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STUDY AND ANALYSIS OF CBIR ALGORITHMS AND TECHNIQUES

Swapnil Baraskar[1], Tusshar Laddha[2], Mahendra Patil[3]

[1,2]Student, Department of Computer Engineering University of Mumbai, Atharva College of Engineering, Malad, Mumbai, India
[3]Assistant Professor, Department of Computer Engineering University of Mumbai, Atharva College of Engineering, Malad, Mumbai, India

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Abstract - *Images are very important pieces of well-structured data composed of pixels having unique numeric values assigned to them which in turn represent intensity or Gray level or color at that part in an image. Large databases are used to store images but as data is dynamic it will grow & shrink in size. The problem of image retrieval arises & there is huge increment in need & storage of images from end-users, art museums, legal departments, medical institutes, environmental agencies & other organizations. Methods of retrieval of images play a vital role in applications in various domains like Digital Forensics, Information systems, Digital libraries, Archaeology, Image Search Engine etc. Image retrieval systems are rapidly growing due to its effective and well-organized approach for retrieving images. An image retrieval system is used to search for images in the database. When an image is searched on the internet it is a really computationally heavy task to retrieve an image from a database which is huge in size and in a limited time span. Image retrieval systems need to search and arrange images in a proper user expected order so that the user gets best results. Author and researchers have proposed various techniques for efficient image retrieval. This paper aims to do review and study the various methods/techniques & algorithms used for content-based image retrieval (CBIR) by Authors and discuss working of those proposed systems.*

Key Words: **Image Retrieval System, Image retrieval techniques, image retrieval methods, Content-Based Image Retrieval, CBIR.**

1. INTRODUCTION

Image retrieval systems are designed with the intention to help users find accurate image results. They use two common techniques to achieve the goal of image retrieval Content-based & text-based. Content-based uses visual characteristics of image shape, color, texture etc. to retrieve images from the database. Text-based use metadata and other text information indexed using text from web pages and retrieve images. By applying machine learning to images we can retrieve accurate images & can further train a model to achieve higher accuracy. Usually indexing is done by humans which relate an image with a set of keywords. Retrieving images from databases is a complex task generally they are searched by using metadata for retrieving images. Another method is Content based image retrieval (CBIR) where contents of images like shapes, colors, textures etc. & any other derivable information from the image is used. Image retrieval techniques suffer from semantic gap problems and other problems. Semantic gap is the difference in the expected results by the user and the result acquired by the Image retrieval system.

2. LITERATURE SURVEY

2.1 Content-Based Image Retrieval (CBIR)

Content based image retrieval is the application of computer vision technique to solve the problem of image retrieval in large image databases. Content means properties in images like colour textures and shape or any other information that can be derived from image. Content based image retrieval is an alternative to the traditional text-based Image searching and can achieve higher accuracy of images returned. CBIR retrieves images on the basis of texture, colour, shape etc. CBIR matches the visual contents of the input image with the images in the database and find similarity in terms of feature vector of input image and the images in the database. CBIR methods based on the extraction of image features are [1, 2] Colour-based retrieval: Colour picture plays a role in human visual perception; colour histograms and the statistical methods of colour representation are used for representing colour. Colour histogram of the input image and all database images are calculated, those histograms matching with input image's histogram will be retrieved from database. Structure-based retrieval: Images can have similar colour causing retrieval of false positive images, this can be made accurate using structure/texture. Textures are matched by input image & images from database. Shape-based retrieval: Shape features are extracted by using commonly used global features like aspect ratio, circularly and moment invariants; the local features like sets of consecutive boundary segments can also be used.

2.1.1 CBIR based on Interactive Genetic Algorithm (IGA)

Authors in [3] have proposed a system which uses User-interaction along with Interactive Genetic Algorithm to judge images that would be most relevant to the user. This system allows a cooperative combination of human & machine for problem solving. Visual features like texture, colour & edges are used. Initial population which has solutions is initialized at the beginning, to adapt to first results of input image.

Fitness function is used to compute quality of chromosomes (features) in population. This algorithm has two stages for image retrieval: first is the query stage and second is the evolution stage.

