International Journal of Information, Control and Computer Sciences
ISSN: 2517-9942
Vol:3, No:3, 2009

Standard Deviation of Mean and Variance of Rows and Columns of Images for CBIR

H. B. Kekre, Kavita Patil

***Abstract*—**This paper describes a novel and effective approach to content-based image retrieval (CBIR) that represents each image in the database by a vector of feature values called "Standard deviation of mean vectors of color distribution of rows and columns of images for CBIR". In many areas of commerce, government, academia, and hospitals, large collections of digital images are being created. This paper describes the approach that uses contents as feature vector for retrieval of similar images. There are several classes of features that are used to specify queries: colour, texture, shape, spatial layout. Colour features are often easily obtained directly from the pixel intensities. In this paper feature extraction is done for the texture descriptor that is 'variance' and 'Variance of Variances'. First standard deviation of each row and column mean is calculated for R, G, and B planes. These six values are obtained for one image which acts as a feature vector. Secondly we calculate variance of the row and column of R, G and B planes of an image. Then six standard deviations of these variance sequences are calculated to form a feature vector of dimension six. We applied our approach to a database of 300 BMP images. We have determined the capability of automatic indexing by analyzing image content: color and texture as features and by applying a similarity measure Euclidean distance.

***Keywords*—**Standard deviation Image retrieval, color distribution, Variance, Variance of Variance, Euclidean distance.

I. Introduction

CONTENT Based image retrieval aims at developing new effective techniques to search and browse similar images from the large image database by analyzing the image contents. There are two main approaches to design an Image Retrieval System, first is text based approach in this method images are first annotated with text and then text-based image retrieval uses traditional database techniques to manage images. Through text descriptions, images can be organized by topical or semantic hierarchies to facilitate easy navigation and browsing based on standard Boolean queries. However, since automatically generating descriptive texts for a wide spectrum of images is not feasible, most text-based image retrieval systems require manual annotation of images.

H.B.Kekre is a Senior Professor with MPSTME, NMIMS University, Vile-parle(W), Mumbai-56, India (email:hbkekre@yahoo.com). Ms. Kavita Patil is a lecturer with St. Francis Institute of Technology (Engineering,College) Borivli (W), Mumbai-103, India (e-mail: kavitabpatil@rediffmail.com).

Kavita Patil is a lecturer with St. Francis Institute of Technology (Engineering,College) Borivli (W), Mumbai-103, India (e-mail: kavitabpatil@rediffmail.com).

Obviously, annotating images manually is a cumbersome and expensive task for large image databases, and is often subjective, context-sensitive and incomplete [22],[23]. As a result, it is difficult for the traditional text-based methods to support a variety of task-dependent queries. Because of all these factors in recent years, there has been a growing interest in developing these effective methods for searching large image databases based on image contents by ranking the relevance between query image feature vector and database image feature vector. According to the scope of the representation these features roughly fall into two categories global features and local features. The former category includes texture histogram, colour histogram; colour layout of the whole image, and features selected from multidimensional discriminant analysis of a collection of images [1], [2], [3], [4]. While colour, texture, and shape features for sub images [9], segmented regions [5], [6], [7], [8], or interest points [11] belong to the latter category. Similarity measure is significant factor which quantifies the resemblance in database image and query image [10]. Depending on the type of features, the formulation of the similarity measure varies greatly. The different types of distances which are used by many typical CBIR systems are city block distance, chess board distance [24], intersection distance [12], the Earth mover's distance (EMD), Euclidian distance [14] [18]. Most approaches to image database management have focused on "search-by-query". The users provide the query, for which the database is searched exhaustively for images that are most similar to query image [15]. The query image can be an existing image in the database or can be given by the user. The problems of image retrieval are becoming widely recognized, and the search for solutions is becoming an increasingly active area of research and development. A considerable amount of information exists in images, and it would be advantageous to have an automatic method for indexing and retrieving them based on their content [20]. The growing need for robust image retrieval systems has led to a need for additional retrieval methodologies.

