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Image Retrieval in Mobiles using Signature based Approach

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Abstract - Since camera based handheld devices are widely used in today's world, and we also tend to click pictures and store it. Hence there is a need for a system that could process the pictures clicked from a hand-held device and retrieve back similar images from a central image database along with the information tagged with it. Mobile phones have very limited display size and limited number of control keys, so most of these systems encounter serious difficulties for both presenting the query image and also showing the retrieval results. In this paper, we describe a way in which a captured image can be searched in the web using content based retrieval system.

Keywords **- Image database, Feature database, Signature, HSV-based histogram, Canny edge detection; Chamfer matching, Grey-level Co-occurrence matrix, Precision, Recall.**

1. Introduction

With the increased use of cameras in mobile phones which is affordable to buy, we have been able to capture images spontaneously and send or share them easily. Since new generation smart phone allows us to capture never seen images from the remotest parts of the world, there is a need of an application that helps the user to identify the images he or she has clicked and enhance the amazing possibilities. The mobile industry is going through change over the past few years by offering higher bandwidth with significant advances in areas of multimedia and communication.

Mobile phones have only recently been utilized for image retrieval purpose and we can find only a few image retrieval tools in mobiles. In text based image retrieval system, a user can make use of synonyms and annotation text which varies from person to person [1]. Hence we have come up with an application that captures a real time image from a hand-held device and searches for similar images on web along with the description of the image.

This is suitable for searching certain flower type, monuments, CDs, books, outdoor landmarks, museum paintings. We propose content based image retrieval system in windows mobile devices. In content-based approach, the visual features of the query image are extracted and images with similar features are searched in the database. A typical CBIR system views the query image as well as images in the database (target images) as a collection of features, and ranks the relevance between the query image and any target image according to similarity measure. The image features such as color, shape and texture can be used to compute similarity between images.

2. Components of The System

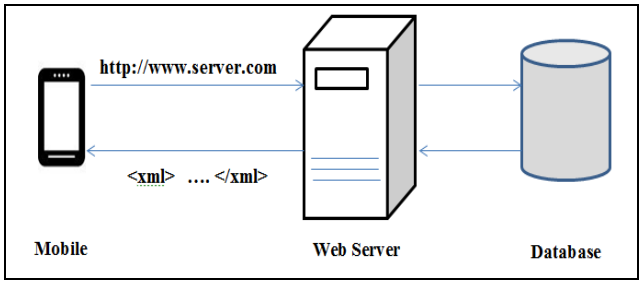

Fig 1 Components of image retrieval system in mobile

The components of the system are given in the figure 1. The components are as follows

Mobile: We have used windows mobile 6.0 device which sends an image request to the webserver.

Web Service: The web server processes the image and considers most commonly used features including color, texture, and shape in an image to calculate the overall characteristic of the image.

Image Database: Image Database contains a collection of Images from the Wang Database [14] and the images are of the size 256 x 384 or 384X256.

Feature Database: The web server extracts the feature of each image from the Wang database and stores it in feature database. Feature database contains the feature vector of all the images in the image database.

2.1 Image Processing At Server End

Once the query image is being sent from mobile device to the server, the features such as color, texture and shape is extracted from the image and is matched with the already existing features stored in the feature database. After matching the images based on 3 different features a similarity measure is obtained for all three features. Finally a signature is created by taking the weighted sum of all three features (color, texture, shape). The images are then listed in the increasing order of their signature value. The matching images thus obtained are sent to the mobile device in the XML format in the decreasing order of relevance.

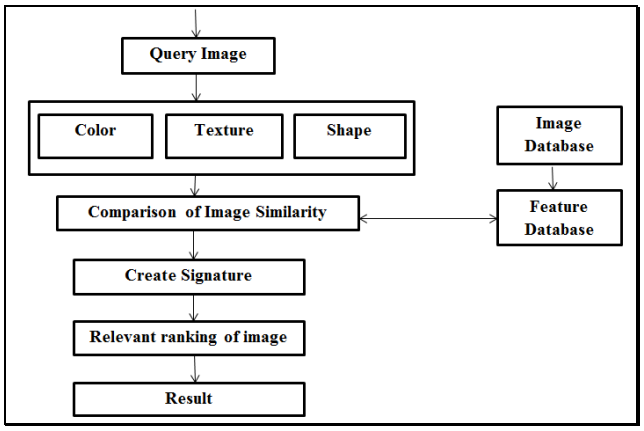

Fig 2 Image Feature Extraction

2.2 Feature Extraction

Each of the images can be represented in terms of following features:

Color: We use the concept of cumulative HSV histogram wherein we divide each image of size (384X256) in the database and the target image into 6-equal sized sub-blocks [2]. For each sub-block construct cumulative HSV color histogram. The color feature vector is cumulative HSV histogram for each block.

Shape: We use canny edge detection algorithm to detect the edges and the threshold of each image is calculated using Otsu threshold technique. The shape feature vector is a set of coordinates (x, y) representing set of edges.