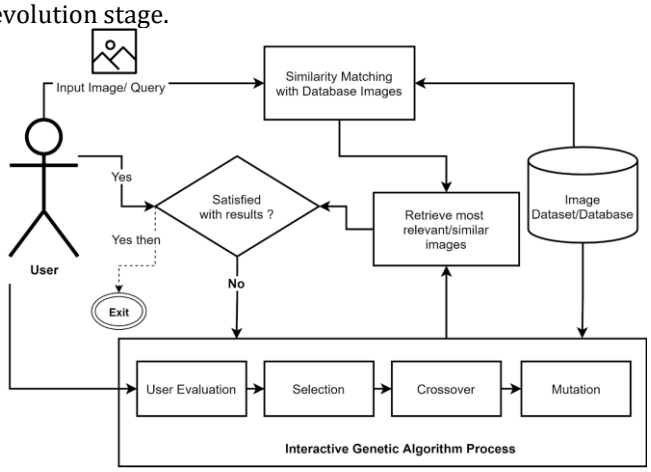

Fig-1: Proposed System of CBIR using IGA with user threshold value [3]

Query Stage: Features of the input images calculated and the images stored in the database are extracted; these features will be used for similarity matching of the input and images stored in the database. Similarity matching: Similarity between two images input & images from database is done by calculating Euclidean distance. Retrieval: At this stage using these features most relevant images will be calculated and retrieved. Images are displayed in the descending order of similarity, having the highest similarity image at top. Incremental Search: User evaluates the results & gives feedback as relevant or irrelevant using this system updates relevance information. Fulfilment: User when not satisfied with results, user gives a value(image) to the system to find more accurate & similar results.

2.1.2 CBIR Using Color Strings Comparison

This technique classifies images then performs feature extraction & similarity measures are calculated. Using all this information efficiency of image retrieval is achieved [4]. Database is first classified using SVM Classifier, to get different classes & each class is associated with unique class labels. When an input image is received features are extracted using colour string coding & comparison method. Features are also calculated for all images in the database. Colour string coding is done by based on 6 rules [4], but before these frames are resized to decrease effects of variation & then all frames are normalized to 20x20 pixels using bi cubic interpolation technique. 6 Rules [4] are:

1. if a pixel R > G > B, then assigns the pixel as 'R';[4]
2. if a pixel R > B > G, then assigns the pixel as K(i,j,1)= 'S';[4]
3. if a pixel G > R > B, then assigns the pixel as K(i,j,2)= 'G'; [4]
4. if a pixel G >= B >= R, then assigns the pixel as K(i,j,2)= 'H';[4]
5. if a pixel B >= R >= G, then assigns the pixel as K(i,j,3)= 'B';[4]
6. if a pixel B >= G >= R, then assigns the pixel as K(i,j,3)= 'C';[4]

After this Coding each frame will become a 2D string array and this 2D string array will be converted as CCCHBHRRR etc. 400 Characters. Now perform string comparison by comparing two strings and return their matching with each element of string is compared with the strings of other element and so on matching weight is increased when the character location is same, when an image will be having exactly same weight then the total weight of the image will be 400 because 20 x 20 pixels = 400 characters [4].For comparison similarity between input image feature & database image features are compared using Class labels & Color String Coding. First class is determined to which image belongs to, then use color string coding & string comparisons to compare input image with database images, based on matched score retrieve those related images.

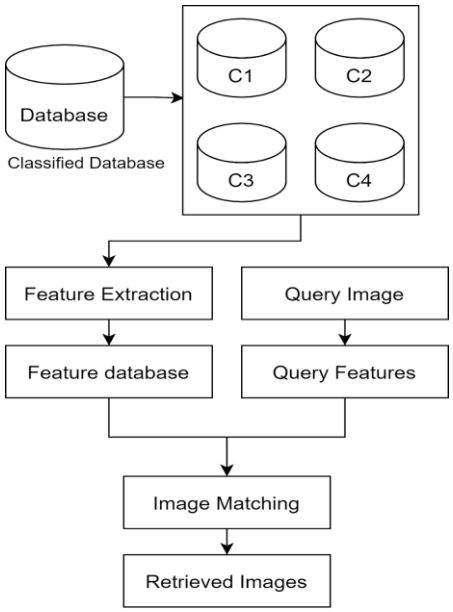

Fig-2: Content Based Image Retrieval Using Colour Strings Comparison [4]

Database Classification: Using Support Vector Machine (SVM) all images stored in the database are classified.

