



# Support Vector Machine Based Approach to Content Based Image Retrieval Using Combination of Color and Texture Features

<sup>1</sup>Sukhbeer Kaur, <sup>2</sup>Anupama Gupta

<sup>1,2</sup>Department of Computer Science and Engineering, Lala Lajpat Rai Institute of Engineering and Technology, Moga-142001, Punjab (India)

**Abstract**— Content based image retrieval (CBIR) is the mechanism of fetching images from the database on the basis of its content like color, texture or shape. In this paper, an improved approach to CBIR is set forth to perk up accuracy and time for producing the results. To accomplish this task, first of all the images present in the database are categorized using support vector machine and the query image is passed to the CBIR system. Afterwards, to search relevant images of the query image from a database, the color, texture and the combination of both features is used. Then, to nominate similar images from the selected class of database, Euclidean distance is calculated. Finally, the relevant images are displayed in the order of increasing Euclidean distance. The proposed work is validated using two performance metrics, namely, precision and recall. The time required for retrieving the relevant images is also studied. The results show a significant improvement over the existing techniques.

**Index Terms**— Content based image retrieval, Feature extraction, Support vector machine, Euclidean distance.

## I. INTRODUCTION

In today's world, the interest in the potential of digital images has inclined tremendously, mainly, because of the brisk growth of imaging on the World-Wide Web. In many skilled fields, professionals are taking the advantages of the opportunities offered by the ability to access and manipulate remotely-stored images in all kinds of new and interesting ways. However, they are also exploring that the process of locating a desired image in a huge and heterogeneous collection can be a source of considerable frustration [1]. The image retrieval problems are becoming widely recognized and the search for solutions to these problems is an increasingly active area for research and development. Over the last 10 years, content-based visual information retrieval (CBVIR) or content based image retrieval (CBIR) has been one of the vibrant research areas in the field of computer vision at an alarming rate [2]. The term content based image retrieval originated in 1992 was used to describe the retrieval of desired images from a king sized database on the basis of syntactical image characteristics such as color, texture or shape [3].

Instead of searching relevant images by using keywords, tags or any other description related with the image in text or concept based image retrieval, content based image retrieval system is used to fetch the desired images from a database on the basis of image features like color, texture or shape when a query image is input to the system. These features can be used individually or in combination with each other for plucking out the required images [4]. The work flow of general CBIR system is shown in Fig. 1. When query image is passed to the system, the desired features are extracted and stored in a feature vector. In parallel, the features of images present in database are also extracted and stored in another feature vector. Then the two feature vectors are compared based on some criteria for evaluating the similarity between them. The database images satisfying the criteria are displayed to the user while others are tucked away/ concealed.

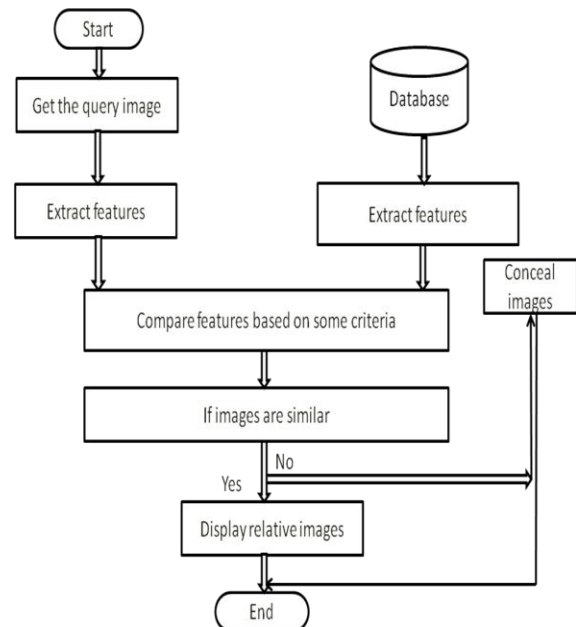


Figure 1: Basic model of CBIR system.

This paper is aimed at minimizing the time required for the retrieval of desired images from the database with improved accuracy by using support vector machine (SVM). The remaining paper is organized as follows.

