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Color Image Retrieval Based on Chernoff Distance Measure

S.Selvaraj[1]*, K. Seetharaman[2]

[1]MCA Department, ARS College of Engineering, Chennai, Tamil Nadu 603209 India
[2] Department of Computer Science & Engg., Annamalai University, Annamalai Nagar 608 002 Tamil Nadu, India

**Corresponding Author: selva344@gmail.com*

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***Abstract*—** This paper proposes a novel technique, based on distributional approaches with distance measure, i.e. Chernoff distance measure. Since the proposed system is automatic retrieval, it is difficult to understand the nature of the query and target images and which distribution they follow. The Chernoff distance measure overcome this problem, because it adapts itself accordingly the nature of the images, viz. the Chernoff distance could be adapted though the query and target images do no distributed to Gaussian or mixed or even if they are distribution free. This is the main advantage of the proposed technique. In order to examine the proposed technique, an image database is constructed, which contains variety of images such as texture, structure, blurred, noise, artifacts images and their features.

***Keywords*—**Color Image, Retrival, Chernoff Distance Measure

I. Introduction

NOW-a-days, across the world, since almost all the countries show interest on digitizing the functions of their private, public sector and governmental organizations, it is necessitated to increase the repository capacity of the devices as well as increasing the speed of the accessing and retrieving the data through internet becomes inevitable. Due to the importance and awareness of the Internet and World Wide Web, the number of Internet users are monotonically and exponentially increasing. Though a number of techniques have been developed with the consideration of the internet users and the difficulties in accessing and retrieving the data available in Internet and WWW, they are not completely satisfying the users' requirements. In particular, images occupy more space and demand more time to retrieve from the volume of image databases.

At the outset, text annotation based image retrieval system has been developed, which is time consuming [1], and not effective and efficient. Since, it retrieves the images based on the text annotated manually by the user. Then, the content-based image retrieval (CBIR) system has been developed, and a number of researchers turned their attention on CBIR. Most of the techniques developed based on the contents in the images, namely low-level global visual features such as color properties, shape, texture, and spatial orientation etc., which are used as query for the retrieval process [2]-[5]. Jing *et al*. [6] suggested that a single signature computed for the entire image cannot sufficiently represent the important features of individual objects, and there is a gap between the visual features and semantic concepts of images. To overcome this problem, region-based system is developed

[7]-[11], which represents the focus of the user's perceptions of the image contents. The method proposed in [12]-[17] classifies / segments the entire image into various regions according to the objects / structures present in the image, and then the region-to-region comparison is made to measure the similarity between two images [4],[13],[14]. Though, a number of works developed based on the statistical distributional approaches and parametric tests of hypothesis, most of them are not effective and efficient, since there is no guarantee that all images are distributed independent and identical to Gaussian. The statistical parametric tests can be applied on the image if it is distributed to Gaussian. Otherwise, it does not lead to good results. The Bhattacharyya distance measure may be appropriate for feature extraction. Many authors have used the Bhattacharyya [18]-[21] and Kullback-Liebler distance measures in control theory and signal processing for feature extraction and comparing the distance between two distributions. The work proposed in [19], [20] extract the features and they are used for pattern recognition problems. Sfikas et al. [21] suggested that though the Kullback-Liebler distance provides good results, it demands more computational complexities compare to that of Bhattacharyya distance measure. They, also, suggested that nevertheless the Bhattacharyya distance measure is fast, it does not yield good results in terms of class separation.

As suggested in [21], the BD measure is superior to the KL distance measure, there are some problems in using the BD measures, i.e. the BD measure can be used to extract features and compare two distributions only if they strictly follow the Guassian properties; otherwise, it cannot be used. To overcome this problem, the Chernof distance measure can be used. Because, it relaxes from strictly follow the Gaussian properties. Also, the BD is a special case of the Chernoff distance measure. Hence, in this paper it is believed that the CD measure will lead to better results than that of the KL, BD and Mahalanobis distance measures. The obtained results are presented in section 5, and the results prove that the CD measure outperforms the KL, BD and Mahalanobis distance measures. This motivated us to perform the proposed research work.

