CONTENT-BASED IMAGE RETRIEVAL USING MULTI-EATURED ALGORITHM

Rhea Suzette M. Haguisan
University of Science and Technology of Southern Philippines
Corresponding email: rhea.haguisan@ustp.edu.ph;

ABSTRACT: *The purpose of this research is to describe our study and solution to individual Content-Based Image Retrieval, CBIR system. It outlines the problem, the proposed individual solution, the final solution with the combined algorithm, and the accomplishments achieved. With the vast amount of images available, the need for CBIR development arises. This research outlines the basic features of an image; color, texture, and shape. These features are extracted and used as the basis for a similarity check between images. These algorithms are then incorporated into a single solution to calculate these features. The final output was a MatLab-built application with an image database that makes use of these features in a single algorithm as the basis of comparison and retrieval. The structure is then illustrated. Furthermore, the results are illustrated by a detailed example.*

Keywords: image retrieval, CBIR, content-based image retrieval

1. INTRODUCTION

Multimedia data has always been ubiquitous in the modern world. For many decades, organizations and individuals have acquired images in the form of photographs, magazines, book pages, and artwork. With that large amount of copies of those images, the proponents want to store them in the database and make use of it in the future providing easy access to retrieving them. The best way to have an efficient and probably the most accurate solution is using the CBIR or the Content-Based Image Retrieval system. Content-based image retrieval system is a technique for retrieving images from a database on the basis of automatically-derived features such as color, texture, and shape.

Content-based image retrieval systems have traditionally used color and texture analysis. These analyses have not always achieved an adequate level of performance and user satisfaction. The growing need for robust image retrieval systems has led to a need for additional retrieval methodologies. Most of the content-based image retrieval systems focus on similarity-based retrieval of natural picture images by utilizing color, shape, and texture features.

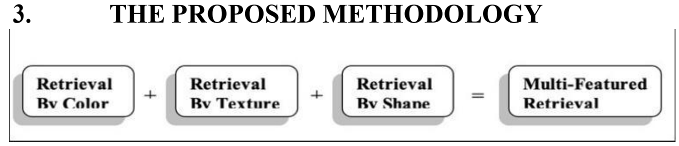
Interest in digital images has increased enormously. This interest has been motivated in part by the rapid growth of imaging on the World Wide Web. Content-Based Image Retrieval (CBIR) is becoming increasingly important in visual information. management systems. With the proliferation of image data, the need to search and retrieve images efficiently and accurately from a large image database or a collection of image databases has drastically increased.

2. BACKGROUND

Content-based Image Retrieval (CBIR), also known as query by image content (QBIC) and content-based visual information retrieval (CBVIR) is the application of computer vision to the image retrieval problem, that is, the problem of searching for images in large databases. "Content-based" means that the search makes use of the contents of the images themselves, rather than relying on human-inputted metadata such as captions or keywords. A content-based image retrieval system (CBIRS) is a piece of software that implements CBIR. It consists of two processes namely feature extraction and matching. Feature extraction is the first step in the process of extracting image features to a distinguishable extent. Matching, the second step involves matching these features to yield a result that is visually similar.

The ideal CBIR system from a user perspective would involve what is referred to as semantic retrieval, where the user can make a request. Current CBIR systems generally make use of lower-level features like texture, color, and shape. Different implementations of CBIR make use of different types of user queries. For this research, the respondents are making use of queries by example. Query by example is a kind of CBIR implementation where the user searches with a query image (supplied by the user or chosen from a random set), and the software finds images similar to it based on various criteria.

3. THE PROPOSED METHODOLOGY



To accomplish the objective of this research, the integration of the existing content-based image retrieval algorithms was done to have a more refined and effective image retrieval algorithm.

Content-based image retrieval has two steps for image retrieval; each image that was stored in the database has its feature extracted and compared to the features of the query image namely feature extraction and matching. For this part, the proponents tended to explain the underlying concept of feature extraction.

