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INTEGRATION OF SPATIAL INFORMATION WITH COLOR FOR CONTENT RETRIEVAL OF REMOTE SENSING IMAGES

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Abstract
There is rapid increase in image databases of remote sensing images due to image satellites with high resolution, commercial applications of remote sensing & high available bandwidth in last few years. The problem of content-based image retrieval (CBIR) of remotely sensed images presents a major challenge not only because of the surprisingly increasing volume of images acquired from a wide range of sensors but also because of the complexity of images themselves. In this paper, a software system for content-based retrieval of remote sensing images using RGB and HSV color spaces is presented. Further, we also compare our results with spatiogram based content retrieval which integrates spatial information along with color histogram. Experimental results show that the integration of spatial information in color improves the image analysis of remote sensing data. In general, retrievals in HSV color space showed better performance than in RGB color space.

Keywords:
Content Based Image Retrieval, RGB, HSV, Spatiograms

1. INTRODUCTION

Size of digital image databases and collections has enormously increased due to availability of wide variety of image acquisition devices such as digital cameras & digital scanners. The conventional method of image retrieval is searching for a keyword that would match the descriptive keyword assigned to the image by a human categorizer. Several methods exist today & many are under development for retrieval of images based on their content, called Content Based Image Retrieval, CBIR. CBIR systems are usually based on extraction of color, texture & shape features of different objects in an image. Such systems have shown results far more accurate than conventional image indexing systems [1, 2].

There is rapid increase in image databases of remote sensing images due to image satellites with high resolution, commercial applications of remote sensing & high available bandwidth. Satellite remote sensing is an evolving technology with the potential for contributing to studies of the human dimensions of global environmental change by making globally comprehensive evaluations of many human actions possible. Remotely sensed image data enable direct observation of the land surface at repetitive intervals and therefore allow mapping of the extent and monitoring of the changes in land cover. This information, combined with results of case studies or surveys, can provide helpful input to informed evaluations of interactions among the various driving forces. Thus remote sensing image (RSI) is one kind of important images in present image resources. RSI contents abundant details and its data size is very large. In this paper we present & compare three different approaches for content based image retrieval of remote sensing image using RGB, HSV color space & Spatiogram [3].

The latter of the paper is organized as follows: In section two we give a brief overview of RGB & HSV color space. In section three histogram and spatiogram along with their relationship is discussed. In section 4 & 5 we explain the methodology & results followed by conclusions in section 6.

2. COLOR SPACE

A color space is defined as a model for representing various color components of an image in terms of intensity values [4]. Typically, color space defines a one- to four-dimensional space. A color component, or a color channel, is one of the dimensions. A color dimensional space (i.e. one dimension per pixel) represents the gray-scale space. The following two models are commonly used in color image retrieval system [5,6]:

2.1 RGB COLOR SPACE

The RGB color model is composed of the primary colors Red, Green, and Blue. This system defines the color model that is used in most color CRT monitors and color raster graphics. They are considered the "additive primaries" since the colors are added together to produce the desired color.

2.2 HSV COLOR SPACE

The HSV stands for the Hue, Saturation, and Value based on the artists (Tint, Shade, and Tone). The Value represents intensity of a color, which is decoupled from the color information in the represented image. The hue and saturation components are intimately related to the way human eye perceives color resulting in image processing algorithms with physiological basis.

As hue varies from 0 to 1.0, the corresponding colors vary from red, through yellow, green, cyan, blue, and magenta, back to red, so that there are actually red values both at 0 and 1.0. As saturation varies from 0 to 1.0, the corresponding colors (hues) vary from unsaturated (shades of gray) to fully saturated (no white component). As value, or brightness, varies from 0 to 1.0, the corresponding colors become increasingly brighter.

3. OVERVIEW OF HISTOGRAM & SPATIOGRAM

3.1 HISTOGRAM

A digital image, in general, is a two dimensional mapping I: x → v from M × N pixels x = [i,j] T to values v. The histogram of an image can be found as

$$r_b = \sum_{i=1}^{M}\sum_{j=1}^{N} S_b(i,j), \qquad \forall b = 1, 2, \ldots, B \qquad (1)$$