II. PROPOSED IMAGE RETRIEVAL

The images are assumed to be a Gaussian random field [22] . But in the case of real-life images, the distribution is usually not known, and it could follow a certain distribution function, not necessarily normal, or even a mixture of distribution functions. At that situation, the Bhattacharyya, Kullback-Liebler and Mahalanobis distances measures could not be used, since these measures adhere strictly the Gaussian properties. But in the case of real-life images, the Chernoff distance measure could be adopted, because it can be used even though the normality is not in place [23]. Let *f* be a random process function that represents the intensity value with additive noise of a pixel at location (k, l) in a color image. The pixel $f(k,l) \in \Re^3$ is a linear combination of three colors, such as red, green, and blue, i.e. $f(k, l) = [r(k, l), g(k, l), b(k, l)]^T$, where T represents the transformation of the vector. The mean intensity value of each color is represented in vector form by M_r, M_g and M_b respectively, and the variance-covariance matrix is denoted by Σ .

A. Figures and Tables Proposed Chernoff Distance Measure for Similarity of Images

Let $f_{(c)}^{(q)}(k,l)$ and $f_{(c)}^{(t)}(k,l)$ be intensity values of the c-th color (c = 1, 2, 3: red, green, blue) of a pixel at location (k, l) of the query and target images $F^q(k,l)$ and $G^t(k,l)$ that are independent and identical to randomly distributed to Gaussian with mean vector **m** and variance-covariance Σ , i.e. $F^q(k,l) \sim N(m_q, \Sigma_q)$ and $F^t(k,l) \sim N(m_t, \Sigma_t)$ with probabilities p_q and p_t . The Chernoff distance between the two distributions such as query image and target image, $F^q(k,l)$ and $F^t(k,l)$, is defined as in (4).

$$\int p_q(F)\, p_t(F)\, dF = e^{-CD_{q,t}} \tag{3}$$

Where,

$$CD_{q,t} = \frac{P_q P_t}{2}(M_q - M_t)^T \Sigma_{q,t}^{-1}(M_q - M_t) + \frac{1}{2}\left(\log\left|\Sigma_{q,t}\right| - P_q \log\left|\Sigma_q\right| - P_t \log\left|\Sigma_t\right|\right) \tag{4}$$

Where, $P_q = \frac{N_q}{N_q + N_t}$ and $P_t = \frac{N_t}{N_q + N_t}$; $0 \le P_q, P_t \le 1$ (5)

$$\Sigma_{q,t} = P_q \Sigma_q + P_t \Sigma_t \tag{6}$$

P_q *and* P_t *are* the prior probabilities of the query and target images; Σ_q *and* Σ_t are the variance-covariance matrices of the query and target images.

The expression in (4) represents the distance in between the two distributions, $F^q(k,l)$ and $F^t(k,l)$, of query and target images; M_q and M_t are the mean vectors, and Σ_q and Σ_t are covariance matrices, of the distributions, $F^q(k,l)$ and $F^t(k,l)$, of the query and target images; P_q^i and P_t^i represent the probability values of the pixels in the query and target images respectively, where $i = 1,2,\ldots,N_{(\bullet)}$.

The main advantage of the proposed technique is, (i) it adopts itself for any type of images, i.e. the images follow either Gaussian or mixed or non-Gaussian distributions; (ii) in the case of Bhattacharyya distance, the optimum value is fixed as 1/2, thus, it is not appropriate for any type of image, and it does not lead to better result; (iv) in the case of Chernoff, the values P_q and P_t are computed adoptively itself according to the nature of the images.

III. EXPERIMENTAL SETTINGS AND IMAGE DATABASE DESIGN

In order to construct image database, 627 color images of size 512×512 pixels have been collected from various sources that is, 202 texture images from Brodatz Album, 251 images from Corel image database, and 274 images from VisTex image databases. The remaining 72 images with size 128×128 are photographed with digital camera; 58 images with size 128×128 have been downloaded from internet [36]. The textured images collected from Brodatz, Coral and VisTex image databases are divided into 16 non-overlapping sub-images of size 128×128. To examine that the proposed system is invariant for rotation and scaling, the images are rotated through 90^0, 180^0 and 270^0, and scaled. Thus, totally there are ((16 × (202+251+274)) + 72 + 58) × 3 (rotated by 90^0, 180 and 270^0) +11762 (scaled) = 47048 images. Based on this image collection, an image database and their feature vector database are constructed as discussed in the previous section. For sample, some of them have been presented in this paper. In addition to that a number of different types of and noise polluted images, and medical images such as mammogram images, cancer images also have been considered to prove that the proposed system works well for real-life images.