II. Image Retrieval Using Standard Deviation of Row and Column Mean vectors

A. Basic Algorithm

In this approach feature vector of 6 components is formed by calculating standard deviation of row and column vector of R, G, and B planes of an image. Then by using the similarity

measure that is Euclidean Distance we have calculated the distance between the query image and database images. Finally determination of threshold is done so that similar images are retrieved.

1) Implementation Details

1. Split image into R, G, and B components.

Fig. 1 Separation of R, G and B components.

2. Calculation and plot of row and column vectors of each plane:

Mean of each row is calculated and a sequence is formed. Similarly a column sequence is also formed. Following figure shows the plots of row and column vectors of R, G and B planes.

Fig. 2 Row and column vectors for R, G and B plane.

3. Calculate the variance for all six components obtained above using:

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}\left(x_i - \bar{x}\right)^2 \quad (1)$$

where x_i is data vector and $\bar{x}$ is mean given by:

$$\frac{1}{N}\sum_{1}^{N} x_i$$

As this value tends to be very large we are taking its square root to get standard deviation σ.

In this way we obtained the standard deviation σ for following data vectors Redrow, Redcol, Greenrow, Greencol, Bluerow and Bluecol to form feature vectors of six components as:

V= [V1 V2 V3 V4 V5 V6]

4. Application of similarity measure 'Euclidean Distance':

$$D_{QI} = \sqrt{\sum_{i=1}^{6}\left(FQ_i - FI_i\right)^2} \quad (2)$$

Where FQ is feature vector for query image and FI is feature vector for database image.

5. Select those images where the distances are less than threshold value T.

6. Selection of T is done by following process:

B. Determination of Threshold

Results obtained as Euclidean distances between query image and database images using above step are sorted in ascending order. We selected five threshold values as 10 %, 20%, 25%, 30% and 40% of maximum Euclidean distance. After trying the result for above five threshold values we found better results are obtained for threshold value equal to 25% of Maximum Euclidean distance and this is selected as the standard threshold for this particular approach.

III. Image Retrieval Using Standard Deviation of Variance

A. Basic Algorithm

In this approach instead of calculating the mean values for rows and columns of an image, we calculate *'Standard deviation of variance* of rows and columns By using the Euclidean Distance as similarity measure we have calculated the distance between the query image and database images. Finally determination of threshold is done by taking 10 %, 20%, 25%, 30% and 40% of maximum Euclidean distance.

B. Implementation Details.

1. Split image into R, G, and B components.
2. Calculation of variance of rows and columns of each plane of an image.
3. Calculation of 'standard deviation of variance'.

Whatever sequences we obtained in above step, i.e sequences of variance for rows and columns per R, G, and B planes, we calculate the standard deviations which give the feature vector of six dimensions.

4. Application of similarity measure: Find Euclidean Distance between the query image and database images.
5. Select those images where the distances are less than a preselected value threshold T obtained by taking 25% of the maximum Euclidean distance.

IV. Experimental Results and Discussion

A. Database and Query Images

The approaches discussed in section II and III are applied to database of 300 images which includes 75 images of Flower, Sunset, Barbie and Mountain.

As per the discussion in algorithm Euclidean distance is calculated between the feature vector of query image and feature vector of database image for standard deviation of mean and variance approaches. Both approaches tried with same four query images one from each category.

Four queries we used for discussion are: Flower26,

Sunset144, Barbie211 and Mountain298**.**

B. Systematic Evaluation

To evaluate the performance of these image retrieval algorithms we have used two traditional parameters defined as follows:

Precision: Precision is the fraction of the relevant images which has been retrieved (from all retrieved):

$$\text{Precision} = A / B \quad (3)$$

Where, A is "Relevant retrieved" and
B is "*All* Retrieved images"

Recall: Recall is the fraction of the relevant images which has been retrieved (from all relevant):

$$\text{Recall} = A / C \quad (4)$$

Where, A is "Relevant retrieved" and
C is "*All* Relevant images" in database.