where Sb(i, j) = 1 if the value v at pixel location [i, j] falls in bin b, and Sb(i, j) = 0 otherwise and B is number of bins in the histogram[7]. Histograms have proved themselves to be a powerful representation for image data in a region. Discarding all spatial information, they are the foundation of classic techniques such as histogram equalization and image indexing [8]. Color histograms are flexible constructs that can be built from images in various color spaces, whether RGB, rg chromaticity or any other color space of any dimension. The histogram provides a compact summarization of the distribution of data in an image. The color histogram of an image is relatively invariant with translation and rotation about the viewing axis, and varies only slowly with the angle of view [9]. By comparing histograms signatures of two images and matching the color content of one image with the other, the color histogram is particularly well suited for the problem of recognizing an object of unknown position and rotation within a scene. Importantly, translation of an RGB image into the illumination invariant rg-chromaticity space allows the histogram to operate well in varying light levels. Color Histograms are a commonly used as appearance-based signature to classify images for content-based image retrieval systems (CBIR) [10]. In remote sensing, color histograms are typical features used for classifying different ground regions from aerial or satellite photographs. In histograms the representation is dependent on the color of the object being analyzed while the shape and texture features of the object are completely ignored. Thus two different images with same color information may have identical histograms. Hence without spatial or shape information, color histogram simply may not be efficient for classifying two similar objects with different color information.

3.2 SPATIOGRAM

Birchfield and Rangarajan have extended the popular concept of histograms with spatial layout information, yielding spatiograms. Like histogram, spatiograms are approximations of attribute distributions. Unlike histograms, in spatiograms the spatial layout for each attribute bin is part of the model as well. A limited amount of information regarding the domain may be retained by obtaining higher order moments of binary function. A histogram is a zeroth-order spatiogram, while second-order spatiograms contain spatial means and covariance's for each histogram bin. This spatial information still allows quite general transformations, as in histogram, but captures richer description increase robustness in tracking. Promising results have been obtained with the tracking of local features in video [11]. We define the k_{th} order spatiogram to be tupe of all the moments up to order k. The second-order spatiogram of an image may be then represented by

$$h_I^{(2)}(b) = [n_b, \mu_b, \textstyle\sum_b] \qquad b=1, 2, \ldots, B \qquad (2)$$

where n_b is the number of pixels whose value is that of the b_{th} bin, μ_b and $\sum_b$ are the mean vector and covariance matrix respectively of the co-ordinates of those pixels and B is the number of bins in the spatiogram. It can be noted that

$$h_I^{(0)}(b) = [n_b] \qquad b=1, 2, \ldots, B \qquad (3)$$

is just histogram of I. From probabilistic point of view a spatiogram captures the probability density function (PDF) of the image values

$$P(I(x) = v) = p(x, v) = p(x/v)\, p(v) \qquad (4)$$

where p(x, v) and p(v) joint PDF and marginal PDF respectively. For zeroth – order spatiogram i.e. histogram, there is no spatial dependency hence p(x, v) = p (v).

4. METHODOLOGY

Experiments were conducted on database of 665 remote sense images. A proposed system is developed for image retrieval using MATLAB 7.1 version. Then the query image is taken and images similar to the query images are found on the basis of RGB, HSV & spatiogram similarity. The main tasks of the proposed system are:

4.1 RGB ANALYSIS

For RGB analysis a color histogram of an image is produced first by discretization of the colors in the image into a number of bins, and counting the number of image pixels in each bin. Color histogram of the Query image & stored image in the data base is obtained & compared using Bhattacharyya distance function. Fig.1. show color histogram of two different images from database. It can be observed that the histogram is different for these images.

