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Multispectral Satellite Image Retrieval Using The Combination of Features Color, Shape and Texture*

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Abstract

The satellite images are the valuable source of information in any of the areas in today's era. These images are growing tremendously due to the increased number and resolution of the Earth imaging sensors and image acquisition technique. Due to this the image storage and retrieval of images are becoming a problem nowadays. Images are retrieved using the traditional retrieval system i.e. Text based image retrieval (TBIR), but it is inefficient. Content Based Image Retrieval (CBIR) technique is used to retrieve the images on the basis of visual content such as color, shapes and textures. In this paper a new system is designed which will allow the users to retrieve the images on the basis of the features such as shape, color and texture and the hybrid approach. The multispectral high resolution images are taken for the study. The similarity of the query image and archived image is calculated by the Euclidean distance. The accuracy of the results is calculated based on the Precision.

Keywords: TBIR, CBIR, Feature Extraction, Euclidean Distance.

1. Introduction

Image retrieval is concerned with techniques for storing and retrieving images both efficiently and effectively. Work on image retrieval started from 1970 [11].Content Based Image Retrieval (CBIR) iretrieves the images on the basis of visual content such as color, shapes and textures [1].With the help of single content let's say color we would not be able to get the optimized result because of the similarity of the color of different objects. For this along with the color, the texture or shape or both should be combined to retrieve similar result. Color, textures, shapes are still low level feature and they should be used along with the high level features like text annotation for the optimized results [9].By extracting the, descriptors, histograms, colors, shapes, textures, etc., the content of the image is analyzed. The performance or the accuracy of the retrieved images can be calculated by some of the methods available such as by the Precision and recall or by Length of String to Recover All Relevant Images i.e. LSRR [3, 4]. The problem faced with the low level feature extraction was the semantic gap. This was due to the difference between the low level features connected with the high level user semantics. It was difficult to convert the user need for the image in a complete manner to a Content Based Image Retrieval (CBIR). Due to this problem, images retrieved would not be more effective and efficient. Through extensive research, CBIR came into existence in 1992 and since then many systems are developed for Content Based Image Retrieval for uses in commercial fields. The

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author of the paper has retrieved the satellite images on the basis of the region, using the Motif Co-occurrence Matrix (MCM) in conjunction with spatial relationships [5]. Maheshwary et al., have used the 3 LISS III + multi-spectral satellite images with 23.5m resolution. With the features like color and texture the four semantic categories such as mountain, vegetation, water bodies, and residential area, were used for the retrieval of the similar images from the database [6]. Ning et al., developed a web based application through which the user can find the images by the query being raised. The domain-dependent concept for the image retrieval was used [7]. In another research paper, Mamatha et al., used the color feature similarity measure for the image retrieval. A low resolution satellite image of the rural area had been taken for the experiment [8].

2. Objective

Objective of the paper is to extract the content specific satellite images and its different features such as water body, agriculture, forest and settlement on the basis of color, texture and shape. On the basis of the similarity measures the images is compared and extracted.

3. Feature Extraction:

3.1) Color Feature [1,2]

3.1.1) Conventional Color Histogram

In this method the rate by which every single color in any of the image has occured is shown by the conventional color histogram (CCH).In the probabilistic point of view it is concerned with the probability mass function (PMF) of the image intensities. The image intensities are combined of the color channels as in RGB colorspace the R,G,B and in the HSV colorspace the H, S and V and similarity value for other colorspaces. CCH is expressed as below:

h_{ABC}(a, b, c) = N. Prob (A=a, B=b, C=c) (1)

Where the parameter A, B and C represents the three color channels, and N shows the number of pixels in the image[1]. In the computing aspect it can be created in the quantized colorspace by counting the number of pixels of each color [2]. It has some difficulties associated with it than too it is used because of its simplicity and ease of computation. The difficulty it that for different bins it is not able to account for similarity in color.

3.1.2) Fuzzy Color Histogram

In this method, every pixel color has realtion to all histogram bins, with different degrees of memberships to every bin. The Fuzzy Color Histogram for the image I is given by: F (I) = [f_1, f_2,….. ,f_K] for a given color space where [1]:

$$fi = \sum_{j=1}^{N} \mu_{ij} P_i = \frac{1}{N} \sum_{j=1}^{N} \mu_{ij} \quad (2)$$

Where N reperests the countable value of pixels in an image, and μ_{ij} represents membership value of the j^{th} pixel in the i^{th} color bin[1]. The FCH is advantageous because it finds the similarity value of each pixel color to that of the histogram bins from a fuzzy-set membership function. With the advantages the FCH has some disadvantage also that it has the higher dimensionality than the CCH and it has a problem of computing the appropriate fuzzy membership function μ_{ij} and same as CCH it delineates the global properties of the image.

