Texture Dependent Content-Based Image Retrieval System: A Review

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***Abstract*—**Texture features are considered as the most obvious and most intuitive form of image features. It is also a significant perception feature. When it is compared with characteristic of image such as shape and color etc., features of texture are robust and stable. It is not susceptible to translation, revolution, and variations level. In addition, the texture attribute evaluation is undemanding and easier. A texture nature is the majorly adopted technique to take out the contributions of texture. In this paper, the texture traits, applications, and challenges of the Content-Based Image Retrieval (CBIR) system is reviewed and also analyzed.

Keywords*—CBIR; Texture features; Applications; Challenges.*

I. INTRODUCTION

CBIR is considered as one of the most efficient ways of deploying visual data. It handles with the contents of image like shape, color, and structure of image in spite of texts that are annotated. A large quantity of data retrieval restricts the conventional database technology; anyhow the conventional text-object database was not able to satisfy the necessities of an image database [1]. The conventional way of an annotated image by means of text reduces the effective and automatic image description. For implementing CBIR, the system requires understanding and thus interprets the content of images that are managed [2] [3]. The recovery index has to be generated that offers best recovery interface to customers. It further denotes the contents of an image that are directly recovered, through which the images with particular characteristics or including specific content will be explored in an image database [4]. The important idea of CBIR is to investigate the information of image by low characteristics of an image that involves texture, spatial relationship of objects, color, and shape, etc., and to build up characteristic vectors of an image [5] [6].

Retrieval techniques concern on similar recovery and are significantly executed corresponding to the various dimensional image features [7]. As images are possessed with rich contents in the absence of language limitations to assess international exchanges, etc., CBIR has very important and broad applications in many regions involving medical science, military affairs, architectural design, education, agriculture and the justice department, etc. [8] [9] [10]. Several CBIR systems have been created gradually. Typical examples of the CBIR retrieval systems comprises of, Netra, VisualSEEk, etc. [11] [12] [13].

Because of the effectiveness, robustness, low storage requirements and implementation simplicity advantages, color has been the most efficient characteristics, and most probably all the CBIR systems deploy colors [13] [14]. The texture feature is another most widely adopted feature in CBIR that targets to capture the repetitive patterns and granularity of surfaces within an image [15] [16] [17]. In the MPEG-7 standard, a group of texture and color descriptors including spatial color descriptors, histogram-dependent descriptors, and texture descriptors was described to interpret images that are natural [18] [19] [20].

This paper contributes the CBIR system by conducting an expanded review on it. Further, the features, applications, and challenges of CBIR system are reviewed and analyzed. The paper is arranged as follows. Section II depicts the reviews and related works done under this topic. Section III discusses the problem definition, and section IV terminates the paper.

II. STATE-OF-THE-ART OF CBIR TECHNIQUES

A. Related works

In 2017, Fadaei *et al.*[1] has presented a novel local pattern descriptor known as Local Derivative Radial Pattern (LDRP) for texture illustration in content-dependent image recovery. The implemented LDRP is dependent on gray-level variation of pixels throughout a line and their combinations that were weighted. Moreover, multi-level coding in various directions was employed rather than binary coding. The computation of the implemented method was compared with previous methods as well as local derivative pattern (LDP) etc.

In 2017, Islam [2] has suggested CBIR system with significance in one common objective and two face image databases by means of two MPEG-7 image descriptors. The implemented method adopts various complicated fuzzy-rough characteristic selection procedures and joins the outcomes of these methods to attaining a well-known feature subset for representing an image for a specific query. The efficiency of the implemented technique is improved by the comparative outcomes achieved from various single dimensionality minimization processes.

In 2017, L.K. Pavithra and T. Sree Sharmila [3] have implemented new hybrid architecture for CBIR system to signify the accuracy problems related to the conventional image recovery systems. The implemented structure primarily chooses pertinent images by means of color moment information. Consequently, Local Binary Pattern (LBP) and

Canny edge detection techniques were utilized to extract the edge and texture characteristics respectively. Then the performance of the implemented hybrid framework by means of recall and precision measures were estimated.

In 2017, Mutasem K. Alsmadi [4] has suggested widespread important and robust features that were extracted from image database and they were further accumulated in the feature repository. This feature group included color signatures by the color and shape texture characteristics. The characteristics were taken from the provided QI in the same fashion. The outcomes were better to other conventional CBIR systems concerning precision.

