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Study of Texture features for Content Based Image Retrieval

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ABSTRACT

To retrieve the required images from databaseshas become an area of wide interest in many applications. Relevant images can be retrieved using unique image features like texture, color or shape. This paper presents a extensive survey of the Content Based Image Retrieval (CBIR) techniques based on texture features. Paper presents through discussion on three texture features used for development of CBIR systems. These features includesGray-Level Co-Occurrence Matrix (GLCM), Gabor filterand Local Binary Pattern (LBP). Performance analysis of these features is compared to showcase effectiveness in retrieval problems.

Keywords-CBIR,gray-level co-occurrence matrix (GLCM), Gabor filter, Local Binary Pattern(LBP).

I.INTRODUCTION

Image databases are used in many fields including biometric security, medicals and satellite image processing. Content Based Image Retrieval (CBIR) is a technique used to search images from such large image databases according to user's demand, which is known as query image. It is based on image visual contents, known as features.Most of the CBIR systems are developed using three basic image features which includes texture, color and shape of an image. Figure 1 shows general block diagram of CBIR system.

It consists of two major phases i.e. feature extraction and similarity matching. The features are extracted from images and formulated as feature vectors and stored in feature database for further use. When query image is given similar feature vector is extracted and compared with the stored feature vectors from feature database. If the distance among the feature vector of the query image and database image is insignificant enough compared with predefined threshold, then the corresponding image in the database is considered as a match to the query image and is retrieved[1].

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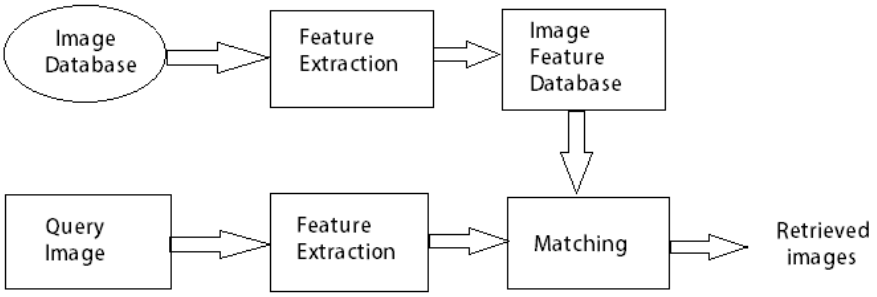


Fig1: CBIR block diagram system

Phase 1: Feature Extraction:

In this phase image feature are extracted using relevant feature extraction algorithms. The image features can be low level or high level image features. Low level image features includes color, shape and texture of an image [2,3].In computer vision applications like pattern recognition and in image processing, feature extraction starts from an initial stage. Feature extraction phase also includes dimensionality reduction. To find the subset in initial features is called feature selection. In this process selected features contain relevant information from the input data. This aids ease in performing retrieval using this reduced representation of the complete initial data.

Phase 2:Feature Matching:

This phase compares feature vector of query image with the feature vectors stored in feature database. When query image is given, its feature vector is extracted in a similar way as feature vector is extracted for database images. Then this feature vector is compared using appropriate distance measure such as Euclidian, Manhattan etc. The database images which exhibit smaller distance in this comparison are considered as beat match of query image. Such all images are member of retrieval result.

The CBIR founds applicationsin various field of day to day life which include fingerprint identification, biodiversity information systems, Military, digital libraries, crime prevention, Medical Diagnosis, historical research,etc. As CBIR can be implemented using various features, we here represents the study of CBIR systems which are implemented using various texture features such asGray Level Co-occurrence Matrix (GLCM), Gabor filter andLocal Binary Pattern(LBP).

The rest of paper is organized as followssection 2 gives brief reviewof workdone by earlierresearchersin the field of CBIR using texture features and section 3 presents concluding remark based on study presented in section2.