3.1.3) Color Correlogram

The color Correlogram (CC) shows the changes occurs in the spatial correlation of pairs of colors with correspondence to the distance. "The Color Correlogram for an image is calculated on the basis of table indexed value by color pairs, in which the d^{th} entry for row (i,j) specifies the probability of finding a pixel of color j at a distance d from a pixel of color i in the image" [1]. As we know that the global correlation between different colors in an image is less significant than the local correlation in a image, the value of d which could be small is adequate to capture the spatail correlations. The benefit of using CC method is that it works well with coarse color images and it encodes the local along with the global spatial information. Huang et al. have shown that it does not work well with the higher dimensionality of the feature space.

3.1.4) Color-Shape Based Method

This concept deals with the "color, area and perimeter-intercepted" lengths of the segmented objects in an image. The process works with the concept of K-means algorithm in which the pixels are clustered into K clusters. "For each cluster, mean value is treated as a representative color measure for every cluster. From the original image I the quantized color image I' is obtained by quantizing pixel colors in the original image into K colors" [1]. A pixel of similar color in a connected region is regarded as an object. Through the 'perimeter-intercepted lengths' (PILs), the shape of the object is characterized. The method can encodes the colors along with the shape of the object. The disadvantage is that it is impressionable to contrast and noise variation. More computation is required and for the quantization of the colors the need arises to determine the appropriate color threshold.

3.2) Texture Feature [3, 12]

As of the color feature, the texture feature is also an important property of an image. The texture provides us the visual pattern and the information on the structural arrangement of surface and object on the image. It has the property of homogeneity. The visual pattern is defined in terms of regularity, resemblance, directionality and uniformity.

3.2.1) Statistical Feature

The general parameter is calculated from pixel intensity values in the frequently used statistical feature. The parameters are calculated based on the co-occurrence matrix. Texture histogram build upon Tanura feature and it consists of a six visual feature such as roughness, disparity, directionality, regularity, line resemblance, unevenness.

3.2.2) Spectral Method

In this method the Fourier Transformation is used on the original image to obtain there corresponding representation in frequency space because this approach deals with the images in the frequency domain. The direction of the texture and its periodicity can be revealed by the 2-D power spectrum of an image. the coarser texture image have a tendency towards low frequency components in its power spectrum, while finer texture would have higher frequency for instance.

3.2.3) Gabor Filters [5]

Gabor filters transform is a good multi resolution approach which represents the texture of an image. It is an effective way using multiple orientations and scales. The Gabor function in 2-D can be specified by the frequency of the sinusoid *W* and the standard deviation σx and σy, of the Gaussian envelope as:

$$g(x,y) = \frac{1}{\sigma_x \sigma_y}\exp[-\frac{1}{2}(\frac{x^2}{\sigma_x^2} + \frac{y^2}{\sigma_y^2}) + 2\pi j W_x] \quad (3)$$

3.2.4) Wavelet-Based Texture Description

The wavelet based descriptor is used in the region based image retrieval so that it can cope up with the cases in which user want to retrieve the images based on the information of their regions. It is being categorized as: a moving window, a hierarchical block, and a pixel. Using wavelet coefficients of all regions, the texture features are calculated, since this method has some limitation. In the case of wavelet analysis the decomposition is performed on the signals in terms of a special basis. The basis wavelet functions are constructed from one mother wavelet function obtained by performing translation and scaling operations. Approach and homogeneous decomposition, accuracy of such results was greater than 90%. This wavelet transform is known as pyramidal wavelet transforms (PWT).But the disadvantage is that the frequency bands attained are in the logarithmic relation. However, the problem can be overcome by using the tree-structured wavelet transform (TWT). In which wavelet transform is extended to wavelet package. This method is suggested in 1992 by Coifman and Wickerhauser**.** [5]

3.3) Shape Feature [4, 10]