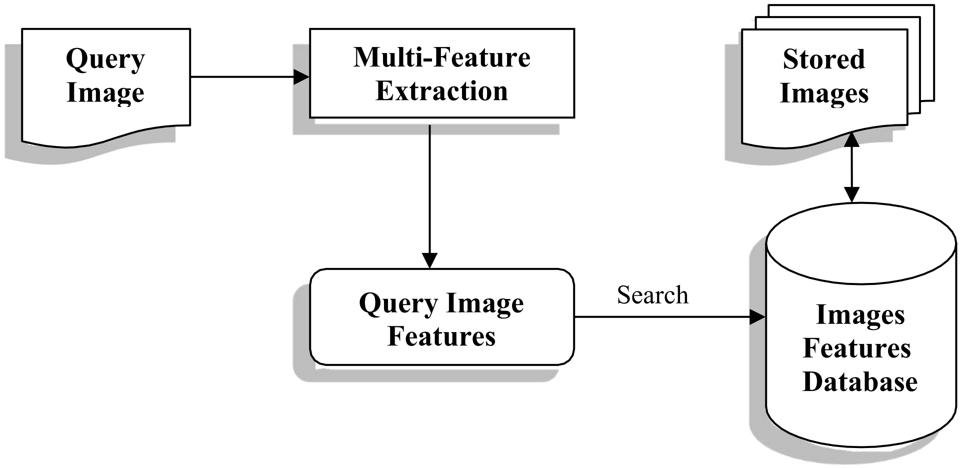


Figure 2: Image Feature Extraction and Matching

After the features have been extracted from a given image, these features were then passed on for image matching. Every image in the database would have its features extracted. This would be done differently on different primitive features of an image.

Matching algorithms will take the numbers from the feature extraction algorithm and pass them through the other images in the database and compare these numbers. Color matching for instance used the quadratic distance metric to basically compare one color bin from an inputted image with all those of the bins of the images in the database and find which color bin was the most similar, and this was continued until allimage features had been evaluated. The closest possible color bin was outputted in the end of the search. The equation used in deriving the distance between two color histograms is the quadratic distance metric. The first term consists of the difference between two color histograms, or more precisely the difference in the number of pixels in each bin. This term is obviously a vector since it consists of one row. The number of columns in this vector is the number of bins in a histogram. The third term is the transpose of that vector. The middle term is the similarity matrix. The final result represents the color distance between two images. The closer distance is to zero the closer the images are in color similarity. The further the distance from zero the less similar the images are in color similarity.

For texture, the proponents used the existing Euclidean distance algorithm which decomposes the query image and gets the energies of the image. The Euclidean distance was calculated between the query image and every image in the database until all the images were compared. Upon completion, the closest possible match was outputted in the user's screen, which is an array of Euclidean distances, which is then sorted. This is also the same with shape matching.

The development of the proposed algorithm was done using the integration of the existing CBIR algorithm. Currently, the majority of these algorithms were programmed and made using MatLAB. To preserve these codes and maintain their integrity and value, the researchers would pursue the algorithm development using MatLAB itself. The purpose of using MatLAB was to make an algorithm out of existing algorithms without compromising the integrity of existing codes. And since most of the feature extraction programs include calculations of a series of algorithms, using MatLAB would prove to be very efficient and flexible. In addition, MatLAB can be integrated with other programming languages so making a user-friendly system would be a breeze. The user interface of the algorithmis simply designed to provide the necessary elements to ensure the user's convenience while accessing the system.

4. RESULTS

Making the system under the MatLab development software proves very promising not only in mathematical calculations but also in its graphical user interface. Though MatLab can be incorporated in other programming languages by using MatLab's scripting capability, the said software also has its own sets of interfaces and GUI guides. Because of this capability, the interface was made using MatLab itself. There is also a directorytext field wherein the location of the images can be located in the left corner of the application and the retrieval algorithms and the like at the other corner of the application screen. A search button leads to the overall retrieval. In addition, are waiting for bars in full color for waiting options leading to the resultwindow together with the retrieved images according to various user specifications set before the retrieval phase.

