

A Novel Approach for Content-Based Image Retrieval based on Color, Shape and Texture Features

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Abstract: Content-based image retrieval system is the field of digital image processing for retrieval of relevant information from dataset that contains huge amount of images. In this paper, a novel approach has been developed that is based on shape, color and texture features for retrieval of relevant information from the datasets. In this, features from the images have been extracted based on various features extraction techniques. Fuzzy rule based knowledge extraction model has been implemented so that color based features can be extracted from images and ICH, MDLBP and SURF has been used for extraction of all other features from the images. All these features have been fused into a single feature vector that provide information about image that containing shape, texture and color features. On the basis of these approaches, retrieval of the images has been done. Precision, recall and Computation time are the parameters that describe proposed model outperforms existing approaches.

Keywords: CBIR, FCH, ICH, LBP, GLCM and Fuzzy

1. INTRODUCTION

1.1 Content-based image retrieval (CBIR)

Content-based image retrieval is based on (automated) matching of the features of the query image with that of image database through some image - image similarity evaluation. Therefore, the images will be indexed according to their own visual content in the light of the underlying (chosen) features like colour (distribution of colour intensity across image, texture (presence of visual patterns that have properties of homogeneity and do not result from the presence of single colour, or intensity), shape (boundaries, or the interiors of objects depicted in the image), or any other visual feature or a combination of a set of elementary visual features. Needless to say, the advantages and end users of such systems range from simple users searching a particular image on the web as well various type of professional bodies, like police force for picture recognition, journalists requesting pictures that match some query etc. [1] The most punctual business CBIR framework was created by IBM and was called QBIC (Query by Image Content).

1.2 Content comparison using image distance measures

1.2.1 Color: Processing separation measures focused around shade similitude is attained to by registering a color histogram for each one picture that recognizes the extent of pixels inside a picture holding particular values. Examining pictures focused around the colors they contain is a standout amongst the most broadly utilized procedures in light of the fact that it can be finished without respect to picture estimate or orientation. However, inquire about has additionally endeavored to section shade extent by locale and by spatial relationship among a few shade regions. [2][3]

1.2.2 Texture: Surface measures search for visual examples in pictures and how they are spatially characterized. Compositions are spoken to by Texel's which are then set into various sets, contingent [4] upon what number of surfaces is identified in the picture. These sets not just characterize the composition, additionally where in the picture the surface is located. Composition is a troublesome idea to speak to. The distinguishing proof of particular compositions in a picture is accomplished essentially by demonstrating composition as a two-dimensional ash level variety. The relative splendor of sets of pixels is figured such that level of differentiation, consistency, coarseness [5] and directionality may be estimated. The issue is in distinguishing examples of co-pixel variety and partners them with specific classes of compositions, for example, smooth, or unpleasant. [6]

1.2.3 Shape: Shape does not allude to the state of a picture yet to the state of a specific locale that is being searched out. Shapes will regularly be resolved first applying division or edge recognition to a picture. Different routines utilization shape channels to recognize given states of an image. Shape descriptors might likewise need to be invariant to interpretation, pivot, and scale.

1.3 CBIR System

CBIR frameworks have been displayed in this area. QBIC-Query by image content framework, created by IBM, makes visual substance similitude examinations of pictures focused around properties such as color rates, shade design and compositions happening in the pictures. The question can either be sample pictures; client developed outlines and drawings or chose color furthermore surface examples. The IBM created QBIC engineering based Product manager. [12]

Excilibur is different engineers of business CBIR frameworks. Visual seek - a joint spatial-gimmick picture look motor created at Columbia College performs picture comparability examination by matching striking color areas for their shades, sizes and outright & relative spatial locations. Photo book created at Media Research facility, Massachusetts Institute of Technology - MIT for picture recovery focused around picture substance where in shade, shape and surface gimmicks are matched for Euclidean. Difference, vector space point, Histogram, Fourier top, and wavelet tree separations. The fuse of intuitive learning operators, named Four eyes for selecting & consolidating gimmick based models has been a special gimmick of Photo book. Defaces - Mixed media analysis and Retrieval Systems and FIRE- Flexible Image Retrieval Engine consolidate pertinence input from the client for ensuing result refinements. Comparative pictures are recovered focused around shade characteristics, Gabor channel bank based surface peculiarities, and Fourier descriptor based

shape characteristics and spatial area data of divided picture areas in Nitra.

