Introduction to Query Techniques for Large CBIR Systems

Pravin D. Pardhi, Prashant L. Paikrao, Devendra S. Chaudhari

Abstract—Content-based image retrieval (CBIR) has received much research interest since couple of decades. The query technique for CBIR using relevance feedback is being used by the researchers, to search desired image from huge collection of visual data. This paper reviews various processes of image search and few query techniques.

Keywords—Content-based image retrieval (CBIR), image search, query technique, relevance feedback (RF).

I. INTRODUCTION

Because of increasing popularity of digital devices and personal computers, the usage of multimedia data including real time videos has been increased in today's electronic world. Vast amount of multimedia data brings a lot of significant challenges for retrieving the contents successfully from large-scale multimedia databases [12]. Gigabytes of multimedia content are produced by every user of cell phone, digital camera or PC and are being made available as multimedia database [11]. The main concern is how to find out desired data from such huge collection.

Text-oriented search engines, that are generally used, tried to give response to above query. On completely manual annotations of multimedia content, such systems are based. A lot of time and efforts requires in process of manual annotating. Clarifying the images in just few key words may be very complex and tough task, even if there is sufficient time to annotate them. These types of annotations are quite personal, disturbing the class of retrieval, and the class of searching frequently depends on user's understanding, skilfulness and capability to define satisfactory query [11]. Other important drawbacks are the sensory gap and the semantic gap. Sensory gap is the gap between the object in the real world and it's representation in recorded form. It could be understood by observing that how one can imagine a 3D scene from a 2D picture/image. Semantic gap is the difference between the representation / description made in a given condition to the prior information available about the visual data [10].

Content-based image retrieval (CBIR) systems are built-up as an answer to above mentioned problems [11]. In recent days, retrieval of multimedia data has received much research attention and the most admired research area is CBIR [12]. Retrieval of information from real data that is most relevant to a query is the major intention of CBIR systems [9].

Two main disadvantages of text-based images retrieval are: slowness of manual image annotation process and personalise human annotation methods. Slowness of manual image annotation is mainly true with the large collection of data. In personal human annotation different viewers can annotate the same image in a distinct way. CBIR systems are dedicated to rise above these difficulties by indexing images according to low-level visual features such as colour, texture, shape to retrieve similar images [1]. An example image serves as a query to the system and all similar images are retrieved as outcome. CBIR system is not only used for image retrieval purpose but also to organize the content of common intent image databases of a digital library [6].

By comparing pairs of images and assigning a similarity measure to every pair a CBIR system selects images from a dataset. The comparison is made through automatically extracted features from each image [5]. The feature extraction may be carried out for a complete image or for image sub parts (sub-images). By using standard grid, like 3x3, 4x4 or more pixels, sub-images can be created, to split the image into square shaped sub-sections. Superior outcome can be produced using more section (6x6, 10x10) but the execution speed becomes very time-consuming [11]. The mentioned features are described in more detail as follows.

A. Colour Features

Colour is linked to the chromatic part of an image. A colour histogram provides allotment of colours which is achieved by damaging image colour and plus how many numbers of pixels fit into every colour. For the whole collection every image's colour histogram is examined and saved in the database. Retrieval of those images has been done in the matching process whose colour allotment matches to the example query very much [6].

B. Texture Features

By dissimilarity in brightness with high frequencies in the image spectrum, textures are characterized. While making a distinction between areas of the images with same colour, these features are very useful. Measures of image texture such as the degree of contrast, coarseness, directionality, regularity and randomness can be calculated using second-order statistics [6].

C. Shape Features

By either the global form of the shape or local elements of its boundary, shape

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features can be differentiated. Global form of the shape: like the area, the extension and the major axis orientation. Local elements of its boundary: like corners, characteristic points or curvature elements. The degree of similarity between two shapes is evaluated through standard mathematical distances measures, like Euclidian distance between two points. The capability of shape features to tolerate semantic significance can be used for semi-automatic extraction of high-level content-dependent multimedia data by providing characteristic shapes for special real-world- objects in the CBIR systems [6].

D. Spatial Features

By spatial units like points, lines, regions and objects and their allocation in an image, spatial relationships can be articulated. Spatial features can be classified into directional relationships and topological relationships. Directional relationships: like right, left, above, below together with a distance and topological relationships: like disjunction, adjacency, containment or overlapping of entities. Image retrieval with local features can be improved by using spatial information [6].

Executions of an image query is done by producing a weighted mixture of features as autograph for the example image and straightforwardly match up it with the autographs saved in the database. The adjacent neighbour of the example query in the feature vector space is found out using a similarity metric. There are three levels of complexity of query types used for classification. In level 1, on the basis of low-level features, queries are represented (Find the image that look similar to my query image), level 2 includes queries for valid features / annotations (Find an image of the Taj Mahal) and level 3 locate queries with abstract features (Find a image that expresses happiness). CBIR generally envelops level 1 query while level 2 and level 3 queries need a mixture of image and textual queries in most of the cases [6].