Shape refers to the boundary or the shape of the region in the image not the shape of the image.
Shape could be determined by applying the shape filter or by segmenting and edge detection. Representation of the shape has been categroised into two forms i.e. 'Boundary Based' and the 'Region Based'. In the boundary based only the outer boundary of the shape is used i.e. the pixel along the object boundary. But in the region based the internal characteristic has been described because it covers the entire shape region. In preprocessing the method used for edge detection are:-

i**) Canny Edge Detection Algorithm** –It has been termed as an best edge detection technique because it supports the good detection which implies that the algorithm used to mark as many as possible real edges in the image. It supports the good localization and the minimal response which means that the marked edges should match to the edges in the real images and the noise in the image should not create the false edges respectively. A given edge in the image should be marked only once.

ii) Sobel Edge Detection Algorithm-The measurement on the image has been done by 2-D spatial gradient given as:

$$H=\sqrt{h_x^2 + h_y^2} \quad (4)$$

The Sobel Edge Detector uses two convolution kernels: one is used to detect the changes in vertical contrast (*hx*) and another one to detect horizontal contrast (*hy*).

4. Results and Discussion

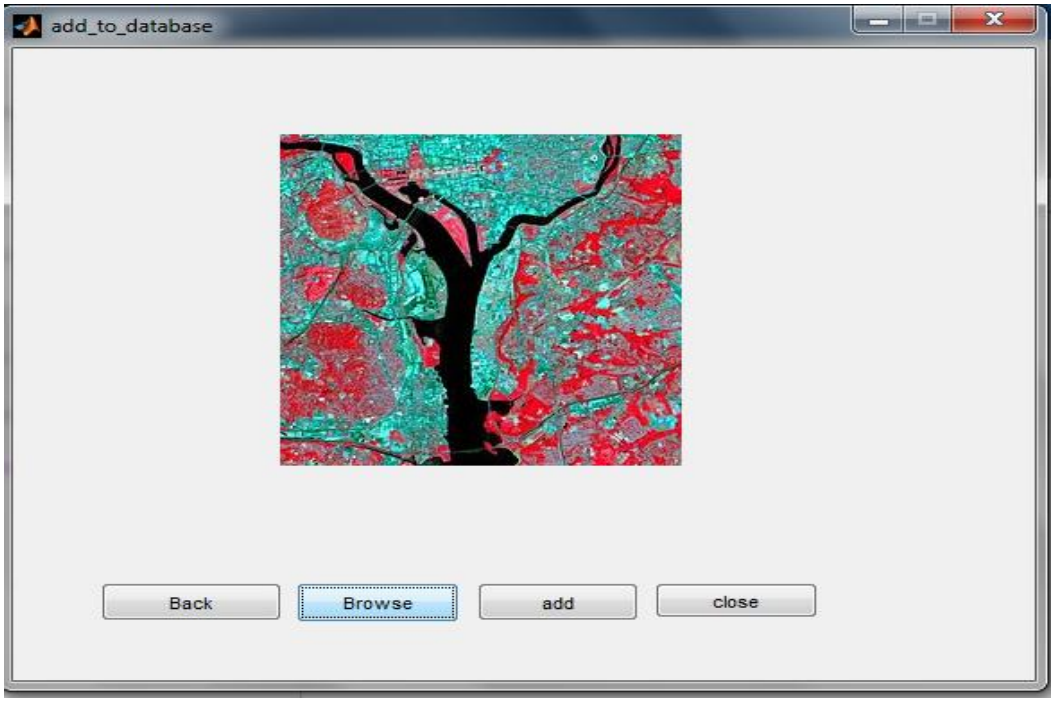

Fig.1 The Query image browsed for the matching

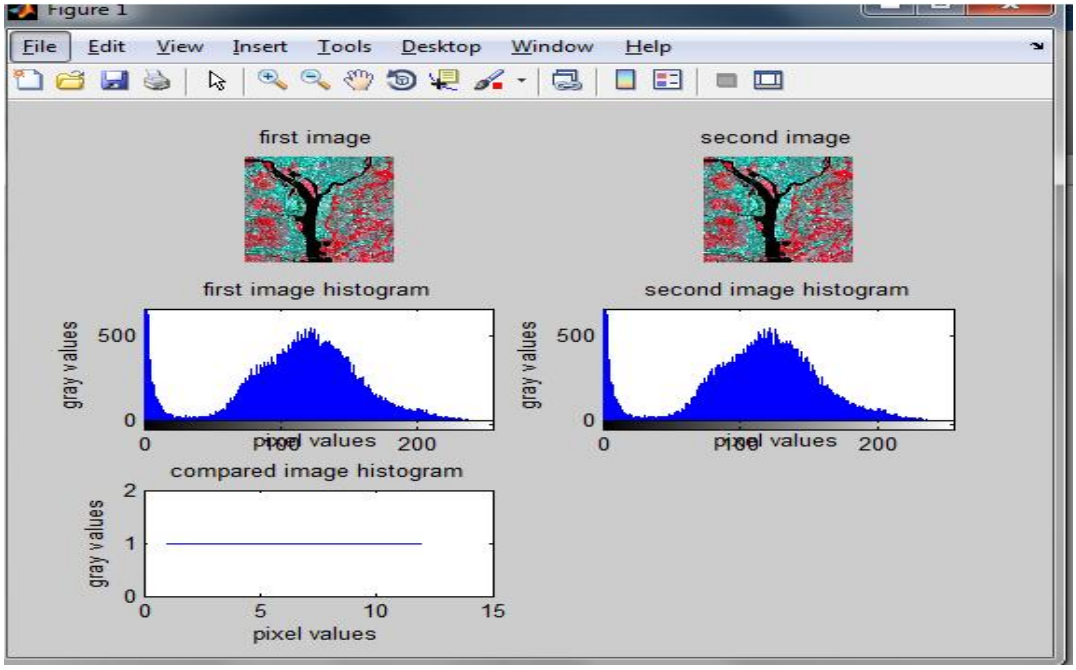

Fig.2 Similar images with the histogram of the images

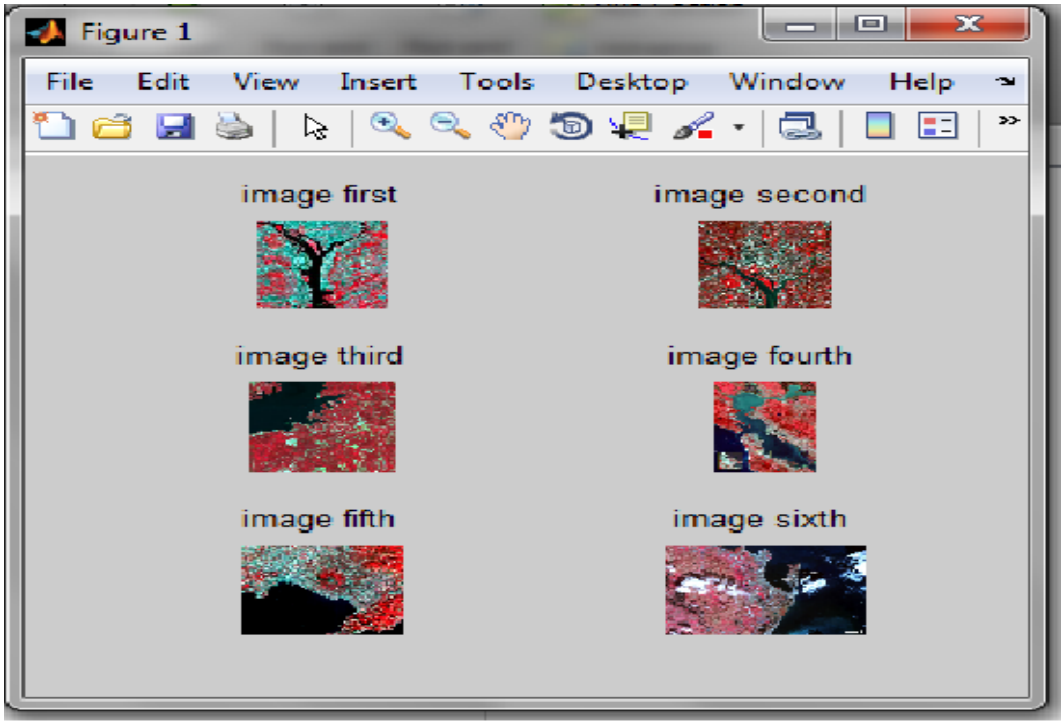

Fig.3 Similarity results

5. Conclusions

The study shows similar images obtained on the basis of the color feature extraction techniques and similarity extraction technique. The CBIR technique provides the accurate result, based on the query image.

6. Future Work

The satellite images stored in the databases would be retrieved on the basis of different feature extraction technique. The obtained results would be more accurate and precise. The experiment would be performed on the large database.

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