Texture: Image is divided into sub blocks and Statistical Feature such as energy, contrast, entropy and inverse difference is calculated for each block [2] and is used to determine the texture feature vector. The texture feature vector is set of features such as energy, entropy, contrast and inverse difference for each block.

2.3 Matching of Images

Once the feature of the image is extracted, the image is compared with the other existing image based on these three features. Each of the features can be matched as shown below:

Color: Distance between Query image and Database image is calculated for each of the Block and is given by:

$$C=\sqrt{\sum (H_Q[i]-H_N[i])2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where H_Q and H_N are color histogram for query image and database images respectively.
Add the Euclidean distance for each of the Blocks.
D=d1+d2+d3+d4+d5+d6

Shape: We use the chamfer matching technique in order to match the shape. Given a Shape Feature Vector we create the 3-4 distance transform and superimpose the polygon image on the distance image. The Distance between polygon image and the distance image is calculated and the similarity measure is calculated using the formula:

$$S= 1/3 \sqrt{1/N \sum_{i=1}^{n} (Vi)2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Texture: Four texture features are computed for all the blocks of an image and is used as feature descriptor. Euclidean distance is calculated for the features like energy, entropy, contrast, inverse difference for each block 'i' and the distance between query image 'Q' and existing image 'I' is given by:

$$Di(Q,I)= \sqrt{\sum (F_Q[j]-F_N[j])2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

T=d1+d2+d3+d4+d5+d6

Where 'j' refers to each feature of image. The Euclidean distance for each of the block is added. The total distance is sum of the distance for all six blocks and is given by 'T'.

2.4 Creating a Signature

Since a single feature may not help in retrieving images of our choice, we have combined three features of the image in order to retrieve relevant images. Hence, in order to produce efficient results, we use color, shape and texture features of an image and each of these features is weighted based on the experimental performance. Precision and recall is calculated for different values of weights assigned to the features and the best weights are selected based on the experimental results. The distance between the query image and the image in the database is calculated as follows:

$$D=w1*C+w2*T+w3*S \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Here, w1 is the weight of color features, w2 is the weight of texture feature, w3 is weight of shape feature and C,T,S are the distances calculated using Eq.(1) , Eq.(2) and Eq.(3).

3. Performance Analysis

Wang's [14] dataset comprising of 1000 Corel images was used for the analysis. The images are of the size 256 x 384 or 384X256.
We used recall, precision, f-measure in order to check the relevancy of image retrieval. The definitions of these three measures are given by following equations:

$$\text{Precision} = \frac{\text{No of relevant images retrieved}}{\text{Total no of images retrieved}} \quad \ldots\ldots. (5)$$

$$\text{Recall} = \frac{\text{No of relevant images retrieved}}{\text{Total no of relevant images in db}} \quad \ldots\ldots.. (6)$$

$$\text{F-measure} = \frac{(2 * \text{precision} * \text{recall})}{(\text{Precision} + \text{recall})} \quad \ldots\ldots (7)$$

In order to test the performance of proposed content based image retrieval system, 63 queries (3 from each category) are fired on the database of 1000 images spread across 21 categories. We calculate the precision, recall, F-measure as shown in equation (5, 6, 7), for the images retrieved based on color, texture, shape and image signature. The average precision and average recall are computed by grouping the number of retrieved images and is shown below:

Table 1: Precision, Recall, and F-Measure

Image	Precision	Recall	F Measure
1.Maldives			
Based on Color Feature	0.857142857	0.352941176	0.4999
Based on Texture Feature	1	0.3	0.4615
Based on Shape Feature	0.75	0.75	0.75
Combined Feature	0.391304347	0.9	0.5454
2.Buildings & Monuments			
Based on Color Feature	0.5242718446	0.84375	0.6466
Based on Texture Feature	1	0.3	0.4615
Based on Shape Feature	0.8888888888	0.32	0.4705
Combined Feature	0.8888888888	0.32	0.4705
3.Bus			
Based on Color Feature	0.5164835164	0.870370370	0.6481
Based on Texture Feature	1	0.1	0.1818
Based on Shape Feature	0.6785714285	0.655172413	0.6665
Combined Feature	0.5357142857	0.75	0.6249
4.Car			
Based on Color Feature	0.33112582	0.75757575	0.4607
Based on Texture Feature	1	0.14285714	0.2499
Based on Shape Feature	0.77777777	0.35	0.4827

