ISSN No. 0976-5697

Volume 7, No. 4, July-August 2016
International Journal of Advanced Research in Computer Science
REVIEW ARTICLE
Available Online at www.ijarcs.info

Semantics Based Image Retrieval from Cyberspace-A Review Study

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Abstract—the content based image retrieval is an important research matter since people are using and transferring more and more video and image data. Earlier the research was confined to searching and downloading the image from the cyberspace. Now-a-days, owing to syntax attributes and ability of compression of vast data, CBIR techniques are proving for useful. It has become feasible to locate the desired image with the aid of their properties and tags. The recent advancements and developments in the various techniques and process, for increasing the accuracy in finding the required image is being discussed, in the paper.

Keywords— CBIR, color space, color texture, similarity matching, feature extraction.

I. INTRODUCTION

In present society, the internet has become an integral part of our lives. Present era is of electronic gadgets. Today, almost everyone is equipped with multimedia mobile phones, tabs, laptops etc. All these devices have inbuilt cameras of good quality. This facility has increased the tendency of taking pictures and recording videos. Through these multimedia devices, it has become easier to share these images/videos on internet, with the friends and the members of family. However, this fact has lead to a large amount of images of every kind i.e. desired and undesired being uploaded on internet. Further, people from various spheres like, scientists, medicine, education, engineering etc. are generating and uploading different digital images on the internet daily.

The retrieval of these images from the cyberspace is an interesting and challenging task. Whenever a user wishes to retrieve an image from web, using present search engines, large number of images are retrieved, most of which are unrelated to user query. The user feels overburdened in finding the exact image, because useful images are scattered on different pages amongst the unrelated ones. Hence retrieval of the required image from this large collection is really troublesome. On the other hand, the users are making random queries and conventional methods can not yield results in efficient and effective manner, thus leaving the user unsatisfied most of the time. Research community has been making efforts towards efficient retrieval of useful images from web but till date this problem has not been solved and it still prevails as open research challenge.

An **image** is a picture which illustrates visual properties unique to itself, e.g. a bi-dimensional image, which looks similar to something, it can be a thing or a person, providing us a visual representation of it. An image may be bi-dimensional or tri-dimensional e.g. a photograph or an image shown on a screen or a figure is bi-dimensional whereas image on a sticker may be tri-dimensional. These images may be captured through different electronic gadgets e.g. smart phone, digital cameras, telescopes, microscopes, etc. or even a human eye. Some of the images can also be *rendered* manually, for example by drawing, painting, carving etc. as well as automatically with the help of a printer or computer aided graphical technology, or being generated by different methods combined together, especially in a pseudo-photograph. An image which remains in existence only for a short period of time is called volatile image. Henceforth, an image might be a reflection of an object by a mirror, or a projection of a camera, or any scene appearing on a cathode ray tube (CRT).

These images are stored in images database in the cyberspace for their future processing. The logical storage of these images in the cyberspace takes place through low structured query language (SQL) database, which stores binary objects with the help of metadata or low level features such as colour, texture and shapes. Major low level features of an image are being described as follows:

Colour: A colored image is made up of pixels each of which holds some value of red, green and blue colours corresponding to a particular location of an image. The Red, Green and Blue also referenced by RGB, are the primary colour for mixing light. Any colour can be created by mingling the appropriate amount of red, green and blue light. The process of converting image to pixels is called digitization. It is obvious to say that the memory occupied by a colour image is three times more than that of the black and white picture.

Texture: A Texel is a smallest graphical element of texture of image element which may be represented in two-dimensional (2-D) texture mapping. A pixel of picture element and a texel of texture is similar because it represents an elementary unit in a graphical presentation. But main difference between the texels in a texture map and the pixels in an image display exists by their appearance on the screen. Eventually, every texel can become smaller than that of a pixel. Therefore, each pixel can be created by combining various texels.

Shape: Shape of an image does not refer to the shape of a particular region, but how it displayed or appeared on the screen. Shapes will in many instances be determined either by applying segmentation or by edge detection of an image.

In order to retrieve an image, a sample image colour, texture and shape values of source is provided and it helps in facilitating to compare with the target image.

