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Image Retreivel using DWT and new Dimensionality Reduction Methods: A Review

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***Abstract*—Content based face image retrieval (CBFIR) is a hot research topic since the last decade. Face image retrieval techniques can be used in applications such as Crime prevention, Security Check, etc. This review paper focuses on a specific domain of Content based image retreivel (CBIR) that involves the development of a content-based facial image retrieval system based on Combination of wavelet transform and dimensionality reduction methods. Features are extracted using combinations of Discrete Wavelet Transform (DWT)-Principal Component Anal- ysis (PCA), Discrete Wavelet Transform-Generalized Principal Component Analysis (GPCA), Lifting Wavelet Transform (LWT)- Principal Component Analysis and Lifting Wavelet Transform- Generalized Principal Component Analysis. K-NN classifier is incorporated to enhance the retrieval rate. The experimental databases used for this retrieval problem are CalTech and Indian. Manhattan distance measure is used for similarity measurement.**

***Index Terms*—Content based face image retrieval, Lifting Wavelet Transform, Principal Component Analysis, Generalized Principal Component Analysis.**

I. Introduction

CONTENT-BASED image retrieval (CBIR) is a method of searching, browsing, and querying images according to their content. A specific domain of CBIR that involves the development of a content-based facial image retrieval system based on the constrained independent component analysis (cICA). Originating from independent component analysis (ICA), cICA is a source separation technique that uses priori constraints to extract desired independent components (ICs) from data.

In this approach, in addition to a single image-based query, a compound query with multiple query images can be used to search for images with compounding feature content. cICA technique will extract a set of ICs from the whole database using query images as the constraints. The query images are considered as reference information specified by the users. Obviously, the more accurate the user information is, the better the results of IC extraction in terms of retrieval results will be. Then, the extracted ICs are used to reconstruct the database.

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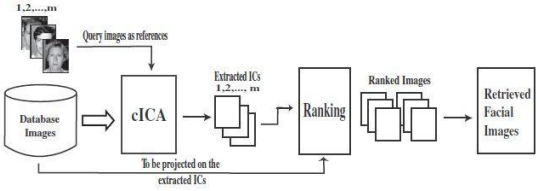

Fig. 1. Architecture of the cICA-based CBIR system

Finally, the similarity between each image in the database and its reconstruction is evaluated for ranking.

cCIA technique supports single and multiple image query requirement. But efficiency of face image retrieval is more in the case of two and three queries than single query. Feature extraction technique of cCIA is very sensitive to scale, rotation and translation. Another important disadvantage of the cCIA technique is, it requires large dimensional space to store the extracted features of the images.

Image retrieval can be used in Criminal investigation system, Medical imaging,Surveillance and Security, Forensic department, Searching specific faces on internet. E.g. Google search.

In Image processing, Feature extraction of face image and Dimensionality reduction methods etc are included. The object implies the purpose of this research. In this, objectives are analyze the frame work of thesis, study the retrieval of face images with the help of different databases, especially Indian and CalTech, different methods to incorporate the databases with MATLAB, study the different types of feature extraction methods of face images, study about Discrete Wavelet Transform (DWT), study about Lifting Wavelet Transform (LWT), analyze the comparison between DWT and LWT, study dimensionality reduction methods like PCA and GPCA It is to analyze the face image retrieval using o LWT-PCA o DWT-PCA o LWT-GPCA o DWT-GPCA, analyze the retrieval rate for each algorithm. Feature extraction of entire database requires large storage space, Limited availability of time, Difficulty in incorporating Indian database with Matlab.

The rest of the report is organized as follows. In Section II, all the reference papers used for the study of this thesis is introduced. The First author's proposed M. Tech. project is explained in the Section III. Section IV will give the brief idea about the applications. Section V Summarizes this paper with some concluding remarks.

