part must not change compared to the original Image.
Translation, Rotation	The location should be changed

3 PROPOSED WORK

In this research Problem mainly focused on **2D Vehicle Images** Likes Car, Auto, Bus, Van, Lorry, Two wheelers etc. This research has concentrated only on the shape of images. It has 2 approaches.

1. **Shape Detection**
2. **Image Retrieval**

3.1 Shape Detection

Shape is an important visual feature and it is one of the basic features used to describe image content. However, shape representation and description is a difficult task. This is because when a 3-D real world object is projected onto a 2-D image plane, one dimension of object information is lost. As a result, the shape extracted from the image only partially represents the projected object. To make the problem even more complex, shape is often corrupted with noise, defects, arbitrary distortion and occlusion.

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Shape is the low features of image processing. It has some procedures to detect the shape of images in MATLAB. The Procedures are shown in below:

Input

RGB image have the shapes to recognize.

1 - Rea d the RGB (colored) image from user.

2 - Convert image from (RGB) colored to digital image using Threshold technique.

3 - Find the boundaries and area of object.

4 - Determine shapes properties (ratio of dimensions, roundness).

5 - Classify shapes according to its properties.

Output

RGB image with shapes recognized and labeled.

Fig 3.1Procedure for Shape Detection

Step 1: Read/capture image

The image is first acquired from an existing image can be loaded from the memory. We shall consider that the acquired image is in RGB format which is a true color format for an image In MATLAB, the captured or imported RGB image is three dimensional and each pixel is represented by an element of a matrix whose size corresponds to the size of the image.

Step 2: Converting RGB image to Gray to Black and White

Now convert is made on 24 bit RGB image. The conversions are done by MATLAB.

Fig 3.2 RGB Image

This process is done in two steps. The RGB image is first converted to a two dimensional grayscale image. The grayscale image is nothing but a matrix that holds the luminance (Y) values of images. Then obtain the luminance values of the image by combining the RGB values using the NTSC standard equation (1) that multiplies the primary colors (red, green and blue) with coefficients based on the sensitivity of our eyes to these colors as shown:

$$\boldsymbol{Y = 0.3 * R + 0.59 * G + 0.11 * B} \qquad \textbf{(3.1)}$$

Fig 3.3 RGB to Gray Conversion

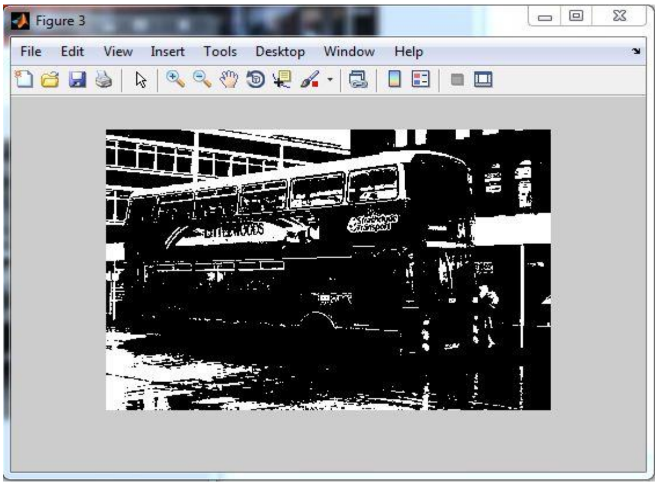

Fig 3.4 Gray to Binary Conversion

Step 3: Recognize boundaries of objects

The image is now a two dimensional array with binary elements. Boundaries of the objects are recognized by first setting a single pixel on the object-background interface as a starting point and moving in a clockwise or counterclockwise direction and searching for other object pixels. The pixels may be searched either diagonally (in 8-connected pixels) or edge-adjacent pixels (in 4-connected pixels). By hunting for object pixels in a fixed direction, the object's boundary can be recognized.