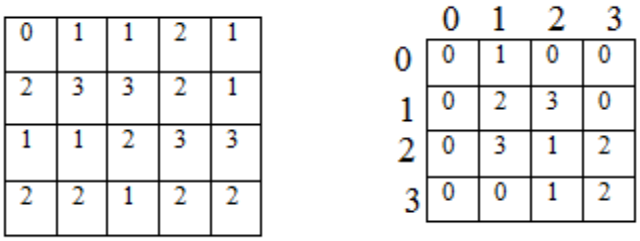
II. RELATED WORK

CBIR can be developed using color, shape and textures features. These features can be used individually or in combination with each other. We did extensive survey of recent development in CBIR system using these features. In this paper we are presenting discussion on some of significant method which are found to be more appropriate for development of CBIR system for many applications using texture features.

2.1 Gray Level Co-occurrence Matrix (GLCM)

The Gray-Level Co-occurrence Matrix (GLCM) is known as statistical technique and it is used for feature extraction. The GLCM represents the combination of different gray levels pixels in an image.Theco-occurrence matrix describes different textural feature descriptors likecontrast, correlation, energy, homogeneity etc. These features can be measured by using probability matrix.

Figure 2represents the formation of GLCM with 4 gray level images using 0°direction at distance d=1.Using figure 3 construction , 0^0 direction is applied to figure 2(a) and resultant 4x4 GLCM is given in figure 2(b) .



0	1	1	2	1
2	3	3	2	1
1	1	2	3	3
2	2	1	2	2

	0	1	2	3
0	0	1	0	0
1	0	2	3	0
2	0	3	1	2
3	0	0	1	2

Fig 2:(a)Example 4 gray level image matrix, (b)GLCM for distance 1 using 0° direction

Figure 3 shows GLCM at distance 1.With respect to center pixel (Cp) considering distance d=1 for all directions,when direction is 0^0, pixel value is 1; when direction is 45^0 pixel value is 2, when direction is 90^0 pixel value is 3 … this goes up to 8 pixels. Various image features can be extracted from such generated GLCM [4].

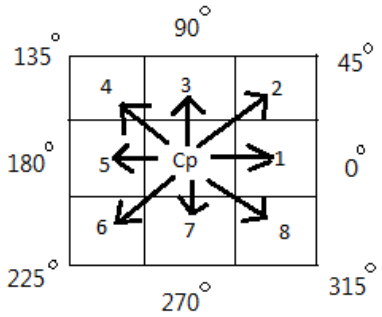


Fig 3: All GLCM generation directions

Anupam Mukherjeeet.al. [4] developed GLCM based CBIR system. GLCM features are extracted for a matrix composed of Histogram, Mean, Std.Deviation, SkewnessValues extracted for red, green and blue channels of an image .The CBIR system is tested on hundred images which includes Different categories such as dumbbell, pen, bus, flower etc.the performance is tested using retrieval precision and recall.

Hany F. Atlam, GamalAttiya, Nawal El-Fishawy[5] developed a system using GLCM. This system is tested on WANG database of 1000images.In this database each image having size of 256 x 384 and all these images are subdivided into 10 categories. These categories include African People, Beach, Building, Buses, Dinosaurs, Elephants, Flowers, Horses, Mountains and Food.The proposed system is developed using 22 texture features which are extracted fromGLCM. Thesefeatures includes: autocorrelation, contrast, maximal correlation coefficient, correlation, cluster prominence, cluster shade, dissimilarity, energy, entropy, homogeneity,

maximum probability, sum of squares, sum average, sum variance, sum entropy, difference variance, difference entropy, information measure of correlation1, information measure of correlation2, inverse difference, inverse difference normalized and inverse difference moment normalized. The performance of developed system is evaluate by using retrieval accuracy. The retrieval accuracy is ratio of number of relevant images retrieved to the total number of images retrieved expressed in percentage.For example, we consider total number of image retrieved=number of relevant images + number of irrelevant images. If the query results in 20 images with 15 relevant images , then the retrieval accuracy is(15/20) = 0.75.