Section II describes the literature review followed by preliminaries in Section III. The proposed work is discussed in Section IV and results are shown in Section V. To hammer the last nail, conclusions and future scope is discussed in Section VI.

## II. RELATED WORK

Till date many CBIR systems have been proposed. Some of them are scrutinized in this section.

Content based image retrieval was proposed which used relevance feedback based on two characteristics, i.e., gap between high level and low level features along with subjectivity of human perception to reduce the efforts of user to compose a query [5]. Another approach to CBIR was introduced based on multiple local color histograms used to capture the color distribution of images to enhance the stability of similar function and the human feelings for various query images [6]. Fuzzy logic method was later used to solve the semantic gap and perception subjectivity problems based on the unsupervised fuzzy clustering algorithm and user's feedback [7]. CBIR system was proposed using center of gravity of fuzzy sets to cover all the fuzzy similarity measures [8]. Later human visual perception knowledge was also used to design and implement the CBIR systems and various questions were opened to control the problems faced by CBIR systems [9]. Another approach to CBIR system was used to compare the small number of feature vector components and high dimensional feature vectors to get high quality results in less time as compared to existing techniques [10]. A method was used to retrieve the images on the basis of texture characterization and to get the promising results by comparing the retrieval performance to the conventional co-occurrence matrices [11]. A novel approach to CBIR was introduced on the basis of semi-supervised and batch mode active learning for the effective relevance feedback [12]. To retrieve the images on the basis of color features and to import the relevance feedback, low layer physical features of the image were extracted based on HSV color space [13]. CBIR system was proposed in medical field based on texture features [1]. Another technique was proposed for retrieving color images based on two variations of image abstraction technique. It was based on strings of signature bit and the similarity metric [14]. Sketch based image retrieval (SBIR) technique was introduced to unfold the problems associated with the design and implementation of CBIR systems [15]. CBIR system known as a Wavelet Based Color Histogram Image Retrieval (WBCHIR) was produced using color and texture features [3]. CBIR system was introduced to reduce the semantic gap between low level features and high level features using Gray Level Co-occurrence Matrix for texture feature extraction [16]. CBIR system was also proposed to retrieve images using multiple feature fusion like color and shape. To overcome the problem of semantic gap, relevance feedback was also used [4].

## III. PRELIMINARIES

### A. Feature Extraction

In the field of image processing, feature extraction is used to pluck out the visual information of an image like color, texture and shape.

**Color** is a powerful descriptor that allows object identification in the scene. The perceived color of an object by the human eye is the light reflected from that object. Colors are usually defined in the RGB (red, green, blue), CMY (cyan, magenta, yellow) and HSI (hue, saturation, intensity) models. The various features of these color models are mean, standard deviation or skewness [13].

**Texture** is a crucial method to describe the image content. In spatial domain, texture can be defined as repeated patterns of pixels. Texture provides various features like entropy, homogeneity, contrast etc. [16].

**Shape** defines the outer appearance of an object in an image. It is used to focus region of interest. Shape can be tracked using two methods such as region based and boundary based. Boundary based techniques work on the basis of abrupt discontinuity in the pixel values, whereas region based techniques find the object based on similarity of pixel values over a region [4].

### B. Support Vector Machine

Support vector machines (SVM) are supervised learning models with the associated learning algorithms that analyze data and distinguish patterns. It can also be defined as a classifier used for the classification of the images stored in the database [17]. SVM makes the classes of the relevant images by making a classification decision based on the linear combination of the characteristics. An object's characteristics also known as feature values are presented to the system in a vector called feature vector. The goal of support vector machine is to find out the optimal support vector out of the feasible support vectors based on the feature vectors for assigning the images to a single category which belong to more than two categories [18].

## IV. PROPOSED WORK

The proposed work puts forward an improved approach to CBIR using support vector machine. It is focused on reducing the time required for producing more accurate results as compared to existing systems. To search relevant images of the query image from a database, color, texture and the combination of two features are used.

The flowchart of the proposed work is put on view in Fig. 2. Initially, the database is created which is a collection of huge number of heterogeneous images. Then, each image present in the database is subjected to undergo the process

of feature extraction. During feature extraction, the color and texture features of an image are squeezed out to constitute feature vector. Feature selection plays a vital role to lay the foundation of CBIR system. Color features are extracted using color moments and texture features like contrast, energy, homogeneity, entropy, mean and standard deviation are extracted by using a grey level co-occurrence matrix (GLCM) and Gabor wavelet transform. In next, these extracted features are gathered in a feature vector for future use.