Step 4: Finding areas of objects and area filtering

Once the object boundaries have been recognized, the area of that object can easily be calculated by summing the number of pixels within the boundary extent. Very minute objects correspond to noisy pixels that may have been treated as object pixels during the thresholding process. It is necessary to remove these pixels before further processing. By using an if-else condition, those objects whose areas are below a threshold value, can be converted to background pixels (i.e., they can be inverted). In this way the image is filtered to remove small, isolated noise pixels.

Step 5: Finding bounding box of the object

The bounding box of an object is an imaginary rectangle that completely encloses the given object and its sides are always parallel to the axes. It illustrates the concept of a bounding box. It is worth noting that due to the various angles of inclination of an object, the dimensions of the bounding box change accordingly. However, to make the shape recognition independent of the rotation of the object, the dimensions of the bounding box must be constant.

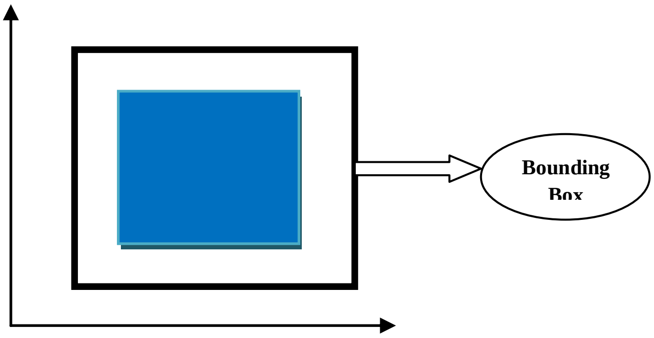

Figure 3.5 Bounding Box of Object

This is because the area of the bounding box is an important parameter which we will be using to classify the shape of the object. This is precisely the reason to rotate the object in the opposite direction by the angle of orientation as mentioned in the previous step. Therefore we ensure that irrespective of the orientation of the object, we can construct a bounding box of constant dimensions. This method works well with squares, circles as well as rectangles.

Step 6: Finding ratio of areas for given object

The next step involves finding the ratio of the area of an object to the area of its bounding box. In MATLAB, this ratio is known as the Extent and is a very useful parameter:

$$\boldsymbol{Extent} = \frac{\boldsymbol{Area\ of\ the\ Object}}{\boldsymbol{Area\ of\ bounding\ box}} \qquad (\mathbf{3.2})$$

3.2 Shape Retrieval

The ability to retrieve by shape is perhaps the most obvious requirement at the primitive level. Unlike texture, shape is a fairly well-defined concept – and there is considerable evidence that natural objects are primarily recognized by their shape. A number of features characteristic of object shape (but independent of size or orientation) are computed for every object identified within each stored image. Queries are then answered by computing the same set of features for the query image, and retrieving those stored images whose features most closely match those of the query. Two main types of shape feature are commonly used – global features such as aspect ratio, circularity and moment invariants and local features such as sets of consecutive boundary segments. Alternative methods proposed for shape matching have included elastic deformation of templates, comparison of directional histograms of edges extracted from the image, and shocks, skeletal representations of object shape that can be compared using graph matching techniques. Queries to shape retrieval systems are formulated either by identifying an example image to act as the query, or as a user-drawn sketch.

Shape matching of three-dimensional objects is a more challenging task – particularly where only a single 2-D view of the object in question is available. While no general solution to this problem is possible, some useful inroads have been made into the problem of identifying at least some instances of a given object from different viewpoints. One approach has been to build up a set of plausible 3-D models from the available 2-D image, and match them with other models in the database. Another is to generate a series of alternative 2-D views of each database

Retrieval the Images using Shape Descriptor

Shape is an important visual feature and it is one of the basic features used to describe image content. However, shape representation and description is a difficult task. This is because when a 3-D real world object is projected onto a 2-D image plane, one dimension of object information is lost. As a result, the shape extracted from the image only partially represents the projected object. To make the problem even more complex, shape is often corrupted with noise, defects, arbitrary distortion and occlusion. Further it is not known what is important in shape. Current approaches have both positive and negative attributes; computer graphics or mathematics use effective shape representation which is unusable in shape recognition and vice versa. In spite of this, it is possible to find features common to most shape description approaches.

