Abstract

The development of a Content-Based Image Retrieval System (CBIRS) is presented. The second-order statistics were adopted as image features by the system as a means of distinguishing between images. The numbers of co-occurrences of pairs of gray values in an image are recorded in the Gray Level Co-occurrence Matrix (GLCM). Five of the second-order statistics which usually have values greater than 1 were selected; Contrast, Dissimilarity, Entropy, Mean (µ), and Standard Deviation (σ). Thus, fifteen features were recorded for each image from the Horizontal GLCM, Vertical GLCM, and Diagonal GLCM. During Database querying, features of the Query Image are computed and compared with those of the Database images, and Euclidean distance is computed as a similarity measure. The system displays the Query Image, the Retrieved Image (if any), the Best Match Image, and Eight Close Images with their Euclidean distances from the Query Image. Columbia Object Image Library image collection of 7,200 images was selected as the test Database. The developed CBIRS system accurately detects and retrieves Exact Match Images to Query Images with Euclidean distance of the Best Match Image being zero. The system also accurately identifies Query Images which
are not in the Database with Euclidean distance of the Best Match Image being greater than zero. The system recorded 100% Recall ratio and 100% Precision ratio.

References

1. Gonzalez R. C. and Woods R. E. 2002. Digital Image Processing (2nd ed.). New York: Pearson Education.
2. Datta R., Joshi D., Li J., and Wang J. Z. 2008. “Image retrieval: Ideas, influences, and trends of the new age”, ACM Computing Surveys (Csur), 40(2), 5.1-5.60.
3. Hui H., Mohamad D. and Ismail N. 2010. “Approaches, challenges and future direction of image retrieval”, Journal of Computing, 2, 193-199.
4. Jabeen S., Mehmood Z., Mahmood T., Saba T., Amjad Rehman A. and Mahmood M. T. 2018. “An effective content-based image retrieval technique for image visuals representation based on the bag-of-visual-words model”, PLoS ONE, 13(4), 1-24.
5. Kato T., Kurita T., Otsu N. and Hirata, K. 1992. “A sketch retrieval method for full color image database-query by visual example”, Int. Conf on Pattern Recognition, 530-533.
6. Zhou H., Sadka A. H., Swash M. R., Aziz J. and Umar A. S. 2009. “Content-Based Image Retrieval and Clustering: A Brief Survey” Recent Patents on Electrical Engineering, 2(3), 187-199.
7. Yasmin M., Mohsin S., Irum I. and Sharif M. 2013. “Content Based Image Retrieval by Shape, Color and Relevance Feedback”, Life Sciences Journal, 10(4), 593-598.
8. Halawani A., Teynor A., Setia L., Brunner G. and Burkhardt H. 2006. “Fundamentals and Applications of Image Retrieval: An Overview”, Datenbank-Spektrum, 18, 14-23.
9. Aly M., Welinder P., Munich M. and Perona P. 2009. “Automatic discovery of image families: Global vs. local features”, 16th IEEE International Conference on Image Processing, 777-780.
10. Choras R. S. 2007. “Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems”, International Journal of Biology and Biomedical Engineering, 6-16.
11. Kaushik M., Sharma R. and Vidyarthi A., 2012. “Analysis of Spatial Features in CBIR System”, International Journal of Computer Applications, 54(17), 11-15.
12. Kong F. H. 2009. “Image Retrieval Using Both Color and Texture Features”, Eighth International Conference on Machine Learning and Cybernetics, 2228-2232.
13. Kwitt R. and Andreas U. 2010. “Lightweight Probabilistic Texture Retrieval”, IEEE transactions on Image Processing, 19(1), 241-253.
14. Selvarajah S. and Kodituwakku S. R. 2011. “Analysis and Comparison of Texture Features for Content Based Image Retrieval”, International Journal of Latest Trends in Computing, 2(1), 108-113.
15. Yue J., Li C. and Li Z. 2015. “An Improved Method for Image Retrieval Based on Color and Texture Features”, In: Li D., Chen Y. (eds) Computer and Computing Technologies in Agriculture VIII (CCTA 2014), IFIP Advances in Information and Communication Technology, Springer, Cham, 452, 739-752.
16. Chanda B. and Majumer D. D. 2000. Digital Image Processing and Analysis. India: Prentice-Hall.
17. Jain A. K. 1989. Fundamentals of Digital Image Processing. India: Prentice-Hall.
18. Zubair A. R. 2012. “Comparison of Image Enhancement Techniques”, International...
Journal of Research in Commerce, IT & Management, 2(5), 44-52.

19. Zubair A. R. 2019. “Image as a Signal: Review of the Concept of Image Frequency Estimate”, Computing, Information Systems & Development Informatics Journal, 10(1), 73-86.

20. Clausi D. A. 2002. “An analysis of co-occurrence texture statistics as a function of grey level Quantization”, Canadian Journal of Remote Sensing, 28, 45–62.

21. Ferro C. J. S. and Warner T. A. 2002. “Scale and texture in digital image classification”, Photog. Eng. and Rem. Sen., 68(1), 51-63.

22. Hall-Beyer M. 2017. GLCM Texture: A Tutorial version 3.0.

23. Hann D. B., Smith A. M. S. and Powell A. K. 2003. “Classification of off-diagonal points in a co-occurrence matrix”, Int. Journal of Remote Sensing, 24(9), 1949-1956.

24. Zubair A. R. and Alo O. A., 2019. “Grey Level Co-occurrence Matrix (GLCM) Based Second Order Statistics for Image Texture Analysis”, International Journal of Science and Engineering Investigations, 8(93), 64-73.

25. Columbia-University. 1996. “COIL-100: Columbia Object Image Library”, Retrieved March 15, 2019 from Columbia University Website: http://www1.cs.columbia.edu/CAVE/software/softlib/coil-100.php

26. Sameer A. N., Shree K. N. and Murase H., 1996. “Columbia Object Image Library COIL-100”, a Technical Report.

27. Wu G., Chang E. Y. and Panda N. 2005. “Formulating context-dependent similarity functions”, In Proceedings of the ACM International Conference on Multimedia.

28. O'Neill B. 2006. Elementary Differential Geometry. California: Academic press.

29. Liberti L., Lavor C., Maculan N. and Mucherino A. 2012. “Euclidean distance geometry and applications”, Siam Review, 1-65.

30. Dokmanic I., Parhizkar R., Ranieri J. and Vetterli M. 2015. “Euclidean Distance Matrices: Essential theory, algorithms, and applications”, IEEE Signal Processing Magazine, 32(6), 12-30.

31. Fu Y., Zeug H., Ni Z., Chen J., Cai C. and Ma K. 2017. “Screen content image quality assessment using Euclidean distance”, International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), Xiamen, 44-49.

32. Sokolova M. and Lapalme G. 2009. “A systematic analysis of performance measures for classification tasks”, Elsevier Information Processing Management 45, 427–437.

33. Powers D. M. W. 2011. “Evaluation: From Precision, Recall and F-Measure to ROC, Informedness, Markedness & Correlation”, Journal of Machine Learning Technologies, 2(1), 37-63.

34. Brownlee J. 2020. “How to Calculate Precision, Recall, and F-Measure for Imbalanced Classification”, Machine Learning Mastery Tutorial, Retrieved May 12, 2020 from https://machinelearningmastery.com/precision-recall-and-f-measure-for-imbalanced-classification/

**Index Terms**

Computer Science Image Processing
Keywords

Image retrieval, Second-order statistics, Gray Level Co-occurrence Matrix, Euclidean distance, Recall ratio, Precision ratio.