Survey of Image Retrieval Techniques and Algorithms for Image-Rich Information Networks

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ABSTRACT
Social networking sites allow users to share images, E-commerce web sites also contains millions of images and thus forms image-rich information networks. Retrieving images from image-rich information networks is very challenging task, due to existence of information like text, user, image, feature, tags and group. The concept of image-rich information networks, image retrieval system and techniques like CBIR and TBIR are explained in this paper. The comparative study of image ranking and retrieval algorithms like simrank, k-simrank, HMOK-simrank is also mentioned in this paper.

General Terms
Image-rich information networks, CBIR, TBIR.

Keywords
Image retrieval techniques, image retrieval algorithms.

1. INTRODUCTION
Social multimedia (photo and video) sharing and hosting websites such as Flicker, Facebook, ImageShack and Photobucket are popular around the world, billions of photos are uploaded on it by users. Popular internet commerce websites such as Amazon, Snapdeal and FlipKart etc are furnished with tremendous amounts of product related image. E-commerce web sites also using social networking sites to display their advertisements.

Images in social networks and E-commerce websites are accompanied by information such as tags, links, producer and

Consumer information, annotations and comments. They can be represented as heterogeneous image-rich information networks.

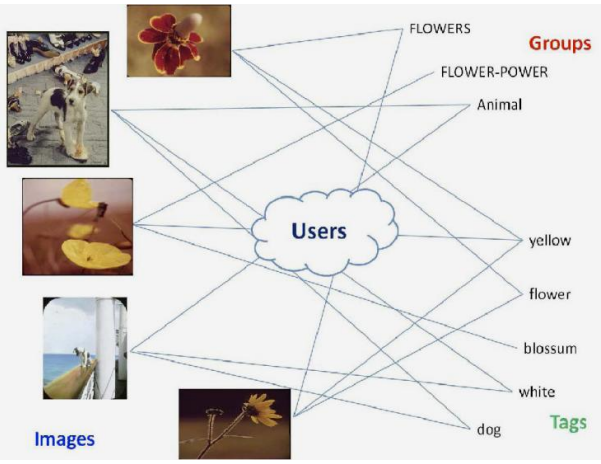

Figure 1. Image-rich Information network for Flickr dataset, connected by Images, user tags, and groups [1]

Figure (1) shows an example of the Flickr information network, where tags are given to images by the users and image owners contribute images which can be a part of image groups. Figure (2) indicates an Amazon information network showing its product images, product categories and consumer tags.

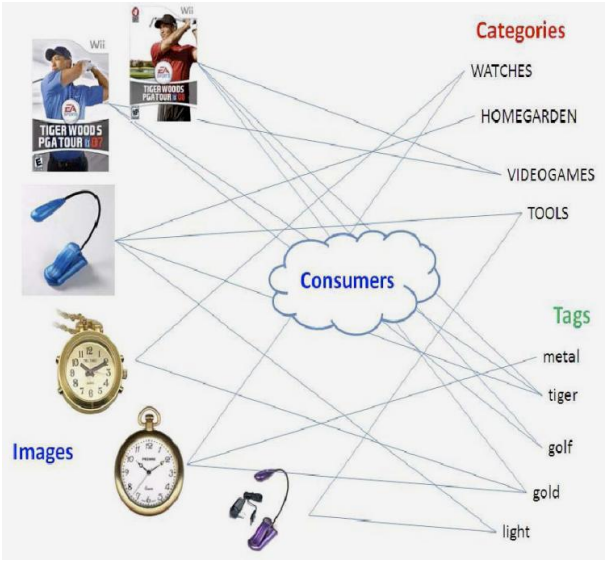

Figure 2. Amazon Information network, connected by products, user tags and categories [1]

Information retrieval in image-rich information networks is a very useful but it is very challenging task, because there exists a lot of information such as text, image feature, user, group, and most importantly the network structure.

1.1 Image Retrieval Systems
Information Retrieval is the activity of obtaining information from a collection of information resources which should be relevant to user query and suppose to fulfill the search needs. Generally Metadata or full text or Content-based Indexing can be used to search information in information retrieval system.

Image Retrieval Systems: An image retrieval system is a computer system for browsing, searching and retrieving images from a large database of digital images.

Image search is specialized data search used to find images. To search images user may provide query terms such as keyword, image file/link and click on some image and the system will return images similar to the query.

