Fast Image Retrieval Using Content Based Approach

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ABSTRACT

Content Based Image Retrieval (CBIR), is focusing on developing a Fast And Semantics-Tailored (FAST) image retrieval methodology. Image retrieval is very important step for computer aided plant species recognition. In this project we are using different transform techniques for plant image recognition on the basis of shape and texture features. Basically we are calculating Euclidean distance of plant image in the database from query image by applying following transforms.

1. Gabor Zernike.
2. Fourier Descriptor
3. Generic Fourier Descriptor
4. Curvature Scale Space

By applying all these transforms to plant image we are characterizing shape and texture features of plant. In this project we have 100 plant images in the database. We calculated Euclidean distance of every plant image in the database from the query image. On the basis of Euclidean distance of query image all the plant images are arranged as per ascending order of Euclidean distance. The experimental result showed that Gabor Zernike transform gives better results to retrieve plant images from the database on the basis of feature vector of plant.

Finally we did comparative study of all these transform by drawing precision and recall graph which gives percentage retrieval result of plant image from the database

Keywords

Fourier descriptors, CBIR, retrieval. Gabor Zernike, Curvature Scale Space.

INTRODUCTION

Due to the rapid development of digital and information technologies, more and more images are generated in digital form. This requires image to be effectively and efficiently described to facilitate automatic searching. Content Based Image Retrieval (CBIR) is a technique whereby images are described by a few top level features such as color, texture, shape or the combination of them. There is an increasing trend towards the digitization of plant imagery. Shape is the fundamental visual features in CBIR. Various shape techniques exist in the literature, these methods can be classified into two categories: Region-based and Contour-based. Contour-based shape descriptors use only the boundary information, ignoring the shape interior content. Examples of contour based shape descriptors include Fourier descriptors, Wavelet descriptor, and Curvature scale space descriptor. Since they are computed using only boundary pixels, their computational complexity is low, but they cannot represent shapes for which the complete boundary information is not available.

1. system architecture

In contrast to conventional text-based retrieval, a CBIR system uses image content instead of text to retrieve the counterparts in the database. In general, there are two ways to retrieve information from a database: one is the global approach which uses the complete information contained in an image to search the database; the other is the local approach which selects a region-of-interest (ROI) as the base to perform search. The advantage of the former is that less human intervention is involved, but at the sacrifice of retrieving relatively incorrect data to introduce too much irrelevant results.

2. Feature Extraction

In image processing, Feature extraction is a special form. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called features extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. Feature extraction involves simplifying the amount of resources required to describe a large set of data accurately.

A. Shape

The human vision system identifies objects with the edges they contain, both on the boundary and in the interior based on the intensity differences among pixels. These intensity differences are captured as the shape content of salient objects with respect to their centroids in images. The shape descriptors are classified in two groups: contour-based (e.g., Turning Angle representation and Fourier descriptors) and region-based (e.g., moment descriptors, generic Fourier descriptors, and grid descriptors).

B. Texture

Texture is an important feature since the images can be considered as the composition of different texture regions. There are various techniques for texture feature extraction. The statistical approaches make use of the intensity values of each pixel in an image, and apply various statistical formulae to the pixels in order to calculate feature descriptors

Preprocessing of shape image

The shapes in the database are plants images in the form of gray level images. The preprocessing is to extract the boundary information, or coordinates of the boundary, from the shape. The block diagram for preprocessing is shown above. The first step in the preprocessing is to binarizing the shape image; a simple threshold is applied to convert the gray level shape image into binary image. In reality, shape images are often corrupted with noise, as a result, the shape obtained from the thresholding usually has noise around the shape boundary, therefore, a denoise process is applied. The denoising process eliminates those isolated pixels and those isolated small regions or segments. For the nonsilhouette shape, the shape boundary is not always connected; therefore, a m-connectivity connection technique is used to fill the gaps between boundary points. The shape is then traced using a 8-connectivity contour tracing technique to obtain the shape boundary coordinates.