1.1 Image Retrieval Techniques: Image retrieval is a process by which a computer system handles the large database of digital images for the purpose of retrieving the desired image in the cyberspace, with the help of different internet browsing applications. Most conventional and common methods of adding metadata to the image such as captioning, keywords, or descriptions to the images, so that retrieval process can be accomplished on the basis of the keywords tagged with the images. The process of adding keywords, manually takes a lot of time, energy and money. Thus, some image retrieval software have been developed which helps in storing and organizing images in computer databases such as *image viewer*[11]. Therefore, an image viewer (computer program) is used to shows images which have been stored graphically. They can be used to handle different image file formats. The '*image viewer*' portrays the image according to its characteristics e.g. colour intensity, visual distinctness and colour range. It facilitates the user to choose from the directory structure by using the indexing methods from the hard disk. Most of such software don't give any kind of automatic organization

of images. Hence, user has wide range for creating and maintaining the folder structure. However, some of the image viewers programs also have effective features for organizing images, especially in an image database. Therefore, these could be used as image organizers.

Now, let us discuss the types of image retrieval techniques

(i) Content-based techniques

(ii) Context-based techniques

(i) Content-based image retrieval (CBIR): CBIR is defined as query by image content (QBIC), and it is also named as content-based visual information retrieval (CBVIR) [49]. It uses a computer enabled program on to the retrieve the desired image from the database. Thus it suffers from the problem of finding relevant image from the large databases. To overcome the problem of traditional concept-based approaches, the content-based method is used.

"Content-based" explained that the search which analyzes the texts/contents of the picture/image instead of the information such as tags, keywords or other methods of tagging the text with the image. Therefore, "content" defined to color, shape, texture, or any other related useful data that can be extracted from the image/picture. The CBIR is used to avoid complete dependence on the quality of metadata and annotation tagged with the image. The task of manually annotating images/pictures by adding keywords or metadata, is quite time consuming. This manual process might not capture the exact keywords, as required to explain the type of an image/picture. The effectiveness of the keyword towards the searching of an image is subjective and has not been well-defined accordingly. The figure 1 given below indicates the CBIR system.

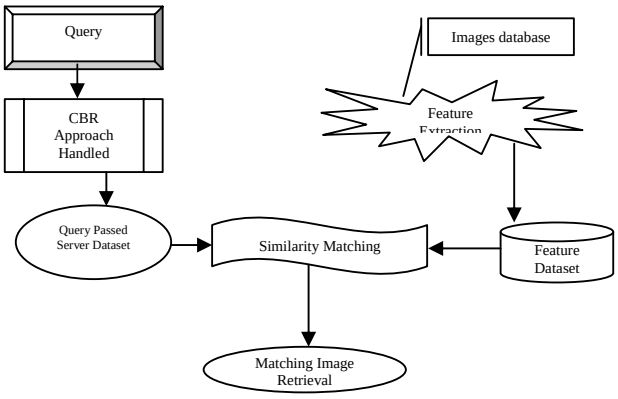

Figure 1. Content Based Image Retrieval System Flowchart

From the [illegible]res of the required image are extracted and kept in the feature dataset and then are compared with those of the input image. Thereafter, various images have been displayed on the user's screen. Some standard techniques for image retrieval available in the cyberspace are given below:

a. Existing Query Concept based Techniques

b. Some other Query Methods

(a) **Existing Query Concept based Technique:** The different techniques of CBIR are used for different types of user queries. The Query by example is a technique that is involved in delivering a query for CBIR system while retrieving an image. Then, on the basis of that example image, CBIR searches the cyberspace. The search algorithms being deployed might be different, depending on the application, but resultant images would be shared to all the common elements.

The query method given above eliminates the problems that are faced when the images are converted into words or phrases.

(b) **Other Query Methods:** It includes browsing the internet, i.e. such the querying by multiple example images, querying by direct specification of image features, querying by visual sketch and multimodal queries i.e. combining touch, voice, machine learning and iterative techniques of application are becoming more famous in CBIR technology. Therefore, various technical approaches are available but all have some problems, in retrieving the desired image from the cyberspace.

However, since CBIR focuses only on low level feature extraction and comparison, it cannot detect the context of stored image or searched image.

(ii) Context-based image retrieval technique

The context-based image retrieval techniques mainly work on the information that is available within the image. The knowledge about the content of an image can come from other sources in addition to that of available in that very image. The information about the image other than its visual attributes is the context of the image for example keywords, annotations, tag etc. Hence the image can be retrieved on the basis of annotations which could be added manually to differentiate the image from the other images for example certain keywords or describing term may be used. At times the caption, subtitles or a text written nearby the image can also contribute in the retrieval. The standard text retrieval techniques can be used to create indexes using the above mentioned sources, having text information about the images.

Content based image retrieval is very popular methods, however, researchers [7, 20, 34, 48 and 66] are making efforts towards associating semantics with image databases to make context based image retrieval possible.

