QBIC in Peer –To – Peer Networks using BOVW Model and Split/ Merge Operation

Kavitha S. K, Soumya Kumar L. K.

Abstract: The term QBIC refers to query by image content. It is also known as content based image retrieval. In QBIC the search analysis the content of the image instead of the metadata like keyword, tags or any descriptive information related to an image. The content refers to the main features that are differentiating one image with another image. So in this thesis work focus on how we can retrieve an image from the peer to peer network with low network cost by using QBIC approach. It mainly focuses on two things network cost and workload balance during image retrieval process. It also take consider to the dynamic creation and uploading into the peer to peer networks by using BoVW model and split/merge operation.

Index Terms: QBIC, BOVW model, Peer-to-peer networks, split/merge operation.

I. INTRODUCTION

In nowadays there are large variety of images are available on the internet. The similar images are annotation by using different keywords. While we are try to search any particular image that make irrelevant result, because having human annotation manually enter the image name, so it make irrelevant result. So the keyword based search that takes irrelevant result requested by the user also it take little more time for the computation. Each image is described with set of properties the properties include color, texture, orientation, shape or etc that can be derived from the image itself. For the effective search of an image using content of an image instead of using metadata like keyword or tags or any other descriptive information. For the effective searching and indexing of the image in the peer to peer networks using QBIC algorithm.

The peer to peer networks provide a scalable solution for sharing multimedia data such as audio, video, images across the network, while performing QBIC in peer to peer network is one of the challenging issues because of the data discriminability, dimensionality problem. The existing QBIC system adopts a global feature vector, i.e. An image is represented as a feature vector. E.g. is color histogram. The similarity between the images is measured by measuring the distance between the image feature vectors. The high dimensional indexing or Locality sensitive hashing methods are used for indexing the feature vector.

The query by image content method faces following issues:

- In contract to the centralized environment, in peer to peer networks the data is distributed among the nodes in the networks, so it need QBIC algorithm for effective search and indexing of images.
- In peer to peer networks under5 constant churn a node is leaves or join from the networks. Any file is added or published into the network, the corresponding changes should be updated into the networks, and otherwise it works in statically manner.
- unlike distributed servers/ clouds, nodes in peer to peer networks have limited network bandwidth and computational power, thus the QBIC algorithm should keep the network cost low and the workload among nodes balanced.

Query By Image Content (referred to as QBIC in this thesis), which is based on automatically extracted primitive features such as color, shape, texture, and even the spatial relationships among objects, has been employed since the 1990’s[4]. In the last ten years, a great deal of research work on image retrieval has concentrated on CBIR technology.

Some commercial products based on CBIR technology have come to the marketplace, well-known examples including QBIC[1]. Image databases and collections can be enormous in size, containing hundreds, thousands or even millions of images. The conventional method of image retrieval is searching for a keyword that would match the descriptive keyword assigned to the image by a human categorizer. Currently under development, even though several systems exist, is the retrieval of images based on their content, called Content Based Image Retrieval, CBIR[5]. While computationally expensive, the results are far more accurate than conventional image indexing. Hence, there exists a tradeoff between accuracy.

The need for Content- Based image retrieval is to retrieve images that are more appropriate [1], along with multiple features for better retrieval accuracy. Usually in search process using any search engine, which is through text retrieval, which won’t be so accurate. So, we go for Query By Image Content. Query By Image Content I also known as Content- Based Image Retrieval (QBIC) and content-based visual information retrieval (CBVIR) [2]. “Content-based” means that the search makes use of the contents of image themselves, rather than relying on human-inputted metadata such as captions or keywords [3]. The similarity measurements and the representation of the visual features are two important issues in Content-Based Image Retrieval (CBIR) [8].

Given a query image, with single / multiple object present in it; mission of this work is to retrieve similar kind of images from the database based on the features extracted from the query image [1].

