Optimized Image Retrieval System: Texture and Shape Based Approach

Monika Sahu[#1], M.A. Rizvi[#2]

#1 NITTTR Bhopal (M.P.),
#2 NITTTR Bhopal (M.P.), 9425012014.

ABSTRACT

Rising need of image retrieval from databases t is abundant than strict keyword exploration. With the appearance of prevalent large image databases i.e. both commercial and personal, content-based image retrieval has become an imperative research area. While ancient retrieval of images was based on appearance, it is now accepted that most users want to retrieve images based on the queries.
In this paper an attempt is made to develop a image retrieval as per user need from the databases. In the proposed system the image is saved in form of visual content matrix in the database. At the time of retrieval the matching is performed on the basis of these stored visual contents. As the result images are retrieved from the database in decreasing matching order.

Key words: visual content, features extraction, Histogram, segmentation, similarity measures, horizontal and vertical edge, energy, entropy, contrast, image database

INTRODUCTION

The innovatory internet and digital technologies produces the need to have a system to organize abundantly available digital images for easy categorization and retrieval. Progress in storage and image attainment technologies have enabled the creation of large image datasets. In this scenario, it is obligatory to develop suitable systems to efficiently manage these collections. The mostly used system for such problems is Content-Based Image Retrieval (CBIR). The goal of CBIR systems is to support image retrieval based on certain parameters of image like shape, color, texture. CBIR plays a important role in the application areas such as multimedia database systems in recent years. The work focused on using low-level features like color, texture, shape and spatial layout for image representation **[1].**

Content-based image retrieval, also known as query by image content and content-based visual information retrieval is the application of computer vision to retrieval of image in the digital format. Content-based means the search, based on the contents of the images, rather than waiting for the human-input metadata such as indexing or keywords. As the amount of collections of digital images increases, the difficulty finding a preferred image in the web becomes a hard [2].

There are two approaches to image retrieval: Text-Based approach and Content- Based approach. Today, the most common method of retrieval is textual descriptions and

categorization of images. This approach also has some problems, because the mentalities of people are different from one another so the differentiating criteria of images by the people will be obviously different and it is leading to problems of retrieval again. CBIR is a way to get around these problems [2].
CBIR systems search collection of images based on features that can be extracted from the image files themselves without manual description. CBIR is originated from fields such as statistics, pattern recognition, signal processing *and* Image Processing. It is a combination of different areas of knowledge, such as pattern recognition, object matching, machine learning, wavelet filtering etc. CBIR is devoted to understanding visual characteristics of images without any text descriptions. It involves two steps:

- Feature Extraction: In the first step the extraction of the visual content of image is performed
- Matching: In the second step matching of the images based on those visual content is accomplished

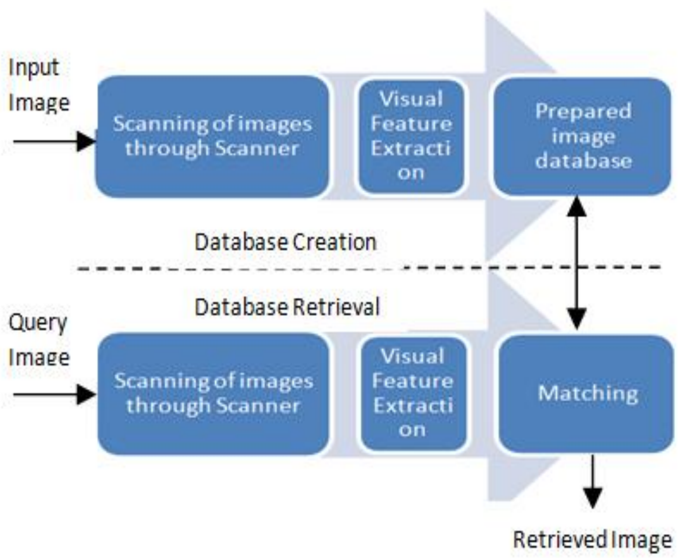


Fig 1: Image Retrieval Model

Fig 1 shows a block diagram of the image retrieval system model. In the database creation phase the image are preprocessed means scanned via its visual features, and the features are extracted and stored in the database called "image database". In the database retrieval phase the query image is inserted as an input and preprocessed as general image. Now the features are extracted and will compare with the existing database features. The matched feature images are displayed as an output. This is the complete working of the system. This work is basically depends on the visual features extracted for image database are related to the "Texture" and "Shape" content of the image and the matching is also done on the same basis.[3]
Some of the examples of CBIR applications are:
- Crime prevention: Police uses digital face recognition systems.
- The military: Based on satellite photography, enemy aircraft recognition.
- Medical Diagnosis: to support diagnosis by matching similar past cases.
- Geographical Information System (GIS) and remote sensing etc.