In parallel, a query image is also input to the feature extraction process where color and texture features are extracted and stored in a feature vector. After finishing the execution of feature extraction process, all the images present in database are categorized using SVM. Also the query image is categorized to identify its class. This categorization step can be skipped if results need to be calculated without using SVM. If SVM is not used, then the query image is evaluated against all images present in the database to find the relevant images. This is done by calculating the Euclidean distance between query image and all other images. Then the calculated distance is sorted in increasing order and the corresponding images are displayed to the user while other images are concealed. If SVM is used, then query image is evaluated against images of its class only. This reduces the time required for retrieval of images along with improved accuracy in terms of precision and recall.

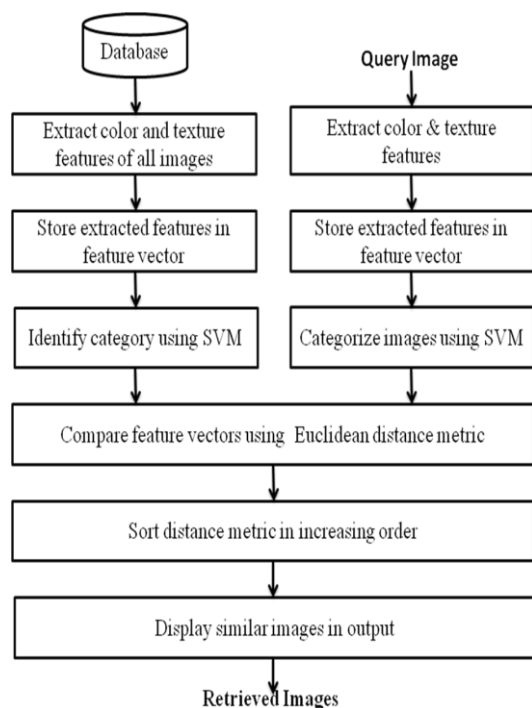


Figure 2: Flowchart of proposed work.

## V. RESULTS AND DISCUSSION

In this section, the proposed work is quantitatively validated using two performance metrics, namely, precision and recall. Precision is the ratio of number of

relevant images retrieved to the total number of images retrieved, whereas recall is the ratio of number of relevant images retrieved to the total number of relevant images present in the database. Precision and recall can be calculated using Eq. 1 and Eq. 2 respectively.

$$P = \frac{\text{Number of relevant images retrieved}}{\text{Number of total images retrieved}} \quad (1)$$

$$R = \frac{\text{Number of relevant images retrieved}}{\text{Number of relevant images in the database}} \quad (2)$$

By selecting the food image as a query image randomly, it retrieves the 20 similar images to the query image. Query image is shown in Fig. 3 whereas the output images are shown in Fig. 4. and Fig. 5.



Figure 3: Query image.