Basically, shape-based image retrieval consists of measuring the similarity between shapes represented by their features. Some simple geometric features can be used to describe shapes. Usually, the simple geometric features can only discriminate shapes with large differences; therefore, they are usually used as filters to eliminate false hits or combined with other shape descriptors to discriminate shapes. They are not suitable to stand alone shape descriptors.

1. **Mass**

It is the number of pixels contained in one image. It is given as

$$\boldsymbol{mass} = \sum_{xy} \boldsymbol{h(x, y)} \qquad (3.3)$$

Where $$\boldsymbol{h} = \begin{cases} \boldsymbol{1\ if\ s(x, y)\ \epsilon\ c} \\ \boldsymbol{0\ if\ s(x, y) \epsilon\ c} \end{cases}$$

2. **Centroid**

Centroid is also called as the center of mass; h is a mask of cluster c over image S(x, y). The coordinates (x_c, y_c) of the Centroid are defined as

$$\boldsymbol{x_c} = \frac{\sum_{xy} x * h(x,y)}{mass} \qquad \textbf{(3.4)}$$

$$\boldsymbol{y_c} = \frac{\sum_{xy} y * h(x,y)}{mass} \qquad \textbf{(3.5)}$$

3. Mean and Variance

The mean and variance features are computed over the original image considering the resulting segmentation S, they are respectively denoted by μ_c and σ^2_c

$$\boldsymbol{\mu_c} = \frac{\sum_{x,y} I_{x,y} * h(x,y)}{mass} \qquad \textbf{(3.6)}$$

$$\boldsymbol{\sigma_c^2} = \frac{\sum_{x,y}(I_{x,y} - \mu_c) * h_c(x,y)}{mass} \qquad \textbf{(3.7)}$$

4. Dispersion

Dispersion is the distance of each region. Using similarity metrics find the distance of database image based on query image.

$$\boldsymbol{Disp} = \sum_{i} \boldsymbol{dist(o_c, o_{i,c})} \qquad (3.8)$$

In image retrieval system; since an object, in most case, can form by a set of shape (e.g. **a Bus is consisted of a few rectangles and a few circles**), most similar objects have a high correlation in the set of shapes. Shape-based image retrieval should extract the shapes from images by segmentation, and classify the shape, where each shape should have their own representation and should variant to scaling, rotation, and transition.

Moments

This concept is issued from the concept of moments in mechanics where mass repartitions of objects are observed. It is an integrated theory system. For both contour and region of a shape, one can use moment's theory to analyze the object.

Invariant moments (IM) are also called geometric moment invariants. Geometric moments, are the simplest of the moment functions with basis while complete, is not orthogonal.

In general, the moment's technique provides a better recognition and perimeter and area method. In this case, Geometric moment function the moments of gray levels at each pixel in the image is calculated in the same way as mechanical moment

$$M_{ij} = \sum_{(x,y)} x^i y^j f(x, y) \qquad (3.9)$$

Where f(x,y) is an image function and equals to 1 if the pixel at position (xc,yc) is on otherwise equals to 0. IM are computationally simple. Moreover, they are invariant to rotation, scaling and translation.

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Vol.2 Issue. 8, August- 2014, pg. 15-25 ISSN: 2321-8363

The advantage of boundary moment descriptors is that it is easy to implement. However, it is difficult to associate higher order moments with physical interpretation.