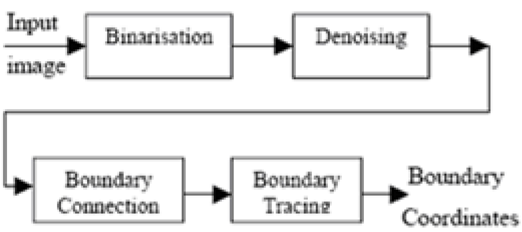


Figure 1 Preprocessing of Image

Related work

Spectral descriptors include Fourier descriptors (FD) and wavelet descriptors (WD), they are usually derived from spectral transform on shape signatures. With Fourier descriptors, global shape features are captured by the first few low frequency terms, while higher frequency terms capture finer features of the shape. Apparently, Fourier descriptors not only overcome the weak discrimination ability of the moment descriptors and the global descriptors but also overcome the noise sensitivity in the shape signature representations. Other advantages of FD method include easy normalization and information preserving. Recently, wavelet descriptors have also been used for shape representation.

A. Shape signatures

In general, a shape signature is any 1-D function representing 2-D areas or boundaries. Four shape signatures are considered in this paper, these are central distance, complex coordinates (position function), curvature and cumulative angular function. The reason for choosing these four shape signatures for test and comparison is because they are mostly used in recent FD implementations and have been shown practical for general shape representation. The shape boundary coordinates have been extracted in the preprocessing stage.

$$(x(t), y(t)),\ t = 0, 1, \ldots, L-1,$$

B. Complex coordinates

A complex coordinate's function is simply the complex number generated from the boundary coordinates:

$$z(t) = x(t) + iy(t)$$

In order to eliminate the effect of bias, we use the shifted coordinates function

$$z(t)=[\,x(t) - x_c\,] + i\,[\,y(t) - y_c\,]$$

Where (xc, yc) is the centroid of the shape, which is the average of the boundary coordinates

$$x_c = \frac{1}{L}\sum_{t=0}^{L-1} x(t),\ y_c = \frac{1}{L}\sum_{t=0}^{L-1} y(t)$$

This shift makes the shape representation invariant to translation.

C. Centroid distance

The centroid distance function is expressed by the distance of the boundary points from the centroid (xc, yc) of the shape

$$r(t) = ([x(t) - x_c]^2 + [y(t) - y_c]^2)^{1/2}$$

Due to the subtraction of centroid, which represents the position of the shape, from boundary coordinates, the centroid distance representation is also invariant to translation.

D. Curvature signature

Curvature represents the second derivative of the boundary and the first derivative of the boundary tangent. The curvature function used is defined as the differentiation of successive boundary angles calculated in window however, this curvature function defined in this way has discontinuities at size of 2π in the boundary, therefore,

$$K(t) = \theta(t) - \theta(t-1)$$

where

$$\theta(t) = \arctan\frac{y(t)-y(t-w)}{x(t)-x(t-w)}$$

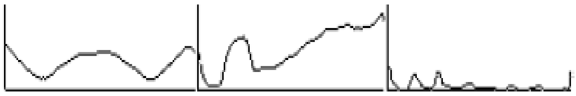
$$K(t) = \varphi(t) - \varphi(t-1)$$

Where θ (t) is defined as above. Curvature is invariant under translation and rotation.

E. Cumulative angular function

Shape can also be represented by boundary angles, but due to that the tangent angle function θ (t) can only assume values in a range of length 2π, usually in the interval of [-π, π] or [0, 2π]. Therefore θ (t) in general contains discontinuities of size 2π. Because of this, a cumulative angular function is introduced to overcome the discontinuity problem. The cumulative angular function θ (t), is the net amount of angular bend between the starting position z(0) and position z(t) on the shape boundary In order to make it accord with human intuition that a circle is "shapeless", a normalized cumulative angular function ψ(t) is used as the shape signature (assuming shape is traced in anti-clockwise direction)

$$\varphi(t) = [\theta(t) - \theta(0)]\bmod(2\pi)$$



(a) $r(t)$ (b) $\varphi(t)$ (c) $K(t)$

Figure 2: Shape Indexing Using Fourier

F. Texture feature extraction

Texture, a global shape feature could be used to associate related shapes. Here we combine the Gabor filters and Zernike moments to form a set of features suitable for texture shape features.