IV. MEASURE OF PERFORMANCE

In order to measure the performance of the proposed method, the precision and recall measures [22] are used, which are given in equations (7) and (8).

$$Precision = \frac{|\{Relevant\ Images\} \cap \{Retrieved\ Images\}|}{|Retrieved\ Images|} \quad (7)$$

$$Recall = \frac{|\{Relevant\ Images\} \cap \{Retrieved\ Images\}|}{|Relevant\ Images|} \quad (8)$$

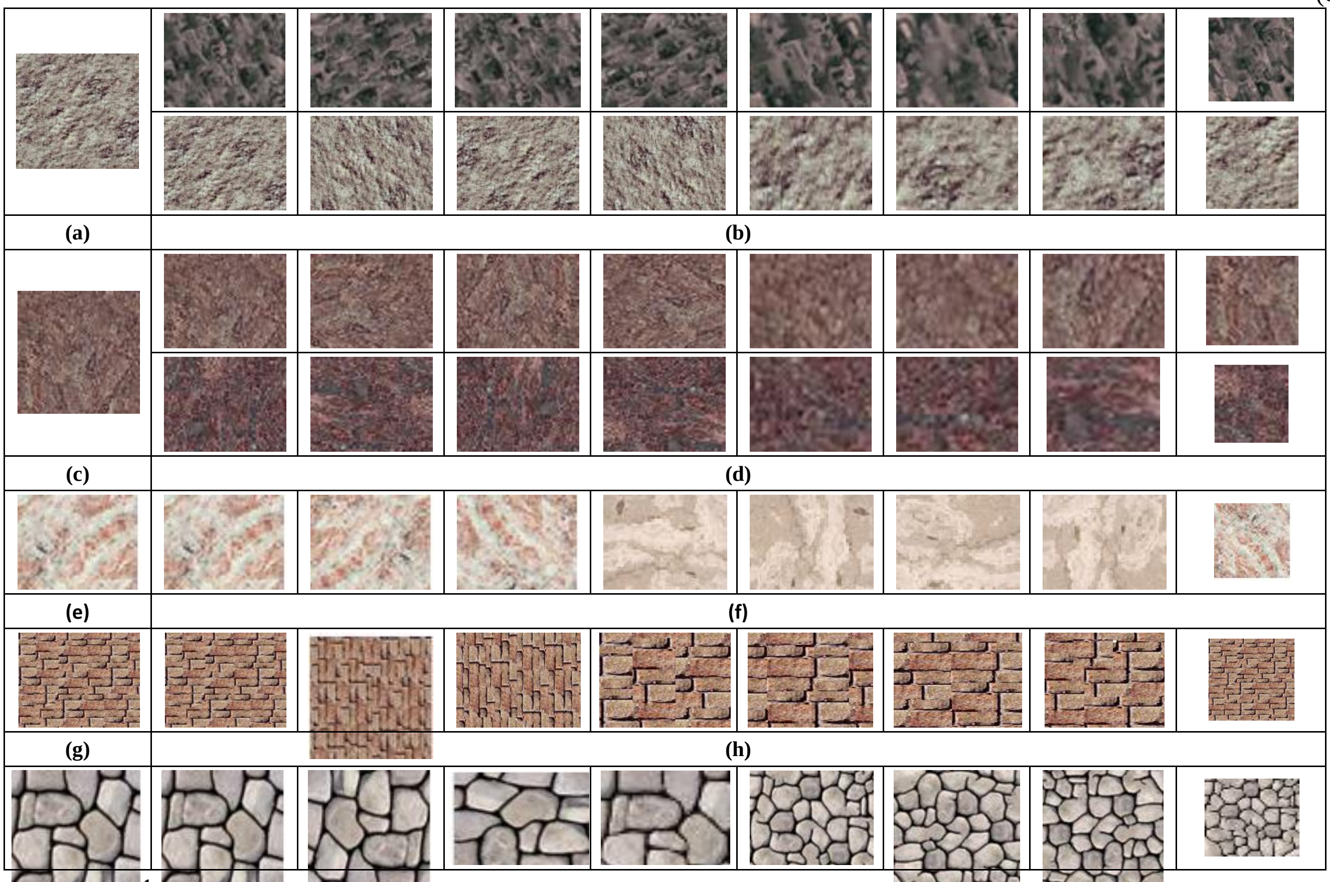
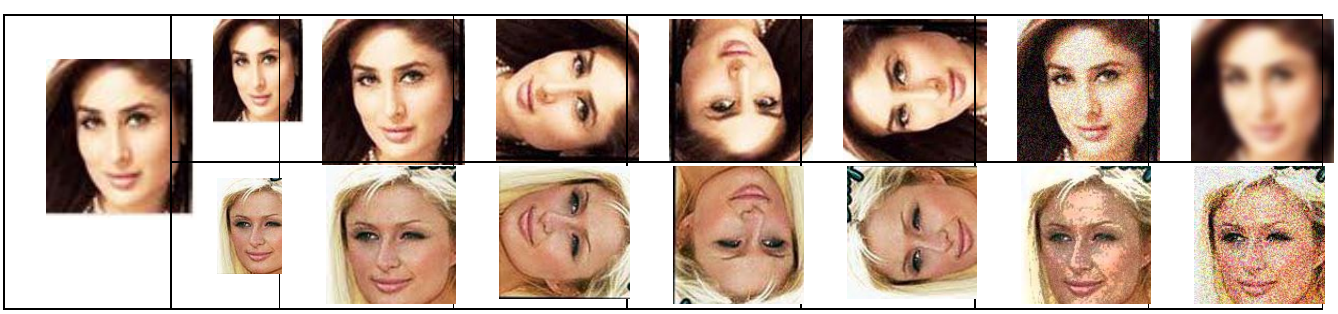