In the paper after the introductory part relevance feedback approach to the query technique is discussed. After that search types are explained in short, next to that, query techniques for target search and category search are visited and their comparison is discussed.

II. RELEVANCE FEEDBACK APPROACH

By bringing user in the retrieval loop, as one of its part, the retrieving process can be considerably enhanced. Providing the initial query from image database or chosen from a random set, system extracts initial set of images independently more nearer to a query, from which the user chooses best-matched samples personally and annotates them in suitable manner. From these samples, an active learning tactic, develop both positive and negative examples, is applied to renew weights of image features, as per personal opinion. This method generally is called as relevance feedback (RF) technique [8].

In the improvement of the usage of CBIR systems, relevance feedback (RF) technique is most important, because it consists of the human bias into the retrieval process, and takes benefit of expert's knowledge [5]. These kinds of systems can assist user to have high-level subjective query. Human opinion subjectivity can come into picture at various levels of subjectivity. For example, people under different conditions may identify the same image content in a different way. Continuous learning is other inspiring aspect to utilize these kinds of systems. To build up a well-organized algorithm to expose user's preferences is the most important aim of interactive techniques [3].

In a usual RF methodology, retrieval method offers outcome as an answer to the user's initial query which is given by example image or keyword. Then, user's decision (relevant/irrelevant) on the retrieved images is utilized by precise algorithm for modification in system constraint [3]. Image which is "closer" to the objects selected as relevant (Positive objects), and "farther" from the objects selected as irrelevant (Negative objects) [5]. Until user is convinced with the image outcome these steps are repeatedly performed [3], by doing it, desired query can be obtained. This technique is called as Query Point Movement (QPM) [5].

III. SEARCH TYPES

A barrier in CBIR research is due to the lack of a quantitative evaluation for comparing the performance of search algorithms. In general, on the search length, the statistics are presented, for example, the number of images that were observed before an image was found, and that was accurately "similar" to an aimed image. Image search can be categorized into three main categories [4].

A. Target-Specific Search (or Target Search)

An exact target image has to be found out by user from image database. The searching process should continue till exact target image is not found. It should not stop if similar images other than target image are found. For testing purposes this type of search is useful in applications like in inspection of a particular logo whether it has been previously registered or not, or in searching of a correct historical photograph to follow a document, or while looking for a particular painting whose artist and title lost from the searcher's memory [4].

B. Category Search

An ideal category images are searched by users, e.g., "dogs," "skyscrapers," "kitchens," or "picture of basketball games;" in some sense, when an image is to be find out by user that is similar to a target image, the user prefer a category search [4].

C. Open-Ended Search

Users search in a specific database without any goal. In a typical application, a user may start a search for a wallpaper of rose with yellow colour, but the goal not remain constant it may change many times throughout the search process, as the user navigates through the database and is exposed to various available results and immortal expectations, which may be completely different from searched initial query[4].

IV. TECHNIQUES FOR TARGET SEARCH

Two famous techniques for target search are Query by Image Content (QBIC) and PicHunter. In QBIC system user create queries on the basis of visual image features such as colour percentage, colour layout, and texture present in the target image, and position the retrieved images according to those criteria [2]. QBIC is having two key properties, first: it uses image as well video contents. Image having computable properties of colour, texture, shape and video having motion of the images, videos and their objects; these properties are used in the query evaluation. Second: it involves representation of queries by graphical means like drawing or selecting of an example image or by other graphical means [7]. QBIC is not a relevance feedback technique, hence, while generating initial query user faces some difficulty. To reduce the load on users a PicHunter technique is proposed. PicHunter is relevance feedback technique to direct query modification and target search. The performance of PicHunter technique relies on the regularity of user's performance and the correctness of the prediction algorithm. Notably, both QBIC and PicHunter do not give assurance to find target images and get affected by local maximum traps and slow convergence [2].

V. TECHNIQUES FOR CATEGORY SEARCH

Category search techniques can be divided into two types: single-point and multipoint movement technique. If the refined query 'Q' at each iteration consists of only one query point such technique is called as a single-point movement technique. Or else, it is a multi-point movement technique. Single-point movement techniques, like MARS and MindReader, create a lone query point, which is nearer to relevant images and far from irrelevant images. Standard deviation in particular dimension is calculated and its inverse is considered as MARS weighted distance. MindReader produces much better results by using a generalized weighted distance. Relevance feedback can be used to alter the weights based on the verified images, while the measure of time since an image was verified is used in a decay function to modulate the impact of those already checked images [2].

VI. CONCLUSION

Overview of a large CBIR system's query techniques for finding out desired query along with three major types of search processes i.e. target, category and open-ended are reported. It is observed that use of relevance feedback in the query techniques improved the search result to a large extent. Knowing the drawbacks like local maximum traps and slow convergence of existing techniques makes a way to develop a new one.

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