ADVANCED RELEVANCE FEEDBACK STRATEGY FOR PRECISE IMAGE RETRIEVAL

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ABSTRACT

Relevance feedback is effective technique for bridging the semantic gap in image retrieval which diminish semantic gap between low-level visual features and high-level semantic concepts for image retrieval. Currently, crucial image retrieval system is content-based image retrieval. To improve performance of proposed content based image retrieval system, automatic relevance feedback technique is proposed which based on inductive learning involve inductive concept learning by decision tree. We implement and tested proposed image retrieval system which refine the retrieval result as per user requirement until get required accuracy. Experimental result shows improved performance in term of precision, recall and accuracy.

Keywords: Content based image retrieval, Decision tree, Inductive learning, Inductive concept learning, Relevance feedback, Semantic gap.

1. INTRODUCTION

As we know, an immense growth and development in internet technology give birth to gigantic digital images which are exploited in variety of applications such as medical, academic, virtual museums, military etc. it is really difficult for users to search large image databases for particular required image. In order to address this requirement, initially text based and then content based image retrieval system is proposed. In text based image retrieval system, images are retrieved on the basis of text annotation. Text based retrieval systems are suffered from low precision, recall and accuracy. To overcome these limitations, Content based image retrieval system is introduced. In content based image retrieval system, initially visual features such as color, texture and shape are extracted from images and store in feature vector which are used to represent image. When user fired an image query, then a query model converts the image into a feature vector of query image and retrieval module performs image retrieval by computing similarities between query image and images in image database. Finally, the retrieval results are ranked according to computed similarity.
values. Content based image retrieval systems are also critically suffer by semantic gap which address by using relevance feedback mechanisms.

Relevance feedback mechanism provides way to interact human and computer to remodel high-level queries to low-level features. Relevance feedback is a potent skill used to improve accuracy and speed of retrieval in content based and text-based retrieval systems. Relevance feedback is an iterative method, which filter and improve the retrieval result based on the previously retrieved results user's feedback. Traditional there are two types of RF, short term RF and Long term RF. Some retrieval system used merging of short-term and long-term learning with virtual feature [8]. Relevance feedback automatically adjust an active query using the information provided by the user about the earlier retrieved objects considering low-level features can capture high-level concepts, the relevance feedback mechanism attempt to form the relation between high-level concepts and low-level features from the user’s feedback.

1.1. Types of Relevance Feedback

![Figure 1. Types of Relevance Feedback](image)

1.2. Challenges Faced by Relevance Feedback

As mention earlier, relevance feedback is used to improve accuracy of image retrieval. There are some challenges which need to address to improve relevance feedback strategy such as high level feature extraction, imbalance feedback samples and real time processing.

1) High Level Semantics Extraction:
Image retrieval system is suffered from semantic gap. Extraction of high-level semantics from images is difficult because RF used only low-level features.

2) Imbalance of feedback samples:
Machine learning algorithms are unable to accurate result, because smaller numbers of feedback samples are labeled by the users during RF iteration which are far smaller feature space dimension. Labelling of negative samples is generally greater than positive samples which result in imbalance of training data. Thus the small positive sample definitely confines RF accuracy.

3) Real time processing:
Online relevance feedback takes more time which is addressed by implementing efficient image representation and storage structures.
2. ROLE OF RF IN CBIR

A number of relevance feedback techniques have been designed as a key tool to bridge the semantic gap in content based image retrieval, and thus to improve the performance of CBIR systems. By using relevance feedback scheme, a CBIR system learns from feedback given by the user. Learning in CBIR systems is categorized into short-term learning, and long term learning [21].

- **Short-term learning**
  CBIR system refines and tunes query using relevance feedback in single retrieval iteration. This type of learning is usually known as intra-query learning or short term learning. A lot of standard machine learning techniques are used in short-term learning which include support vector machines, Bayesian learning, boosting and feature weighting, discriminant analysis etc. Short term learning is online, which takes additional real time.

- **Long term learning**
  The learning strategy analyzes the relationship between the current and past retrieval iterations. This form of learning is inter-query or long term learning. Long-term learning methods overcome the problem of short term learning. It confiscates inability of capturing semantics and imbalance of feedback examples, and memory mechanism. It based on collaborative filtering.