TEXTURE AND SHAPE FEATURES

A. Texture Features:

Texture is that instinctive property of all surfaces that defines visual patterns, each having characteristics of homogeneity. It contains essential information about the structural collection of the surface, such as; bricks, fabric, flowers, floor etc. It also defines the relationship of the surface to the surroundings [4]. It is a feature that describes the unique physical composition of a surface.

Texture properties include:

- Coarseness
- Contrast
- Directionality
- Line-likeness
- Regularity
- Roughness
- Entropy
- Energy
- Contrast

Fig 2: Different Textures

Texture is one of the crucial features of an image. It is characterized by the spatial distribution of gray levels in a neighborhood. In order to capture the spatial dependence of gray-level values, which contribute to the perception of texture, a two-dimensional dependence texture analysis matrix is taken into consideration [5]. Ability to fetch images on the basis of texture may not seem very effective and useful. But the ability to match on texture equality can often be useful for distinction between areas of images with similar color (such as sky and water, or leaves and grass).

A variety of techniques has been used for measuring texture similarity; the best-established technique is *second-order statistics* which calculated from query and stored images. Essentially, these calculate the relative brightness of selected pairs of pixels from each image. From these it is possible to calculate measures of image texture such as the degree of contrast, coarseness, directionality and regularity or periodicity, directionality and randomness.

Alternative methods of texture analysis for retrieval include the use of Gabor filters and fractals. Texture queries can be formulated in a similar manner to color queries, by selecting examples of desired textures from a palette, or by supplying an example query image. The system then retrieves images with texture measures most similar in value to the query. A recent extension of the technique is the texture thesaurus developed by Ma and Manjunath, which retrieves textured regions in images on the basis of similarity to automatically-derived code-words representing important classes of texture within the collection. [6]

Methods used for texture Representation

There are three principal approaches used to describe texture; statistical, structural and spectral…

1. Statistical techniques characterize textures using the statistical properties of the grey levels of the points/pixels comprising a surface image. Typically, these properties are computed using: the grey level co-occurrence matrix of the surface, or the wavelet transformation of the surface.

2. Structural techniques characterize textures as being composed of simple primitive structures called "texels" (or texture elements). These are arranged regularly on a surface according to some surface arrangement rules.
3. Spectral techniques are based on properties of the Fourier spectrum and describe global periodicity of the grey levels of a surface by identifying high-energy peaks in the Fourier spectrum [7].
For optimum classification purposes, what concern us are the statistical techniques of characterization. The most popular statistical representations of texture are:

- Co-occurrence Matrix
- Tamura Texture
- Wavelet Transform

B. <u>Shape Features:</u>

Shape may be defined as the characteristic surface configuration of an object; an outline or contour. It permits an object to be distinguished from its surroundings by its outline [8]. The ability to retrieve by shape is perhaps the most obvious requirement at the primitive level. Shape is a fairly well-defined concept – and there is considerable evidence that natural objects are primarily recognized by their shape [9].

A number of features characteristic of object shape (but independent of size or orientation) are computed for every object identified within each stored image. Queries are then answered by computing the same set of features for the query image, and retrieving those stored images whose features most closely match those of the query.
Shape representations can be generally divided into two categories mathematically [10]:

- Boundary-based, and
- Region Based

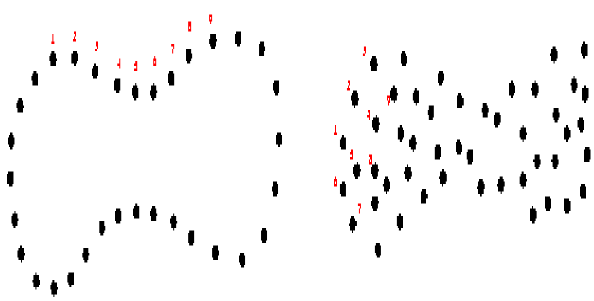


Fig 3: Boundary-based & Region-based

Boundary-based shape representation only uses the outer boundary of the shape. This is done by describing the considered region using its external characteristics; i.e., the pixels along the object boundary. Region-based shape representation uses the entire shape region by describing the considered region using its internal characteristics; i.e., the pixels contained in that region [11].