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II. LITERATURE SURVEY

Content Based Image Retrieval (CBIR) is any technology that helps to organize digital image archives by their visual content [9]. By this definition, anything ranging from an image, Similarity function to a robust image annotation engine falls under the purview of CBIR. The most common form of CBIR is an image search based on visual features. The increasing amount of digitally produced images requires new methods to archive and access this data. Conventional databases allow for textual searches on Meta data only [4]. Content Based Image Retrieval (CBIR) is a technique which uses visual contents, normally called as features, to search images from large scale image databases according to users’ requests in the form of a query image.

Apart from the usual features like color and texture, a new feature extraction algorithm called edge histogram is introduced [10]. Edges convey essential information to a picture and therefore can be applied to image retrieval. The edge histogram descriptor captures the spatial distribution of edges [5].

This model expects the input as Query by Example (QBE) and any combination of features can be selected for retrieval [12]. The focus is to build a universal CBIR system using low level features. These are mean, median, and standard deviation of Red, Green, and Blue channels [13] of color histograms. Color feature is the most intuitive and obvious feature of the image, and generally adopt histograms to describe it. Color histograms method has the advantages of speediness, low demand of memory space and not sensitive with the images changes of the size and rotation, it wins extensive attention consequently [11].

Information for proceeding in the project are collected from different books such as Greg Pass, Ramin Zabih, “Histogram refinement for content based image retrieval” WACV ’96 [6], Yong Rui, Thomas S. Huang and Sharad Mehrotra “Relevance Feedback Techniques in Interactive content based image retrieval.”,1996 [7] and also from some IEEE papers and other online links.


Table 1: Comparison study of first paper

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Step</th>
<th>Method</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feature Extraction</td>
<td>Color / Coherence Vector</td>
<td>Dense additive spatial information it is more efficient</td>
<td>Very much complex because of its high dimensionality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Texture: Gabor Filter</td>
<td>Used for detection edge, line and different orientation</td>
<td>Only effective for manmade objects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shape:FFT</td>
<td>Used for efficient result</td>
<td>depend on the position</td>
</tr>
<tr>
<td>2</td>
<td>Similarity Measure</td>
<td>Histogram Intersection</td>
<td>computation of the similarity among color images</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Comparison study of second paper

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Step</th>
<th>Method</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feature extraction</td>
<td>Singular Value Decomposition</td>
<td>Useful for Dimensionality reduction</td>
<td>It reduce the efficiency of image</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Principle Component Decomposition</td>
<td>reduce the complexity in image</td>
<td>The covariance matrix is difficult to evaluated in a accurate manner</td>
</tr>
<tr>
<td>2</td>
<td>Feature Selection</td>
<td>Leverage Score</td>
<td>It reduce the irrelevant portion in the image</td>
<td>Complex</td>
</tr>
<tr>
<td>3</td>
<td>classifiers</td>
<td>SVM</td>
<td>Easy to classify</td>
<td>The end user query can meet both requirements by low level features such as colour, shape etc is challenging and hard to articulate</td>
</tr>
</tbody>
</table>


Table 3: Comparison study of third paper

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Step</th>
<th>method</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Feature Extraction</td>
<td>Scale-invariant image regions</td>
<td>Easy to compute</td>
<td>Does not capture semantics</td>
</tr>
<tr>
<td>2</td>
<td>Quantization</td>
<td>Build-frequency histogram</td>
<td>it does not capture position in text, semantics, co-occurrences in different documents, etc.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>classification</td>
<td>Nonlinear SVMs</td>
<td>easily compute the similarity between 2 documents using it</td>
<td></td>
</tr>
</tbody>
</table>

III. RELATED WORKS

BoVW model

The BoVW model is a bag of visual words. The each image is described with set of features. So the BoVW model is a Collection of featured vector. Each image is representing as a feature vector or visual words. Basically the BoVW model consist of following steps