II. Current State of the Art

There are so many literature found in the field of image retrivel based on content based methods. Nguyen Duc et. al. [1] proposed a Content-based facial image retrieval using constrained independent component analysis.It focus on a specific domain of content-based facial image retrieval system based on the constrained independent component analysis (cICA). Originating from independent component analysis (ICA), cICA is a source separation technique that uses priori constraints to extract desired independent components (ICs) from data. By providing query images as the constraints to the cICA [6], the ICs that share similar probabilistic features with the queries from the database can be extracted. Then, these extracted ICs are used to evaluate the rank of each image according to the query. The experimental results obtained on the AR, CalTech, Yale,Olivetti Research Laboratory (ORL) dataset show an impressive accuracy for single image query and for multiple image query.

The N. Lavanyadevi.et.al. [2] compares the performance of face image retrieval system based on discrete wavelet transforms and Lifting wavelet transforms with principal component analysis (PCA). These techniques are implemented and their performances are investigated using frontal facial images from the ORL database. The Discrete Wavelet Transform is effective [7] in representing image features and is suitable in Face image retrieval. Lifting scheme has such intriguing properties as convenient construction as well as flexible adaptively.

The J. P. Ananth et.al. [3], proposed an orthogonal moments were employed as features for the retrieval task. Due to the orthogonal property, these moments are inherently non-redundant revealing good image representation capability. Racah moments defined in a non uniform lattice are evidenced to be better than other orthogonal moments in terms of reconstruction error. Face image retrieval using Dual Hahn moment [8], Racah moment and Tchebicef moment features has been extensively experimented with YALE face database and FERET Database. FERET give 97 and YALE give 93 of retrieval rate for dual Hahn moment and YALE give 93 of retrieval rate for dual Hahn moment.

Content frames which are crucial in instructional video are very rich with textual regions. This fact should be taken into account while selecting representative video clips from content segments. The method proposed in [7] and discussed in previous subsection performs poorly on images with textual contents.

The W.S. Besbas et.al. [4]investigated the problem of CBIR of face images in transform domain. Features of the face image are extracted in the spectrum domain of a selected transforms. These transforms are Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Contourlet Transform (CT), and the proposed use of Walsh Hadamard Transform (WHT). For the performance analyses of features selection methods four face images databases are used. These are ”Sheffield face database”, ”Olivetti Research Laboratory (ORL) face database”, ”Indian face Database”, and ”Georgia Tech (GT) face database”. Euclidian and City block distance measures are analyzed to evaluate the performance of the retrieval process.DWT give a better retrieval accuracy of 73.33.

In this work, orthogonal moments were employed as features for the retrieval task. Due to the orthogonal property, these moments are inherently non-redundant revealing good image representation capability. Racah moments defined in a non uniform lattice are evidenced to be better than other orthogonal moments in terms of reconstruction error. Face image retrieval using Dual Hahn moment, Racah moment and Tchebicef moment features has been extensively experimented with YALE face database and FERET Database. FERET g and YALE give retrieval rate for dual Hahn moment. Since color plays no role in defining the content, the frame is first converted into gray scale and the histogram h(i) is computed.

The Jieping Ye et.al. [5], gave a new dimension reduction scheme, called Generalized Principal Component Analysis (GPCA), is presented. This scheme works directly with images in their native state, as two-dimensional matrices, by projecting the images to a vector space that is the tensor product of two lower-dimensional vector spaces. GPCA is a significant extension of PCA. The key difference between GPCA and PCA is that GPCA works on the matrix representation of images directly, while PCA uses a vector representation. GPCA [9] has asymptotically minimum memory requirements, and lower time complexity than PCA, which is desirable for large face databases. GPCA also uses transformation matrices that are much ‘smaller than PCA.

The Tae-Kyun Kima et.al. proposed [10] ,the image descriptor is obtained by decomposing a face image into several components and then combining the component features. Each facial component is represented in its Fisher space and LDA is then applied to compactly combine the features of the components. To enhance retrieval accuracy further, a simple pose classification and transformation technique is performed, followed by recursive matching. The experimental results obtained on the MPEG-7 dataset show an impressive accuracy.

