An Efficient Indexing Algorithm for CBIR

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Abstract— **Due to the continuous development of high quality multimedia technologies and rapid growth in the computational power along with availability of huge sized storage devices, digital image archives of very large size are being created day by day on the ever growing WWW through many commercial, research & development and academic web sites. The bulk of digitized images over the Internet are attracting significant research efforts for the development of tools to manage the visual data with their fast and effective retrieval. Towards the beginning of the previous decade, the breakthrough techniques called content based image retrieval has emerged in image retrieval field. This technique uses the contents of the image data for segmenting, indexing, retrieval and searching of relevant images from image repository. This paper mainly concentrates on the indexing phase of the image retrieval system for development of an efficient indexing algorithm of CBIR systems.**

Keywords— Image Indexing; Indexing Algorithm; Image Retrieval; CBIR

I. INTRODUCTION

As technological aspects of multimedia and their applications in the society are growing day by day, a huge data over the Web is being accumulated. Due to the abundance of multimodal devices, now every individual wants to upload images, sounds and video through many possible means. They are using Facebook, Youtube and other web media in daily life to upload such data [1], [2], [3]. As of the 3rd quarter of 2014, Facebook witnessed as many as 1.35 billion active users in a month (active users mean who have accessed Facebook in previous 30 days) [4].

Images are generally represented and stored in the digital world as raster images. In media, images are viewed as one dimensional, two dimensional and three dimensional vectors of pixels in which each pixel is described by its color [5]. In text based systems for image retrieval, all vectors represent some suitable kind of keywords to represent images. But any human observer extracts images by its semantics.

To judge images and sounds, semantic contents contribute an important role. The application of low-level semantics (colours, gray shades and textures etc.), middle-level semantics (contours, regions and shapes etc.) and semantics of higher level (frequency, pitch, range and intensity etc.) is offering great opportunity of researches in the area of content-based image retrieval.

This paper focuses on how to index various semantics to make a faster approach of retrieval process. Section II describes the background work, whereas, section III is used for specifying the proposed method. The results and related discussions are provided in section IV and section V is used for the conclusion and future works.

II. BACKGROUND WORK

A. Overview of Image Retrieval System

These systems are being developed as text based and content based image retrieval systems. In the text-based methods, images are described manually by text descriptors (keywords for describing the image semantics based on specific domain) which are then used in the retrieval process. But, this approach requires a considerable effort for manual annotation, and the keywords lack in describing the image contents in the considered domain properly. In addition, users should know little about the domain, and thus can't specify the most appropriate keywords for image retrieval. To reduce the said disadvantages of text based retrieval systems, content based retrieval of images was started from the beginning of 1980s. In this approach, color, shapes and texture types of visual contents are used to index the images. Query image or sketches are used by the users to retrieve images of their choice; then, these examples are changed into internal structures of feature vectors by the system. Various features are being proposed for retrieval of large video and image contents. The color, shape, size, texture and color layout features are being considered for retrieval process. A good review is available in [6], [7]. Traditional retrieval systems for videos use the similar feature set for every frame, besides some temporal analysis as in key shot detection.

Recently, various new methods are being introduced to enhance the features [8]. But few are on the basis of temporal or spatial-temporal analysis, i.e., better methods for grouping the frames and selecting improved key frames. Integration of other media, for example; audio, text, etc. is also included into this. Motion and object based features are the new topics of research. In comparison to traditional features of image data like color, shape, size and texture etc. These features seem more real to human observers [5], [9].

Among the current image retrieval community, CBIR is explained by the term 'image content' which describes the implementation of the image contents in terms of its pixel contents.

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At present, the routines of CBIR are respectively more adaptive in identifying the color, shape, size and texture distributions. This information is the basis for specification some image signatures that can act as a surrogate for the image and that can be indexed to provide rapid access to elements of image collection. As of now, there is a little ability to connect this information to the semantics of the image, i.e. to object, its action(s) and associated event identification. Notable exceptions include image collections from very specific domains, such as face and fingerprint recognition, recognition of faults in specific structures, e.g. pipe systems, bridge foundations and up to some limit LOGO identification.