Feature Extraction: Features from images are extracted for classification using colour String coding & comparison. Colours string coding convert all the frames into a uniform size then these frames are transferred to colour string. Then using these colours string code two strings are compared and matching weight is calculated The One Frame having higher matching weight and lower distance is declared as most accurate similar image. Similarity Measure: Labels are assigned to every class that contains related images and

caption of the input image is compared with a label for each class in the database the input image which has the same label belongs to a particular class and only the matched images are selected from the database.

2.1.3 Integrated Approach to CBIR

In this approach colour and texture features are extracted colour is extracted using Color Moment (CM) and texture using Local Binary pattern (LBP) both of these features are further combined together and stored as a single feature vector. Similarity matching is done using Euclidean distance where the input image vector and the vectors returns are compared [5]. Image retrieval is done in total three phases. Before feature extraction pre-processing is performed which includes steps like image conversion, image enhancement, image segmentation etc. Image contrast is improved by performing image enhancement, segments are created based on colours using image segmentation & image is converted to another required colour space (RGB to HSV) by image conversion.

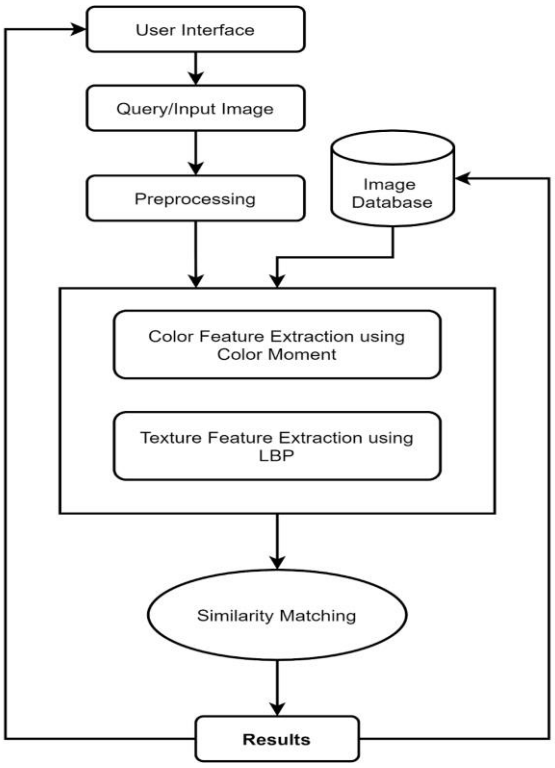

Fig-3: Architecture of an Integrated Approach to Content Based Image Retrieval [5]

Pre-processing: Input image is pre-processed by operations like image segmentation in image enhancement noise filtering image conversion are performed. Feature Extraction: Now features are extracted by Local Binary Pattern & Color Moment, these features will be used for comparison after integrating them as one feature vector. Final feature vector containing both color feature & texture feature is made. This step is performed on all images in the database. Similarity Measurement: Euclidean distance will be calculated between the final input feature vector and the final feature vectors of all images from the database by this similarity matching is performed. Retrieval process involves retrieving topmost images having similarity specified by a threshold value.

2.1.4 Combination of TBIR & CBIR for CBIR System for an Image Gallery Search Application

Semantic gap problem exists & cannot ever be completely removed or minimized to zero, but it can be reduced pretty close to zero. Authors in [6] have combined TBIR & CBIR for achieving higher accuracy in results, for optimizing image search & retrieval problems in an image gallery [6]. This system contains 3 main components: 1. Gallery Interface 2. Query Processing Module 3. Image Database. System provides three modes for searching by an input/query image, a text/name, & a predefined tag.