3. Shape Based Plant Image Retrieval

Fourier transformation on shape signatures is widely used for shape analysis, there are also some recent attempts to exploit it for shape retrieval The Fourier transformed coefficients form the Fourier descriptors of the shape. These descriptors represent the shape of the plant in a frequency domain.

Along with this descriptors we have implemented different transform to recognize plant image on the basis of features extracted from the plant image

A. Generic Fourier Descriptor

Generic Fourier Descriptor proposed by is extracted from spectral domain by applying 2-D Fourier transform (FT) on polar raster sampled shape image. Shape analysis using FT is backed by well developed and well understood Fourier theory

B. Fourier descriptor

The multiscale Fourier descriptor is formed by applying the complex wavelet transform to the boundary function of an object extracted from an image. After that, the Fourier transform is applied to the wavelet coefficients in multiple scales.

C. Gabor Zernike

With an optimized implementation, retrieval rates of several 10Hz can be reached, which makes the fast Gabor transform a superior one-to-one replacement even in applications that require video-rate update. Parameters of the Gabor wavelets, namely frequency and orientation, are adjusted to gain better performance. The processing of plant images by Gabor filter is chosen for its technical properties. The Gabor filter kernels have similar shapes as the receptive fields of simple cells in the primary visual cortex. They are multi-scale and multiorientation kernels.

D. Curvature Scale Space

In curvature scale space (CSS) representation the first step is to extract edges from the original plant image using a Canny detector. The corner points of an image are defined as points where plant image edges have their maxima of absolute curvature. The corner points are detected at a high scale of the CSS image and the locations are tracked through multiple lower scales to improve localization. Corner detection is an important task in various machine vision and image processing systems. Applications include motion tracking, object recognition, and stereo matching.

Curvature Scale Space

1. Corner: The process of CSS image corner detection is as follows:

Utilize the Canny edge detector to extract edges from the original image.

Extract the edge contours from the edge image:

Fill the gaps in the edge contour

Find T-junctions and mark them as T-corners

Compute the curvature at highest scale _high and declare the corner candidates as the maxima of absolute curvature above a threshold t.

Track corners to lowest scale to improve localization.

Compare the T-corners to the corners found using the curvature procedure and remove very close corners.

2. Canny: This function is used to detect edges of the image.

3. Extract curve: This function is used to find number of curves of the image. It gives starting and ending point of the curve.

4. Get corner: This function is used to find T corners in the image

5. Edge direction : This function is used to detect curves in the image.

Applications

Content Based Image Retrieval (CBIR), is focusing on developing a Fast And Semantics-Tailored (FAST) image retrieval methodology. Specifically, the contributions of FAST methodology to the CBIR literature include:

(1) Development of a new indexing method based on fuzzy logic to incorporate color, texture, and shape information into a region based approach to improve the retrieval effectiveness and robustness.

(2) Development of a new hierarchical indexing structure and the corresponding Hierarchical, Elimination-based A* Retrieval algorithm (HEAR) to significantly improve the retrieval efficiency without sacrificing the retrieval effectiveness; it is shown that HEAR is guaranteed to deliver a logarithm search in the average case.