C. Thresholding and Retrieval

For all the above queries Euclidean distances are calculated with database images and then using the standard threshold we selected images having less than 25% of the maximum Euclidean distance. The results obtained are shown in Table I and Figure 3.

Similarly for the second approach (Section- III) is also tried with same query images and the results obtained are shown in Table II and Figure 4.

TABLE I
RETRIEVAL RESULT FOR "STANDARD DEVIATION OF MEAN"
APPROACH AT 25% OF MAX EUCLIDEAN DISTANCE

Query Image	Total Retrieved Images	Relevant Retrieved Images	Irrelevant Retrieved Images	Precision	Recall
Flowers	50	35	15	0.7	0.466
Sunset	27	25	02	0.93	0.33
Barbie	40	30	10	0.75	0.4
Mountain	37	35	02	0.95	0.46

TABLE II
RETRIEVAL RESULT FOR "STANDARD DEVIATION OF VARIANCE"
APPROACH AT 25% OF MAX EUCLIDEAN DISTANCE

Query Image	Total Retrieved Images	Relevant Retrieved Images	Irrelevant Retrieved Images	Precision	Recall
Flowers	86	37	49	0.43	0.5
Sunset	76	25	51	0.32	0.33
Barbie	91	30	61	0.33	0.4
Mountain	104	29	75	0.3	0.4

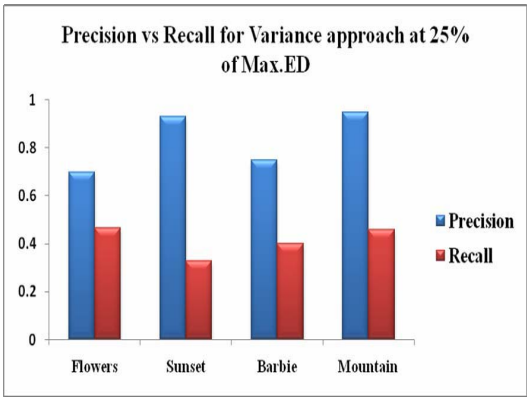

Fig. 3. Precision V/s Recall for variance approach at 25% of Max.Ed

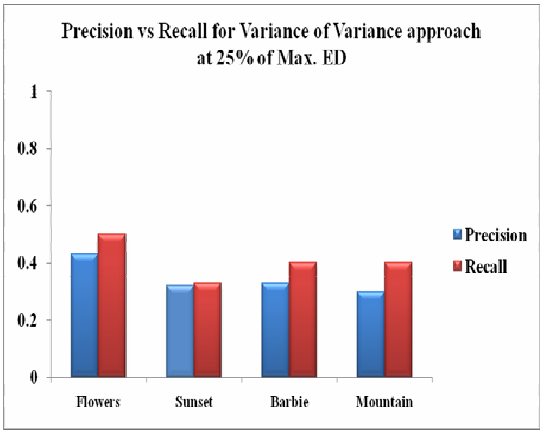

Fig. 4. Precision V/s Recall for Variance of Variance approach at 25% of Max.Ed

D. Standard Deviation Mean AND Standard Deviation of variance

In this section we combine *standard Deviation of Mean'* with *'Standard deviation of Variance'* using AND operation. According to this AND operation; if the image is being "Retrieved" in both the approaches then only the image is retrieved finally.

In this AND operation precision increases and Recall decreases as shown in the Table- III.

TABLE III
RETRIEVAL RESULT FOR
"VARIANCE OF MEAN" AND "VARIANCE OF VARIANCE"

Query Image	Total Retrieved Images	Relevant Retrieved Images	Irrelevant Retrieved Images	Precision	Recall
Flowers	33	26	7	0.8	0.34
Sunset	12	12	0	1	0.16
Barbie	15	10	5	0.66	0.2
Mountain	14	14	0	1	0.2

E. Standard Deviation Mean OR Standard Deviation of variance.

Using the OR operation we have performed second level thresholding for the results obtained in both approaches. According to the effect of OR operation if the image is being

retrieved in either of these two approaches will be retrieved as a part of final retrieval result. As the image is retrieved finally even when it appears in any one of the two approaches *Recall* increases at the cost of decrease in *Precision* as shown in the Table IV.

