Comparison and Analysis of Content Based Image Retrieval Systems Based On Relevance Feedback

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ABSTRACT

Content-based image retrieval has become one of the most active research areas in the past few years. In this paper various methodologies used in the research area of Content Based Image Retrieval techniques using Relevance Feedback are discussed. The comparison and analysis of these methods is done. Relevance feedback techniques were incorporated into Content-based image retrieval for obtaining more precise results. This is an open research area for the researchers in the field of Content-based image retrieval. The paper covers various relevance feedback techniques for Content Based Image Retrieval systems, the parameters used for experimental evaluation of the systems and the analysis of these techniques on the basis of their results.

Keywords: Content-based image retrieval, relevance feedback, precision, accuracy

1. INTRODUCTION

The relevance feedback technique initially developed for document retrieval during the 1960s was transformed and introduced into content-based multimedia retrieval, mainly content-based image retrieval (CBIR), during the early and mid-1990s. Since then, this topic has attracted tremendous attention in the CBIR community – a variety of solutions has been proposed within a short period, and it remains an active research topic today. The reasons are that more ambiguities arise when interpreting images than words, which makes user interaction more of a necessity; and in addition, judging a document takes time, while an image reveals its content almost instantly to a human observer, which makes the feedback process faster and more sensible for the end user.[12]

Number of powerful image retrieval algorithms has been proposed to deal with the problems over the past few years. Content-Based Image Retrieval (CBIR) is the mainstay of current image retrieval systems. A number of relevance feedback (RF) studies have been made on interactive CBIR. In this paper a detail comparison of the various methods developed for content based image retrieval systems using relevance feedback has been provided.

The rest of the paper is organized as follows: Content Based Image Retrieval and Relevance Feedback are discussed briefly in section 2. Section 3 provides a brief about the various methodologies used in Relevance Feedback Based CBIR systems. The analysis of these methods is tabulated in section 4. Section 5 concludes the paper.

2. CONTENT - BASED IMAGE RETRIEVAL AND RELEVANCE FEEDBACK

Content-based retrieval is characterized by the ability of the system to retrieve relevant images based on the visual and semantic contents of images. [2] Content-based image retrieval, uses the visual contents of an image such as color, shape, texture, and spatial layout to represent and index the image. CBIR is the application of computer vision techniques to the image retrieval problem, that is, the problem of searching for digital images in large databases. The CBIR system works as follows: The visual contents of the images in the database are extracted and described by multi-dimensional feature vectors. The feature vectors of the images in the database form a feature database. To retrieve images, users provide the retrieval system with example images or sketched figures. The system then changes these examples into its internal representation of feature vectors. The similarities/distances between the feature vectors of the query example or sketch and those of the images in the database are then calculated and retrieval is performed with the aid of an indexing scheme. The indexing scheme provides an efficient way to search for the image database. [3]

Relevance Feedback (RF) is the process of automatically adjusting an existing query using the information fed back by the user about the relevance of previously retrieved objects such that the adjusted query. The key issue in relevance feedback is how to effectively utilize the feedback information to improve the retrieval performance. [11] After obtaining the retrieval results, user provide the feedback as to whether the results are relevant or non relevant. If the results are non-relevant the feedback loop is repeated many times until the user is satisfied.
3. METHODOLOGIES USED IN RELEVANCE FEEDBACK BASED CBIR SYSTEMS

RUI, Huang, and MEHROTRA (1998) [4] have presented a relevance-feedback based approach to CBIR, in which a human and a computer interact to refine high-level queries to representations based on low-level features. Which addresses the gap between high level concepts and low level image features and, subjectivity in human perception of image content?

Benitez, Beigi, and Chang (1998) [5] described MetaSeek, which is a Meta search engine to query distributed image collections on the Web. The Meta search engine interfaces with four image search engines: Visual Seek, Web Seek, QBIC, and Virage. User feedback was used to evaluate the quality of search results returned by each engine, and this history was preserved in a database.

Vasconcelos and Lippman (2000) [6] used a Bayesian learning algorithm that integrate relevance feedback provided by the user over a retrieval session.

Xiang Sean Zhou Thomas S. Huang (2001) [7] proposed the on-line learning algorithms for content-based multimedia information retrieval which focused on the similarity metric issue named as Kernel based biased discriminate analysis (KBDA).

Jorma Laaksonen et al. (2001) [8] implemented relevance feedback by using self organizing maps. The Self-Organizing Map (SOM) is an unsupervised, self-organizing neural algorithm widely used to visualize and interpret large high-dimensional data sets.

Sean D. MacArthur et al. (2002)[9] proposed a relevance feedback technique that have used decision trees to learn a common thread among instances marked relevant. The technique was applied in preexisting content-based image retrieval (CBIR) system that was used to access high resolution computed to monographic images of the human lung.

Su, Zhang, Li, and Ma (2003) [10] have given an approach to relevance feedback based CBIR using a Bayesian classifier. Positive examples in the feedback were used to estimate a gaussian distribution that represents the desired images for a given query.

Deok-Hwan Kim, Chin-Wan Chung, Kobus Barnard (2005) [15] have designed a method which constructs clusters and changes them without performing complete re-clustering. It’s computing time was short since the same statistical measures were used at both the classification stage and the cluster-merging stage.

Anelia Grigorova et al. (2007)[16] have suggested a new concept semantically based feature space modification called feature adaptive relevance feedback (FA-RF). FA-RF is a RF-based approach that have used two iterative techniques to exploit the relevance information: query refinement and feature re-weighting.

Chueh-Yu Li and Chiou-Ting Hsu (2008)[17] have used graphs to represent images, transform the region correspondence estimation problem into an inexact graph matching problem, and proposed an optimization technique to derive the solution.