Methods of Representation

For representing shape features mathematically, we have [12]:

Boundary-based:

- Polygonal Models, boundary partitioning
- Fourier Descriptors

- Splines , higher order constructs
- Curvature Models

Region-based:

- Superquadrics
- Fourier Descriptors
- Implicit Polynomials
- Blum's skeletons

The most successful representations for shape categories are Fourier Descriptor and Moment Invariants [10]:

- The main idea of Fourier Descriptor is to use the Fourier transformed boundary as the shape feature.
- The main idea of Moment invariants is to use region-based moments, which are invariant to transformations as the shape feature[12]

METHODOLOGY USED

In this method initially extract the primitive features of a query image and compare it to the database images. The image features under consideration are texture and shape. Thus, using matching and comparison algorithms, the texture and shape features of one image are compared and matched to the corresponding features of another image. This comparison is performed using characteristics such as energy, entropy and contrast texture features and horizontal and vertical edge shape features of an image. In the end, these characteristics are extracted one after another, so as to retrieve database images that are similar to the query. The similarity between the characteristics of the features are calculated using algorithms one for each specific feature for both extraction and matching.
The five features of texture and shape which have been used in the accomplishment of the proposed solution from the problem statement of the work undertaken in this paper are:

1. Energy
2. Entropy
3. Contrast
4. Horizontal Edge
5. Vertical Edge

It will store the extracted values into an excel file in the form of matrix of order of n by 5 where n is the number of images in the image database. It will then compares the extracted values of the query image as well as that of the images stored in excel file.

ALGORITHM DEVELOPED

The method to extract the similar images from the database based on texture features were proposed earlier i.e. on the basis of “energy, entropy and contrast” is implemented using algorithm i.e.

1. Insert the query image by selecting from the database.

2. Convert the image from RGB to grey to use it by using the method

rgb2grey('imagename')

3. Calculate the total pixel of image by

Tp=xx*yy

4. Extract all the feature of image like

```
texture_img = rangefilt(gray_img);
texture_energy = sum(texture_img(:).^2)/tp;
texture_entropy = entropy(texture_img);
cmap_img = contrast(texture_img);
[x1 y1] = size(cmap_img);
cont_img = sum(cmap_img(:))/(x1*y1);
edge_hv = edge(gray_img,'sobel');
edge_X = edge(gray_img,'roberts');
hv_edge_dens = sum(edge_hv(:))/tp;
X_edge_dens = sum(edge_X(:))/tp;
cent_x = (x1/sum)/tp;
cent_y = (y1/sum)/tp;
```

5. Calculate the feature matrices' and store it into a excel sheet

```
features = [mean_rh, mean_gh, mean_bh, sd_rh, sd_gh, sd_bh,...
    texture_energy, texture_entropy, cont_img, hv_edge_dens, X_edge_dens, cent_x, cent_y];
data_val = xlsread('book1');
```

6. Now compare these feature matrices with already exist feature of the database images

If(feature are matched)
Show all the related images on the GUI window
Else
Report an error that match not found

7. Goto step 2 for every new process.

8. End of process

The flow chart fig. 4 of the algorithm is depicted below:

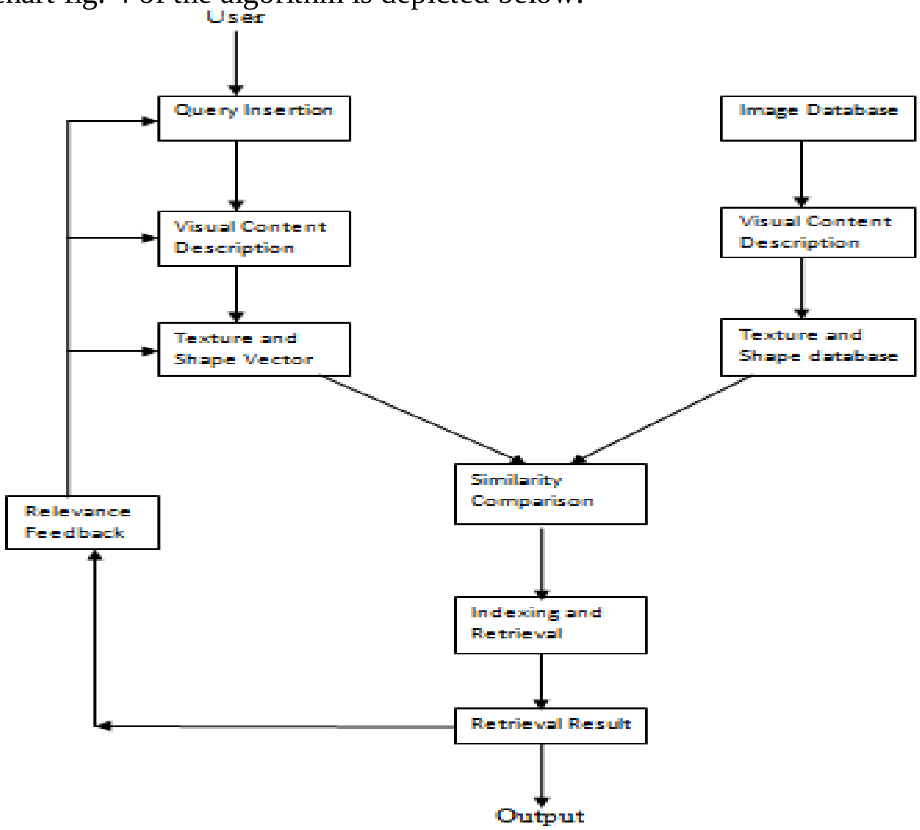


Fig 4: T & SBIR flow chart diagram

PERFORMANCE ANALYSIS OF PROPOSED SYSTEM

The performance analysis of all the three modules is being done on the basis of two criteria's using MATLAB:

1. Precision
2. Recall

Precision = number of relevant images retrieved /total number of images retrieved.
Recall= number of relevant images retrieved /total number of relevant images.
This performance analysis is shown in the tabular as well graphical form below:
Total number of images =100
Number of relevant images=10

TABULAR FORM:

Techniques	Precision	Recall
Texture based image retrieval	0.06	0.6
Shape based image retrieval	0.01	0.1
Texture and shape based image retrieval	0.09	0.9

GRAPHICAL FORM

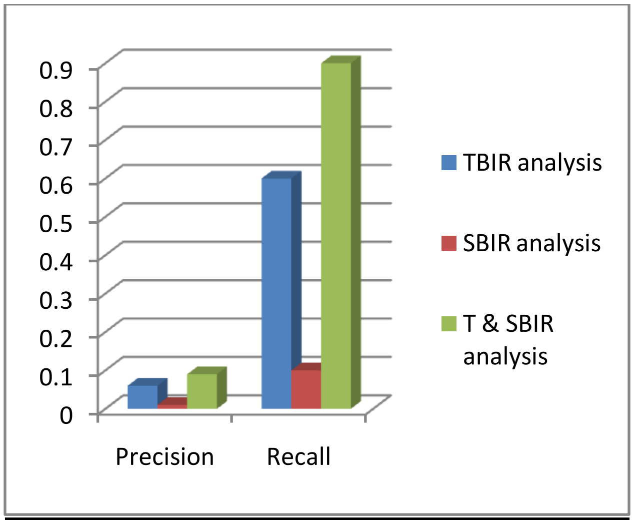
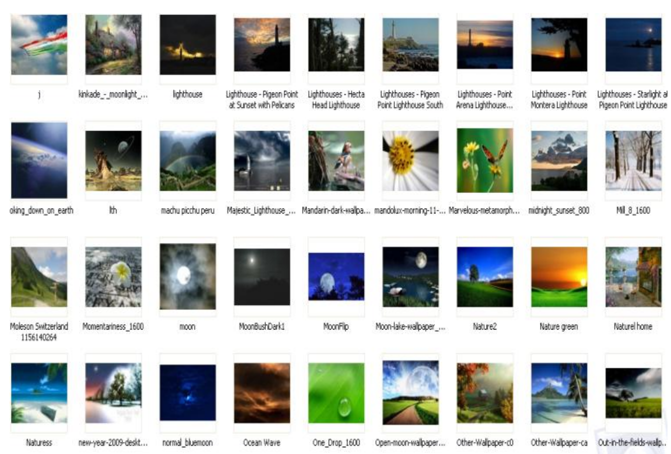


Fig 5: Graphical form of result

The above graph fig 5 and result analysis table shows that the efficiency of only shape based system was 10% (approx.) and efficiency of only texture based system is 60%(approx.), but when we combine both the system into a single unit then the efficiency of texture and shape based image retrieval system is increased drastically and it is approx. 90%. This much efficient system is good to use as matching and retrieval system.