1.1.1 Types of Image Retrieval Systems
1) Concept-Based image retrieval system: - It is also known as Text-based image retrieval system (TBIR) [3]. In text-based image retrieval estimating the similarity of the words in the

context is useful for returning more relevant image. TBIR exploits textual descriptions of images such as caption, annotation, tags and comments. Popular image search engines like Google, Yahoo and Bing are using the concept based image retrieval systems for image retrieval. A user is require to input a keyword as a textual query to the retrieval system then the system returns the ranked relevant images whose surrounding texts contain the query keyword and the ranking score is obtained according to some similarity measurements between the query keyword and the textual features of relevant images [4].

Advantages:

1) TBIR system is very easy to implement.

2) TBIR system works fast i.e. retrieve images fast from database.

Disadvantages:

1) If in the query specific keyword is missing then irrelevant images are found.

2) Manual annotation is not always available.

3) Image annotation is very time consuming process.

2) Content-Based image retrieval system (CBIR):- CBIR is also known as Query by Image Content, it is the application of computer vision techniques to the image retrieval problem. The primary goal of the CBIR system is to construct meaningful descriptions of physical attributes from images to facilitate efficient and effective retrieval. The "content" can be colors, textures, shapes or any other information that can be derived from the image itself [5].

Content-Based Image Retrieval (CBIR) systems are search engines for image databases, which index images according to their content. A typical task solved by CBIR systems is that a user submits a query image or series of images and the system is required to retrieve images from the database as similar as possible.

Advantages:

1) CBIR is more efficient and practical than TBIR.

2) It reduces the task of image description of user and increase usability of system.

Disadvantages:

1) The removal of human interaction, results in a number of issues such as ability to deal with semantic attributes of images.

2) Machines are unable to accurately extract all the image features.

1.2 Flow Chart of CBIR System

In typical content-based image retrieval systems (Figure 3), the visual contents of the images are extracted and represented by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. To retrieve images, users need to give input such as images to the retrieval system. The system then changes these examples into its representation of feature vectors. The similarities /distances between the feature vectors of the user query example or sketch and the images present in the database are then calculated and retrieval is performed according to an indexing scheme.

The indexing scheme provides an efficient way to search images from the database. Retrieval systems have incorporated user's relevance feedback to change the retrieval Process so as to get perceptually and semantically more relevant retrieval results.

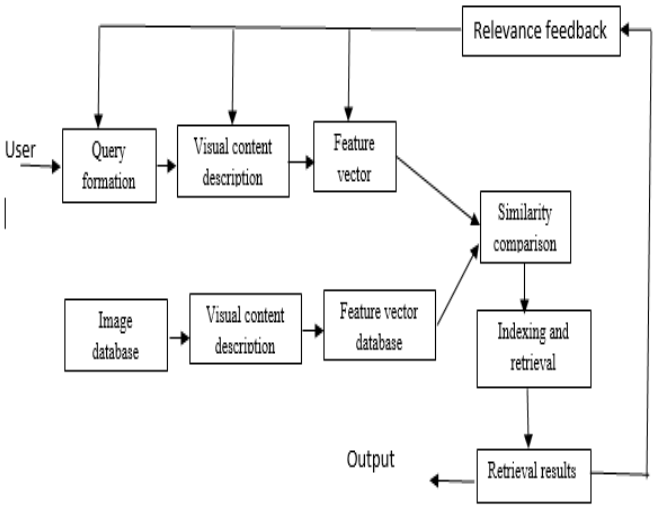

Figure 3. Flow chart of CBIR System

2. LITERATURE REVIEW

2.1 Heterogeneous Information Networks

Xin jin, jiebo luo, jie yu, gang wang, dhiraj joshi and jiawei han [1] explained the concept of image retrieval in image-rich information networks. They designed a system referred to as iRIN for image retrieval in image-rich information networks. They have explained the concept of heterogeneous information networks and also proposed reinforced integrated algorithm to retrieve images in heterogeneous image-rich information networks [2]. Experimental results on Flickr and Amazon data sets show that their approach is significantly better than traditional methods in terms of both relevance and speed. Advanced product search and recommendation system is enforced to search out each visually similar and semantically relevant products based on HMOK-SimRank and IWSL algorithms for heterogeneous image-rich information networks [2].

2.2 Image Retrieval Systems

Lixin Duan, Wen Li, Ivor Wai-Hung Tsang, and Dong Xu [3], have explained the concept of TBIR briefly and designed a new bag-based reranking framework for large-scale TBIR. Hui Hui Wang, Dzulkifli Mohamad, N.A. Ismail [4] have mentioned the evolution of the retrieval approaches specializing in development, challenges and future direction of the image retrieval. They additionally explained the semantic gap issues, user query mechanisms yet as common ways that accustomed bridge the gap in image retrieval. The types of Image Retrieval Systems such as Text based, Content based and Region based are explained in paper [3] and [4] respectively.

