IMAGE RANK TO LARGE-SCALE IMAGE SEARCH: INSPIRATION, INFLUENCES AND APPROACHES

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ABSTRACT

The fast development of internet applications and increasing popularity of modern digital gadgets leads to a very huge collection of image database. Commercial image search engines provide results depending on text based retrieval process. However, it frequently finds irrelevant results, because the search engines use the insufficient, indefinite and irrelevant textual description of database images. In the paper, image ranking techniques for large data base are discussed. The PageRank algorithm is used for improving ranking of search query, depending on link structure of web pages. There are many methods like Topic Sensitive PageRank, Content Based Image Retrieval (CBIR), VisualSEEK were used for the quality image-retrieval. VisualRank offers an additional attribute for image search, by finding "authority" node on visual resemblance graph, among images.

Keywords: *PageRank, Topic Sensitive PageRank, CBIR, VisualSEEK, VisualRank,*

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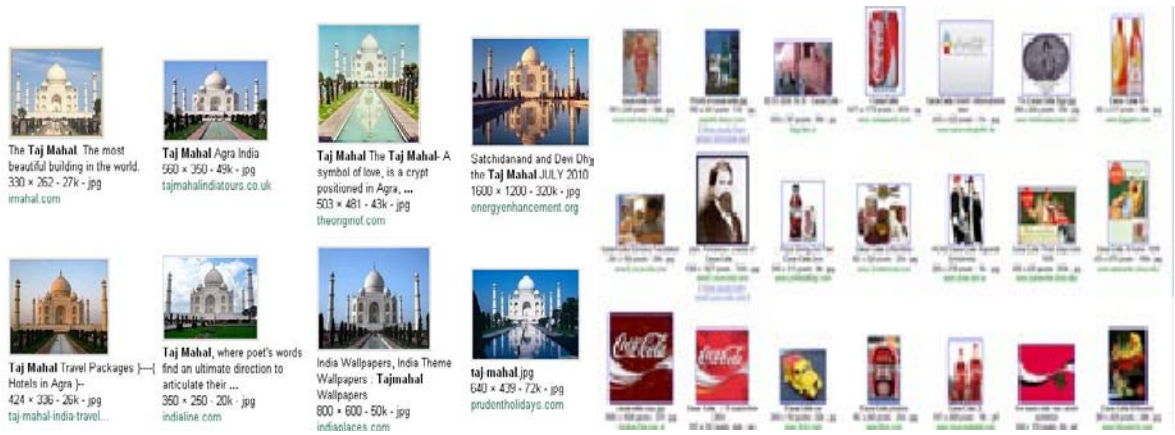
1. INTRODUCTION

Researchers are actively involved in image search since last decade. Image database is increasing day by day, searching image from large and diversified collection using image features as information to search, is difficult and imperative problem. Image search is an important feature widely used in majority search engines, but the search engine mostly employs the text based image search. Text based search uses one or more keyword based search and after matching words results are returned [3].There is no active participation of image features in the image retrieval process; still text based search is much popular. Image feature extraction and image analysis is quite difficult, time consuming and costly process [2].

When a popular image query like “Taj Mahal” is fired, then search engine returns image that occurred on page that contains the term “Taj Mahal”. In real sense, locating “Taj Mahal” picture does not involve image analysis and visual feature based search, because processing of billions images is infeasible and increases the complexity level too [4]. For this very reason, image search engine makes use of text based search.

Image searching based on text search possesses some problems like relevance and diversity. When query is fired, less important or irrelevant images appeared on the top and important or relevant images at the bottom of the web page. For Example, when popular image query like “Taj Mahal” is fired, it provides good image search results but when image query having diversity like “Coca Cola” is fired, searched results provides irrelevant or poor results as shown in Figure 1. Here, required image of Coca Cola can/bottle is seen at the fourth position in the returned images. The reason behind it is large variable image quality [2].



(a) Taj Mahal **(b) Coca Cola**

Fig.1. The query for (a) “Taj Mahal” returns good results on Google. However, the query for (b) “Coca Cola” returns mixed results (source: 2).