1.2 Image Retrieval: An Overview

Image retrieval process started in early 1990 by T. kato [49] to discuss about the experiments which automatically retrieve the images, from an database, depending on the color and shape of an image. Afterwards, some methods of retrieving the images from the cyberspace were developed depending upon the various characteristics and other parameters which have already been discussed in the previous section. Images are created and stored in various types of file formats. The file formats include the proprietary types of an image. There are approximately hundreds different types of image format files. But the Portable Network Graphics (PNG), Joint Picture Expert Group (JEPG) and Graphic Interchange Format (GIF) formats are mostly used to display images in the cyberspace now days. The above mentioned graphic formats are separated into the two main methods of digitization. The file formats of image are known as standard methods of organization and storage of digital images.

These digital image files are made up of digital data by any of the two methods i.e. raster or vector. These formats of images can be used for displaying on monitor screen. An image file format may store data in any format whether it is compressed or uncompressed, or vector formats. An image after undergoing rasterization becomes pixels grid, since each image has a number of bits to impart its color according to the depth of colour displayed on the screen. The raster image is generally related to number of pixels in an image, colour depth and bits per pixel. Image file can be compressed by different techniques which are freely available on the internet. However, these compressions methods use an algorithm that an image file can be adjusted to occupy minimum spacing, which could further enlarged back to its original form, by using respective decompression algorithm. But vector images behave differently as compared to raster images, i.e. the size of the file can be independent of the dimension of the file. But when more vectors are added, the size of the file increases accordingly. Suppose, an image with 24-bit colour having 640 * 480 pixels will occupy around a Mb of storage area:

640 * 480 * 24 = 7,372,800 bits = 921,600 bytes = 900 Kilo Byte

Therefore, it is clear that by using image editors based on raster methods, like Painter, Photoshop, Paint.NET, Microsoft Paint, and GIMP, mainly used the editing of the pixels whereas in image editors based on vector methods, e.g. CORELDRAW, Adobe Illustrator and Inkscape, editing of lines and shapes (vectors) has been used.

Next sub-section explains the various application areas involving image retrieval.

1.3 Applicability of Image Retrieval: There are various areas where the images are used now days. Some of those applications are as follow:

1. Architectural and engineering design Process
2. Face Finding and Crime Investigation
3. GIS and remote sensing systems
4. Intellectual properties and storage of photographs
5. Medical diagnosis systems
6. Military operation
7. Retail catalogues formation
8. Nudity-detection filters
9. Textiles Industry
10. Art collection process

Next section provides literature review to explore applicability of associating semantics with images while retrieval from cyberspace.

II. STATE OF ART ON SEMANTIC GAP IN CBIR

Various software industries and research centers are working hard towards associating semantics with image retrieval systems. Splendid research has already been done in CBIR with different technologies. This section highlights the work of eminent researchers and concentrates on the challenges which still need to be addressed.

Sciascio et al. [10] investigated the joint use of query by sketch as well as relevance feedback techniques that provides interaction of the user with image database and improves the effectiveness of an image retrieval process in content-based image retrieval over the WWW. Authors implemented Draw Search, prototype image retrieval by content system which uses colour, shape and texture of the image for indexing and retrieving the images. They suggested that specific strategies for web-based CBIR system had to be devised. Hung et al. [20] addressed a different way of image retrieval motivated by real-life application for an intelligent system that could automatically select appropriate background images from textual passage. Authors proposed a framework that applied semantic role labeling techniques and commonsense knowledge base termed as ConceptNet. But in bigger databases conceptNet did not provide accurate results. Author concluded that web-based text mining technique could be helpful in efficient image retrieval. Hussain et al. [21] elaborated new procedures to decipher the need of the user., which enables applying PinView to real-world image databases.

Komali et al. [24] explained that the CBIR is desirable since most of the web-based search engines provide images depending mostly on metadata and that is the cause of display of a lot of unrelated images in the results. Therefore, they proposed a technique that could be used to filter images depending on their content, providing better indexing and returning results accordingly. Yu et al. [71] developed a model for effective performance of a text-based image retrieval. They also explained that the additional image re-ranking showed that the use of click prediction was useful for increasing the level of performance of graph-based image re-ranking algorithms.

Douze et al. [11] highlighted that colour, texture and shape properties were recently shown to give good results for the choice of the category. They demonstrated their representation in context of image retrieving. The experiments performed on the holiday data indicated that their method performed well on the latest and sophisticated feature. This work indicated that attribute features when combined with Fisher vectors improved the performance of the technique. They suggested, "semantic" attributes might be helpful in increasing the performance of image retrieval systems, particularly for web queries.

Huang su et al.[58] They suggested to utilize parallel and distributed computing technique, to achieve high efficiency and effectiveness of CBIR in coping with the large-scale image data.