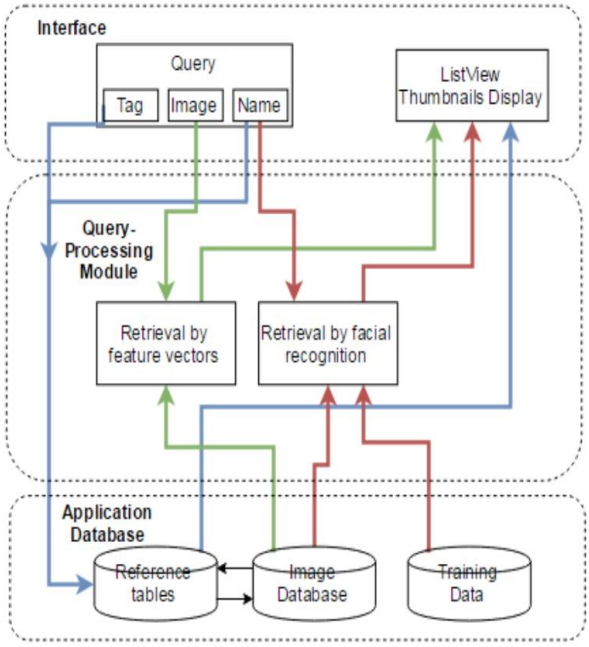

Fig-4: Top-level block diagram of the system [6]

Retrieval by feature vectors is done using Powered Localized Color and Edge Directivity Descriptor (SIMPLE-CEDD). CEDD descriptor is 54 bytes only per image, requires less computation power & memory efficient for searching in large databases. Feature vector is robust as SIMPLE-CEDD first locates feature-rich regions before extraction. Tanimoto coefficient is used for similarity comparison of extracted feature vectors'-means is used to show only most relevant images. Retrieval by text is done using tags, Automatic tagging is done by the query-processing module by retrieving similar images with respect to the query image &

most relevant images will be given the same tag. Tagging is done with reference to the reference table, names & tags are treated separately having their own reference tables. During auto-tagging EXIF meta information of image is added to the reference table. Images are retrieved using the reference table to get the image location, if a particular image is deleted then corresponding tags name of the image will not exist and remaining row information will also be removed. Retrieval by facial recognition is done by using Training data set containing images with faces Haar feature based Cascade Classifier is used for a face detection, region of interest in the images are located by scanning images at different scales all regions containing faces are saved to the training data set along with name. Canny edge detector is used to ignore a few edges or many edges in an image thereby reducing unwanted information. Principal component analysis (PCA) is used to perform facial recognition on a set of training images which are further converted into a set of Eigenfaces for each Eigenfaces there is noise and less features hence only few first K Eigenfaces are selected to reduce the number of values needed to recognise and reduce error and also speedup recognition process. After all images are decomposed as iron values query image and other training images are compared to calculate Euclidean Eigen-distance between them.

2.1.5 CBIR Using Multi-Sequential Search

In this technique a single sequential search is used which merges all 3 feature vectors Color-Shape-Texture together for one-step feature extraction. This combined feature method may not give accurate result because of this merging process as it will carry irrelevant information which will get passed to further stages. One feature is considered at a time and only necessary information/features are extracted & passed in the next stage for further feature extraction process, by this we eliminate unnecessarily processing of image [7].

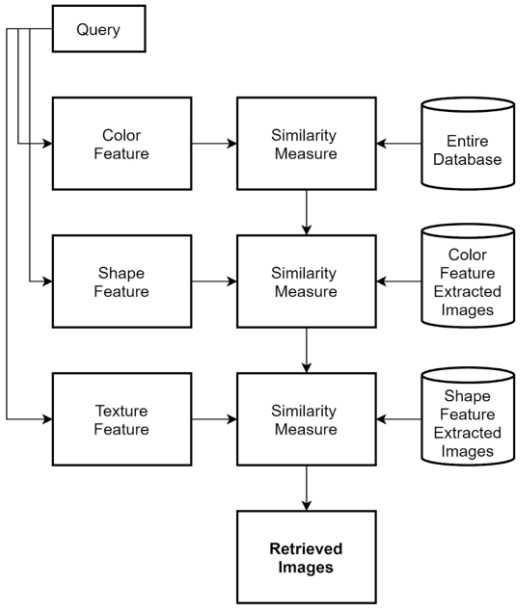

Fig-5: Multi-sequential approach [7]

Input Stage: In this stage the system takes input, a query image from the user. On this image in the further stage features extraction will be performed.