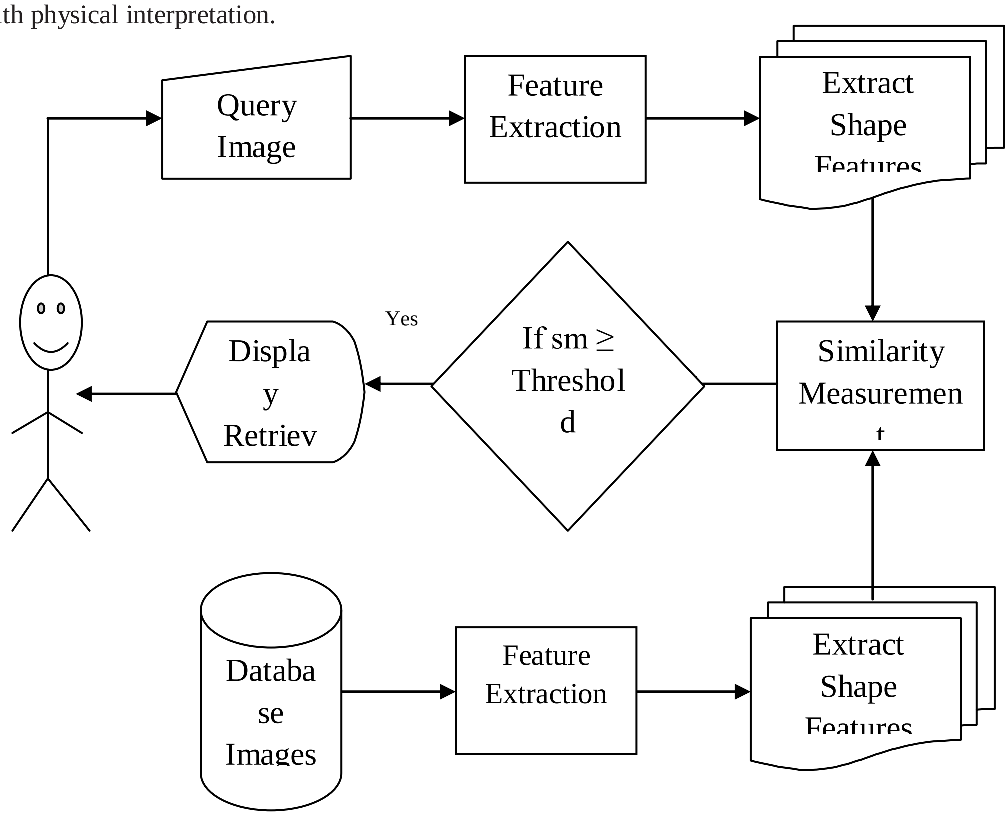

Fig 3.6 Diagram for Shape Based Image Retrieval

1. Read the image which has been observed previously.
2. Calculate the mass using formula.
3. Calculate the edge using CANNY Edge detection technique.
4. Extract the contour of the given input image.
5. Compute the Boundary Moments using Geometric Shape Feature Descriptors (GFD).
6. Extract the shape features of image row and column wise.
7. Load moment features of the image database.
8. Calculate the distance function of each image.
9. Compare the features of the query image and the image database image based on distance function.
10. Retrieved images have the value of similarity measure is greater than 0.5, only that images are display the Retrieval Window.

Fig 3.7 Procedure for Shape Based Image Retrieval

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3.3 Similarity/Distance Measures

Instead of exact matching, content-based image retrieval calculates visual similarities between a query image and images in a database. Accordingly, the retrieval result is not a single image but a list of images ranked by their similarities with the query image. Many similarity measures have been developed for image retrieval based on empirical estimates of the distribution of features in recent years. Different *similarity/distance measures* will affect retrieval performances of an image retrieval system significantly.

The different distance measures used for matching some are as follows:

1. Manhattan Distance
2. Euclidean Distance
3. Spearman Distance
4. Chebychev Distance
5. City block distance

1. Manhattan Distance

The Manhattan distance function computes the distance that would be traveled to get from one data point to the other if a grid-like path is followed. The Manhattan distance between two items is the sum of the differences of their corresponding components.