Shanmugapriya and Nallusamy[53] developed a computer vision method that gave a simple solution to problem, searching digital images in large databases. Wang et al. [65] suggested a new method for semantics-based image retrieval technique of high-level content based and context based querying. The content of a image was divided into its salient features and the low level features of the image, including colour and texture used in the image. Wang Hoi and Ying [63] concluded and investigated a search-based face annotation framework by mining weakly labeled facial images on the internet. Giveki et al. [14] proposed model of division schemes based on wavelet transform were taken into account which improved the performance of the model. They found it, to improve complexity of retrieval rate. It used techniques of computer vision and provided solution to the problems of retrieving digital images amongst huge database. Santoro et al. [48] proposed a technique for the arctic animals based on semantic methods of image retrieval. This technique prepared a semantic engine which is capable to process the needs of the user and the arctic image. Minu and Thyagharajan[34] proposed an system of image retrieval based on the ontology of a Flower Family. Their proposed ontology may be used for other semantic-based image retrieval systems. Darwish and Ali [07] proposed a framework based on T2FL to eliminate the two basic problems in CBIR systems. Their work focused on mapping low-level visual statistical feature to high level semantic concepts, Type 2 fuzzy logic was used to fuse extracted feature and Modeled the human perception subjectivity.

Asha et al.[04], Akgül et al.[01] and Sasikala & Gandhi [49] has emphasized that use of image queries from database was increased radically. Along with this, CBIR system became popular for retrieving images from internet, as it required less human interference. Further, in medical diagnosis required realistic interpretation in radiology images. Therefore, CBIR techniques could be beneficial to radiologist in identifying similar images in large databases. They concluded that the CBIR was a popular and increasing the concept of research in the areas of the digital image processing.

Arthi and vijayaraghavan [03] has developed an image retrieval algorithm based on content of colour models. They developed and proposed an algorithm based on Color Co-occurrence Matrix for efficient image retrieval. Selvarajah and kodituwakku [51] had analyses that the texture of an image was necessary features in CBIR. Texture is divided into statistical and structural categories. They determined one of the best texture feature is most suitable for efficient representation for spatial allocation of an image. Velmurugan and baboo [61] had developed an algorithms based on SURF and colour moments. To increase the performance of the CBIR system the SURF works with the combination of color moments. It is the drawback of this system that it works only on gray scale images. Rafiee et al. [42] had made a comprehensive survey on patch recognition, which was a crucial part of content-based image retrieval (CBIR), was presented. Their aims were to evaluate meaningful models for one of the most challenging problems in image understanding, specifically, for the effective and efficient mapping between image visual features and high-level semantic concepts. Cascia et al. [25] had propounded a system, in which data related to text and images was integrated in a single vector for searching the content from WWW image database. Latent Semantic Indexing is for capturing the textual data in the vector, color and orientation histograms, are used for capturing visual data in the vector form. The above mentioned technique helps in accomplishing the content based search in a better way.

Belongie et al. [06] postulated 'blob world' technique to retrieve the specific image from a huge repository of images, leased on the content of that very image. Color and texture characteristics of the image were used as a key in identifying the required image on the

basis of segmentation applying the expectation maximization algorithms. Lew et al. [28] studied the recent researches on the multimedia retrieval based on content based and analyzed its concept in ongoing researches in browsing and searching paradigms, effective computing, queries regarding semantics etc. Lehman et al.[27] had developed a system for semantic analysis of image, beneficial for an application used in medical purposes. It involves analysis of medical images consisting of six layers such as raw data, registered data, scheme, feature, knowledge and object layer.

Zhang et al. [72] proposed "Gabor wavelet" technique for retrieving the required image from the database. Zabih [38] designed a technique, named histogram refinement in which additional constraints were imposed on histogram based matching. With this methods even those images could become distinguishable, whose histograms were not distinguishable. Dubey et al. [12] had elaborates that the human apprehension is beyond the imagination. Therefore, they suggested that the semantic approach could not be able to define in a single algorithm to complete the various operations in the field of image mining. Vogel and Schiele [62] used local semantic description for retrieving of content based retrieval system. Lu et al. [31] discovered a new methods for retrieving images, which were JPEG formatted. The characteristics of color, space and texture, which were leased on the DCT domain, are taken for retrieving the image. this method directly retrieves the images in the DCT domain, without decompressing them. Amanatiadis et al. [02] proposed a analysis based on the comparison between three variable for representing the shape and for retrieving it. Numerous coefficients are required for indexing and retrieving the images using shape as a feature. For representation of shape, space in curvature scale, angular radial transform (ART) and image moment depiction were studied. Wang et al. [66] had explained that a mining massive, image could be automatically assigned the annotation, which further used for the retrieval purpose is highly required by the researcher in the field of image processing. They mainly focused on face annotation for retrieving of an image. They also proposed a technique WLRLCC, which is called Weak Label Regularized Local Coordinate Coding. For efficient data management, a system was proposed which generates metadata for image contents. They suggested that the system might be improvised by means of its accuracy and performance improvements.

