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SURVEY ON TECHNIQUES, ISSUES AND ACHIEVEMENTS IN IMAGE RETRIEVAL

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ABSTRACT

This study offers a comprehensive interview of technical accomplishments in research study of image retrieval particularly image retrieval based on content, an area that has been prosperous and active in the past few years. The interview involves 100+ studies enclosing the research perspectives of image feature extraction and representation, system design and multidimensional indexing 3 of the leading bases of image retrieval based on content. Furthermore based on state of art technique feasible now and the demand from real world applications, open research problems are recognized and future favorable directions of research are recommended.

Keywords: Image retrieval, Technical achievements, Content-based image retrieval, Visual feature extraction

Introduction:

Presently there has been a fast development in digital image collections size. Everyday both civilian and military equipment produces images with gigabytes. However the author makes use or cannot access the data unless it is organized so as to permit effective searching, retrieval and browsing. Since 1970s, the retrieval of image has been active area of research with the thrust from two leading communities of research, computer vision and database management. These two communities of research learns retrieval of image from varied angles one being visual based and other being text

based. The image retrieval based on text can be signed to late 1970s and a familiar image retrieval framework was to comment on the images first by text and then utilizes DBMS based on text to carry out retrieval of image. Several advances such as multidimensional indexing, query evaluation and data modeling have been made along this research study. However there occur two leading difficulties particularly when the image collections size is big. One is huge number of labor needed in annotation of manual image. The other difficult is much important outcomes from images rich content and the human perception subjectivity. The comments impreciseness



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and perception philosophy may affect unrecoverable mismatches in later processes of retrieval. Several technologies in this research directions have been developed and numerous systems of image retrieval both commercial and research have been constructed. The progress in these directions of research is contributed primarily by community of computer vision. This approach has set up a general image retrieval framework from a new prospect. However there are numerous issues in research to be resolved before such systems of retrieval can be applied into practice. Since excellent interviews for image retrieval paradigms based on text already occurs in this study the author dedicate their effort mainly to image retrieval paradigm based on content. There are 3 leading bases for image retrieval based on content that is multidimensional indexing, retrieval system design and feature extraction.

Feature Extraction:

The fundamentals of image retrieval based content are feature extraction. In a wide sense, the features may involve both visual

features namely texture, color, faces and shape and text based characteristics namely annotations and key words. However there already occurs rich literature on feature extraction base on text in information retrieval research communities and database management systems the author will enclose themselves to visual feature extraction techniques. Within the scope of visual feature the features can be classified further as domain specific and general features. The former involve texture, shape and color features while the latter is dependent on application. The domain specific features are enclosed better in literature of pattern recognition and may include most of the domain knowledge which the author will not have enough space to cover in this study.

One of the most vastly used visual features in retrieval of image is the color feature. It is robust relatively too independent of orientation and image size and background complication. The color histogram is one of the most commonly used representations of color feature in image retrieval. Numerous other representations of color feature have



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been used in retrieval of image involving color sets and color moments besides color histogram. Stricker and Orengo suggested the approach of color moments to overcome the effects of quantization as in color histogram.

Texture defines to patterns of visuals that have homogeneity properties that do not outcome from the existence of an individual intensity or color. It is an inherent asset of entire surfaces virtually involving hair, fabric, clouds, trees and bricks. It consists of essential data about the surfaces structural arrangement and their rapport to enclosing surroundings. Because of its usefulness and significance in computer vision and pattern recognition there are rich study outcomes from the past 3 decades. Now it further predicts its way into retrieval of image and several other research accomplishments are being added to it.

Shape:

Relying on the applications in retrieval of image, certain applications needs representation of shape to be invariant to

scaling, translation and rotation while others do not. Evidently if a representation fulfills the earlier need it will fulfill the latter. Usually the representations of shape can be categorized into two classifications namely region based and boundary based. The most successful representatives for these two classifications are moment invariants and Fourier descriptor. Present work in matching and shape representation involves turning function, wavelet descriptor and finite element method. In Wallace and Wintz presented a technique for Fourier descriptors normalization which kept entire information of shape and was effective computationally.

Color layout:

Although the feature of global color is easy to evaluate and can offer cheap power of discrimination in retrieval of image it tends to provide numerous false positives when the collection of image is big. Several results of the study recommended that using layout of color is a good solution to retrieve image. A natural approach is to categorize the complete image into sub blocks and retrieve features of color from every sub blocks to



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expand the universal feature of color to a local one. In Rickman and Stonham suggested an approach of color tuple histogram. In Stricker and Dimai retrieved the first three moments of color from 5 predefined partially overlapping fuzzy areas. The layout of visual features and texture can also be built to facilitate much advanced retrieval of image.