The system can be easily implemented even by an inexperienced user. First, a specified directory was specified where the desired images, that is meeting the system image's specifications as presented in the methodology, were stored and kept. After the directory specification, the images were alphabetically listed in the textbox. The user can either view orselect the image by simply highlighting the desired image. Viewing the image by clicking the View Button leads to anotherMatLab window where the image can be seen, its file name, and other MatLab image functionalities. Once the desired query image was found, it can now be passed on to the database for content-based image retrieval by simply clicking the Select Button. Further specifications can be set such as the type of retrieval algorithm to be implemented, the maximum number of images to be outputted and its accuracy level. The retrieval algorithm only has three options from the supposedly four aimed options but shape retrieval was not implemented due to its difficulty and inaccuracy in retrieving images. For this system, the three retrieval algorithms were retrieval by color, retrieval by texture, and the combined features. One option can be chosen at a time by simply clicking the radio button of the desired algorithm. Then the maximum number of images was also specified ranging from one to at most ten images per query. However, the outputted images cannot necessarily meet the number of images desired for it will still depend on the query processing as well as the accuracy level specified. The last thing that was considered was the accuracy level from level one to level 5. This feature can either be used or unused. Since various images can have the same color and texture present in both their histogram and energy level these are not the mere basis for retrieving such. There were instances that even if they both have the same features it can be totally two different unrelated images. Thus the need for an accuracy level arises.

For this system, we presented five levels of precision. Level one is the lowest accuracy and level five is the most accurate point. This was based on the different matching values of the different image features. After these functionalities were specified, the Search Button can be pressed. A wait bar will appear wherein the feature extraction and matching algorithms take place behind the scenes. Status was also shown in order to have an overview of what's happening in the system. After an ample amount of time, the closest possible images that met the set specifications were outputted in one window. An image's grid can also be seen, with the image's file name and the image itself. This was sorted out from left to right, top to bottom according to the image's accuracy. These functionalities can also be accessed through the system's menu and one can also insert images in the database and retrieve these images too.

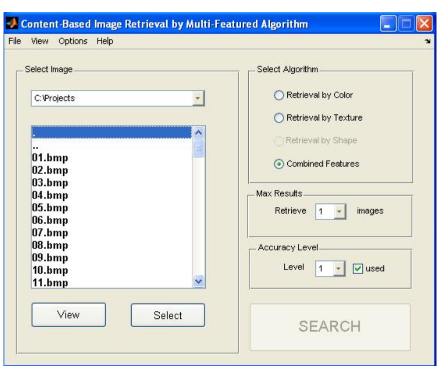


Figure 3: Application Screenshot

The image databases that were used in the project contain an array of 8-bit uncompressed bit maps BMPs that have been randomly selected from the World Wide Web. These images were stored under the same directory having a 256 by 256-pixel dimension and exactly 65.0kb in size. The following figure depicts a sample of images in the database:

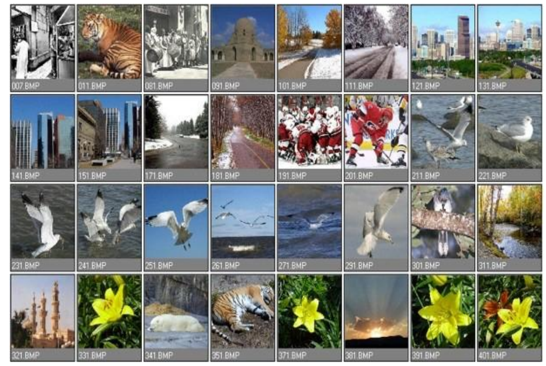


Figure 4: Image Database

A user can choose one image at a time to be inputted as the query. This image was then processed for immediate retrieval based on the other images directly found in the image database. After obtaining all the necessary terms, similarity matrix, color histogram differences, and energy levels, for a number of images in the databases, the results were implemented in the final equations, Quadratic Distance Metric, and Euclidean distances for color and texture retrieval algorithms respectively.

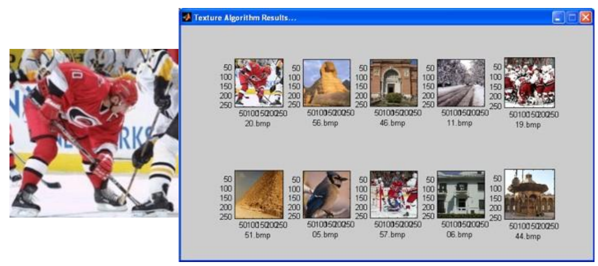


Figure 5: Inputted Image and Resulting Images

Based on the result, the Egyptian tombs and structure were put after the queried image thus instilling that in terms of texture, these were closely matched to our image. Though in the human sense, they have no relationship at all. While the other two hockey games, though outputted in the result window were far off the original. Much complexity lies in using shape as the basis for retrieval. Though the proponents used a number of shape detection algorithms such as edge detection, boundary-based detection, and the like, these algorithms cannot directly be implemented in the images. Much more the matching algorithm was quite complex to tackle and a number of inconsistencies were also found. For instance, the size of the shape can affect the whole results, even if they were of the same shape but the size of that shape can influence the output. Thus no matter how we resize some images in the database, still it doesn't show a more reliable set of results.