2.3 Content-based Image Retrieval

Mehwish Rehman, Muhammad Iqbal, Muhammad Sharif and Mudassar Raza [5] explained the concept of content based image retrieval system in brief. They also explained low level features such as color, shape and texture for retrieval of images because traditional indexing method has been proven neither suitable nor efficient in terms of time and space. Most

popular algorithms of feature extraction and relevance feedback that try to bridge extracted low level features and features with high level semantics gap from image are discussed in paper [5].

Survey on Image Content Analysis is performed by the Z. Yang and C.-C.J. Kuo [6]. Laaksonen J., E. Oja, M. Koskela and S. Brandt [7], have explained the concept of low level features of CBIR and analysis of low level features using CBIR.

2.4 Similarity Measure, Indexing and Ranking

J. Huang, S.R. Kumar, M. Mitra, W.-J. Zhu,and R. Zabih have explained the concept of Image Indexing Using Color Correlograms [8]. Color correlograms feature distills the spatial correlation of colors, it is both effective and inexpensive for content based image retrieval. Experimental evidence suggests that this color correlogram outperforms not only the traditional color histogram method but also the recently proposed histogram refinement methods for image indexing/retrieval.

VisualRank retains the commonly used text query interface and utilizes the visual similarities within the entire set of images for image selection. VisualRank can be effectively used in combination with other CBIR systems by generating a more relevant and diverse set of initial results, which often results in a better starting point for pure CBIR systems [9].

SimRank algorithm is one of the most popular but very expensive to calculate is proposed in paper [10], it is the solution for the problem of measuring similarity of object in many applications. Simrank is based on simple and intuitive graph theoretic model. Extension of SimRank i.e. Mok-SimRank algorithm is proposed explained briefly in paper [11] [1]. Authors of paper [1] proposed MOK-SimRank algorithm to significantly improve the speed of SimRank.

Savvas A. and Chatzichristofis [12] proposed a new low level feature for indexing and Retrieval of images which called as color and edge directivity descriptor. One of the most important attribute of the low computational power needed for its extraction.

3. SUMMARY OF LITERATURE REVIEW

Image Retrieval System is a computer system for Browsing, Searching and retrieving image from large database. The use of metadata such as captioning, keywords or decrypt ions to the images store in the database along with the images or low level features extracted from the image like shape, color and texture have been use till now for the image retrieval from existing search engine.

There is need to develop such system which will find both visually and semantically relevant output and also provide recommendation to user. A System which will provide accurate output in less response time and will also make querying for image retrieval very easy.

Table 1 describes the time and space complexity of algorithms in homogeneous network and it has been proved that Mok-SimRank algorithm has improved time and space complexity.

Table 1: Time and Space complexity Homogeneous algorithms [1]

Algorithm	Time Complexity	Space Complexity
SimRank	O **(In^{2}P)**	O **(n^2)**
K-SimRank	O **(InkP)**	O **(nk)**
Mok-Simrank	O **(InkP$_{min}$)**	O **(nk)**

Table 2 describes the time and space complexity of algorithms in weighted heterogeneous networks.

Table 2: Complexity of Algorithms in (Weighted) Heterogeneous Network [2]

Algorithm	Time Complexity	Space Complexity
HSimRank	$O(\sum_{i=1}^{p} m_i^2 P)$	$O(\sum_{i=1}^{p} m_i^2)$
HK-SimRank	$O(\sum_{i=1}^{p} m_i kP)$	O **(nk)**
HMok-Simrank	$O(\sum_{i=1}^{p} m_i kP_{\min})$	O **(nk)**

Proposed Integrated Weighted Similarity learning (IWSL) [2] algorithm which is enhancement in HMOK SimRank is implemented in image rich information networks, it uses HMOK SimRank, local feature extraction techniques, weighting and feedback techniques to improve the accuracy of results in CBIR systems.

4. CONCLUSION

It is also observed that use of only content or concept information to retrieve images lead to give unsatisfying results so combination of concept and content information is required for accurate and robust performance in Pattern Recognition, Statistics and Computer Vision. CBIR provides vast and diverse application possibilities which requires research in CBIR System to improve its accuracy. More research is required to retrieve images or data in image-rich information networks accurately and efficiently.

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