Feature Extraction : At this stage the query image is processed and colour feature is extracted and this colour feature will be compared with the colour features with the database images after comparison, images that are found similar matrix will be given to the second stage which is shape feature extraction after that shape features will be extracted and compared with the shape features in the database images found having similar shape features will be selected those images will be given for further texture feature extraction now using the images obtained through the previous stage texture feature will be extracted and compared with the shape features extracted from the images in the database and finally these images will be given back to the user as result of image retrieval process. Shape Feature is extracted using Edge Histogram, filters like Vertical edge filter, Horizontal Edge Detection filter,45-degree edge filter,135-degree edge filter & non-directional edge filter. Color Histogram is used for color feature extraction.

2.1.6 Content Retrieval Using Hybrid Feature Extraction from Query Image

Authors in [8] were able to make CBIR robust to Shifting, Scaling & rotation thereby increasing the accuracy of the CBIR system & reducing false detection. Their quantitative analysis shows considerable improvement over existing image retrieval techniques. Search is based on similarity instead of exact matching of images.

Algorithm [8]:

1. Data Acquisition: At this stage data is collected from standard resources.

2. Feature Computation: It is done by color model obtained from RGB Color space, & average color is calculated. Number of features are obtained by resizing the image & color features are further normalized. Color features are enhanced using padding & pixels coordinates are normalized for various sizes of images. Spatial locations and color features are concatenated, color variance is used as a feature metric. Images with no color return empty features.
3. Bag of Features is formed
4. Images are indexed
5. Similar images will be retrieved
6. Retrieval time & Matching scores are returned as Results.

A large group of proximity functions were used to effective similarity measurement like Euclidean distance, Cityblock, Manhattan distance, Normalized L2, Minkowski, Mahalanobis, standardized L2, Chebychev, Relative Deviation.

2.2.7 Fast Wavelet Based Image Characterization for CBMIR

In this technique Authors in [9] have proposed a CBMIR (Content based Medical Image Retrieval) system to assist medical practitioners/Doctors to retrieve relevant images to an input query image these images retrieved will play an important role in quick classification & provide more information for taking a decision if a patient needs certain medication or whatever necessary treatment without wasting time.

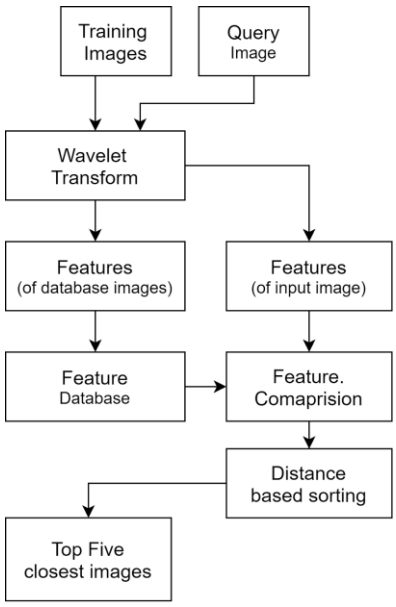

Fig-7: Fast Wavelet based Image Characterization for CBMIR [9]

Algorithm [9]:

1. Compute features for all images in the database & store them.
2. Provide an input/query image to the system.
3. Using wavelet transform extract detail coefficients of input/query image.
4. Calculate features from these coefficients.
5. Using Euclidean Distance measure, compare features of input/query image with all the features in the database.
6. Sort relevant images in ascending order of tier distance values.
7. Return the top five relevant images to the user as output.

FWT based methods gave better results in terms of precision, correlation & computation when compared with Non-wavelet-based methods & wavelet-based methods (Non-separable Lifting scheme & Separable lifting scheme).