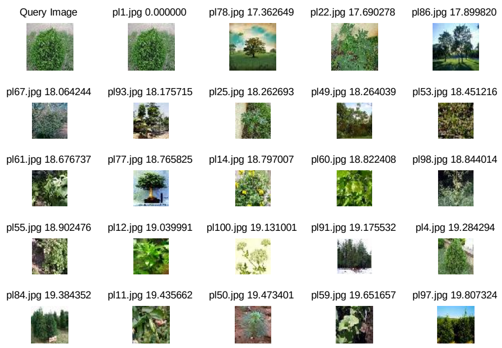
(3) Employment of user relevance feedbacks to tailor the semantic retrieval to each user's individualized query preference through the novel Indexing Tree Pruning (ITP) and Adaptive Region Weight Updating (ARWU) algorithms.

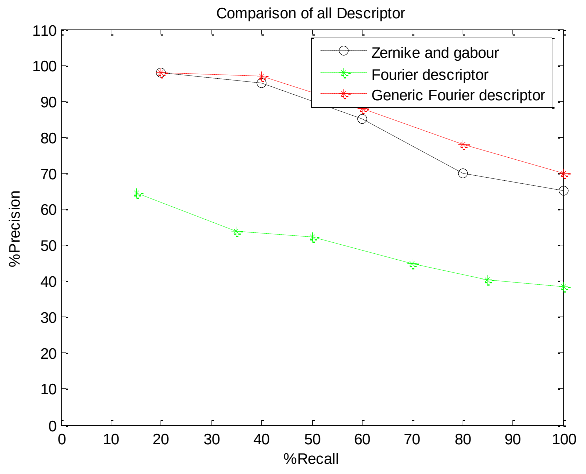
4. Sample Test Results to Recognize Plant Image

The performance of all descriptors is evaluated by using plant database. The precision and recall graphs are drawn for each descriptor. The database created in this way makes the evaluation more reliable. The performance of the retrieval is evaluated using precision and recall. Precision P is defined as the ratio of the number of relevant retrieved shapes r to the total number of retrieved shapes n. Recall R is defined as the ration of the number of retrieved relevant images to the total number m of relevant shapes in the whole database. Therefore

$$P = \frac{r}{n} \qquad R = \frac{r}{m}$$

Query image is Christmas tree. The related plant images retrieved by applying all Transform are six. The Euclidean distance of these images is approximately same to the query image. Out of six plant images three plant images are retrieved within first twenty five images.





CURVATURE SCALE SPACE

Curvature Scale Space gives results for some plants. In result of Curvature Scale Space Original plant image is Papaya for which we are getting edge map and corners properly

Conclusion

A. Gabour Zernike

As compared to Fourier Descriptor Gabour Zernike transform gives seventy percent accurate results to retrieve plant images.

B. Fourier Descriptor

Fourier Descriptor gives forty percent accurate results to retrieve plant images.

C. Generic Fourier Descriptor

Generic Fourier Descriptor gives forty percent correct results to retrieve plant images.

D. Generic Fourier Descriptor and Fourier Descriptor (Combined)

As per the Precision and Recall graph Generic Fourier Descriptor and Fourier Descriptor (Combined) the accuracy of result to retrieve plant images is fifty percent.

E. Generic Fourier Descriptor, Fourier Descriptor and Gabour Zernike (Combined)

By observing the Precision and Recall graph of Generic Fourier Descriptor, Fourier Descriptor and Gabour Zernike (Combined) the percentage of accuracy to retrieve plant images is fifty.

G. Curvature Scale Space

By observing the results and Precision and Recall graphs of all methods it can be said that Curvature Scale Space is not applicable for plant type of images because shape of plant is not regular and plants don't have proper edges and corner points. The Curvature Scale Space method gives better results for images having regular shape (Like rectangle, square, triangle) in which getting proper edges and corner points is possible. In plant images it is not possible to extract proper edges and corner points. So Curvature Scale Space results are not satisfactory to retrieve plant image.

Finally it can be said that Gabour Zernike is the best technique to retrieve plant images because the results getting by applying Gabour Zernike to plant database are more accurate as compare to other techniques which are used in this project. It is proved by drawing Precision and Recall graph for plant database and results

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