Perhaps the most popular CBIR system (that can be found easily) is QBIC for DB2. According to QBIC, image indexes are constructed based on their visual characteristics along with their description in the form of keywords. A query in QBIC can be submitted in the form of sketches for primitive shapes and colors.

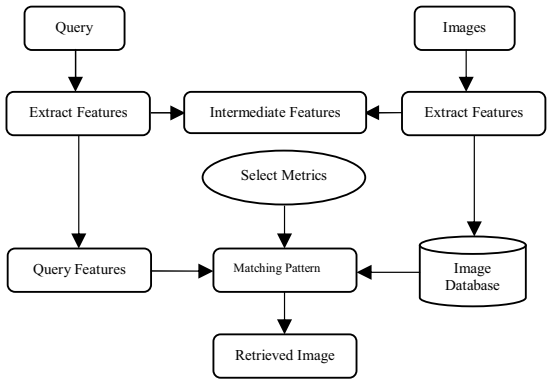
QBIC has been used as a way of displaying images in the art galleries of virtual Hermitage Museum [10].

As the size of image database is becoming large in scientific, medical and enterprise domains and in the ever evolving advertising/marketing domain, methods for image database organization for better retrieval is important.

Important phases in CBIR based system are query building, feature extraction, indexing, matching semantics, retrieval and browsing etc. [Fig. 1].

To make CBIR more efficient, an algorithm for indexing has been designed in this paper. The attempt is to design an automatic routine to analyze images by their semantics taken from the index.

Fig. 1. Visual Information Retrieval System



B. Color Semantics for systems of Image Retrieval

High level semantics is a challenging thing to achieve in image labeling and retrieval although the interest for color semantics has increased relatively coming out through few papers. Many early experimental works is present in Beretti et al. [11], Corridoni et al. [12] and Corridoni et al. [13]. Clustering with a modified K-means algorithm has been used for image segmentation resulting into some homogenous color regions [14]. Another approach, using clustering and segmentation, is described by authors in [15], in which both regional and global semantic descriptors are extracted. A three-dimensional emotional space description and retrieval were used by authors of [16]. An interactive genetic algorithm was proposed by Cho and Lee in [17] which was based on human emotions and their preferences.

A Ph.D. work of Andy Berman in 1999 on efficient CBIR was a innovative work that was an attempt to develop new indexing techniques for image databases as the indices in which matrices has been used for triangular inequality for computing lower bounds of simple and compound distances. Using these techniques the bounds allowed ruling out major part of the database and the images of similarity have been stored in query.

C. Indexing of Images in CBIR

This is an important phase in systems of CBIR. Indexing mechanism should be designed such that that inserting the images in indices is easy and fast and later on, the retrieving and browsing of the indexed images should able to be performed effectively and efficiently. A very comprehensive list of papers on indexing procedure on CBIR is available in [18], [19], [20], [21], [22], [23] and [24].

III. Proposed Method

A. The Query Procedure

Firstly the query procedure is performed on the query image which is being described as below:

1. Extract all features from image query.
2. Compute vector of features from image query.
3. The vector of features computed for the query image is to be quantized in a lattice point.
4. Exploit the lattice space properties to compute the nearest lattice points from computed and quantized query feature vector.

B. Indexing Procedure

Then the indexing procedure is performed on every images of database. Outline of the indexing procedure [25], [26] has been described as below:

1. Extract the features from every image of database.
2. Compute the vectors of features about each of the images of database.
3. The vectors of features of the images are quantized in a lattice point.
4. Exploit each property of the lattice space to compute each lattice point which is nearest to the quantized feature vectors of images.
5. Collect the images in database which are quantized by nearest lattice points.

C. Algorithm of Semantic Indexing

Semantic Indexing is now performed on vectors of the feature of the collected images, which is being described as below:

Semantic Indexing Procedure: SI (A, q_1, q_2, q_3, k)

function sim = si(A, q_1, q_2, q_3, k)

A → the m × n document matrix

q_1 → the query vector1

q_2 → the query vector2

q_3 → the query vector3

k → the computed k^{th} largest eigen values and eigen vectors k[n].