Segmentation:

Segmentation is very essential to retrieval of image. Both the layout and shape feature rely on better segmentation. In Lybanon et al researched an approach of morphological operation in segmentation of image. They verified their approach in different kinds of images involving infrared ocean images, magnetograms and optical astronomical images. In Hansen and Higgins described the separate strengths of relaxation labeling and watershed analysis. In Li et al suggested a segmentation approach based on entropy. This approach was efficient for images whose histograms do not have clear valleys and peaks. Other techniques of segmentation based on edge flow, Delaunay triangulation

and fractals can be predicted in. The needs of segmentation accuracy are quite varied for layout and shape features in segmentation.

Summary:

There occur numerous representations which model the human perception of that feature from varied prospects for every visual feature. There is a requirement of developing a description of image content to conduct the features. The features must not only be related with images but also they must be invoked at proper place and at proper time whenever they are required to support retrieval.

High Dimensional Indexing:

To make the image retrieval based on content scalable truly to big sized collections of image, effective techniques of multidimensional indexing required to be described. There are two leading challenges in such image retrieval exploration namely:

Measure of non-Euclidean similarity: Since the measure of Euclidean may not simulate



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human perception of some visual content efficiently different measures of similarity such as cosine correlation and histogram intersection required to be assisted.

Greater dimensionality:

The feature vectors dimensionality is generally of 10^2 orders.

One promising approach is to first carry out reduction of dimension towards solving these issues and then to utilize proper techniques of multidimensional indexing which are capable of assisting measures of non-Euclidean similarity.

Systems of image retrieval:

Content based image retrieval has become an active area of research since early 1990s. Several systems of image retrieval both research and commercial have been constructed. Several systems of image retrieval assist more than one choice namely: 1) search by example; 2) random browsing; 3) search by text; 4) navigation with categories of customized image; and 5) search by sketch. The author have viewed

the supply of rich set of search choices nowadays but systematic studies including actual users in practical application still required to be performed to explore the tradeoffs among varied choices described above. The author will choose little representative system and highlight their unique features:

QBIC:

QBIC expansion is query by image content which is the first image retrieval system based on commercial content. Its system techniques and frameworks have profound impacts on later systems of image retrieval. The color feature used in QBIC are the mathematical transform to Munsell (MTM) coordinates, k-element color histogram and an average red, green and blue. QBIC is one of the few systems which consider greater dimensional indexing of feature.

Virage:

Virage is an image search engine based on content evolved at Virage Inc. Virage assists visual queries based on composition, structure, color and texture common to



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QBIC. But Virage moves one step further than QBIC. It assists arbitrary integrations of the above 4 atomic queries and users can adjust the weights related with atomic characteristics according to their own emphasis. Different useful primitives can be added to open structure relying on domain needs.

Retrieval Ware:

Retrieval ware is an image retrieval engine based on content developed by Excalibur Technologies Corp. The author can view that its emphasis was in neural nets to retrieval of image from one of its former publications. It's much recent search engine utilizes shape, color, color layout, texture, aspect ratio and brightness of image as the query characterizes.

Photobook:

Photobook is a group of interactive components for searching and browsing images evolved at MIT Media Lab. Photobook comprises of 3 sub-books from which texture, face and shape characteristics are retrieved. Then the users can query

based on corresponding characteristics each of the 3 sub-books.

Web-Seek and Visual SEEK:

Web-SEEK is a WWW oriented image/text search engine and Visual SEEK is a visual characteristic search engine both of which are evolved at Columbia University. Major features of research are spatial rapport query of image areas and feature extraction of visuals from compressed domain. The visual characteristics used in their systems are wavelet transform and color set feature based on texture. Visual SEEK assists questions based on spatial rapport and visual characteristics. Web-SEEK is a search engine oriented on web and comprises of 3 major modules that is subject classification, video/image collecting module and module of indexing and browse, retrieval and search module.

Netra:

Netra is an image retrieval system of prototype evolved in UCSB ADL (Alexandria Digital Library) project. Netra utilizes texture, shape, spatial location and



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color data in regions of segmented image to retrieve and search common areas from database. The major research characteristics of Netra system are its neural net based image thesaurus building, edge flow based region segmentation and Gabor filter based analysis of texture.