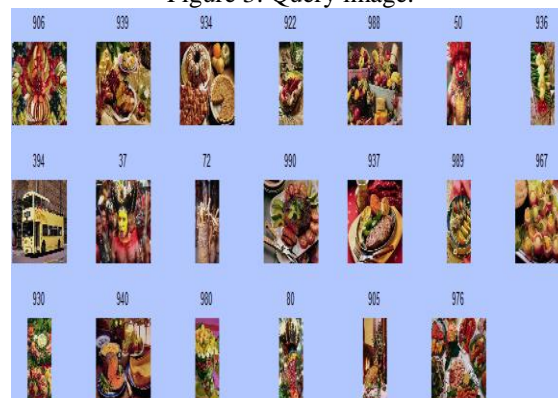


Figure 4: Images retrieved without using SVM

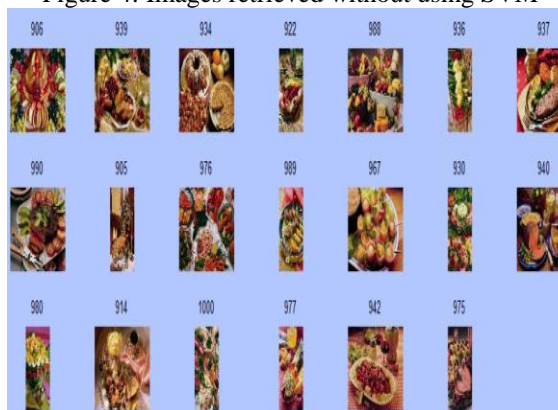


Figure 5: Images retrieved using SVM

The results are tested for ten types of query images. For all types of query images, 100 relevant images are present in the database. Out of all the images present in the database, first 20 retrieved images are considered for evaluating the results. The precision and recall values for all types of query images are listed in the following tables with and

without using SVM. The values of these performance measures based only on color features are listed in Table 1 and based only on the texture features are listed in Table 2. Table 3 represents performance measures based on the combination of both color and texture features.

Since the required values of precision and recall should be high, it is evident from the tables that the proposed system offers promising results without using SVM and gives almost ideal results by using SVM. In Table 4, the comparison of proposed work is carried out with respect to the existing technique [4]. The values of performance measures are plucked out for a random query image of food for comparing the two techniques based on color features without using SVM.

TABLE 1: PERFORMANCE MEASURES BASED ON COLOR

Query Image	Precision		Recall	
	Without SVM	With SVM	Without SVM	With SVM
African	0.5	1	0.1	0.2
Beaches	0.9	1	0.18	0.2
Buildings	0.55	1	0.11	0.2
Buses	0.65	1	0.13	0.2
Dinosaurs	1	1	0.2	0.2
Elephants	0.85	1	0.17	0.2
Roses	1	1	0.2	0.2
Horses	0.65	1	0.13	0.2
Mountains	0.55	1	0.11	0.2
Food	0.75	1	0.15	0.2

TABLE 2: PERFORMANCE MEASURES BASED ON TEXTURE

Query Image	Precision		Recall	
	Without SVM	With SVM	Without SVM	With SVM
African	0.6	1	0.12	0.2
Beaches	0.5	1	0.1	0.2
Buildings	0.55	1	0.11	0.2
Buses	0.95	1	0.19	0.2
Dinosaurs	0.95	1	0.19	0.2
Elephants	0.8	1	0.16	0.2
Roses	1	1	0.2	0.2
Horses	0.75	1	0.15	0.2
Mountains	0.65	1	0.13	0.2
Food	0.35	1	0.07	0.2

TABLE 3: PERFORMANCE MEASURES BASED ON COLOR &amp; TEXTURE

Query Image	Precision		Recall	
	Without SVM	With SVM	Without SVM	With SVM
African	0.9	1	0.18	0.2
Beaches	0.65	1	0.13	0.2
Buildings	0.55	1	0.11	0.2
Buses	0.95	1	0.19	0.2
Dinosaurs	1	1	0.2	0.2
Elephants	0.8	1	0.16	0.2
Roses	1	1	0.2	0.2

Horses	0.8	1	0.16	0.2
Mountains	0.75	1	0.15	0.2
Food	0.4	1	0.08	0.2

TABLE 4: COMPARISON OF EXISTING AND PROPOSED TECHNIQUE

Performance metrics	Existing method	Proposed method
Precision	0.30	0.75
Recall	0.06	0.15
Time	0.7727	0.1028

## VI. CONCLUSIONS AND FUTURE SCOPE

The proposed work introduced an improved approach to CBIR which is mandatory to access remote images from the database. The presented CBIR system uses the color, texture and combination of color and texture features based on support vector machine for fetching the required images.

Using color features for a random query image from a food class, 15 relevant images and 5 irrelevant images are retrieved and by using texture features, 7 relevant images and 13 irrelevant images are retrieved. By using the combination of color and texture features for the same query image, 8 relevant and 12 irrelevant images are retrieved. But by using SVM for the same query image, the number of relevant images retrieved is 20 where 20 is the total number of images retrieved. The time required for retrieving the relevant images of the query image is also reduced from the existing technique. For future work, the system can be improved by using efficient edge detection technique along with color feature based on SVM.