3. ADVANCED DEVELOPMENT IN RF

This section highlights advance development in relevance feedback technique such as Navigation-Pattern-based Relevance Feedback, Click-based relevance feedback, pseudo-relevance feedback for multimedia retrieval, user historical feedback log, semi-supervised long-term Relevance Feedback algorithm, a gaze-based Relevance Feedback, Gaussian based relevance feedback, Advanced long-term relevance feedback system generalized biased discriminant analysis relevance feedback algorithm etc.
View-based 3D model retrieval system implemented a relevance feedback method to balance the contributions of multiple topic models with specified numbers of topics [1]. View-based 3D model retrieval uses a set of views to represent each object. Click-based relevance feedback is proposed which emphasizes the successful use of click-through data for identifying user search intention [2]. Leverage click-through data can be considered as an implicit user feedback and help to understand the query. Spoken term detection is a basic technology for spoken content retrieval, which retrieve and browse multimedia content over the Internet. The concept of pseudo-relevance feedback used in multimedia retrieval, which divide some spoken segments in the first-pass retrieved results into relevant or pseudo-relevant and irrelevant or pseudo-irrelevant [3]. Adaptive wavelet-based image characterizations used to characterize each query image which improves the retrieval performance. Flexibility in wavelet adaptation also enhanced relevance feedback on image characterization itself [4]. A novel subspace learning framework for learning an effective semantic subspace is proposed on user historical feedback log data for a Collaborative Image Retrieval [5]. Basically, CPSL can efficiently assimilate discriminative information and geometrical information of labeled log images, and the weakly similar information of unlabeled images together to learn a reliable subspace.

Navigation-Pattern-based Relevance Feedback (NPRF) achieves the high efficiency and effectiveness of CBIR in coping with the large-scale image data [6]. Proposed NPRF Search discovered navigation patterns and three kinds of query refinement strategies, Query Point Movement, Query Reweighting and Query Expansion, to match the user's goal successfully. A semi-supervised long-term Relevance Feedback algorithm is designed which refine the multimedia data representation and utilizes both the multimedia data distribution in multimedia feature space and the history RF information provided by users [8]. Geometric optimum experimental design is a novel active learning method selects multiple representative samples in the database as the most informative ones for the user to label which improve relevance feedback [9]. A gaze-based Relevance Feedback approach to region-based image retrieval is presented [12]. Proposed object-based RF overcome the major drawback of region-based RF approaches, i.e., the frequently inaccurate estimation of the regions of interest in the retrieved images. A biased maximum margin analysis (BMMA) and a semisupervised BMMA (SemiBMMA) are proposed for integrating the distinct properties of feedbacks and exploiting the information of unlabeled samples for SVM-based RF schemes [14]. The BMMA distinguishes positive feedbacks from negative ones based on local analysis, whereas the SemiBMMA can efficiently incorporate information of unlabeled samples by introducing a Laplacian regularizer to the BMMA. Advanced long-term relevance feedback system was proposed which integrates the user feedback from all iteration and instills memory into the feedback system of content based retrieval without earlier retrieval log [16]. A new relevance feedback approach for content-based image retrieval was introduced, which uses Gaussian mixture (GM) models as image representations [17]. Proposed RF technique categorizes the relevant and irrelevant images according to the preferences of the user. The generalized biased discriminant analysis algorithm is the most promising relevance feedback way employed for content-based image retrieval [18]. It evades the singular problem by adopting the differential scatter discriminant criterion and manages the Gaussian distribution assumption.

New RF method with active sample-selecting and manifold learning was proposed for CBIR of SAR images with limited feedback samples [19]. Particle swarm optimizer which merges relevance feedback with an evolutionary stochastic algorithm was proposed which grasp user's semantics through optimized iterative learning [20]. For improvement of performance, a real-time textual query-based personal photo retrieval system for millions of Web images implemented two relevance feedback methods using cross-domain learning, which efficiently employ both the Web images and personal images [22].
4. PROPOSED SYSTEM

Proposed system has basic four components, image DB, features extraction, similarity measure, and relevance feedback.

• **Image database:**
  
  We proposed and tested image retrieval system based Inductive Learning strategy using image database of 2400 images. Used image database consist of both image natural as well as synthetic images.

• **Feature extraction:**
  
  Feature extraction consists of extracting the significant information from the images. Once the low level features are extracted, they are stored in the form of feature vector in Database. Feature extraction is significantly reduces the information storage space as it represent an image for understanding using image content. In the CBIR system, low level features of image such as color, texture and shape are extracted using Discrete Wavelet Transform. Low level contents of the images in the database are extracted and described by multi-dimensional feature vectors in image feature database.