In 2008, Chun *et al.* [5] suggested a CBIR technique which is based on a well-organized mixture of a variety of texture along with resolution color characteristics. The description of color, auto-correlograms in color of the shade and diffusion constituent images in HSV space is deployed. Moreover, the implemented method always demonstrates the performance gain in recall versus precision and in Average Normalized Modified Retrieval Rank (ANMRR) over the other methods.

In 2016, J. K. Dash *et al.* [6] presented a new CBIR method. According to this technique, efforts are implemented to minimize the whole exploration time of the currently implemented technique called CMR. The implemented technique detects the self-assurance in the categorization and restricts the exploration to a particular output group and consequently, minimizes the entire exploration time by 21.76% when distinguished with CMR. Quantitative techniques are implemented to choose different variables adopted in the algorithm that is executed for previous CMR methods. Simulations performed on several databases including various complications regarding the texture classes, size, and direction.

In 2016, Ashnil Kumara *et al.* [7] suggested a technique for the routine semantic explanation of medical images that leverages techniques from CBIR. CBIR is an image exploring skill, and it further utilizes image features to signify the high-level semantics described in such images. This technique broadens CBIR methods to retrieve or recognize a compilation of labeled images which have related low-level descriptions and further adopts the compilation to establish the sophisticated semantic observations. This method was distinguished with numerous well-established baseline methods (regression and classification), and it has revealed that this technique has attained the maximum exactness in the explanation of CT images.

In 2017, Yanyan Xu *et al.* [8], anticipated a privacy-preserving CBIR technique dependent on orthogonal decomposition. The image is partitioned into two dissimilar elements, for which feature extraction and encryption were implemented individually. Consequently, cloud server can extract the characteristics directly from an encrypted image and evaluate them with the characteristics of the queried images, so that users can acquire the image. Results from experiment established that the implemented method can attain better retrieval performance and better security.

In 2016, Mistry *et al.* [9] presented a hybrid feature dependent well-organized CBIR system by means of different distance measures. Spatial domain characteristics together with, HSV histogram features, color moments, auto-correlogram and frequency domain characteristics like moments by means of SWT, features by means of Gabor wavelet transform were utilized. In addition, to improve accuracy binarized statistical image quality and edge directivity and color descriptor characteristics are engaged for improving well-organized CBIR system. A variety of distance metrics were employed for retrieval. Experimental results demonstrated that the implemented approach achieves better precision when compared to other conventional systems.

In 2016, Zhihua Xiawe *et al.* [10] suggested a method which helps CBIR images devoid of edifying the susceptible information to the server in cloud. Initially, the characteristic vectors are taken out to signify the related images. Subsequently, the filters were built up with the locality-responsive hashing to expand the effectiveness of search. Subsequently, the characteristic vectors are secured by the k-nearest neighbor (kNN) algorithm. The experiment proves the efficiency and security of the implemented scheme.

In 2017, Mutasem K. Alsmadi [11] proposed a method that extracts robust and significant characteristics expansively from the database of the images. These characteristics are subsequently kept within the characteristic arsenal. This characteristic position is included with features of color and shape. Here, from the provided QI, characteristics are extracted in the similar approach. Consequently, a new estimation of similarity utilizing a meta-heuristic algorithm was performed among the query image characteristics and the database images characteristics. Consequently, new estimation of similarity utilizing a meta-heuristic algorithm was conducted among the database image features and the query images features.

In 2017, Min Huang *et al.* [12] introduced the color instant in RGB space in mixture within HSV color space that was utilized for characteristic extraction of color. The enhanced Zernike instants were exploited for extraction of properties in shape, and the gray level matrix was exploited for extraction of texture features. Investigational results illustrated that the image recovery technique dependent on various fusions had improved recovery presentation.

In 2016, Davar *et al.* [13] implemented a new technique to recover images of various prospects by establishing a new image descriptor. The implemented descriptor facilitates with Local Ternary Pattern (LTP), Histogram of Oriented Gradients (HOG), etc. and other feature descriptor that can be employed on the image pixels. Comprehensive simulations have been performed by means of different image features and different classifiers to reveal the superiority of the implemented method.

In 2016, Jayamala Kumar Patil and Raj Kumar [14] suggested an attempt to describe CBIR system constructed for recovering leaves of soybeans that were diseased. It utilizes shape, color and texture characteristics of leaf. The color features are obtained by means of HSV color histogram. Scale Invariant Feature Transform (SIFT) offers shape

characteristics in the type of matching key points. Combined characteristics achieved average recovery effectiveness of 80% for the top 5 recovery and 72% for the top 10 recovery. This recovery precision was dependent on database and differs with database size and image quality.