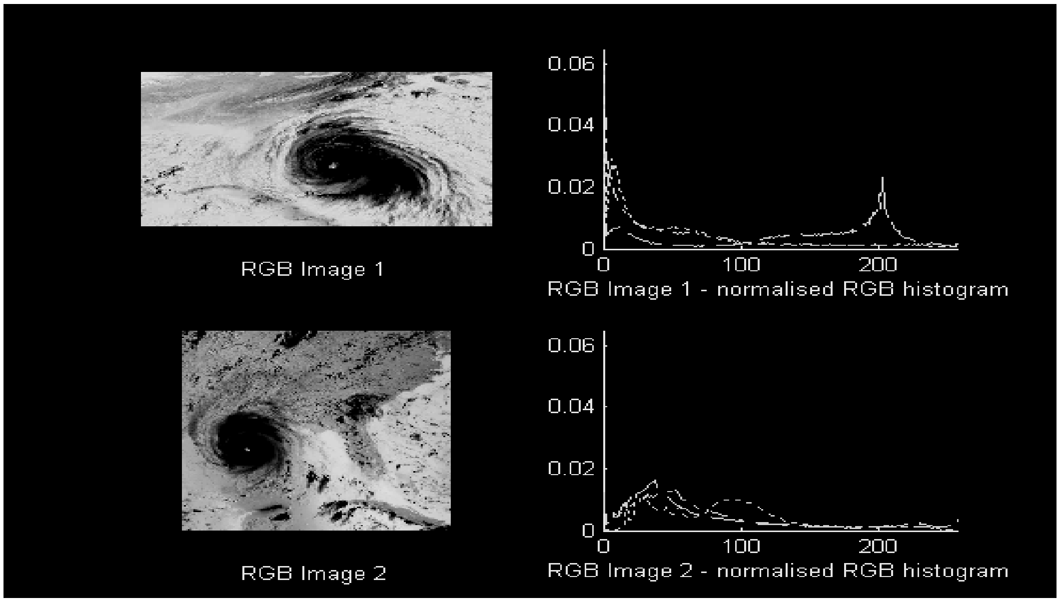

Fig.1. Normalized RGB histogram of two images from database

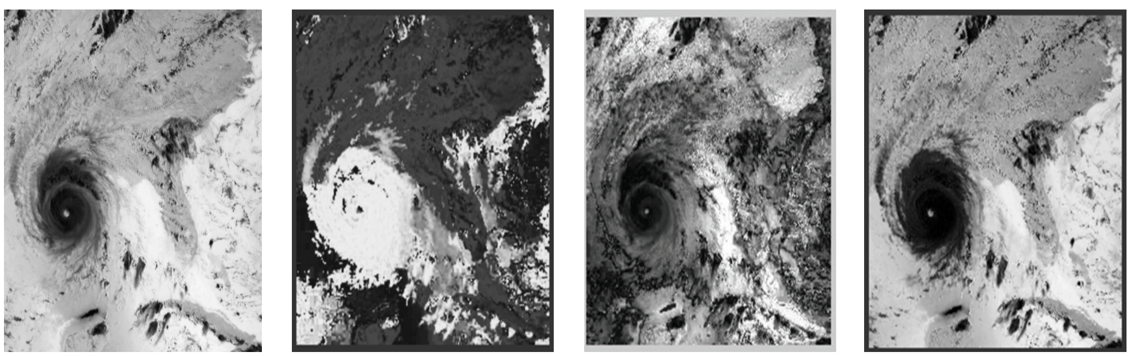

Fig.2. Original Image & its separated Hue, Saturation & Value Components

4.2 HSV ANALYSIS

For HSV analysis, the hue, saturation & value components of each image is first separated. Figure II shows HSV components of one image from database. The Hue, Saturation & value of Query image was then compared with each image using Euclidean distance function to determine images similar to Query image.

4.3 SPATIOGRAM ANALYSIS

Spatiogram of Query image is obtained & compared with that of each image in the data base using Bhattacharyya distance function. Figure III shows spatiogram of three images from the database. It can be observed that the spatiogram is different for these images.

5. RESULTS

Table 1 shows Bhattacharyya distance of RGB histogram of image 1 (Id- I1) with nine other images of the database. Table II, III & IV shows the result of HSV analysis. The dissimilarity between hue, saturation & value of image 1 with nine other images of the database is obtained using Euclidean distance & is tabulated in Table II, III & IV respectively. Table V shows Bhattacharyya distance between Spatiogram of image 1 with nine other images of the database. It can be observed from the table that all the three approaches i.e. analysis of RGB color space, HSV color space as well as spatiogram is efficient for retrieval of remote sensing images. However spatiogram is more effective than color histogram as in former similarity of two different images are obtained to be much less.