- Feature Extraction
- Quantization
- Codebook creation

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1. Feature Extraction

The image is a collection of features. Each image is differentiated with other images depending on the features present in the image. The features of an image include color, texture, shape or any other important information that can be derived from the image itself. Depending on the features extracted from the image, different methods are used. Here, basically, the features are classified as two categories:

Key Features

The key features are very essential or important information that will be derived. Different algorithms are used for deriving and identifying the key features uniform an image. For the extraction of key features there are two algorithms used such as color histogram equalization and wavelet transformation. It first calculates the RGB value of each pixel after calculating that value goes to the histogram representation. From that, we can calculate the intensity of each pixel. There is a threshold value setting point present. The pixel values that satisfy this threshold value go to the 1 state i.e., upper state the remaining go to the lower state i.e., lower it setting two values 0 and 1.

Local feature identification

The local features of images are the background information present in the image. The background information are identified by using the edge detector and segmentation etc.

2. Quantization

Quantization is the process of analyzing the feature vector. The feature vectors are one of the representations of an image. By analyzing the feature vector, we can easily identify the similar values. The similarity can be measured by using cosine similarity.

For example, \( v_1 = \{a_1, a_2, a_3, a_4 \ldots \} \), \( v_2 = \{b_1, b_2, b_3, b_4 \ldots \} \) and \( v_3 = \{c_1, c_2, c_3 \ldots \} \ldots \) these are the feature vectors, and each vector consist of set of values. The similarity measurement will calculate how these points close to each other.

The cosine similarity is calculated by measuring the similarity between two vectors (or two documents on the Vector Space). It is actually a measure that calculates the cosine of the angle between these documents. It can be seen as a comparison between documents. The magnitude of each word (Present in the document or may be in vector) count (tf-idf). After calculating the similarity making the clustering. Here using clustering algorithm is K-means clustering.

Clustering:

Clustering is the process of making different groups, each group contains similar group of values.

K-Means Clustering:

It is one of the best approaches for making the clustering. Because it will take small amount of time for grouping as well as the similarity measurement.

3. Codebook Creation

In vector quantization, we need to determine the reconstruction levels and corresponding cells \( C_i \). A list of reconstruction levels is called a "codebook" (CB). If there is L-reconstruction levels in the list it is referred to as an L-level codebook.

IV. PROPOSED SYSTEM

In the proposed system, introduce one of the methods is split/merge operation. It considers both the problems such as

- Data discrimination
- Workload problem
- Network cost reduction

The new method that takes into consideration these problems while processing a query, the relevant information as well as the workload information are collected by using this relevant information. The information provided by the codebook is maximized or minimized. It also reduces the quantization problem. The fair workload can be achieved by avowing overloading nodes as well as underloading nodes. By using these criteria, the codebook size is maximized or may be minimized, i.e. shrink or merge the codebook.

To reduce the network cost during the updating of the codebook, each node individually takes the decision whether the codebook expanded or split depend upon the previously collected feedback values, after the end of the iteration it is updated to the whole network.

New proposed method is split/Merge operation. It is used for the workload balance among the nodes and network cost during indexing and codebook updating and image searching time. The proposed system is divided as two phases.

- **Phase I**
  - Data base selection
  - Feature Extraction
  - Indexing
  - Codebook Generation
  - Codebook Updating
Here basically two dataset for the processing

- Uk bench
- Holidays

Why using these DB instead of others????

- Uk bench consist of different size image
- Holiday DB consist of variety of images with different features

So I try to prove the efficiency of this project by using different database.

1. **Feature Extraction**

   Depend upon the Feature extracted, choose different algorithms. The main features of an image is
   - Texture
   - Color
   - Shape

2. **Indexing**

   - Providing unique id to the each features.
     - Global indexing
     - Inverted index
   - Global Index is independently partitioned and placed away from the data on the nodes.
   - Inverted index help to indicate each image with its corresponding collection of features id.