VI. RESULTS AND DISCUSSION

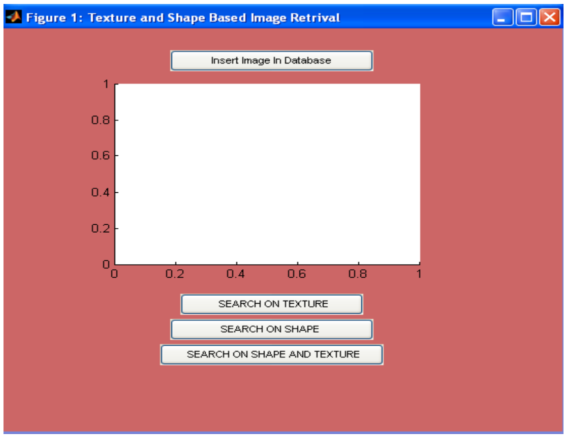
6.1 Image Database:

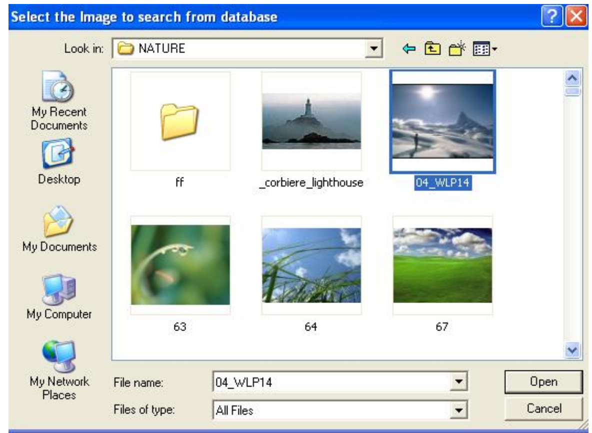


6.2 Graphical User Interface:

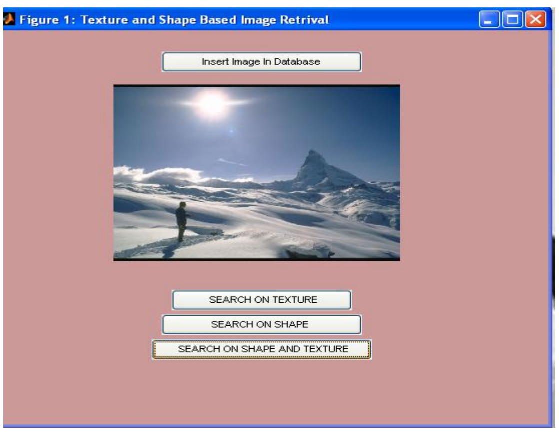
The Graphical User Interface was designed using **MatLab GUIDE** or **Graphical User Interface Design Environment**. Using the layout tools, screen shot of graphical user interface for TBIR application is shown below:

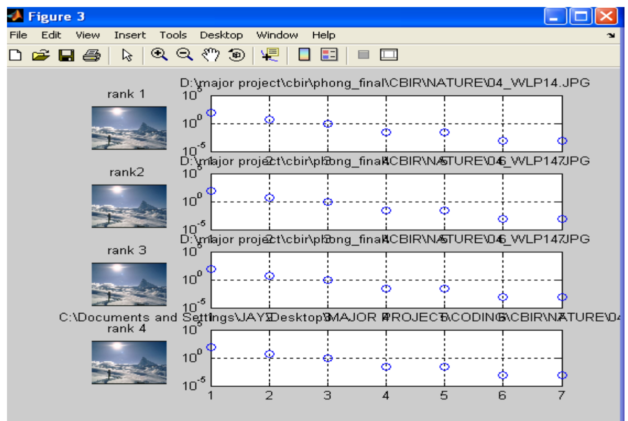
Inserting an Image:



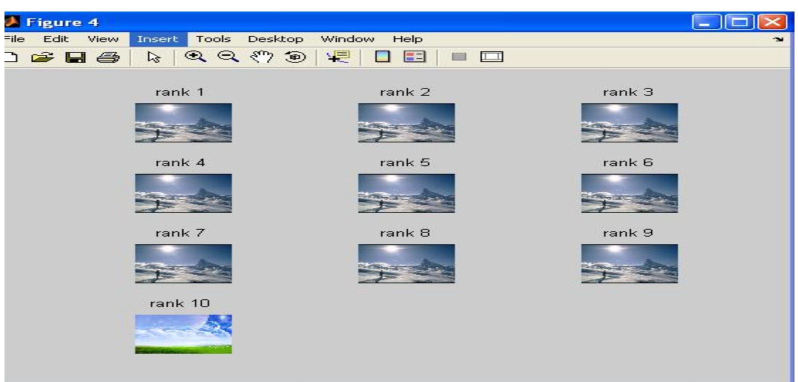


Characteristic graph of similar images:





Similar images:



CONCLUSION

Content-based image retrieval (CBIR) is a well-known research area because of the explosion of video and image data in digital form. The increased bandwidth availability to access the internet in the near future will allow the users to search for and browse through video and image databases located at remote sites. Therefore, swift retrieval of images from large databases is an important difficulty that needs to be addressed. The technology is already exist but not complete to retrieve efficient and reliable results, so can be further expand with respect to demand, time and research in this area.

A method for image processing and retrieval is based on texture and shape content of the image i.e. "Energy, Entropy Contrast, Vertical and Horizontal edge" which is differ from the existing methods for the query image processing and can be used for efficient retrieval purpose. The result received using above approach and performance analysis of the images for texture and shape based image retrieval technique given an average precision of 0.9 which is better than other approaches used by various other researchers in this area. The results are good but can further be improved upto 100% with the use of other features of images like color.

REFERENCE

[1] P.S.SUHASINI , Dr. K.SRI RAMA KRISHNA, Dr. I.V. MURALI KRISHNA"CBIR USING COLOR HISTOGRAM PROCESSING" Journal of Theoretical and Applied Information Technology Vol6. No1. (pp 116 - 122)

[2]Neetu Sharma, Paresh Rawat and jaikaran Singh"Efficient CBIR Using Color Histogram Processing" Signal & Image Processing : An International Journal(SIPIJ) Vol.2, No.1, March 2011

[3] Monika Sahu, Madhup Shrivastava, M.A. Rizvi " IMAGE MINING: A NEW APPROACH FOR IMAGE DATA MINING BASED ON TEXTURE" ICCCT-2012 (International IEEE conference at Allahabad).

[4] Thomas Seidl Hans-Peter Kriegel "Efficient User-Adaptable Similarity Search in Large Multimedia Databases" http://www.vldb.org/conf/1997/P506.PDF

[5]http://km.doc.ic.ac.uk/pr-p.techasith-2002/Docs/OSE.doc

[6] Linda G. Shapiro, and George C. Stockman, *Computer Vision*, Prentice Hall, 2001..

[7] "Texture," class notes for *Computerized Image Analysis MN2*, Centre for Image Analysis, Uppsala, Sweden, Winter 2002, Found at: http://www.cb.uu.se/~ingela/Teaching/imageanalysis/Texture2002.pdf

[8] Anil K. Jain and Aditya Vilaya "Image retrieval using color and shape" , May 1995 (Department of Computer Science Michigan University

[9] Lexico Publishing Group, LLC, "shape", [Online Document], Available at: Http://dictionary.reference.com/search?Q=shape

[10] Marinette Bouet, Ali Khenchaf, and Henri Briand, "Shape Representation for Image Retrieval", 1999, [Online Document], Available at: http://www.kom.e-technik.tu-darmstadt.de/acmmm99/ep/marinette/

[11] Barbeau Jerome, Vignes-Lebbe Regine, and Stamon Georges, "A Signature based on Delaunay Graph and Co-occurrence Matrix," Laboratoire Informatique et Systematique, Universiyt of Paris, Paris, France, July 2002, Found at: Http://www.math-info.univ-paris5.fr/sip-lab/barbeau/barbeau.pdf

[12] Monika Sahu, Madhup Shrivastava, M.A. Rizvi "IMAGE BASED QUERY PROCESSING SYSTEM USING EDGES" IISN 2012