Combined Feature	0.7032258	0.333	0.4519
5.Sheep			
Based on Color Feature	0.569230769	0.948717948	0.7115
Based on Texture Feature	0.272727272	0.3	0.2856
Based on Shape Feature	1	0.2	0.33333
Combined Feature	0.8	0.571428571	0.6666
6.Chimney			
Based on Color Feature	0.729411764	0.642857142	0.68
Based on Texture Feature	0.538461538	0.583333333	0.5538
Based on Shape Feature	1	0.125	0.2222
Combined Feature	0.714285714	0.4166666666	0.5262
7.Field			
Based on Color Feature	0.854166666	0.7454545454	0.7960
Based on Texture Feature	0.714285714	0.2941176470	0.4118
Based on Shape Feature	0. 714285714	0.6666666666	0.6895
Combined Feature	0.6	0.4	0.48
8.Kitchen Utensil			
Based on Color Feature	0.833333333	0.75	0.7893
Based on Texture Feature	1	0.2	0.3333
Based on Shape Feature	1	0.375	0.5454
Combined Feature	1	0.4	0.5714
9.Bird			
Based on Color Feature	0.69	0.7	0.6949
Based on Texture Feature	0.125	0.5	0.2
Based on Shape Feature	0.666666	0.285714285	0.3999
Combined Feature	1	0.428571428	
10.Fruit			
Based on Color Feature	0.66666	0.5	0.57
Based on Texture Feature	0.23333	0.314285714	0.267
Based on Shape Feature	1	0.307692307	0.4704
Combined Feature	0.5	0.407692307	0.44
11.Banana			
Based on Color Feature	0.3	1	0.4615
Based on Texture Feature	0.16	0.16	0.16
Based on Shape Feature	1	0.3	0.4615
Combined Feature	1	0.3	0.4615
12.Cycle			
Based on Color Feature	0.4380	1	0.609
Based on Texture Feature	1	0.2	0.333
Based on Shape Feature	0.75	0.6	0.666
Combined Feature	0.44285714	0.6	0.509
13.Bottle			
Based on Color Feature	0.5555555	1	0.714
Based on	0.41428571	0.5	0.45

Texture Feature			
Based on Shape Feature	1	0.3	0.46
Combined Feature	0.42777777	0.5	0.46
14.Spoon			
Based on Color Feature	0.5	0.916	0.6468
Based on Texture Feature	0.272727	0.409090	0.32
Based on Shape Feature	0.333	0.166666	0.22
Combined Feature	0.39	0.16666	0.23
15.Rose			
Based on Color Feature	0.79487179	0.775	0.78
Based on Texture Feature	1	0.05	0.09
Based on Shape Feature	0.5	0.2666	0.3472
Combined Feature	0.30588	0.35	0.32
16.Horse			
Based on Color Feature	0.58	0.8529	0.69
Based on Texture Feature	0.6667	0.16	0.25
Based on Shape Feature	0.4	0.2	0.266
Combined Feature	0.3831	0.2470	0.29
17.Road and Sky			
Based on Color Feature	0.7128	0.66667	0.684
Based on Texture Feature	0.5	0.3	0.375
Based on	0.6	0.375	0.4615

Shape Feature			
Combined Feature	0.5714	0.5	0.5327
18.Gunny Material			
Based on Color Feature	0.5517	0.8	0.6518
Based on Texture Feature	0.48	0.55	0.51
Based on Shape Feature	1	0.21	0.34
Combined Feature	0.33333	0.6	0.4258
19.Elephant			
Based on Color Feature	0.2884	0.75	0.40
Based on Texture Feature	1	0.2	0.333
Based on Shape Feature	0.2	0.2	0.2
Combined Feature	0.2	0.2	0.2
20.Seal			
Based on Color Feature	0.875	1	0.93
Based on Texture Feature	0.5454	0.857142	0.66
Based on Shape Feature	0.16	0.571428	0.24
Combined Feature	0.4	0.571428	0.4701
21.Purle Flower			
Based on Color Feature	0.571428	0.36	0.4434
Based on Texture Feature	0.25	0.1428	0.18
Based on Shape Feature	1	0.1428	0.24

Combined Feature	0.327586	0.775510	0.4521
22.Dull waters			
Based on Color Feature	0.313131	0.692307	0.4307
Based on Texture Feature	0.086	0.30769	0.13
Based on Shape Feature	0.5	0.25	0.333
Combined Feature	0.375	0.6	0.46

In this system, we send an image request from windows mobile. The search result was analyzed based on color, texture and shape individually as shown in figure 3. Average precision, recall, f-measure was calculated for each of these features.

Fig 3: Selection of Query Image in Windows Mobile6.0

Since the F-Measure for "Texture" is too low, we have assigned a lower weight for the texture feature. The weights varied for each features and it was observed that the number of false positives increases as the weights for color increases above 0.75. And the number of false negatives increases as the weights for color decreases below 0.35. A group of images were tested with varying color, shape, texture weights. Average precision, recall, F-measure was calculated for combined features. And it was observed that the color weight=0.75, shape weight =0.2, texture weight=0.05 provides the best results for given set of images.

The final image signature would be: (0.75*color_weight) + (0.2*shape_weight)+ (0.05*texture_weight)

The above value is calculated based on trial and error and the best match is selected from the features. The search result for the query image is listed below in figure 4.

Fig 4: Extraction of similar images from the web server

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