Figure 1[1]. column 1: query image with size 512 × 512; column 2: actual images with size 512 × 512 retrieved from image database; column 3: images in column 1 are rotated by 90° clock-wise; column 4: images in column 1 are rotated by 180° clock-wise; column 5: images in column 1 are rotated by 270° clock-wise; column 5-8: retrieved similar images; column 9: scaled images.



[1] **All the images in Figure 1 are of size with 512×512. Due to space constraint, the images in columns 1 to 6 are minimized here. The images in columns 7 to 10 are part of the actual images with size 512×512.**

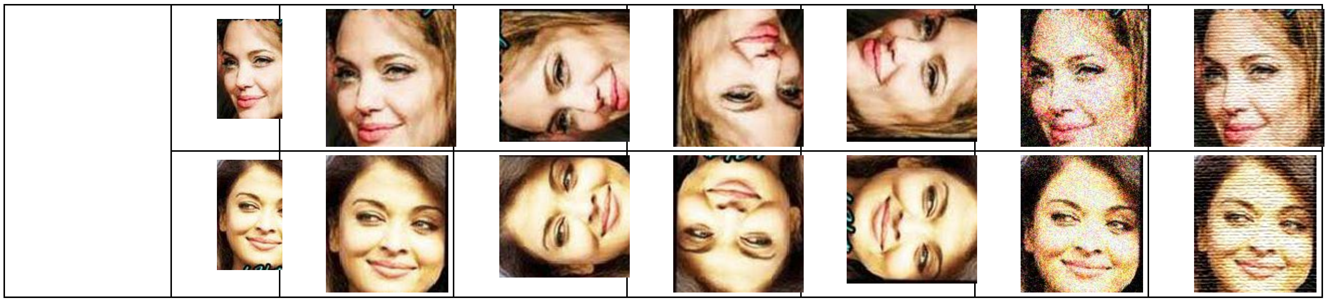


Figure 2. Structure images – column 1: query image with size 128 × 144; column 2: scaled images; column 3: actual images with size 128 × 144 retrieved from image database; column 4: images in column 3 are rotated by 90° clock-wise or counter clock-wise; column 5: images in column 3 are rotated by 180° either in clock-wise or counter clock-wise; column 6: images in column 3 are rotated by 270° either in clock-wise s noise added, third and fourth images are with artifacts.