MARS:

Multimedia Analysis and Retrieval Systems was evolved at Illinois University at Urbana Champaign. Multimedia Analysis and Retrieval Systems varies from other systems in both scope of research and technologies utilized. IT is an interdisciplinary effort of research including numerous communities of research namely DBMS (database management system), IR (information retrieval) and computer vision. The research characteristics of MARS are the combination of IR and DBMS, combination of retrieval and indexing and combination of human and computer.

Future and Research Directions:

From above review the author can view that numerous progress have been made in

different aspects of research involving multidimensional indexing, feature extraction of visuals and system design. However still there are numerous open research problems that required to be solved before the present retrieval of image can be of practical use.

Human in the loop:

A major difference between a recognition system of computer vision pattern and a system of image retrieval is that a human is an indispensable latter system part. The author required to explore the synergy of a computer and a human. This trend of study has been reflected in the history of image retrieval based on content.

Low level visual characteristics and High level concepts:

Humans tend to utilize high level concepts in everyday life. However what present techniques of computer vision can retrieve from image automatically are mainly low level characteristics. In limited applications namely fingerprint and human face it is feasible to connect the low level



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characteristics to high level concepts (finger prints or faces). However the low level characteristics do not have a straight link to high level concepts in general setting.

Web oriented:

The WWW expansion is amazed. Every day 1000s of documents among which several images are added to web. To better retrieve and organize the unlimited data, search engines based on web are desired highly. Such a solution occurs for information based on text. The fact that Info seek, Alta Vista, etc. are the most frequently used web sites which represents the requirement for a search engine based on web. For web images even though certain better work has occurred technical breakthroughs are required to make search engines of image contrast to their counterpart based on text.

High Dimensional Indexing:

The web expansion's by product is large number of images and most present existing prototype systems of research manage only 100s or at most a few 1000 images. Therefore a sequential scan of entire images

will not degrade the performance of system severely. Because of this reason only a few existing systems described the aspect of multi-dimensional indexing of image retrieval. However as the collections of image is getting bigger the speed of retrieval is becoming a bottle neck.

Standard Test bed and performance evaluation criterion:

Any technology is pulled forward by its criteria of domain evaluation. SNR is utilized in data compression and recall and precision are utilized in information retrieval based on text. Better metric will lead the technology in correct place while bad ones may mislead the efforts of research. Presently certain systems of image retrieval measure performance based on time and cost to predict correct images. Although these criteria estimate the performance of system to certain extent they are far from satisfactory. An equally essential task is to set up a well-balanced big scale test bed. For a successful test bed it has to be big in scale to verify the scalability to be balanced in content of image to verify overall



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performance of system and image feature effectiveness.

Image content's human perception:

Human is the best end user of a retrieval system of image. Therefore the human perception study of image content from a psychophysical level is difficult. This concept is acquiring develop attention presently targeting at describing how humans understand content of image and how the author can combine such a human model into retrieval systems of image. Much present study of human perception concentrates on human perception's psychophysical aspects.

Combination of Media and Disciplines:

Both the literature of database community and the literature of computer vision community have utilized database of image as the heading of several articles [33]. Most systems of database community are non-image databases while several computer vision systems are non-image databases. A successful system of image database needs an interdisciplinary effort of research.

Besides the combination of computer vision and database management the study from traditional area of information retrieval is an indispensable part. Certain successful instances of research effort involve the use of relevance feedback in image retrieval and Boolean retrieval models in retrieval of image. Another examination is that combination of multimedia, multi modalities offers huge importance for developed classification and indexing of images in usual domains.

Conclusion:

In this study present and past technical accomplishments in feature extraction of visuals, system design and multidimensional indexing are summarized. Open research problems are recognized and future directions of research are recommended. From the former part the author can view that a successful retrieval system of image needs the seamless combination of numerous efforts of research communities. Advancement in every separate community of research and an overall architecture of systems are equally essential. There are



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three DB in this architecture system. The first one is the database of image collection consists of raw images for purpose of visual display. The database of visual feature stores the extracted features of visuals from images using different techniques. This is the data required to assist image retrieval based on content. Image understanding and computer vision are the communities of research contributing to this DB. The database of text annotation comprises of free text descriptions and key words of images. It is becoming evident in the community of image retrieval that image retrieval based on content is not a renewal of but rather a supportive tool to image retrieval based on text. Only the combination of two can outcome in fulfilled performance of

retrieval. The research advancement in database management system and information retrieval is the major thrust to this database. The retrieval engine module involves a sub module of query interface and a query processing. To interact with user in a friendly way the query interface is based on graphics. The interface gathers the needed data from users and shows back the outcomes of retrieval to users in a meaningful manner. The progress of research in user interface and user psychology supports to develop the design of interface. Furthermore similar query from a user can be operated in varied ways. The sub module of query processing manipulates the user query into procedures of best processing.