The PageRank algorithm is introduced to improve the quality result of image search, which provide the ranking for web pages depending on link structure of the web. Before introduction of PageRank, there were no standards for measurement the quality of web pages [5]. After that, image retrieval and ranking technique like Topic Sensitive PageRank, Content Based Image Retrieval (CBIR), VisualSEEK, etc. are introduced to enhance the performance of image search.

The paper is organized as; Section 2 discusses PageRank algorithm overview and different image retrieval techniques. Section 3 discusses feature generation, representation and provides VisualRank approach and Section 4 concludes the paper with suggestion.

2. RANKED BASED IMAGE RETRIEVAL

2.1. PageRank Algorithm overview

Sergey Brin et al. [6] ordered web information hierarchy based on link popularity. A page was ranked higher having more links to it and a page with higher ranked page links, become much highly ranked. PageRank concepts within the web pages have the theory of link structure. Consider a small universe of four web pages *Z, Y, X* and *W*. Initially, PageRank is considering as 1 and it would be evenly divided between these four documents, hence each document has 0.25 PageRank. If pages *Y*, *X* and *W* are links to the Page *Z* only, then PageRank of page *Z* is given as

$$PR\ (Z)\ =\ \frac{PR\ (Y)}{L(Y)} + \frac{PR\ (X)}{L(X)} + \frac{PR\ (W)}{L(W)} \quad (1)$$

Therefore, PageRank of page *Z* is 0.75. If Page *Y* is link to page *X* as well as page *Z*, page *W* link to all other pages and page *X* link to only Page *Z*, then PageRank of page *Z* is

$$PR\ (Z)\ =\ \frac{PR\ (Y)}{2} + \frac{PR\ (X)}{1} + \frac{PR\ (W)}{3} \quad (2)$$

For M number of document, PageRank for a page is defined as follow

$$PR\ (Z) = \frac{1-\xi}{M} + \xi\ \sum_{j=1}^{m} \frac{PR\ (Aj)}{L(Aj)} \quad (3)$$

Where, *PR (Z)* is PageRank for page *Z*, L (*Aj*) is the number of outgoing link for page *Aj*, *m* is the number of page linked to the page being computed, ξ is the damping factor used in computation. Damping factor ξ lies between 0 and 1 typically being equal to 0.85 [5]. Through whole web link structure, PageRank was created without small subset. The main drawback of PageRank is, a new page with very good quality and it is not a part of existing site, has limited links; as results PageRank method favours the older pages.

2.2 Topic Sensitive PageRank

The densely connected web pages, through link structure may have higher ranking for the query for which they are not containing resources with useful information. The same web page may have different importance for different query search; it may have higher weightage in one query and less weightage for another. To overcome this, Topic Sensitive PageRank is introduced. In this approach, set of PageRank vector is calculated offline for different topics, to produce a set of important score for a page with respect to certain topics, rather than computing a rank vector for all web pages [7].

2.3 Content Based Image Retrieval

In CBIR (Content Based Image Retrieval), images are arranged systematically according to their visual feature. Image feature extraction and segmentation are basic steps in CBIR to look for similar images. Image retrieval in CBIR is processed by three ways, in the target search method; pattern matching and object recognition is performed. Image retrieval from large data base with indefinite information is challenging task. The category search method involves object recognition and arithmetic pattern recognition problems. Features selection and classifications from huge number of classes is relatively difficult task. Search by association is the third method, which suffers from semantic gap. Semantic gap is the difference between extracted information from the visual data and its interpretation for a user in a given situation [8].

Feature of an image involves global or local features. Global features of image contain complete characteristics of entire image and local feature used for a small group of pixels. Global features are very sensitive to location so there is problem in distinguishing forefront and background of image; so it is difficult to decide grade for identifying important visual features. On the other hand, local feature is an image pattern which differs from its immediate neighbourhood. To decrease computation, entire image is divided in nonoverlapping small blocks and features are extracted for each block separately. Thereafter, segmentation is done by k-means clustering or normalized cut criteria [13].