In 2011, Jun Yue *et al.* [15] suggested a technique to extract texture and color features of an image rapidly for content-based image retrieval (CBIR). Initially, HSV color space was enumerated rationally. Texture features and color histogram dependent on a co-occurrence matrix were taken out to form feature vectors. The related recovery testing demonstrated that the fused characteristic retrieval obtains better visual feeling than the single feature recovery that means improved recovery results.

In 2017, Sadegh *et al.* [16] suggested CBIR method where the DCD characteristics are extracted primarily as the color features, and after that, a suitable comparison measure is employed. In addition, numerous curvelet and wavelet properties are described as texture characteristics to prevail over the difficulty of image translation and noise. At last, the texture and color features are optimally joined by means of the particle swarm optimization (PSO) algorithm. Moreover, the optimum combination defines the average precision of 76.50 % that was considerably higher than other conventional methods.

In 2014, Nishant Shrivastava and Vipin Tyagi [17], suggested a novel technique for image retrieval which is dependent on selective regions matching by means of region codes. The entire images in the database are evenly partitioned into various regions, and every region was allocated with a 4-bit region code dependent upon its location associated to the central region. Local Binary Pattern (LBP) and dominant color dependent texture characteristics are extracted from these areas. Experimental results demonstrated that the implemented method minimizes the image retrieval time and increases the accuracy.

In 2014, P. Vijaya Bhaskar Reddy and A. Rama Mohan Reddy [18] integrated the theory of local directions and their model for CBIR and indexing. The directional local extrema pattern (DLEP) takes the edge details dependent on local extrema directions in 0◦, 45◦, 90◦, and 135◦ in an image. Anyhow, no focus is kept on the directions of local extremas. The outcomes after being demonstrated a certain improvement regarding the estimation process when compared with the other conventional methods.

In 2014, Pengcheng Shangguan and Imad L. Al-Qadi [19], presented a novel technique to deduce the data for quantification. The technique is dependent on the surveillance that various stinking levels produce dissimilar textures in GPR. The technique was modeled subsequent to CBIR process that involves, similarity measurement, and feature extraction. Initially, texture characteristics were extracted by means of DWT. Secondly, resemblance calculation was done. GPR data was employed to compute the preciseness of the method. The accuracy was 93% that illustrates the efficiency of the algorithm.

In 2014, Subrahmanyam Murala and Q.M. Jonathan Wu [20] introduced new image retrieval and indexing algorithm for CBIR. By deploying the local difference operator (LDO), local images are obtained which is partitioned into sign and magnitude. Examination exposed a capable attainment of technique on distinguishing to S-LBP and availing transform methods regarding the estimation.

TABLE I. REVIEW ON THE STATE-OF-THE-ART OF CBIR METHODS FOR MEDICAL IMAGE

Author [citation]	Adopted methodology	Features	Challenges
Fadaei *et al.* [1]	LDRP system	❖ Offers better precision ❖ More robust	❖ Needs more feature matching processing rather than VisTex data base.
Islam *et al.* [2]	Fuzzy rough set model	❖ Improves the retrieval performance ❖ Not too much computational burden	❖ No extraction and combination of multiple MPEG-7 descriptors from image-block.
L.K. Pavithra, T. Sree Sharmila *et al.* [3]	LBP with Manhattan similarity measure	❖ Offers better average precision ❖ Better computational efficiency	❖ High feature dimensions are not considered.
Mutasem K. Alsmadi, *et al.* [4]	Memetic algorithm	❖ Offers better precision ❖ Strong capability to discriminate color, shape, and color texture features.	❖ No employment of filtering techniques.
Chun *et al.* [5]	Multi-resolution wavelet domain	❖ Offers better average precision ❖ Better computational efficiency	❖ High feature dimensions are not considered.
Dash *et al.* [6]	CM-CCR algorithm	❖ Better speed of retrieval ❖ Offers better flexibility and threshold	❖ Reported results are unbiased to the training data.