2. REVIEW OF LITERATURE

Khodaskar, A. A, Ladhake et. al. (2015) [7] “A novel approach for Content-based image retrieval in context of combination S C techniques” This paper was used to proposed the combination of soft computing technique like artificial neural network, fuzzy logic and support vector machine. Traditional CBIR was the image which used the low level visual feature. There need to reduce semantic gap and improve accuracy of CBIR even though size of image databases improve rapidly. A client offers contribution to the framework as indicated question picture and framework return set of important pictures. Research framework utilizes pertinence input in view of SVM that astutely arrange pictures pertinent or contemptuous to given inquiry picture. Execution of research content based picture recovery framework even-mindedly assessed in term of exactness, review and precision.

Shiv Ram Dubey et al. (2016) [8] “Multichannel Decoded Local Binary Patterns for Content-based image retrieval”, LBP was hugely used for efficient image feature description & simplicity. LBP can be combined with the image. This paper was used to propose the novel method for image description with multichannel. Image retrieval experiments were performed to observe the effectiveness of the research approaches and compared with the existing ways of multichannel techniques.

Sadegh Fadaei et al. (2017) [9] “New content-based image retrieval system based on optimized integration of DCD, wavelet and curvelet features” in this paper, author proposed an approach that had been used for Content-based image retrieval based on DCD features. DCD had been used for extraction of color features from the images. Wavelet based and curvelet based features had been also extracted that provide information about the texture component of the image so that color and textures features can be combined into a single feature vector. To recombine color and texture feature extracted by the approaches that were DCD, wavelet and curvelet PSO (Particle Swarm Optimization) approach had been implemented. The proposed approach provides better Content-based image retrieval in terms of precision, recall and accuracy.

Filip Radenović et al. (2018) [10] “Fine-tuning CNN Image Retrieval with No Human Annotation” They showed that both hard-positive and hard-negative examples, selected by exploiting the geometry and the camera positions available from the 3D models, enhance the performance of particular-object retrieval. CNN descriptor whitening discriminatively learned from the same training data outperforms commonly used PCA whitening. Author proposed a novel trainable Generalized-Mean (GeM) pooling layer that generalizes max and average pooling and show that it boosts retrieval performance. Applying the proposed method to the VGG network achieves state-of-the-art performance on the standard benchmarks: Oxford Buildings, Paris, and Holidays datasets.

Gylfi Þór Guðmundsson (2018) [11] “DeCP-Live: A Web-Interface for DeCP, a Distributed High-Throughput CBIR System” A vast number of algorithms and methods are proposed and developed every year in the domain of indexing and searching multimedia documents. Much of this work results in published papers and some sources are made

openly available, but rarely will you find a fully working end-to-end system that has been pre-installed, configured, and is ready-to-go on a virtual machine available for download. In this paper we present such a system, the DeCPLive web interface, that is built on top of the distributed, high-throughput, content-based image retrieval algorithm DeCP The virtual machine is ready-to-go as on it we have pre-installed services, indexed openly available datasets, binaries for DeCP and DeCPLive as well as the source code.

Candra Irawan (2018) [12] “CBIR for Herbs Root Using Color Histogram and GLCM Based on K-Nearest Neighbor”, Ginger, concur, kunzite, temulawak, and temu hitam are herbs root that is widely used as a spice and herbal medicine in Indonesia. Visually the shape and color of herbs root are quite similar so that the common people difficult distinguish. The problem can be solved with the help of Content-Based Image Retrieval (CBIR). There are three main modules in CBIR namely pre-processing, feature extraction and identification. The study proposed the Color Histogram and Gray Level Co-occurrence Matrix (GLCM) as feature extraction to identify these types of herbal remedies. While the identification stage used K-Nearest Neighbor (KNN) and the calculation of the distance closest to the Euclidean distance. The amount of data used as training data is 250 images, while data testing used 25 images. The results of this study the system can recognize the image of herbs root in accordance with the type with the highest accuracy obtained.

3. PROPOSED WORK

In the processing of CBIR, various steps have to be followed. These different steps have been used for extraction of relevant images from huge database. The different phase has been described below:

In proposed work, color features from images have been extracted using two different approaches that provide information about available color content in the images. Fuzzy based color histogram has been used that provide information about the color regions in the images. The image has been converted into LAB format so that image color description can be done on the basis of fuzzy membership rules. These rules have been used for evaluation of the color region from image so that these color descriptors can be used for feature storage. Invariant color Histogram has been used that computes the features from the images using derivatives of the images. On the basis of Invariant color histogram, viewpoints based features have been extracted so that images that are available at different viewpoints must be able to extract easily. In this, all the color regions of image that are RGB has been used for extraction of derivative coefficients. These coefficients have been used as feature values of invariant color histograms.