TABLE IV
RETRIEVAL RESULT FOR
"VARIANCE OF MEAN" OR "VARIANCE OF VARIANCE"

Query Image	Total Retrieved Images	Relevant Retrieved Images	Irrelevant Retrieved Images	Precision	Recall
Flowers	103	46	57	0.44	0.61
Sunset	61	38	23	0.62	0.5
Barbie	116	50	66	0.43	0.66
Mountain	127	50	77.	0.4	0.66

V. CONCLUSION

The main contribution of this work is to overcome some of the problems of text based approach by using content features of an image for comparison. In this paper two algorithms have been discussed which are focusing on the colour and texture component of images for forming a feature vector.

In this work we have introduced the idea of using mean and variance of all rows and columns of R, G, and B planes to extract the colour and texture feature of the image. Further the feature vectors are formed by taking standard deviation of these sequences. Database used for the experiment includes 300 images of four different categories as 75 images of each category. Results obtained for these approaches are shown in Table I and Table II respectively. We observe that Precision and *Recall* both are better for standard deviation of Mean sequence than the standard deviation of variance sequences.

Further when we take AND and OR operation of these two approaches, it is observed that AND operation improves Precision whereas OR operation improves Recall.

REFERENCES

[1] C. Faloutsos, R. Barber,M. Flickner, J. Hafner,W. Niblack, D. Petkovic, and W. Equitz, "Efficient and effective querying by image content," *J. Intell. Inf. Syst.*, vol. 3, no. 3–4, pp. 231–262, 1994.

[2] A. Gupta and R. Jain, "Visual information retrieval," *Commun. ACM*,vol. 40, no. 5, pp. 70–79, 1997.

[3] J. R. Smith and S.-F. Chang, "VisualSEEK: a fully automated contentbased query system," in *Proc. 4th ACM Int. Conf. Multimedia*, 1996, pp. 87–98.

[4] D. L. Swets and J. Weng, "Using discriminant eigenfeatures for image retrieval," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 18, no. 8, pp. 831–837, Aug. 1996.

[5] C. Carson, S. Belongie, H. Greenspan, and J. Malik, "Blobworld: image segmentation using expectation-maximization and its application to image querying," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 24, no. 8, pp. 1026–1038, Aug. 2002.

[6] Y. Chen and J. Z.Wang, "A Region-Based Fuzzy Feature Matching Approach to Content-Based Image Retrieval," *IEEE Trans. Pattern Anal.Mach. Intell.*, vol. 24, no. 9, pp. 1252–1267, Sep. 2002.

[7] W. Y. Ma and B. Manjunath, "NeTta: a toolbox for navigating large image databases," in *Proc. IEEE Int. Conf. Image Processing*, 1997, pp.568–571.

[8] J. Z. Wang, J. Li, and G. Wiederhold, "SIMPLIcity: semantics-sensitive integrated matching for picture libraries," *IEEE Trans. Pattern Anal.Mach. Intell.*, vol. 23, no. 9, pp. 947–963, Sep. 2001.

[9] R. W. Picard and T. P. Minka, "Vision texture for annotation," *J. Multimedia Syst.*, vol. 3, no. 1, pp. 3–14, 1995.

[10] S. Santini and R. Jain, "Similarity measures," *IEEE Trans. Pattern Anal.Mach. Intell.*, vol. 21, no. 9, pp. 871–883, Sep. 1999.

[11] [11] C. Schmid and R. Mohr, "Local grayvalue invariants for image retrieval," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 19, no. 5, pp. 530–535, May 1997.