The formula for this distance between a point **X**=(**X**1, **X**2, etc.) and a point **Y** = (**Y**1, **Y**2, etc.)

$$d = \sum_{i=1}^{n} |x_i - y_j| \qquad (3.10)$$

2. Euclidean Distance

The Euclidean distance function measures the 'as-the-crow-flies' distance. The formula for this distance between a point **X** (**X**1**,** **X**2**,** etc.) and a point **Y** (**Y**1**,** **Y**2**,** etc.) is:

$$d = \sqrt{\sum_{i=1}^{n} (x_i - y_j)2} \qquad (3.11)$$

Deriving the Euclidean distance between two data points involves computing the square root of the sum of the squares of the differences between corresponding values.

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4 EXPERIMENTAL RESULTS

The Geometric shape Feature Descriptor retrieval algorithms are implemented in MATLAB with the database of 250 images. All the images are stored in JPEG format with size 384 × 256 or 256 × 384. There are Bus, Car, Auto, Van, Bike etc.

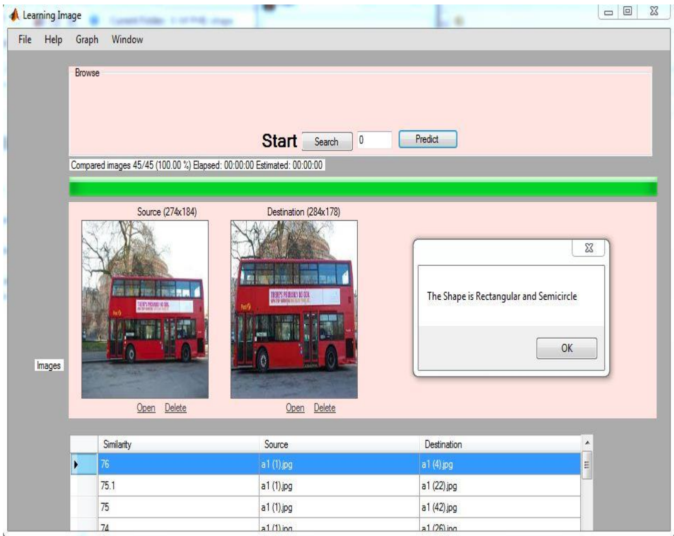

Fig 3.1 Shape Detection of Bus

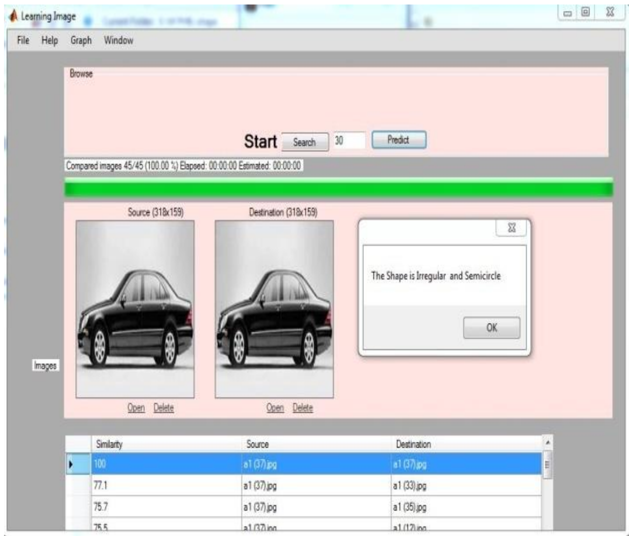

Fig 3.2 Shape Detection of Car

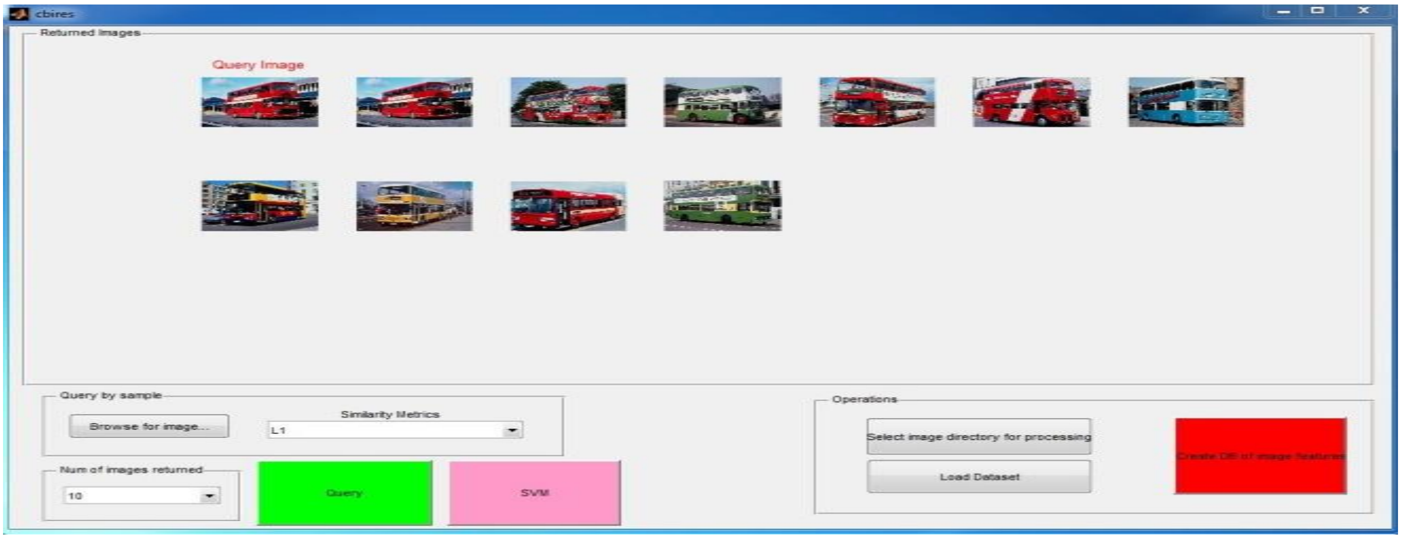

Fig 3.3 Bus shape images Retrieval based on Manhattan Distance

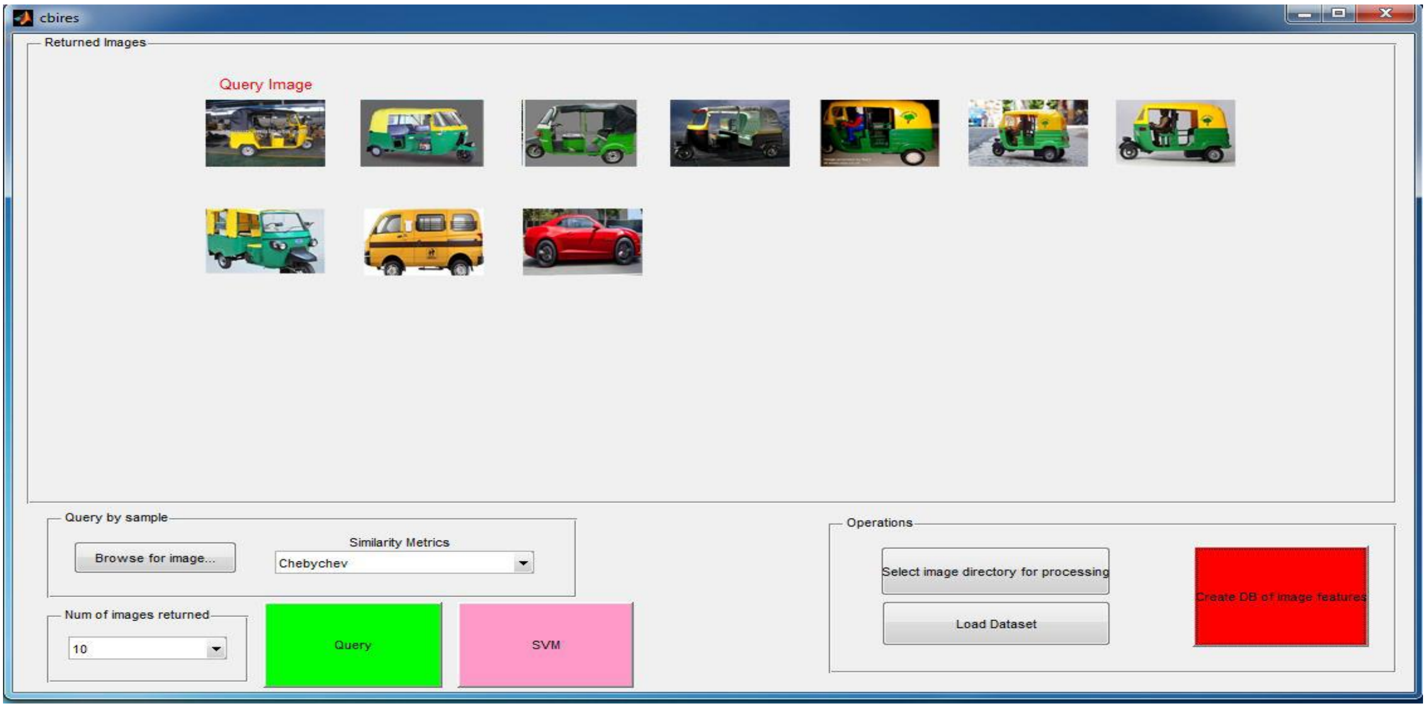

Fig 3.4 Auto shape images Retrieval based on Chebychev Distance

4.1 Recall and Precision Evaluation