The Peichung Shih et.al. [11] assesses comparatively the performance of content-based face image retrieval in different color spaces using Principal Component Analysis (PCA). In particular, we comparatively assess 12 color spaces (RGB, HSV, YUV, YCbCr, XYZ, YIQ, Lab, UVW, Luv, I1I2I3, HSI, and rgb) by evaluating 7 color configurations for every single color space. A color configuration is defined by an individual or a combination of color component images. Experimental results using FERET and FRGC(Face Recognition Grand Challenge) color images. Color configurations, such as Y and V in the YUV color space and Y,I in the YIQ color space, help improve face retrieval performance.

The locations for high quality frames give the temporal marking around which the desired video clips are to be selected, along with the audio. There are two points to be taken care of during clip selection. First one is the temporal duration of a clip. It should be neither too short such that it is incapable of conveying any pedagogic content, nor too long such that variety would be lacking in the generated video capsule. The second one is the proportion in which the snippets from the different classes of instructional activities are to be combined

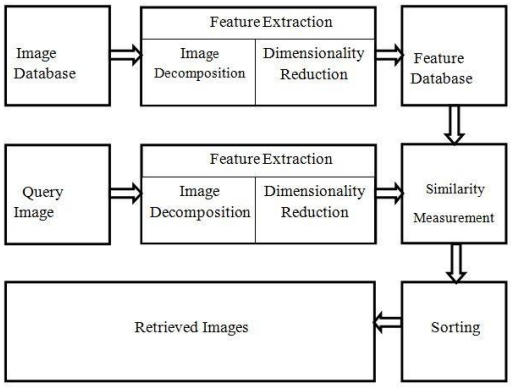

Fig. 2. Block Diagram of image retrivel with DWT and GPCA

Fig. 3. Some images in Indian database

to produce the synopsis.

III. Proposed M.Tech. Project

The proposed method will be using the two efficient methods DWT and GPCA. In this work, retrieval of face image will performed using single image query instead of multiple queries. The Databases selected for this retrieval work is Indian and Caltech. From the Literature survey, it is very clear that combinations of transform and dimensionality reduction method are used for better image retrieval rate. Hence in the proposed work We have selected DWT-GPCA, DWT-PCA, LWT-GPCA and LWT-PCA methods for face image retrieval from the databases. The block diagram of proposed work is shown in the Fig 2. Preliminary stages of the thesis work as shown in the Fig 2 that have been performed in Matlab. We have incorporated the face image databases such as Indian and CalTech with Matlab and extracted all the texture features of the images using Discrete Wavelet Transform (DWT).Thease can be seen in the Fig 3 and Fig 4.All these extracted texture features are stored for future development.

DWT is widely used for multi-scale image analysis. It decomposes an image into four sub-bands: an approximated image and horizontal, vertical, and diagonal detailed images.

The detailed images measure variations along the columns

Fig. 4. Some images in Caltech database

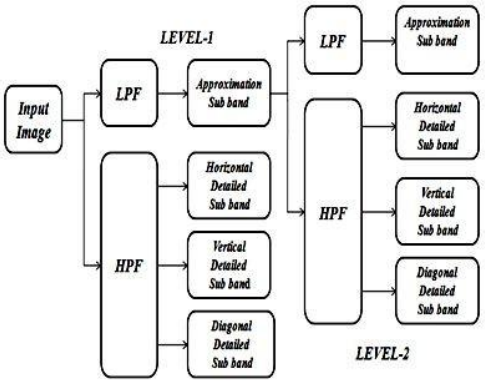

Fig. 5. Image Decomposition using DWT

(horizontal edges), rows (vertical edges), and diagonals (di- agonal edges) respectively. A signal is decomposed into a set of basis functions called wavelets in DWT can be see in Fig
5. More than one decomposition level may be utilized for face retrieval task to give reduced but meaningful information describing face image.