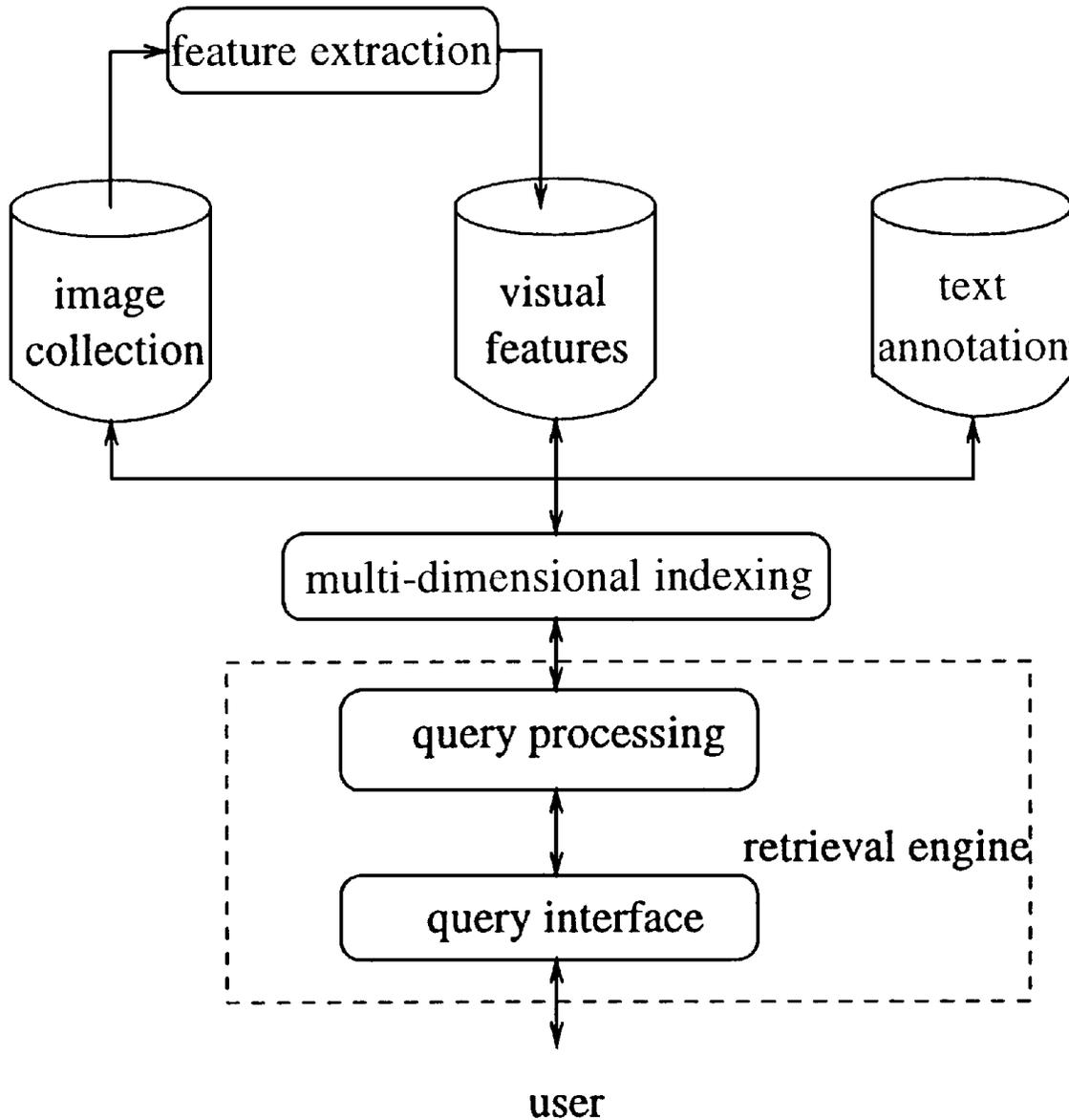


FIG. 1. An image retrieval system architecture.

There are two leading features of this system architecture. One is its inter-discipline and multidiscipline nature as mentioned in the

above discussion. The other is its interactive nature between computer and human. In all combination of different disciplines of numerous sources of data and of the



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computer and human will lead to a successful retrieval system of image.

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