1. Compute the pixel coordinates of all documents in the k-dimensional space for the SI of the term-document matrix using the equation as follows:

   A[*x*, *y*, *z*] = eigenv($A' \times A$, k);

   Here *x, y,* and *z* are three dimensional document data.

2. Compute the coordinate of the query vector and k eigen values of A using the k eigen values of step 1.

   $q_1 = q_1' * x * \text{inv}(y)$;

   $q_2 = q_2' * x * \text{inv}(y)$;

   $q_3 = q_3' * x * \text{inv}(y)$;

   The vector q includes the coordinate of the query vector.

   The matrix inv(y) accommodates the reciprocals of singular values.

   The quote (′) symbol is used for denoting transpose operator for a matrix.

3. Compute the coefficients of seminaries among the coordinates of the query vector and documents.

   For i = 1 to n % Loop over all documents

   si[i] = (q_1[i] * q_2[i] * q_3[i] * *z*[i]) / (norm(q_1[i] * q_2[i] * q_3[i]) * norm(*z*[i]));

   endFor;

   Output:

   SI → the similarity index matrix coefficients.

D. Explanation of the Algorithm

The procedure SI (A, q1, q2, q3, k) takes input a document matrix A, query vector (q1, q2, q3) and eigen values k. This procedure computes the vectors of similarity coefficients si for the user. The i^{th} value of si is a measure of similarity of semantics between i^{th} document and the query document. The increasing value of i^{th} element of si indicates the increasing semantic similarity.

This algorithm takes dimension of keywords, extracted pixel from processed documents which are images. The results obtained from implementation prove that this algorithm is not difficult to implement and very suitable for indexing of images for CBIR systems.

E. Some Common Challenges in CBIR

- The images are special documents which are represented through pixels rather than conventional characters-based text documents. So, the algorithms for comparing text documents are not suitable for the images.
- An algorithm used for matching images cannot match like human beings can match them. So, objective of image retrieval algorithms is to retrieve as similar images to the query image as possible under the context.

IV. Results and Discussion

A collection of data set containing medical images which are downloaded from the google search engine available through the website https://google.co.in [27] is used as the image database for loading into the Matlab software. With the help of the coding in the Matlab software, the proposed index for the medical images were created. The GUI is showing promising results.

One partial set of the results showing the image query and corresponding retrieved images limited to ten images only, is being illustrated in the figure 2 of next page.

V. Conclusion And Future Work

In this paper, the efforts is being focused on indexing of image documents in CBIR for improving the accuracy and efficiency of performance for content-based information retrieval systems. A gap between low-level image data, middle-level features and high level semantics has been the main obstacle for developing more successful retrieval systems.

In this paper an attempted is being made to provide some background research of the fundamentals of image retrieval, CBIR and indexing. New procedures for query image, an indexing procedure and an innovative algorithm for semantic indexing (SI) has been proposed and implemented. Although, the algorithm is efficient, but in future, the indexing procedure would be made elegant by implementing it in robust programming language like Java.