Ashnil *et al.* [7]	Weighted Nearest-Neighbours.	❖ Higher accuracy in annotation ❖ Effective in high dimensional spaces	❖ No consideration of robust missing values ❖ No implementation of data augmentation methods
Yanyan Xu *et al.* [8]	CEW scheme	❖ Can retrieve image from encrypted image database directly without violating data privacy ❖ No restrictions in using special encryption algorithms	❖ Applying more effective feature extraction algorithm to improve retrieval accuracy is still an open problem.
Yogita Mistry *et al.* [9]	SWT method	❖ Better in terms of precision ❖ Offers higher retrieval rate	❖ More execution time ❖ Increased feature vector size
Zhihua Xia *et al.* [10]	k-NN algorithm	❖ The similarity scores can be directly calculated ❖ Allows the cloud server to order the recovered results	❖ Increase in dimensionality increases the time consumption
Mutasem K. Alsmadi [11]	GLCM based retrieval	❖ It recovers images related to the query image. ❖ Strong capability in varying shape, color and texture features	❖ No employment of the techniques of filtering
HUANG Min *et al.* [12]	Zernike moments	❖ Better recovery effect of the image. ❖ Offers better capability between multiple characteristics	❖ Retrieval preciseness will be minimized with increase in the recovery time
Davar *et al.* [13]	SIFT method	❖ Captures higher level of semantic by extending the ability of pixel-based descriptors. ❖ Captures the appearance and shape of the local object.	❖ No exploitation in the framework of bag of features on large datasets
Jayamala Kumar Patil and Raj Kumar [14]	LGGP	❖ Provides maximum average retrieval efficiency ❖ Provides promising results for the retrieval of diseased leaf images using combination of color, shape and texture features	❖ No consideration on increased random database and clean database
Jun Yue *et al.* [15]	Grey-level co-occurrence matrix	❖ Offers better average precision ❖ Better computational efficiency	❖ High feature dimensions are not considered.
Sadegh *et al.* [16]	PSO algorithm	❖ Offers better accuracy ❖ Improves the average precision metric.	❖ No exploitation of segmentation scheme to extract the features from more important regions of the image
Nishant Shrivastava and Vipin Tyagi [17]	LBP	❖ Increases the accuracy ❖ Improves the of retrieval effectiveness ❖ Reflects the intent of users	❖ No consideration on overlapping region with the ROI
P. Vijaya Bhaskar Reddy and A. Rama Mohan Reddy [18]	DLEPs	❖ Significant improvement in retrieval performance ❖ Small increment of computational cost	❖ If magnitude of local extremas was not considered, performance of the system could not be increased

Pengcheng Shangguan and Imad L. Al-Qadi [19]	GPR	❖ Highest retrieval rate ❖ Interprets GPR data accurately, continuously, efficiently and without user dependence	❖ No deployment of different types of ballast materials and fouling materials
Subrahmanyam Murala and Q.M. Jonathan Wu [20]	RLBP algorithm.	❖ Improves the efficiency of retrieval ❖ Offers increased robustness of the system	❖ Highly complex

B. Taxonomy of texture analysis

Several texture feature analysis were available for image retrieval system. The overall taxonomy of texture analysis is shown in Fig. 1.