[12] M. J. Swain and B. H. Ballard, "Color indexing," *Int. J. Comput. Vis.*,vol. 7, no. 1, pp. 11–32, 1991.

[13] J. Hafner, H. S. Sawhney, W. Equitz, M. Flickner, and W. Niblack, "Efficient color histogram indexing for quadratic form distance functions," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 17, no. 7, pp. 729–736, Jul. 1995.

[14] Y. Rubner, L. J. Guibas, and C. Tomasi, "The earth mover's distance, multi-dimensional scaling, and color-based image retrieval," in *Proc.DARPA Image Understanding Workshop*, May 1997, pp. 661–668.

[15] J. G. Dy, C. E. Brodley,A. Kak, C. Shyu L. S. Broderick "The Customized-Queries Approach to CBIR Using EM", *IEEE Conference on Computer Vision and Pattern Recognition, 1999.*

[16] M. Flickner, "Query image and video by content: The QBIC system,"*IEEE Computer*, vol. 28, no. 9, pp. 23–32, Sep. 1995.

[17] Remco C. Veltkamp, Mirela Tanase Department of Computing Science, Utrecht University, "Content-Based Image Retrieval Systems:A Survey" Revised and extended version of Technical Report UU-CS- 2000-34, October October 28, 2002.

[18] Yixin Chen, *Member, IEEE*, James Z. Wang, *Member, IEEE*, And Robert Krovetz CLUE: Cluster-Based Retrieval Of Images By Unsupervised Learning *IEEE Transactions on Image Processing, Vol.14, No. 8, August 2005 1187*

[19] Qasim Iqbal and J. K. Aggarwal, "Cires: A System For Content-Based Retrieval In Digital Image Libraries" Seventh International Conference on Control, Automation, Robotics And Vision (ICARCV'02), Dec 2002, Singapore.

[20] Guoping Qiu "Color Image Indexing Using BTC"IEEE transactions on image processing, vol. 12, no. 1, January 2003.

[21] Zur Erlangung des Doktorgrades "Feature Histograms for Content-Based Image Retrieval" der Fakult¨at f¨ur Angewandte Wissenschaften an der Albert-Ludwigs-Universit¨at Freiburg im Breisgau 2002

[22] Y. Rui and T. S. Huang, "Image retrieval: Current techniques, promising directions, and open issues," *J. Vis. Commun. Image Repres.*, vol. 10, pp.39–62, Oct. 1999.

[23] Young Deok Chun, Sang Yong Seo, and Nam Chul Kim "Image retrieval Using BDIP and BVLC Moments" IEEE transactions on circuits and systems for video technology, vol. 13, no. 9, september 2003.

[24] Rafael Gonzalez, Richard Woods, "Digital Image Processing" *Second Edition Pearson Education(Sinagpore Pte. Ltd.) 2003.*

Dr. H. B. Kekre has received B.E. (Hons.) in Telecomm. Engineering. from Jabalpur University in 1958, M.Tech (Industrial Electronics) from IIT Bombay in 1960, M.S.Engg. (Electrical Engg.) from University of Ottawa in 1965 and Ph.D. (System Identification) from IIT Bombay in 1970. He has worked Over 35 years as Faculty of Electrical Engineering and then HOD Computer Science and Engineering at IIT Bombay.He has guided 17 Ph.D's more than 100 M.E. and M.Tech Projects. For last 13 years he was working as a Professor & Head in Department of Computer Engineering at Thadomal Shahani Engineering College, Mumbai. Now currently he is working as a Senior Professor with MPSTME, NMIMS University. His areas of interest are Digital Signal processing, Image Processing and Computer Networks. He has more than 200 papers in National / International Conferences / Journals to his credit. Recently five students working under his guidance have received best paper awards.

Ms. Kavita B. Patil has received M.E (Computer Engineering) degree from Mumbai University in 2008, Currently working as a lecturer in Department of Computer Engineering at St. Francis Institute of Technology Mumbai. Her area of interest is Image Processing,