V. EXPERIMENTS AND RESULTS

In order to implement the theoretical concepts discussed in section 2, the images in the image database, constructed as discussed in the preceding section, are included in the experiment. The objects in the given input query image is segmented into various objects, and the segmented color image is segregated into individual color such as red, green and blue. The proposed technique is employed, which computes the number of objects in the query image as discussed in [22], and compares them with the objects in the target image in the image database. Number of objects in the query and target images are represented with π_q and π_t respectively. If it satisfies the condition expressed in equation (9), then the system proceed for retrieval process.

$$\left(\left(1-\frac{\pi_q}{\pi_t}\right)\times 100\right) \leq t_\alpha \quad (9)$$

Where, t_α is the criteria for matching the objects in the images, but in this system it is fixed to 20%; either the query image or the target image, which has lesser number of objects than the other is put in the place of numerator, whereas the other put in the place of denominator. The mean vector **m** and the variance-covariance matrix Σ of the query image are computed as discussed in section 2. The probability values P_q of each region in the query and target images are computed based on the expression given in equation (5). Now, the probability values of the pixels in the target image are decoded. The probability values, mean vector and variance-covariance matrix of the target image are considered from the feature database of the image database. The Chernoff distance measure expressed in equation (4) is employed to compute the distance between the query and target images.

In order to examine the proposed distance measure, a number of images such as stochastic and periodic patterned textured query images considered and included in the experiment. For example, due to space constraint, some of them have been presented in this paper. The experiment is conducted at various levels of significance for the input query images given in column 1 of Figure 1. For which, the system retrieves the images in column 1 of Figure 1(b) at 0.01% level of significance; (confidence level is 99%); For 3% level of significance, the system retrieves the images in column 2; at 8% level of significance, the system retrieves the images in column 3, 4; at 12% level of significance, the images presented in columns 5, 6, 7 and 8 are retrieved; the level of significance is fixed at 12%, the images in the last column are retrieved. If a user wants to retrieve a number of images, he may fix the level of significance at his desire according to the requirements of the images.

Furthermore to prove the efficiency of the proposed technique, a number of structured images are considered for the experiment. For example, a few of them have been presented in Figure 2. The image given in column 1 of the Figure 2 is given as input query to the system, for which the system retrieves the images in first column at the level of significance 0.01%; actually the system retrieves the images in columns 2 and 3 at the level of significance 0.03% or lesser, whereas it retrieves the images in column 4, 5 and 6 are at 0.05%, and at the level of significance at 0.12% or lesser, the system retrieves the images in columns 7 and 8.

VI. CONCLUSION

In order to experiment the proposed distance measure, variety of images have been included in the experiment. The retrieval results are comparable with the Bhattacharya distance. Since the terms P_q and P_t are fixed at ½ in Bhattacharya distance metric, which may lead to wrong retrieval results. By nature, the structure and content of the images may vary, so that the values of the terms P_q and P_t also may vary. But, in the case of Chernoff distance the terms are computed as prior probability, so they are computed according to the nature of the images. Thus, the Chernoff distance leads to better results than the Bhattacharyya distance. Moreover, in the case of Bhattacharya, there is a constraint that the images should be distributed to Gaussian, whereas in the case of Chernoff distance there is no such constraints, viz. the images may be distributed to Gaussian or mixed or distribution free. Hence, the Chernoff distance is more appropriate for image retrieval than that of the Bhattacharyya distance, since the image retrieval system is automatic so that it is difficult one to identify that the images follow which distribution.

REFERENCES

[1] Yap, K.-H., & Wu, K. (2005). A soft relevance framework in content-based image retrieval systems. *IEEE Transactions on Circuits and Systems*, *15*(2), 1557–1568.

[2] J.Huang, S.R. Kunar, M.Mitra, W.J. Zhu, and R.Zabih, "Image indexing using color correlogram," in *Proc. IEEE Comp. Soc. Conf. Comp. Vis. And Patt. Recog*., 1997, pp. 762-768.

[3] M.Stricker and M. Orengo, "Similarity of color images," in *Storage and Retrieval for Image and Video Databases, Proc. SPIE* 2420, 1995, pp.381-392.