2.2.8 Image Based Search Engine

In this author [10] have implemented an algorithm for content-based image retrieval by using a pre-trained CNN model. Authors were able to achieve accuracy of above 0.87 on maximum classes and overall accuracy 0.925. Authors were also able to reduce time complexity of image retrieval the algorithm is simple to understand and can be used for large numbers of images and find similar images out of those.

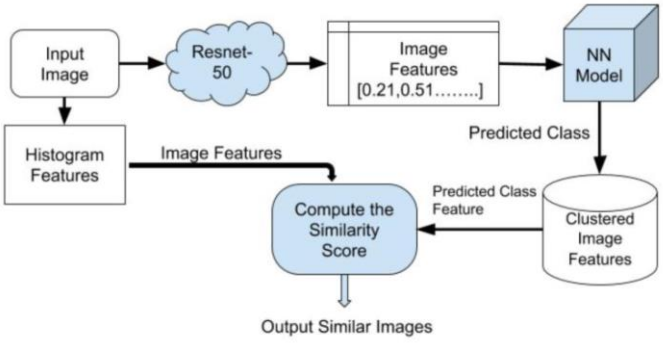

Fig-8: Image based Search Engine- Testing Model [10]

Feature extraction using Resnet-50: Features for each image are extracted using Resnet 50 a pre trained deep learning network, it consists of 50 layers the model learns residual of the features. Training: Keras library is used for developing this neural network that runs on top of TensorFlow platform 3 RELU layers with different neurons and SoftMax activation layer for output generation. 10 epochs are used for training the model on the data. Clustering of Data: Clustering is basically categorising of images in classes for faster image retrieval, the mean is computed over all the classes by using some images as leader's cosine similarity score is computed from each image in that class. Cosine similarity is calculated using histogram features. Cosine similarity computation: After getting the class to which an input image belongs, we will now search for similar images in that predicted class by

using histogram features computed for that input image and then finding cosine similarity between the class leader and storing this closest leader. Results, after calculating cosine similarity between the input and the leaders based on that an output is produced and images are ranked according to their similarity score.

3. ADVANTAGES AND LIMITATIONS

3.1 Advantages:

1. CBIR systems are good at retrieving similar images
2. Just like humans, the CBIR system is able to recognise low level or high-level features in an image.
3. CBIR systems reduce irrelevant results.
4. CBIR systems using Neural Networks can reduce semantic gaps.

3.2 Limitations:

1. Difficult to achieve higher accuracy
2. Difficult to retrieve images when data set size is vast
3. The CBIR system needs powerful hardware, especially GPUs for calculations.

4. APPLICATIONS

1. Image Based Search Engine can be developed for similar image retrieval.
2. Semantic Gap can be reduced in Text Based image searching & retrieval.
3. CBIR systems can solve problems of irrelevant image results & achieve more accuracy.

5. FUTURE SCOPE

1. Image Retrieval Using Interactive Genetic Algorithm [3] can further be combined with TBIR enhancing user interaction. As text is more informative & expressive, it can be stored & used to cluster images in the database thereby making the semantic gap even smaller.
2. Content Based Image Retrieval Using Colour Strings Comparison [4] string used for comparison is huge & uncompressed, simple Run Length Encoding can be used to reduce string size.
3. An Integrated Approach to Content Based Image Retrieval [5] after features are extracted, they are needed to be clustered for achieving higher accuracy & cutting down time needed to traverse/search the whole database for image retrieval.
4. Content Based Image Retrieval System for an Image Gallery Search Application [6] Eigenfaces method in some cases gives undesirable results due to weakness in the method. A pretrained model can help to solve this problem by using machine learning or some other method that can be used.
5. Fast wavelet-based image characterization for content based medical image retrieval [9] needs a very proper & easy to use GUI as the proposed system is to be used by medical professionals everything in GUI.
6. Image Based Search Engine [10] there is need of achieving higher accuracy by increasing the size of the dataset & by changing number of layers, and by changing the hyperparameters.

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