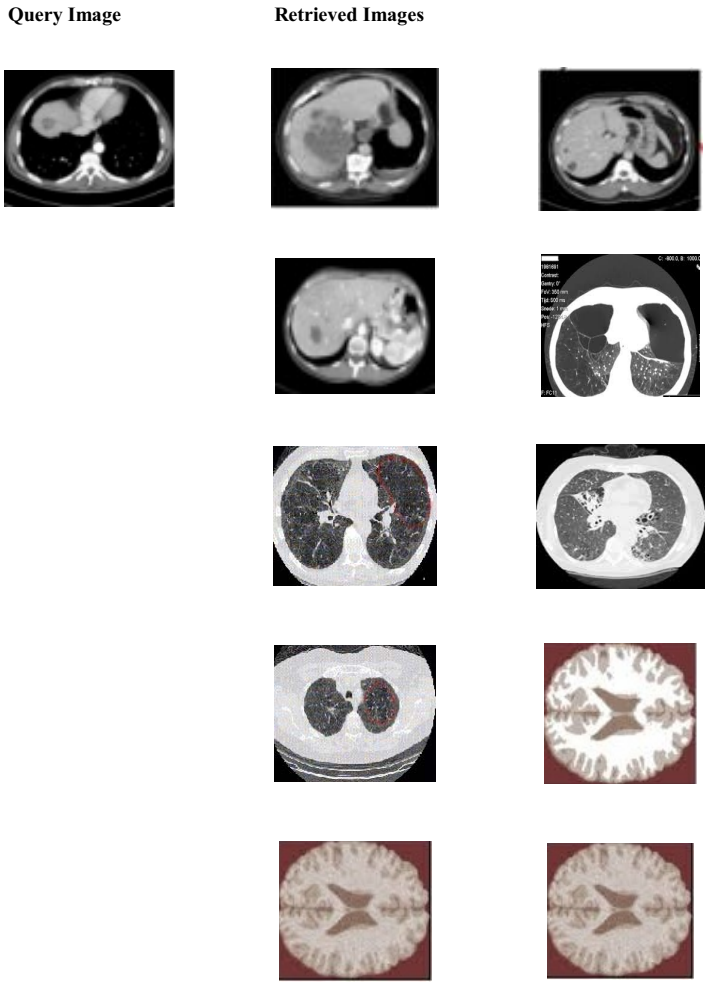


Fig. 2. Result shown on the GUI

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References

[1] A. Yoshitaka and T. Ichikawa, “A Survey on Content-Based Retrieval for Multimedia Databases”, IEEE Trans. on Knowledge and Data Engineering, Vol. 11, No. 1, pp. 81-93, 1999.

[2] M. Petkovic and W. Jonker, "Content-Based Video Retrieval by Integrating Spatio-Temporal and Stochastic Recognition of Events", Proc. of IEEE Work. on Det. and Rec. of Events in Video, pp. 75-82, 2001.

[3] Steven C. H. Hoi and M. R. Lyu, "A Multimodal And Multilevel Ranking Framework for Content- Based Video Retrieval", Int. Conf. on Acoustics, Speech, and Signal Processing, Hawaii, USA, April 2007.

[4] http://www.statista.com/statistics/264810/number-of-monthly-active-facebook-users-worldwide/ accessed on 15.10.2014 at 11:15 am IST.

[5] N. S. T. Sai, R. C. Patil, “Image Retrieval using Upper Mean Color and Lower Mean Color of Image”, IJCST Vol. 3, Issue 1, pp. 191-196, 2012.

[6] M. K. I. Rahmani and M. A. Ansari, “A Color Based Fuzzy Algorithm for CBIR”, Confluence 2013: The Next Generation Information Technology Summit (4th Int. Conf.) 26-27 Sept. 2013, pp. 363 – 370, IET, 2013.

[7] Md. Khalid Imam Rahmani and M. A. Ansari, “Fuzzy Image Retrieval: Recent Trends”, Indian Journal of Industrial and Applied Mathematics, Vol. 4, Issue 2, pp. 131-137, Jul-Dec 2013.

[8] B. Furht and O. Marques, “Handbook of Video Databases: Design and Applications”, CRC Press, 30 September 2003.

[9] Y. Rui and T. S. Huang, “Image Retrieval: Current Techniques, Promising, Directions and Open Issues”, Journ. of Vis. Comm. and Image Rep., Vol. 10, No. 4, 1999.

[10] A. Ion, L. Stanescu, D. Burdescu, and S. Udristoiu, “Mapping Image Low-Level Descriptors to Semantic Concepts”, Comp. in the Global Info. Technology, 2008, ICCGI '08, The Third Inter. Multi-Conf. on, Vol., No., pp.154-159, July 27 2008-August 1 2008.

[11] S. Berretti, A. D. Bimbo and P. Pala, "Sensations and Psychological Effects in Color Image Database", Proceedings of the Inter. Conf. on Image Proc., Volume 1, pp. 560–563, Santa Barbara, CA, USA, 1997.