Neha, TanviJain[6] developed GLCM system for image retrieval. This system is used Brodatz Texture Album database of 288 images including 18 different textures. Each texture part of the image is divided into 16 non overlapping images of size 256x256.Therfore using 18 different texture images out of this 16 relevant images are occurred ,thenprecision of 88% .

MettyMustikasari, SarifuddinMadenda[7] developed GLCM system for texture based image retrieval.Texture Library database is used for this system it includes, 78 Forest category images and 94 Wood category images. In this images are retrieved by using two distance methods first is City Block Distance and another is Euclidean Distance .The result for Wood category, average precision of 0.808 using City Block Distance and using Euclidean Distance average precision of 0.678.The result for Forest category, average precision of 0.888 using City Block Distance and average precision of 0.883 using Euclidean Distance.

2.2Gabor filter

Human visual system is sensitive to different scales and orientations of object. This characteristics can be simulated in machines using Gabor filter as they can be designed for different orientations and scales. Gabor filters are bandpassfilterand can be used for texture extraction.

Gabor filter is used for texture feature extraction because, texture segmentation have spatial and spatial-frequency both domains are required for measured simultaneous,Gabor filter have this ability to measures both of this with multi-resolution decomposition. A Gabor filter function is sinusoidal modulated Gaussian in the spatial domain. Below equation(1) is shows real response part of filter.σ_x andσ_y are spread in the x and y directions respectively for 2-D Gaussian curve, and a u_0 modulating frequency.

$$h(x,y)=\frac{1}{2\pi\sigma_x\sigma_y}\ exp\left\{-\frac{1}{2}\left[\frac{x^2}{\sigma^2{}_x}+\frac{y^2}{\sigma^2{}_y}\right]\right\}.\cos(2\pi u_{0x}) \quad \ldots\ldots(1).$$

The Gabor filter is shifted in modulating frequency at two Gaussian location in spatial-frequency domain.

Equation (2) shows the 2-D frequency response of filter,

$$H(u,v)=\exp\left\{-2\pi^2\left[\sigma^2{}_x(u-u_0)+\sigma^2{}_y v^2\right]\right\}+\exp\left\{-2\pi^2\left[\sigma^2{}_x(u+u_0)+\sigma^2{}_y v^2\right]\right\} \quad \ldots\ldots\ldots(2).$$

The equation(2) is represents only zero degrees orientation with respect to x-axis. Using rotation of spatial domain function and rotation of spatial-frequency domain function, the filter can achieved arbitrary rotation. Spatial function is rotating in spatial domain with *x-y* plane and frequency response is rotating in spatial frequency domain in *u-v* plane Where $u_0$is frequency and θ is rotation angle it defines the center location of filter[8].

JayamalaK.Patil, Raj Kumar[9]developed CBIR system using Gabor filter. Here Gabor filter and additional texture feature extractor which is combination of LBP and Gabor filter is used..In this system texture features are extracted for soybean plant leaf. Three major diseases named Alfalfa Mosaic Virus, Septoria Brown Spot and Pod Mottle are selected for experimentation. Database of leaf images are collected form Kolhapur and Sangali district of Maharashtra state of India. Authors concluded that retrieval precision of 50% is obtained using Gabor filter alone and 58% using LGGP which is derived from Gabor filter.

SatishTunga et.al.[10]developed Gabor filter for CBIR system. In this system Matlab is used for CBIR approach implementation. The database used in this system is includes 1000 images these are separated into 10 categories it means system having 10 classes each class contained with 100 images. System is calculated the average precision and average recall based on performance of model. To improve the effectiveness of system the Gabor filter and genetic algorithm are used therefore system is improve the retrieval rate in large database.Four images are used as query images these images are retrieved by value N=20, 30, 40 and 50 respectively. The result is gives for 4 images for example, consider image 1, precision of 95%, 100%, 100%, 92% respectively and recall of 73%.