Dimensionality reduction technique GPCA and PCA is better than ICA and CICA in case of single image query. GPCA or PCA is can be used to extract the face image features with reduced dimension. But for better retrieval rate we can use any transforms like DCT, WH and DWT. DWT will give better performance. Combination of dimensionality reduction technique and wavelet transform such as DWT-GPCA will give better performance than dimensionality reduction technique alone.

k-NN stands for k-Nearest Neighbour. It is a simple su- pervised classification method.It can be see in the Fig 6. In k-NN , the learning algorithm consists of three steps. For classification purposes, a query q is given to know its class. In k-N N, the class of q is identified as follows: Calculate distances between all training vectors and test vector, Pick k closest vectors,Calculate average/majority First of all calculate the distance between the training vectors and test vector. Here test vector is the query feature vector and training vectors are the database feature vector. Then pick the k database feature vector (training vectors), which are closest to query feature vector (test vector). Based on the majority of these k feature vector the class of q is determined. Fig 6 shows the pictorial representation of this method, assume there are only two attributes A1 and A2, and two different classes. Circles with solid fill represent sample from class one and circles with hashed fill represent sample from class two. Here k is taken as 3, i.e. query q is being classified by its 3 nearest neighbors.Out of three nearest neighbor of q two neighbours are from class one and other is from class two. Since the majority of neighbours are belonging to class one, the query is belongs to class one. Usually k takes odd numbers to avoid ties.

Distance measures are the essential parameters in content- based image retrieval to compare two images in various

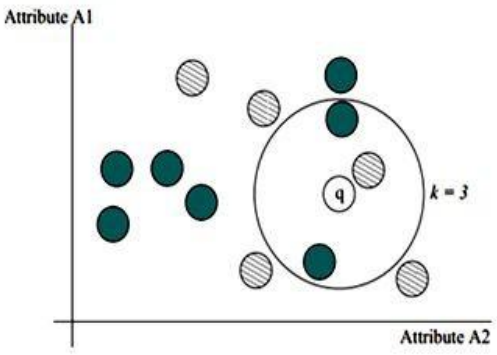

Fig. 6. Example of k-NN Classifier

dimensions such as color, texture, shape, etc... . Euclidian, Manhattan, cosine, Canberra, Square cord, etc is the most commonly used distance measures. Manhattan distance measure is used in this work. Manhattan distance is the summation of modulus of differences between coordinates of a pair of objects.

IV. Applications

The CBIR technology has been used in several applications such as fingerprint identification, biodiversity information systems, digital libraries, crime prevention, medicine, historical research, among others. The use of CBIR can result in powerful services that can benefit biomedical information systems. Three large domains can instantly take advantage of CBIR techniques: teaching, research, and diagnostics.From the teaching perspective, searching tools can be used to find important cases to present to students. Research also can be enhanced by using services combining image content information with different kinds of data. Similarity queries based on image content descriptors can also help the diagnostic process. Clinicians usually use similar cases for case-based reasoning in their clinical decision-making process.In biodiversity information systems,Biologists gather many kinds of data for biodiversity studies, including spatial data, and images of living beings. Ideally, Biodiversity Information Systems (BIS) should help researchers to enhance or complete their knowledge and understanding about species and their habitats by combining textual, image content-based, and geographical queries.In digital libraries,There are several digital libraries that support services based on image content. One example is the digital museum of butterflies, aimed at building a digital collection of Taiwanese butterflies. This digital library includes a module responsible for content-based image retrieval based on color, texture, and patterns. In a different image context, present a content-based image retrieval digital library that supports geographical image retrieval. The system manages air photos which can be retrieved through texture descriptors. Place names associated with retrieved images can be displayed by crossreferencing with a Geographical Name Information System (GNIS) gazetter. In this same domain, describe an architecture for storage and retrieval of satellite images and video data from a collection of heterogeneous archives.
Other initiatives cover different concepts of the CBIR area.In

V. Conclusion

Combinations of wavelet transform and dimensionality reduction techniques such as DWT-GPCA, DWT-PCA, LWT-GPCA and LWT-PCA are taken as the main methods for feature extraction. INDIAN and CalTech are the two databases selected for retrieval performance and analysis. This paper proposes to develop an Image Retrivel Using GPCA and DWT.

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