Wei Bian and Dacheng Tao (2010)[19] have represented images by low-level visual features. They have designed a mapping to select the effective subspace from for separating positive samples from negative samples based on a number of observations. They have proposed the Biased Discriminative Euclidean Embedding (BDEE) which parameterizes samples in the original high-dimensional ambient space to discover the intrinsic coordinate of image low-level visual features.

Peter Auer et al. (2010) [20] have described Pinview, a content-based image retrieval system that exploits implicit relevance feedback during a search session.

Dorota G lowacka, John Shawe-Taylor (2010) [21] have presented a new approach to content-based image retrieval based on multinomial relevance feedback. They have modeled the knowledge of the system using a Dirichlet process.

Ja-Hwung Su et al. (2011) [22] have proposed a novel method, Navigation-Pattern-Based Relevance Feedback (NPRF), to achieve the high efficiency and effectiveness of CBIR. In terms of effectiveness, the proposed search algorithm NPRF Search makes use of the discovered navigation patterns and three kinds of query refinement strategies, Query Point Movement (QPM), Query Reweighting (QR), and Query Expansion (QEX).

3.1 Parameters Used For Experimental Evaluation of Relevance Feedback Based CBIR Systems

The standard parameters which are used for the experimental evaluation of the results by the above stated systems are convergence ratio, precision, recall and accuracy.

Convergence ratio is calculated as weighted relevant count divided by the ideal weighted relevant count of the images. Precision is defined as number of retrieved relevant images divided by total number of retrieved images and the recall is number of retrieved relevant images divided by total number of relevant images in the database.
[16] The Standard Deviation serves as an error-bar, while the precision is the major evaluation method. [19] The criterion precision delivers the ability for hunting the desired images in user’s mind and the coverage represents the ability for finding the accumulated positive images in a query session. [22] Accuracy can be calculated as relevant images retrieved in top $T$ returns divided by $T$. [10]

## 4. ANALYSIS OF CBIR SYSTEMS BASED ON RF TECHNIQUES

Analysis and comparison of various CBIR systems based on relevance feedback technique is provided in the following table.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>AUTHOR</th>
<th>YEAR</th>
<th>PROPOSED METHOD</th>
<th>DATASET USED</th>
<th>PARAMETER USED FOR EVALUATION</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rui, Huang, and Mehrotra</td>
<td>1998</td>
<td>Relevance feedback based interactive retrieval approach</td>
<td>1) MESL test set (Museum Educational Site Licensing Project) 2) Corel Corporation</td>
<td>Convergence Ratio</td>
<td>For MESL test set Convergence Ratio = 0.9 For COREL test set Convergence Ratio = 0.7</td>
</tr>
<tr>
<td>2</td>
<td>Benitez, Beigi, and Chang</td>
<td>1998</td>
<td>Meta seek, which is Meta search engine</td>
<td>12 images of the semantic category “Animals” as the set of target images</td>
<td>Precision</td>
<td>Average Precision = 0.70</td>
</tr>
<tr>
<td>3</td>
<td>Vasconcelos and Lippman</td>
<td>2000</td>
<td>Bayesian Learning Algorithm</td>
<td>Brodatz texture database and Columbia object database.</td>
<td>Precision and Recall</td>
<td>Precision/ Recall curve were plotted.</td>
</tr>
<tr>
<td>4</td>
<td>Xiang Sean Zhou Thomas S. Huang</td>
<td>2001</td>
<td>Kernel Based Biased Discriminate Analysis (KBDA)</td>
<td>COREL image set of 17695 images</td>
<td>Mean and Variance</td>
<td>Mean = 17.0 Variance = 8.86</td>
</tr>
<tr>
<td>5</td>
<td>Jorma Laaksonen, Markus Koskela, Sami Laakso and Erkki Oja</td>
<td>2001</td>
<td>Self Organizing Maps</td>
<td>Corel Gallery 1,000,000 product</td>
<td>Quantitative figure denoted by as the t measure (smaller the t value better the result)</td>
<td>The average ‘t’ value = 0.174</td>
</tr>
<tr>
<td>6</td>
<td>Sean D. MacArthur, Carla E. Brodley, and Avinash C. Kak</td>
<td>2002</td>
<td>Relevance feedback technique using decision trees</td>
<td>Image database of HRCT scans</td>
<td>Precision</td>
<td>Average Precision = 0.504</td>
</tr>
<tr>
<td>7</td>
<td>Su, Zhang, Li, and Ma</td>
<td>2003</td>
<td>Bayesian classifier</td>
<td>Corel Image Gallery</td>
<td>Accuracy</td>
<td>Accuracy increase in top 10 results = 13.4% in top 20 results = 7.8% and in top 100 results = 2.6%</td>
</tr>
<tr>
<td>8</td>
<td>Anelia Grigorova, Francesco G. B. De Natale</td>
<td>2007</td>
<td>Feature Adaptive Relevance Feedback (FA-RF)</td>
<td>UC Berkeley digital library project</td>
<td>Precision and Recall</td>
<td>Precision = 0.6406 Recall = 0.6833</td>
</tr>
</tbody>
</table>
5. CONCLUSION

Relevance Feedback is a powerful Technique in CBIR for Multimedia retrieval. In this paper various relevance feedback techniques for last ten years, their dataset used and their results are discussed in detail. From the results of the various methods discussed, it can be concluded that to improve the retrieval performance of the CBIR systems researchers must have to design the techniques to increase the values of the standard evaluation parameters like precision, convergence ratio or accuracy. The Relevance Feedback technique can be incorporated in CBIR system to obtain the higher values of the standard evaluation parameters used for evaluation of the CBIR system which may lead to better results of retrieval performance. For future research direction in RF, the approaches discussed can be applied to more kinds of applications on multimedia retrieval or multimedia recommendation.

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