Hamid A. Jalab [11] developed system for Gabor filter using Matlab software. The system tested image database contain 1000 images and it split into 10 class each class include 100 images. Out of 1000 images 80 images are used for testing purposed in which eight images choose randomly for each class as query images. The average precision of this system is 56.15% and average recall of 56.25%.

2.3Local Binary Pattern(LBP)

Local Binary Pattern(LBP) is one of the most powerful texture feature extraction descriptor. LBP descriptor is used for only gray scale images therefore first step in LBP is toconvert the color image into the gray level having scale from [0-255]. LBP operator is applied on each 3X3 neighborhood and the central pixel value in 3X3 matrix is replaced by calculating LBP for updating data matrix.

Where LBP is performed for each pixel in image. For example consider, 3x3 matrix pixel set is shown in figure 4 and each surrounding pixels are compared with central pixel start from top left pixel and it rotated clock-wise direction. When pixel value is grate than central pixel value then assigned value ‘1’ otherwise assigned ‘0’.After calculation LBP, central pixel value of matrix is replace by new value[12,13].

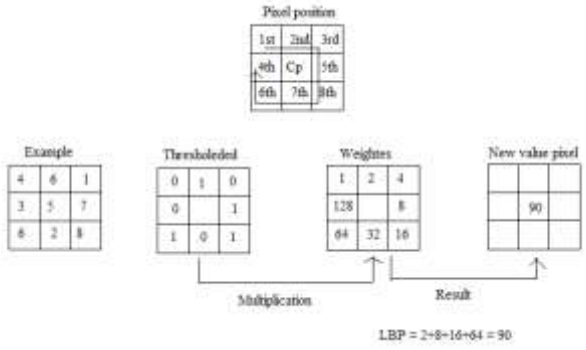


Fig4: LBP representation.

Hardeep Singh, Dr.DheerajAgrawal[14]developedsystem using Local Binary Pattern(LBP).Inthis system wang database is used with ten classes for experimentation. Precision of 60% is obtained in the developed system

ValtteriTakala et al.[15] developed two block-based texture methods, first method is block division and second is primitive blocks approach are used for content-based image retrieval (CBIR) using LBP. In this system Corel Gallery database is used.It consistof 1350 images in which 27 categories of 50 images each. These 27 categories are: Apes, Bears, Butterflies, Cards, Death Valley, Dogs, Elephants, Evening Skies, Fancy Flowers, Fireworks, Histology, Lighthouses, Marble Textures, Night Scenes, Owls, Rhinos and Hippos, Roads and Highways, Rome, Skies, Snakes Lizards and Salamanders, Space Voyage, Sunsets Around the World, Tigers,Tools, Waterscapes, Wildcats, and Winter.The developed LBP based CBIR system resulted in precision rates of 45% for 10 retrieved images.

Simily Joseph, KannanBalakrishnan [16] developed system CBIR using LBP .In this system TFEID (Taiwanese facial Expression Image Database) database is used which having 336 face expressions classified in eight categories. Single image and multiple image used as query image and this system is calculate precision for 5query image with single image query and multiple image query. For example the result query 5 with single query is precision of 75% and using multiple query result is precision of 80%.

Alaknanda Ashok, NitinArora[17] developed LBP for CBIR system this system is tested on database including more 1600 jpg still images resized this all image to 256x256 jpg. The result analysis for Flower, Animal, Vehicle, Natural scene is precision of 86%, 82%, 99%, 86% respectively.

III.CONCLUSION

The extensive survey of texture feature extraction methods for development of CBIR systems is done. These features includes GLCM, Gabor filter and LBP. The systems developed using these features were for different applications. It is found that each of these texture feature has advantages and limitations based on the application for which it is to be used. Based on specific application one may select one of the above discussed features or combination of these features for developmentof efficient CBIR system.

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