[4] A.Pentland, R.Picard, and S. Sclaroff, "Photobook: Content-based manipulation of image databases," *SPIE Storage and Retrieval for Image and Video Databases II*, no. 2185, pp. 34-47, 1994.

[5] Chiou-Shaan Fuh, Shun-Wen Cho, and Kai Essig, "Hierarchical color image region segmentation for content-based image retrieval system," *IEEE Transactions on Image Processing*, vol.9, no.1, 2000.

[6] F. Jing, M. Li, H.J. Zhang, and B.Zhang, "An efficient and effective region-based image retrieval framework," *IEEE Transactions on Image Processing*, vol.13, no.5, 2004.

[7] Jun-Wei Hsieh and W.Eric L. Grimson, "Spatial template extraction for image retrieval by region matching," *IEEE Transactions on Image Processing*, vol.12, no.11, 2003.

[8] F.Jing, M.Li, H.J.Zhang, and B.Zhang, "An efficient and effective region-based image retrieval framework," *IEEE Transactions on Image Processing*, vol.13, no.5, 2004.

[9] S. Belongie, C.Carson, H.Greenspan, and J.Malik, "Recognition of images in large databases using color and texture," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol.24, no.8, pp. 1026-1038, 2002.

[10] F. Jing, B.Zhang, F.Z.Lin, W.Y.Ma, and H.J.Zhang, "A novel region-based image retrieval method using relevance feedback," in *Proc. 3rd ACM Int. Workshop on Multimedia Information Retrieval (MIR)*, 2001.

[11] Y.Deng and B.S.Manjunath, "An efficient low-dimensional color indexing scheme for region-based image retrieval," in *Proc. IEEE Int. Conf. ASSP*, vol.6, 1999, pp.3017-3020.

[12] Ing-Sheen Hsieh and Huo-Chin Fan, "Multiple classifiers for color flag and trademark image retrieval," *IEEE Transactions on Image Processing*, vol.10, no.6, 2001.

[13] J.R. Smith and C.S. Li, "Image classification and querying using composite region templates," *Journal of Computer Vision and Image Understanding*, vol.75, no.12, pp. 165-174, 1999.

[14] J.Z. Wang and Y.P. Du, "Scalable integrated region-based image retrieval using IRM and statistical clustering," in *Proc. ACM and IEEE Joint Conference on Digital Libraries*, VA, June 2001, pp.268-277.

[15] F.Kimura and M.Shridhar, "Handwritten numerical recognition based on multiple algorithm," *Pattern Recognition*, vol.24, no.10, pp. 969-983, 1991.

[16] T.K.Ho, J.J.Hull, and S.N.Srihari, "Decision combination in multiple classifier systems," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol.16, 66-75, 1994.

[17] Chiou-Shaan Fuh, Shun-Wen Cho, and Kai Essig, "Hierarchical color image region segmentation for content-based image retrieval system," *IEEE Transactions on Image Processing*, vol.9, no.1, 2000.

[18] T. Kailath, "The divergence and Bhattacharyya distance measures in signal selection" *IEEE Trans. Comm. Techn.* , COM–15 (1967) pp. 52–60

[19] Ray, S., "On a theoretical property of the Bhattacharyya coefficient as a feature evaluation criterion" *Pattern Recognition Letters* , 9 (1989) pp. 315–319.

[20] Euisun Choi, Chulhee Lee, Feature extraction based on the Bhattacharyya distance, Pattern Recognition 36 (2003) 1703 – 1709.

[21] Sfikas, G., Constantinopoulos, C., Likas, A., Galatsanos, N.P., An Analystic Distance Metric for Gaussian Mixture Models with Applications in Image Retrieval, ICANN'05 Proceedings of the 15-th international conference on Artificial Neural Networks: formal models and their application, volume part II, pp. 835-840, 2005.

[22] K. Seetharaman and M. Jaikarthic, Statistical Distributional Approach for Scale and Rotation Invariant Color Image Retrieval Using Multivariate Parametric tests and Orthogonality Condition, *Journal of Visual Communication and Image Representation*, DOI: 10.1016/j.jvcir.2014.01.004.

[23] R. Duda, P. Hart, and D. Stork. *Pattern Classification*. John Wiley and Sons, Inc., New York, NY, 2nd edition, 2000.