[12] J. M. Corridoni, A. D. Bimbo and E. Vicario, "Image Retrieval by Color Semantics with Incomplete Knowledge", Journal of the American Soc. for Info. Science, 49(3), pp. 267–282, 1998.

[13] J. M. Corridoni, A. D. Bimbo and P. Pala, "Image Retrieval by Color Semantics", Multimedia Systems, 7(3), pp. 175–183, 1999.

[14] M. Solli and R. Lenz, "Color Semantics for Image Indexing", CGIV 2010 Final Prog. and Proceedings, pp. 253-258, Society for Imaging Science and Technology, 2010.

[15] W. N. Wang and Y. L. Yu, "Image Emotional Semantic Query based on Color Semantic Description", In Inter. Conf. on Machine Learning and Cybernetics, ICMLC 2005, pp. 4571–4576, Guangzhou, 2005.

[16] W. N. Wang, Y. L. Yu and S. M. Jiang, "Image Retrieval by Emotional Semantics: A study of Emotional Space and Feature Extraction", In 2006 IEEE Inter. Conf. on Systems, Man and Cybernetics, Volume 4, pp. 3534–3539, Taipei, 2007.

[17] S. B. Cho and J. Y. Lee, "A Human-Oriented Image Retrieval System using Interactive Genetic Algorithm", IEEE Transaction System Man Cybernetic Pt A Syst Humans, 32(3), pp. 452–458, 2002.

[18] Mohamad Obeid, Bruno Jedynak and Mohamed Daoudi, "Image Indexing and Retrieval using Intermediate Features", 2001.

[19] R. SCHETTINI, G. CIOCCA and S. ZUFFI, "A Survey of Methods for Colour Image Indexing and Retrieval in Image Databases, 2007.

[20] Md. Farooque, "Image Indexing and Retrieval", 2003.

[21] C. Faloutous et al., "Efficient and Effective Querying by Image Content", Journal of Intell. Info. Systems, 3, pp. 231-262, 1994.

[22] David Doermann, "The Indexing and Retrieval of Document Images: A Survey", 1998.

[23] R. K. Srihari, "Automatic Indexing and Content-based Retrieval of Captioned Photographs", In Proc. of the Inter. Conf. on Document Analysis and Recognition, pp. 1165-1168, 1995.

[24] R. Maree, P. Geurts and L. Wehenkel, "Content–based Image Retrieval by Indexing Random Subwindows with Randomized Trees", 2007.

[25] N. Gali, B. V. Rao and A. S. Shaik, "Color and Texture Features for Image Indexing and Retrieval", National Conf. on Research Trends in Computer Science and Technology, Volume 3, Issue 1, pp. 10-14, 2012.

[26] R. V. R. Chary, D. R. Lakshmi and K. V. N. Sunitha, "Feature Extraction Methods for Color Image Similarity", Advanced Computing: An International Journal (ACIJ), Vol.3, No.2, pp. 147-157, March 2012.

[27] https://www.google.co.in/search?q=medical+images+%2B+cbir&biw=1093&bih=480&tbm=isch&imgil=1-DzpSQNkQ6QRM%253A%253B6WiZZc1sSzX3VM%253Bhttps%25253A%25252F%25252Fceb.nlm.nih.gov%25252Fproj%25252Fcervigramfinder.php&source=iu&pf=m&fir=1-DzpSQNkQ6QRM%253A%252C6WiZZc1sSzX3VM%252C_&usg=__7sy4xhBXVlWGq9jZUxGv0vIDH1k%3D&ved=0CE4Qyjc&ei=E8qRVJG-IMe3uQTarYHoBQ#facrc=_&imgdii=1-DzpSQNkQ6QRM%3A%3BjNhzuSS6rWN3uM%3B1-DzpSQNkQ6QRM%3A&imgrc=1-DzpSQNkQ6QRM%253A%3B6WiZZc1sSzX3VM%3Bhttps%253A%252F%252Fceb.nlm.nih.gov%252Fcebimages%252Fcbir.gif%3Bhttps%253A%252F%252Fceb.nlm.nih.gov%252Fproj%252Fcervigramfinder.php%3B300%3B184, visited on 12.09.2014 at 11:30 am IST.