Year-wise Analysis of research conducted in the field of Content Based Image Retrieval system in Cyberspace.

Year	Name of Authors	Parameters used in the research	Outcomes
1995	Gudivad, et.al.	High level feature of the image	Unwanted image also display
1996	Pass et.al.	Histogram refinement	Improve the performance
1997	Mehtre et.al.	Shape measures	Increase the accuracy
1998	La Cascia et.al.	Textual and visual cues	improved performance
1999	Di Sciascio et.al.	Sketch and relevance feedback	Refine query dynamically
2000	Hong et.al.	Relevance feedback. incorporate vector	Improve the performance
2002	Yu et.al.	Color texture moments	Achieves good retrieval of image
2007	Vogel et.al.	Semantic modeling on natural	Accuracy but lowered the performance
2011	Su et.al.	Mining user navigation patterns	Increase the performance
2011	Velmurugan et.al.	SURF and colour moments	Improve matching of image
2012	Komali et.al.	3-D colour feature extraction	It is proposed only
2012	Murala et.al.	Local tetra patterns of visual	Improve retrieval rate
2012	Santoro et.al.	Semantic based for arctic animal	Accuracy and flexibility
2013	Jain et.al.	Combination of Colour, Shape and Texture Features	Increase the efficiency
2013	Arthi et.al.	An algorithm is used for color models	Algorithms proposed
2014	Shanmugapriya et.al.	GMM and relevance feedback	Achieves better performance and accuracy
2014	Yu et.al.	Multimodal sparse coding	Beneficial to improving the performance
2015	Darwish et.al.	Type-2 Fuzzy Logic for minimizing the Semantic Gap	Reduce semantic gap
2015	Hole et.al.	Data Mining and Image Processing Techniques	Improvement in similarities
2016	Zhao et.al.	Colour, Texture and Shape	Increase similarities

From the above table, a major drawback related to CBIR approach is "semantic gap". Hence, the approach for the content-based image retrieval methods is still limited [57]. A critical look at the above literature highlights the fact that there are numerous debatable issues which still need to be reached upon. The upcoming section lists few such issues.

After analyzing the above research areas, it is concluded that some issues which are still pertaining in the CBIR are discussed in the next section.

III. CBIR: AN EXISTING ISSUE

There are mainly two issues existing in the image retrieval methods which are discussed as follows:

1. **Mapping low level features with high level semantics:** As the CBIR system works mainly on the low level features, therefore, the compositional aspect of dataset is not significantly well for the retrieval of desired images and the keyword directory becomes more authoritative. To vanquish such issues, a number of researchers have proposed to develop a system that combines keywords and low level features till now. But the mapping of low level feature with high level semantics remains unsolved. Therefore, the mapping of low level features of image with high level semantics is highly desired by the researches for retrieving the appropriate image from the cyberspace.

2. **Associating metadata with stored images:** The image file stores the metadata through the keywords or text attached to the end of an image file in an ad hoc approach. But the metadata structure differs in the image file format and assignment of the same metadata record owing to presence of multiple images, which results in inefficient duplication while comparing a single metadata record with a group of different images in the cyberspace.
   Whereas, in case of an external association metadata, a unique identifier is used to equate exterior metadata with an image e.g. an image is stored on a local machine and the metadata is stored on a server. In case of break in the linkage between the server and the local machine, the significant information may be lost.
   Therefore, above mentioned problems are the major issues in the image retrieval mechanism. Hence, we

need a system which can use semantics association to overcome the above mentioned demerits.

IV. CONCLUSION AND FUTURE WORKS

As people are uploading and downloading images frequently, hence the retrieval of the required image has become a promising area of research now-a-days, due to its utility. The search tools e.g. google search, yahoo image search are using textual annotation of the image. The recently developed techniques of image retrieval have been discussed in the paper.

The main aim is to create application software that could analyze the complex system, which could be materialized if there is higher degree of mutual relationship at different levels such as context information taken into account. In order to achieve it we have to follow a three step process. First step will be to formulate a framework for mapping low level image characteristics with high level semantics. Secondly this very framework is to be developed. Thirdly, a mechanism has to be developed for associating metadata with existing images.

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