Texture features are usually important similar to color features. Texture features provide information about the back ground description of the images. In this process of feature extraction, two different approaches have been used so that efficient texture features can be extracted from image. In this process, LBP (Local Binary Pattern) and GLCM (Grey Level Co-occurrences Matrix) has been implemented. On the basis of these approaches, texture features that are based on neighbor pixel value from each

region has been extracted using LBP and GLCM provide information about energy, contrast, homogeneity, correlation, mean and standard deviation has been measured. On the basis of these features, a complete vector has been developed so that texture description can be done.

Shape features that have been extracted on the basis of SURF (Speeded up Robust Feature) based shape descriptor. This approach is scale invariant approach so that feature from images can be extracted on the basis of scale variations and rotation variations. This approach computes key points on the images so that scales from the images can be extracted. Various angles and location points have been pointed out on the images so that these can be used as feature vector. The key points are detected by using a Fast-Hessian matrix.

4. RESULTS

The research system used for Content-based image retrieval system has been developed on the basis of three different feature extraction approaches. These approaches used for extraction of various features available in query image based on color, texture and shape based features. These features that have been extracted on the basis of color description provide information about the color content

available in the images. Color information available in the image provides information about the color intensity and color saturation. Texture based features have importance in the process of image retrieval due to background and energy, contrast information. Shape descriptor points out various shape based points from the image so that best relevancy from the images can be extracted. In this research system, these features have been extracted separately and embedded into a single feature matrix having high dimensions. Similarity classifier computed the distance between feature matrix of database image and query image. Euclidean distance and L1 distance classifier which provides best similarity constraints values under different feature matrix. Distance has been sorted in descending order such that images with minimum distance with query image can be retrieved easily. Quantity of these relevant images used for extraction process depends upon the user that how many relevant images have to be extracted from derived image available in the database. On the basis of retrieved and relevant images precision and recall of research methods have been calculated. These parameters are helpful in the performance evaluation of the research system.

Table 4.1 Parameters for Proposed model for different categories using Euclidean

Database	Precision (DCD)	Precision (MdLBP)	Precision (Proposed)
Africa	0.72	0.8	0.95
Beach	0.51	0.51	0.85
Building	0.59	0.5	0.85
Bus	0.92	1	1
Dinosaur	1	1	1
Elephant	0.72	0.7	0.9
Flower	0.92	0.8	1
Horses	0.96	0.7	1
Mountain	0.55	0.5	0.8
Food	0.72	0.7	0.95
Average	0.76	0.72	0.93

Table 4.1 represents parameter values for different query image that has been selected from different categories. On the basis of these query images, various images have been retrieved from the dataset that has been used for computation of different performance evaluation parameters that are precision and recall. These parameters have been computed for both research and existing approaches. On the basis of these parameters, comparison can be easily made in existing and research approach so that most efficient approach can be used in real world applications of Content-based image retrieval system.

Table 4.2 Recall for Proposed model for different categories using Euclidean

Database	Recall (DCD)	Recall (MdLBP)	Recall (Proposed)
Africa	0.14	0.16	0.19
Beach	0.13	0.13	0.17
Building	0.11	0.1	0.17
Bus	0.19	0.2	0.2
Dinosaur	0.2	0.2	0.2

Elephant	0.16	0.14	0.18
Flower	0.18	0.16	0.2
Horses	0.19	0.14	0.2
Mountain	0.13	0.1	0.16
Food	0.15	0.14	0.19
Average	0.158	0.147	0.186

Table 4.2 represents parameter values for different query image that has been selected from different categories. On the basis of these query images, various images have been retrieved from the dataset that has been used for computation of different performance evaluation parameters that are precision and recall. These parameters have been computed for both research and existing approaches. On the basis of these parameters, comparison can be easily made in existing and research approach so that most efficient approach can be used in real world applications of Content-based image retrieval system.