The semantic gap between visual feature and image concept are reducing in CBIR in three ways, which includes supervised and nonsupervised learning and relevance feedback approaches. Even though, CBIR system do not fully exploits robust features between image and high-level concept, also having limited accuracy for certain features [9].

2.4 VisualSEEK Overview

VisualSEEK is a crossbreed system, which present a new content based approach. The query results are returned depending on image regions and spatial outline. Spatial features contain

size, location and relationships to other regions. Each image is divided into small regions which have combination of image feature and spatial properties. The combination depends on the representation of colour regions by colour sets. One colour sets are suitable for predetermined region extraction from side to side colour set back projection and other colour sets are simply indexed for retrieval of similar colour sets. So that unobstructed images are decomposed into near representative images, which provide to efficient spatial query and similar regions images are easily searched [12].

The VisualSEEK system was utilizes most important image regions and their feature to compare images. The combination of content based and spatial querying provides useful query structure, which allows similar images retrieval for wide variety of colour and spatial queries. VisualSEEK improve fast indexing and image retrieval by using spatial and feature information for query search.

3. FEATURE EXTRACTION AND REPRESENTATION

Feature extraction of an image required image processing and feature creation. Image is represented by global or local features. A global feature represents an image by one multi-dimensional feature descriptor, whereas local features represents an image by a set of features extracted from local regions in the image. Though, global features has some advantages like required a smaller amount memory, provide speed and simple to work out but provide less performance compared to local features. Local feature extracted and represented by feature detector like Harris point detector, Harris and Hessian Laplace and affine detector, Difference of Gaussian (DoG), etc. and feature descriptor like Gradient location-orientation histogram (GLOH), Shape context, Scale Invariant Feature Transform (SIFT) and PCA-SIFT, etc. Out of them, Difference of Gaussian detector and SIFT provide better results with respect to different geometrical changes and are commonly used [11].

SIFT descriptor provides the large collection of local feature vector from an image, which does not has effect of image rotation, scaling and translation, etc. SIFT contain four major stages; (1) Scale Space extrema finding (2) Key point localization (3) Orientation assignment and (4) Key point descriptor. In the first step, potential interest points are recognized by scanning the image over location and scale. This is implemented efficiently by using difference-of-Gaussian (DoG) images. In the second step, candidate key points are limited to a small area and eliminated if found to be unstable. The third steps, identifies the one or more orientations for each key point based on its local image gradient route. The final stage builds

a local image descriptor for each key point, based upon the image gradients in the region around every key point [10].

3.1 VisualRank Approach

VisualRank approach depends on finding and processing, the distribution of visual similarities between the images. A visualization method supports link structure and ranking of its nodes. In Figure1 (b) repetitions of same visual signal in a large fraction of the images provide an important signal for VisualRank. There are multiple visual signals by collecting them from number of images, provide base for ranking the images. Image ranking involve, providing "authority" node on common visual similarities, to those images that answer the image query well. The main two challenges for using common visual theme concept for image ranking are image processing and a mechanism to utilizing the information for the purpose of ranking [2, 4].

As common visual features among the images are known but by simply counting them, provided poor result. So to solve this task, VisualRank create a graph between images by considering similarity weightage. The goal of visual rank is not to identify the object or their classification, but the finding common visual similarities between images and use of this information, for applying PageRank algorithm to the image ranking. The similarity is measured by studying an image to image distance function; means the distance between images from same category should be less than that from different categories. Depending on similarities among the images graph is obtained [1], using iterative procedure images ranking are provided.

4. CONCLUSIONS

This paper presents a survey on image ranking, which is important part of image retrieval from large scale web-images. Image retrieval techniques including conventional PageRank algorithm with Topic Sensitive PageRank, CBIR and VisualSEEK for better performance of web-image retrieval are discussed. PageRank provide standards for quality measurement of web-page, but it favours older pages of website. More accurate image retrieval results are returned by Topic Sensitive PageRank. CBIR provides much relevant results and reducing semantic gap up to certain level. Along this VisualRank approach is discussed, based on common visual similarities present in link structure of web, where image get higher ranking, because their similarities matches are more than others. Addition of supplementary local and sometime global feature may offer better image retrieval results.

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