3. **Codebook generation**

   - Quantization
     - K-means
     - Sparse coding
   - K-means are used to grouping different index vector. Sparse coding used to set the limit.
     - VLAD
     - Fisher

4. **Codebook updating**

   - Dynamic updating
     - Split / Merge operation
   - Main Objective
     - Workload balancing
     - Reduce Network cost
     - Codebook Information Maximization
   - Codebook information maximization
     - Q : Extracted Query information
     - X: candidate image
     - Y: Query information supported Features on X
     - So the mutual information of x and Y is

\[
\arg \min I(X; Y / Q)
\]

K: codebook value

The probability of query is

\[
P(Q) = \frac{1}{|Q|}
\]

\[
P(r | x, Q) = \begin{cases} 
1 & \text{if } x \text{ is relevant to } Q; \\
0 & \text{if } x \text{ is irrelevant to } Q; \\
P_r & \text{if relevance is unknown.}
\end{cases}
\]

**Workload balance**

The average workload difference for all codeword’s in all queries is given by:

\[
F(K) = \sum_{k=1}^{N} \frac{S_k}{N} F(k).
\]

**Figure 4: Flow design of first phase**

**Figure 5: Global indexing of the feature vector**

**Figure 6: Flow design of codebook creation**

**Figure 7: Split/Merge operation**
Phase 2
The image retrieval is the main task of this work and is effective manner. Here using one of the approach is split/merge operation of effective searching as well as the indexing of the codebook.

![Diagram](image)

Figure 8: Design flow of phase 2
First provide the query is any node of the peer to peer networks. After getting the query the corresponding index values are checked. If any node contain that particular code means send the control signal to that particular node finally get the result as soon as possible, here mainly concentrate on the network cost

V. ANALYSIS
For the analysis using two data set
Holidays:
U K Bench:
The UK Bench contains 10, 200 images with four images per object in different conditions A benchmark dataset for object recognition. 10200 images of N=2550 groups with each four images at size 640x480. The images are rotated, blurred and have a tendency for computer science motives. The dataset is typically used for image retrieval, where one image of a group is used as query. In our experiments, an image is considered relevant to the query image if both of them come from the same object. The SIFT descriptors are used as local descriptors. The holidays dataset contains 1491 images with 500 queries and 991 corresponding relevant images. The number of relevant images for each query varies from 1 to 11. The SIFT descriptors coming with the dataset are used as local descriptors.

Table 4.1 Estimated per-node computation and network cost estimation of different BoVW steps

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Feature Extraction</th>
<th>Quantization</th>
<th>Codebook Updating</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK - Bench</td>
<td>0.188 s</td>
<td>1.168 s</td>
<td>1.456-80.913 KB</td>
</tr>
<tr>
<td>Holidays</td>
<td>0.554 s</td>
<td>2.818 s</td>
<td>1.280-35.641 KB</td>
</tr>
</tbody>
</table>

Ranged values indicate the best/worst values obtained with different methods and settings were evaluated. Feature Extraction: The average time to extract the SIFT features of an image. Quantization: The average time to quantize the SIFT features into codeword’s. Codebook Updating-CPU: the average time to update the codeword on each node. Codebook Updating-Avg. Traffic: The average network traffic of all codeword nodes to update the codebook, assuming a cost of 160 bytes per descriptor.

VI. CONCLUSION
Content-based image retrieval in peer-to-peer networks by employing the bag-of-visual-words model and split/merge. A dynamic codebook updating method by optimizing the mutual information between the resultant codebook and relevance information. The workload balance among nodes that manage different codeword’s. In order to further improve retrieval performance and reduce network cost, indexing pruning techniques are developed.

REFERENCES
12. Rouhollah Rahmani, Sally A. Goldman, Hui Zhang, John Krettek, and Jason E. Fritts “Localized Content Based Image Retrieval” MIR’05.
13. Ying Lua, Dengsheng Zhang, Guojun Lue, Wei-Ying Mab “A survey of content-based image retrieval with high-level semantics” 2006