Table 4.3 Parameters for Proposed model for different categories using L1

Database	Precision (DCD)	Precision (MdLBP)	Precision (Proposed)
Africa	0.65	0.5	0.7
Beach	0.45	0.4	0.6
Building	0.6	0.6	0.65
Bus	0.95	0.9	1
Dinosaur	0.95	1	1
Elephant	0.65	0.5	0.55
Flower	0.8	0.65	1
Horses	0.85	0.75	1
Mountain	0.45	0.4	0.7
Food	0.7	0.55	0.85
Average	0.7	0.62	0.8

Table 4.3 represents precision values for different query image that has been selected from different categories. On the basis of these query images, various images have been retrieved from the dataset that has been used for computation of different performance evaluation parameters that are precision and recall. These parameters have been computed for both research and existing approaches. On the basis of these parameters, comparison can be easily made in existing and research approach so that most efficient approach can be used in real world applications of Content-based image retrieval system.

Table 4.4 Recall for Proposed model for different categories using L1

Database	Recall (DCD)	Recall (MdlBP)	Recall (Proposed)
Africa	0.13	0.1	0.14
Beach	0.09	0.08	0.12
Building	0.12	0.12	0.13
Bus	0.19	0.18	0.2
Dinosaur	0.19	0.2	0.2
Elephant	0.13	0.1	0.11
Flower	0.16	0.13	0.2
Horses	0.17	0.15	0.2
Mountain	0.09	0.08	0.14
Food	0.14	0.11	0.17
Average	0.141	0.125	0.161

Table 4.4 represents parameter values for different query image that has been selected from different categories. On the basis of these query images, various images have been retrieved from the dataset that has been used for computation of different performance evaluation parameters that are precision and recall. These parameters have been computed for both research and existing approaches.

On the basis of these parameters, comparison can be easily made in existing and research approach so that most efficient approach can be used in real world applications of Content-based image retrieval system.

Table 4.5 Computation Time for Proposed model for different categories using L1 and Euclidean Distance

DCD	MdlBP	Proposed	L1 (DCD)	L1 (MdlBP)	L1 (Proposed)
5.45	6.12	5.34	5.85	5.70	5.43
5.5	5.65	3.96	6.19	5.84	4.96
5.46	5.46	3.85	5.84	5.36	4.35
6.24	6.45	3.98	7.24	6.45	5.98
5.12	5.77	3.99	8.82	7.77	6.99
5.45	5.42	3.81	5.95	5.42	4.81
5.41	5.31	3.7	6.41	5.75	3.96
5.55	5.10	3.9	7.55	6.10	4.9
5.46	4.78	3.94	6.46	4.80	4.14
5.5	4.85	3.84	5.86	5.25	3.98

5. CONCLUSION

Content-based image retrieval is the process of extraction of relevant images from huge dataset on the basis of content available in the images. In the proposed work, Content-based image retrieval has been done on the basis of color, shape and texture features so that effective system can be developed to extract relevant images with high accuracy.

Color-based features that have been extracted in proposed work are based on fuzzy based color histogram approach and invariant color histogram based approach. Fuzzy based color histogram approach has been used to convert image in to LAB format so that image color composition can be divided into different regions. On the basis of these regions, various features can be extracted based on set of rules. Rules that have been used in fuzzy based approach are based on different membership functions. On the basis of membership function, various features that describe color composition have been extracted. Invariant color histogram provides information about the color composition at different viewpoints and aspects. SURF based shape features have been used in proposed work so that localization and orientation of the shape in the image can be evaluated so that information about the various contents can be used for matching process. Texture features have been used by using GLCM and LBP approach. On the basis of these approaches, texture features from the database images can be easily extorted that can be used for matching on the basis of texture content available in the images. Extracted features have been combined in single feature vector so that these features can be used for distance classification based on distance classifier. In the proposed work, two different distance classifier has been used that are Euclidean distance classifier and L1 distance classifier. These classifiers have been used for computation of similarity between dataset features to the query image features. On the basis of distance classifier, images that have maximum similarity to dataset images have been indexed and retrieved. Retrieved images have been used for computation of various parameters so that performance of the proposed work can be evaluated. Precision is the parameter that has been evaluated that is ratio of number of relevant images to number of retrieved images from dataset. On the basis of precision, one can conclude that proposed approach provide better result as compare to existing approaches.

Future Scope

In the future reference, proposed approach can be used in real world applications. Secondly, machine learning approaches can be used in CBIR so that feature set optimization can be done. Optimization of the features using machine learning approach can reduce feature set dimensions by removal of non-relevant feature values.

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