## REFERENCES

- [1] L. Xavier, B.M.I. Thusnavis and D.R.W. Newton "Content Based Image Retrieval using Textural Features Based on Pyramid-Structure Wavelet Transform," 3rd International Conference on Electronics Computer Technology, vol. 4, pp. 79-83, April 2011.
- [2] A. Verma and D. Sharma "Content Based Image Retrieval using Color, Texture and Shape Features," International Journal of Advanced Research in Computer Science and Software Engineering, vol. 4, pp. 383-389, May 2014.
- [3] M. Singha and K. Hemachandran "Content Based Image Retrieval using Color and Texture," (SIPIJ), vol. 3, February 2012.
- [4] S. Redrouthu and K. Annapurani "Time Comparison of Various Feature Extraction of Content Based Image Retrieval," International

- Journal of Computer Science and Information Technologies, vol. 5, pp. 2518-2523, 2014.
- [5] Y. Rui, S. H. Thomas and S. Mehrotra "Relevance Feedback Techniques in Interactive Content Based Image Retrieval," Proceedings of SPIE 3312, Storage and Retrieval for Image and Video Databases, December 1997.
- [6] H. Yamamoto, H. Iwasa, N. Yokoya and H. Takemura "Content Based Similarity Retrieval of Images Based on Spatial Color Distributions," International Conference on Image Analysis and Processing, pp. 951-956, 1999.
- [7] C. Chiu, H.C. Lin and S.N. Yang "A Fuzzy Logic CBIR System," The IEEE International Conference on Fuzzy Systems, vol. 2, pp.1171-1176, 2003.
- [8] Y. Li, J.M. Liu, J. Li, W.D.C.X. Ye and Z. Wu "The Fuzzy Similarity Measures For Content-Based Image retrieval," Proceedings of the Second International Conference on Machine Learning and Cybernetics, vol. 5, pp. 3224-3228, 2003.
- [9] O. Marques, L.M. Mayron, G.B. Borba and H.R. Gamba "On the Potential of Incorporating Knowledge of Human Visual Attention into Cbir System," IEEE Conference on Multimedia and Expo, pp. 773-776, 2006.
- [10] S. Rudinac, G. Zajic, M. Uscumlic, M. Rudinac and B. Reljin "Comparison of CBIR Systems with Different Number of Feature Vector Components," Proceedings of IEEE, Semantic Media Adaptation and Personalization, pp. 199-204, 2007.
- [11] J. Zhang, L. Gui-li and H. Seok-Wun "Texture Based Image Retrieval by Edge Detection Matching GLCM," 10<sup>th</sup> IEEE International Conference on High Performance Computing and Communications, pp. 782-786, 2008.
- [12] S.C.H. Hoi, J. Rong, Z. Jianke and M.R. Lyu "Semi-Supervised SVM Batch Mode Active Learning for Image Retrieval," IEEE Conference on Computer Vision and Pattern Recognition, pp. 1-7, 2008.
- [13] Z. Yang "Research of Image Retrieval Based on Feedback Mechanism," International Conference on Multimedia Communications, pp. 145-148, 2010.
- [14] A.S. Abdelrahim, M.A. Abdelrahim, A. Mahmoud and A.A. Farag "Image Retrieval Based on Content and Image Compression," International Conference on Multimedia Technology, pp. 6696-6703, July 2011.
- [15] B. Szanto, P. Pozsegovics, Z. Vamosy and S. Sergyan "Sketch4match — Content Based Image Retrieval System using sketches," IEEE 9th International Symposium on Applied Machine Intelligence and Informatics, pp. 183-188, January 2011.
- [16] K.P. Jisha, B.M.I. Thusnavis and A. Vasuki "An Image Retrieval Technique Based on Texture Features using Semantic Properties," International Conference on Signal Processing Image Processing and Pattern Recognition, pp. 248-252, 2013.
- [17] J.M. Moguerza and A. Munoz "Support Vector Machines with Applications," Statistical Science, vol. 21, pp. 322-336, 2006.
- [18] R. Usha and K. Perumal "Content Based Image Retrieval using Combined Features of Color and Texture Features with SVM Classification," International Journal of Computer Science and Communication Networks, vol. 4, pp. 169-174.