To evaluate the performance of the image retrieval algorithm we use the two most well known parameters; precision and recall. The first measure is called **Recall**. It is a measure of the ability of a system to present all relevant items. The equation for calculating recall is given below:

$$\boldsymbol{Recall = \frac{No\ of\ Relevant\ Imagess\ Retrieved}{No\ of\ Relevant\ Images\ in\ Collection}}$$

The second measure is called **Precision**. It is a measure of the ability of a system to present only relevant items. The equation for calculating precision is given below.

$$\boldsymbol{Precision = \frac{No\ of\ Relevant\ Imagess\ Retrieved}{Total\ No\ of\ Images\ Retrieved}}$$

The system is executed with 10 images from each of using various distance metrics function to calculate precision and recall parameters for all of them. The results obtained using shape for different similarity metrics is shown in Table.

Table 4.1 Evaluation of Precision and Recall

Similarity Metrics	Precision	Recall
Manhattan Distance	0.9	0.39
Euclidean Distance	0.8	0.35
Chebychev Distance	0.1	0.04
City Block	0.7	0.30
Cosine Correlation	0.9	0.39

5 CONCLUSIONS

The main contribution of my work is a method for selecting a of local shape descriptors to use during matching based on shape distinction. The aim of my problem was to investigate the usefulness of moment invariants for the identification of geometric shapes on Objects, for example Buses, Cars, and Auto etc. When tested for the more generalized cartographic Shapes, moment invariants seem to work. I have proposed a Moment shape descriptor, the Geometric Shape Feature Distributions (GFD), in this research Problem. Spatial layouts of local shape descriptors are modeled in the GFD to characterize global shapes. At the same time, distinctive local shape information is preserved. An intuitive shape similarity measure is presented for GFD and compared with the similarity measures of various distance metrics functions and also developed a method to detect similar shape parts between shapes, based on the GFD shape representation. In my problem compared the Manhattan Distance, Euclidean Distance, Correlation Distance, City block Distance, Chebychev Distance, and evaluated experimental results with respect to their qualities of effectiveness, as well as efficiency. As a future work, system can be redesigned to accept semantic in addition to content based queries. To obtain integrated system shape features must be derived from other algorithms.

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BIOGRAPHY

SEETHALAKSHMI D was born in Kumbakonam on in the Tamilnadu, India on March 8, 1990. I did my Post Graduated MCA from Bharathidasan University, Trichirappalli-23, and Tamilnadu. Now I Pursuing my M.Phil, from Bharathidasan University, Trichy-23.My area of interest is Image Processing.