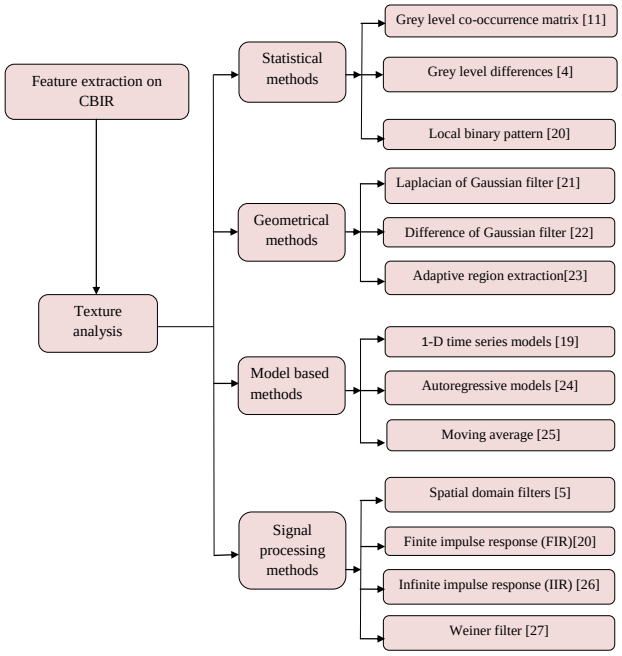

Fig. 1. Overall taxonomy of the image retrieval system

III. PROBLEM DEFINITION

Table 1 shows the methods, features, and challenges of conventional techniques based on CBIR protocols. At first, LDRP is discussed in [1] that offers better precision. Also, it is considered to be more robust. Anyhow, it needs more feature matching processing rather than VisTex database. Moreover, Fuzzy rough set model is proposed in [2] which improve the retrieval performance without much computational burden. However, there is no extraction and combination of multiple MPEG-7 descriptors from image-block. In addition, CBIR is suggested in [3] that provide better average precision and better computational efficiency, but the high feature dimensions are not considered in this paper. Memetic algorithm is presented in [4] which has strong capability to discriminate color, shape and color texture features. Also, it provides better precision, however, there is no any employment of filtering techniques that remains as a drawback of this method. Further, CBIR is suggested in [5] that provide better average precision and better computational efficiency, but the high feature dimensions are not considered in this paper. CM-CCR is implemented in [6] that provides improved retrieval speed and also offers better flexibility and threshold characteristics. Anyhow, the results that are reported to the training data are unbiased. Weighted Nearest-Neighbours is suggested in [7] that offers higher annotation accuracy on small datasets. Further, it offers efficiency in high dimensional spaces. However, there is no consideration of robust missing values and no evaluation of data augmentation techniques to boost the number of training samples. In addition, CEW is implemented in [8] that can retrieve image from encrypted image database directly without violating data privacy. Also, there are no any restrictions in using special encryption algorithms. Anyhow, applying more effective feature extraction algorithm to improve retrieval accuracy is still an open problem. SWT is suggested in [9] that offers better precision and offers higher retrieval rate, but it consumes more execution time and extended feature vector size. Moreover, kNN is implemented in [10] in which the similarity scores can be directly calculated. Anyhow, increase in dimensionality increases the time consumption. GLCM is suggested in [11] which, offers strong capacity in distinguishing color, shape and color texture features. However, there is no any employment of the techniques of filtering in this method. Similarly, Zernike moments are established in [12] that provides better retrieval of image and offers better capability between multiple features. Anyhow, the recovery precision of the image will be diminished with an increase in the retrieval time. SIFT is suggested in [13] which captures semantic by the ability of pixel-based descriptors, and also it captures the appearance and shape of the local object. However, there is no any exploitation in the structure on large datasets. LGGP is proposed in [14], which allows maximum average retrieval efficiency and promising results for the retrieval of diseased leaf images using combination of color, shape and texture features. Anyhow, there is no consideration on increased random database and clean database in the corresponding method. Further, CBIR is suggested in [15] that provide better average precision and better computational efficiency, but the high feature dimensions are not considered in this paper. Moreover, PSO algorithm is established in [16] that offer better accuracy by improving the average precision metric. Anyhow, there is no exploitation of segmentation scheme to extract the features from more important regions of the image. LBP is discussed in [17] which Increases the accuracy and further, it imitates the user's intent in a better way. However, there is no consideration on the partial overlapping region with the ROI. DLEPs are suggested in [18] that offers important developments in retrieval with small augmentation of cost performance. Anyhow, if the magnitude of local extremas was not considered, performance of the system could not be

increased. In addition, GPR is proposed in [19] that offers highest retrieval rate. It also interprets GPR data continuously, accurately, efficiently and without user dependence. However, there is no deployment of different types of ballast materials and fouling materials. Moreover, RLBP algorithm is discussed in [20] that provide increased the robustness of the system with improved efficiency of retrieval, but it is highly complex. Thus the methodologies, features, and challenges of the conventional methods in CBIR systems are analyzed.

IV. RESEARCH GAPS AND CHALLENGES

Although CBIR systems is ued in many applications, it still carries certain issues. The biggest problem in CBIR system is to integrate versatile methods for assessing images of various categories and characteristics. Semantic-gap gives the other most important crises in the novel, which is a gap among the contingent indulgent semantics by pixel domain execution by means of human perceptions of visual cues and of low-level cues of provided image. For improvement of a real-time CBIR systems, the processing time of query response and feature time have be optimized further. Moreover, particular crises, pertaining to domains of application have to be defined for meeting application-specific needs.

V. CONCLUSION

This paper has presented the review on CBIR system with texture basis, which was considered as the most important and most basic method for CBIR. Texture features were the most obvious and most intuitive form of image features. It was also a significant perception feature. When it was distinguished with other image features such as shape and color etc., texture features were very robust and stable. It was not sensitive to translation, rotation, and variations of scale. In addition, the texture feature evaluation was simple and easier. A texture histogram was the most exploited technique to extract the features of texture. In this paper, the texture features, applications, and challenges associated with CBIR system was reviewed and analyzed.

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