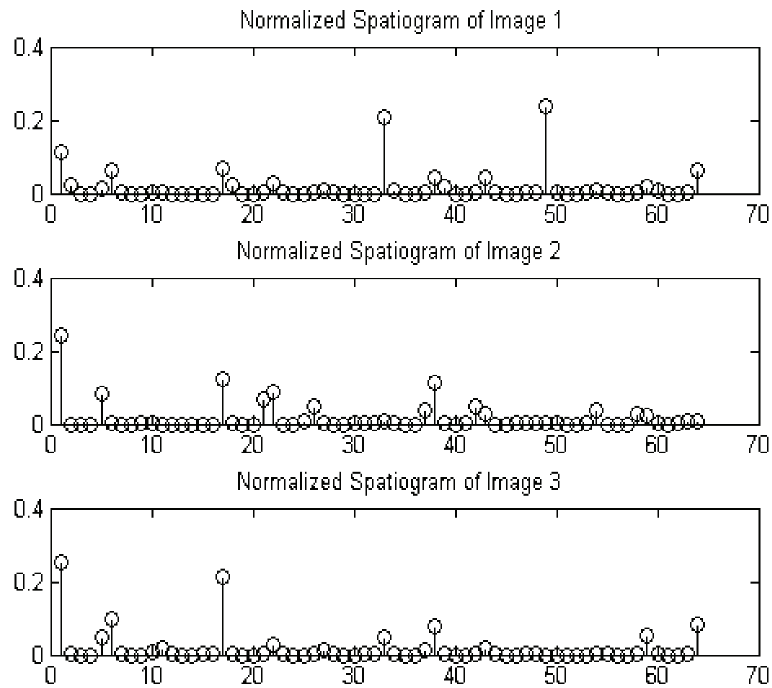

Fig.3. Spatiogram of three different images from the database

Table.1. Bhattacharyya distance between normalized color histogram (between 0 &1) of one image with nine other images of database

Image Id	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Bhattacharyya Distance	0	0.398	0.378	0.344	0.383	0.337	0.426	0.590	0.393	0.374

Table.2. Euclidean distance between Hue components of one image with nine other images of the database

Image Id	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Euclidean Distance	0	21.343	20.892	30.337	25.384	25.100	32.023	29.643	19.515	19.609

Table.3. Euclidean distance between Saturation components of one image with nine other images of the database

Image Id	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Euclidean Distance	0	10.928	6.738	18.043	13.396	7.423	6.760	20.267	5.711	7.703

Table.4. Euclidean distance between Value components of One image with nine other images of the database

Image Id	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Euclidean Distance	0	8.500	8.595	13.417	11.695	6.881	8.319	12.438	7.8845	8.842

Table.5. Bhattacharyya distance between normalized Spatiogram (between 0 &1) of one image with nine other images of database

Image Id	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
Bhattacharyya Distance	0	0.913	0.903	0.772	0.777	0.831	0.897	0.910	0.868	0.951

6. CONCLUSIONS

In this paper, three methods were investigated which includes two different color spaces, RGB and HSV & Spatiogram. Histogram search characterizes an image by its color distribution, or histogram but the drawback of a global histogram representation is that information about object location, shape, and texture is discarded. Content retrievals in HSV color space showed better performance than in RGB color space. Further we examined the concept that extends the familiar histogram in a natural way by capturing a limited amount of spatial information between the pixels contributing to the histogram bins i.e Spatiogram for content retrieval of remote sensing images. This spatiogram, as we call it, is a generalization of a histogram to higher-order moments and is more efficient for content based retrieval of remote sensing images. For future work, it is possible to include other features such as shape and texture to improve the overall image retrieval performance.

REFERENCES

[1] Shapiro, L. G., and Stockman, G. C., 2001. Computer Vision, Prentice Hall.

[2] Al-Tayeche, R., & Khalil, A., 2003. Available at www.sce.carleton.ca/faculty/cuhadar/CBIR/files/finalreport.doc.

[3] B. Kr. Singh, G.R. Sinha & I. Khan, 2010, "Comparison of histogram & spatiogram for content based retrieval of remote sensing images," in proc. BAIP 2010, CCIS 70, pp.152–156.

[4] Wang, J. Z., 2001, "Integrated Region-Based Image Retrieval": Boston, Kluwer Academic Publishers.

[5] Sangoh, J., 2001, "Project Report on line: Histogram Based Color Image Retrieval". Available at sojeong@stanford.edu.

[6] Muhammad Riaz, Kim Pankoo and Park Jongan, 2009, "Extracting Color Using Adaptive Segmentation for Image Retrieval", in proc. International Joint Conference on Computational Sciences and Optimization CSO, Vol. 1, pp.925-929.

[7] Shapiro, L. G., and Stockman, G. C., 2003. Computer Vision, Prentice Hall.

[8] M. Stricker & M. Swain, 1994, "The Capacity of Color Histogram Indexing," Computer Vision and Pattern Recognition, Proceedings CVPR IEEE Computer Society Conference on pp. 704 – 708.

[9] Ulges, A., Lampert, C., Keysers, D., Spatiogram-Based Shot Distances for Video Retrieval Online. Available at http://www.dfki.de/iupr.

[10] Djouadi, A., Snorrason, O., & Garber, F, 2009, "The quality of Training-Sample estimates of the Bhattacharyya Coefficient". IEEE Transactions on Pattern Analysis and Machine Intelligence , pp. 92-97.

[11] Venteres, C. C., & Cooper, Dr. Matthew.: "A Review of Content-Based Image Retrieval Systems". Online available at, http://www.jtap.ac.uk/reports/htm/jtap-054.html.