5. CONCLUSION

The dramatic rise in the size of images and the vast number of this kind of multimedia files has stirred the development of an effective and efficient retrieval system. In the past, retrieving images from a database would require one to use keywords and the like. A user must have predefined knowledge and information about the image to be searched and retrieved before passing it. But such textual connotations proved to be ineffective to users thus retrieval by image content was later introduced, and this came to be known as CBIR or Content-Based Image Retrieval System. This kind of application was based on an image's visual features like color, texture, and shape. In this research, we researched current CBIR algorithms and integrated these codes into a single mode of application. That is integrating different image features to have a combined feature retrievalalgorithm. However, we were only able to combine color and texture because of shape difficulties and lack of time. The resulting system was made from MatLab software and the image database lies in a unit's local directory. It performs a color-based search for an input query image using color histograms. It then compares these extracted features using Quadratic Distance Equation. For texture, we used the pyramid decomposition of energy levels and matched these using the Euclidean distance algorithm. These techniques were then integrated thus one can perform a query image with an output of the combined algorithms. However, ourimplementation is yet simple compared to the developing area of CBIR. This area proves to be very promising, especially in the future where we will be overwhelmed with different multimedia files. It is still in its infancy stage but such development of powerful processing power and cheaper system would definitely revolutionize the way of accessing multimedia files. Such development promises an immense range of future applications using CBIR.

6.REFERENCE

[1] Al-Tayeche R., Khalil A. (2003) *CBIR: Content Based Image Retrieval.*
Department of Systems and Computer Engineering, Carleton University

[2] Biederman, I (1987) *Recognition-by-components: a theory of human image understanding*. *Psychological Review* **94**(2), 115-147

[3] Carson C. S., et al (1997) *Region-based image querying*. Proceedings of IEEE Workshop on Content-Based Access ofImage and Video Libraries, San Juan, Puerto Rico, 42-49

[4] Eakins J., Graham M., (1999*) Content-Based Image Retrieval.* University of North Umbria at Newcastle [on-line]; http://www.jtap.ac.uk/

[5] Enser *P G B (1995) Pictorial information retrieval.* Journal of Documentation*, 51(2), 126-170 [on-line];* [downloaded]; July 2,2005

[6] Flickner, M et al *(1995) Query by image and video content: the QBICsystem.* IEEE Computer 28(9), 23-32

[7] Gudivada V. N., Raghavan V. V., (1995a) *Content-based image retrieval systems*. IEEE Computer 28(9), 18-22

[8] Hirata K., Kato T. (1992) *Query by visual example – content-based image retrieval*. in *EDBT'92, Third International Conference on Extending Database Technology*, 56-71

[9] Hsu W., Chua T. S., Pung H. K. (2000) *An Integrated Color-Spatial Approach to Content-based Image Retrieval.* Department of Information Systems and Computer Science

[10] Jain, R (1995) *World-Wide Maze.* IEEE Multimedia 2(3),3

[11] Jain A. K., Vailaya A. (1996) *Image retrieval using colorand shape*. Pattern Recognition 29(8), 1233-1244

[12] Kimia B. B., et al (1997) *A shock-based approach for indexing of image databases using shape*. in Multimedia Storage and Archiving Systems II (Kuo, C C J et al, eds), ProcSPIE 3229, 288-302

[13] Marchand-Maillet S. (2002) *Web-based evaluation of image retrieval systems.*

[14] McDonald S., Ting-Sheng L., Tait J. (2000) *Evaluating aContent Based Image Retrieval System*

[15] Mehrotra R., Gary J. E. (1995) *Similar-shape retrieval inshape data management*. IEEEComputer 28(9), 57-62

[16] Nastar C. *Content-Based Image Retieval: A State of the Art.*