![Workflow of proposed system](image)

**Figure 3.** Workflow of proposed system

• **Similarity measure:**
  
  In similarity measure, feature vector of user query image and database image feature vector are compared using the Euclidean distance metric. The images are ranked based on the distance value. For similarity measure, proposed system use Euclidean distance techniques for matching user
query image with images in database. Similarity measure is based on threshold values of image extracted features. If a Euclidean distance value is less than threshold value than image is irrelevant otherwise image is relevant to query image.

- **Advanced Relevance feedback strategy:**

  Basically, relevance feedback is a technique used in image retrieval to help the users for retrieving the correct images from large database as per user requirement. The users can continue to refine the search from the results of the previous search until they get the desired images or closest to what they desire. In this framework, the Relevance Feedback functionality is described. The Relevance Feedback is a composition of Inductive Learning Framework, Inductive Concept Learning by Decision Tree.

![CBIR with Relevance Feedback](image)

**Figure 4.** CBIR with Relevance Feedback

a) **Inductive Learning Framework:**

  Raw input data is processed to obtain a feature vector, \( x \), that adequately all of the relevant features for classifying examples. Each \( x \) is a list of (attribute, value) pairs. For example, 
  \[
  x = (\text{Person} = \text{Sue}, \text{Eye-Color} = \text{Brown}, \text{Age} = \text{Young}, \text{Sex} = \text{Female})
  \]

  The number of attributes (also called features) is fixed (positive, finite). Each attribute has a fixed, finite number of possible values. Each example can be interpreted as a point in an \( n \)-dimensional feature space, where \( n \) is the number of attributes.

b) **Inductive Concept Learning by Learning Decision Trees**

  Build a decision tree for classifying examples as positive or negative instances of a concept. Supervised learning, batch processing of training examples are employed using a preference bias. A decision tree is a tree in which each non-leaf node has associated with it an attribute (feature), each leaf node has associated with it a classification (+ or -), and each arc has associated with it one of the possible values of the attribute at the node where the arc is directed from. For example,
5. RESULT EVALUATION

Proposed automatic relevance feedback strategy is presented and tested to reduce the gap between low-level visual features and high-level semantic during the process of relevance feedback. We implemented and tested the proposed content based image retrieval system with advanced relevance feedback based on Inductive Learning Framework using a 2400 image subset from the COREL image database. The images used are assorted set comprising both natural and man-made scenes and objects. As proposed system is based on color, texture and shape feature abstraction, equity in terms of these low level features was desired. Therefore, the test set used required striking a balance of low level image content. The main objective of experimentation was to compare and refine retrieval result to achieve high degree of retrieval accuracy.
In the first phase as shown in figure 7, proposed system retrieved a set of relevant image for user query which has low accuracy as per user expectation. To improve accuracy of image retrieval, proposed relevance feedback technique used to refine result as per user requirement as shown in figure 8. During each iteration accuracy of retrieval is improves as shown in table 1 which ultimately reduce semantic gap. Performance of proposed image retrieval system evaluated using parameters such as precision recall and accuracy with dataset of 2400 images. Figure 6 shows improvement of precision with iteration.

![Figure 6. Precision per iteration for user query](image)

<table>
<thead>
<tr>
<th>Query Image</th>
<th>Relevance Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Iteration 1</td>
</tr>
<tr>
<td>White rose</td>
<td>80.5</td>
</tr>
<tr>
<td>White Horse</td>
<td>77.45</td>
</tr>
<tr>
<td>Mountain</td>
<td>76.28</td>
</tr>
<tr>
<td>Beach</td>
<td>79.46</td>
</tr>
</tbody>
</table>

![Table 1. Precision with relevance feedback](image)

![Figure 7. Result for user query](image)
6. CONCLUSION

We proposed automatic relevance feedback which reduces the semantic gap between low-level features and high-level concepts. We proposed a content-based Image retrieval system with automatic relevance feedback which is an effective tool to improve the performance of CBIR in terms of accuracy, recall, and precision. Proposed automatic relevance feedback is based on a composition of Inductive Learning Framework, Inductive Concept Learning by Decision Tree. We used an image dataset of 2400 images to evaluate the result. Experimental results clearly show improvement in precision and accuracy of image retrieval.

REFERENCES


