Feature Extraction of Soil Images for Retrieval based on Statistics

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ABSTRACT
In image processing, Statistical, geometrical and signal processing features are used to describe the texture of an image region. The signal processing methods involve enhancing original image using filters and calculating the features of the transformed images. In this paper, Law mask, Gabor Filter and color quantization are applied to the original images to extract the texture features of soil images for retrieval. Results on a database of 200 soil images belonging to 10 different types of Soils with different orientations, scales and translations show that proposed method performs retrieval efficiency effectively.

Keywords
Soil texture, Law mask features, Gabor Filter, Color Quantization

1. INTRODUCTION
The content-based image retrieval (CBIR) system is used in many fields to browse and search huge image databases. Agriculture or Ground Water identification purpose people are usually brought to use large collections of soil images. They need an automatic soil identification system to assist them in their work. This paper presents a soil retrieval system which takes input image as a Soil images taken from Tirunelveli region, TamilNadu (shown in fig 1.) and pictured by Coolpix Camera. It gives the most similar images from the database. The problem involves identification of the matching soil, as well as retrieval of related varieties in a database.

Fig.1 red soil, clay soil, river soil, sea soil, alluvial soil, black soil, silt soil, silt-black, alluvial-sea, alluvial-river, alluvial-red, alluvial-clay, clay-alluvial, river-red, clay-sea, alluvial river red, alluvial-red-river, alluvial-silt-clay soil.

1.1. Soil Texture
Soils are recognized by its characteristics, such as physical appearance (e.g., color, texture, landscape position), and assist in vegetation [1]. A vernacular distinction is used in classifying texture as heavy or light. Light Soils have better structure and easy for cultivation [1]. Soil texture is an important soil characteristic that drives crop production and field management. The textural class of a Soil is determined by the percentage of Sand, Silt and Clay [1]. Soils can be classified as one of four major textural classes: (1) Sands; (2) Silts; (3) Loams; and (4) Clays. A clay soil is referred to as a fine-textured soil whereas a sandy soil is a coarse textured soil [2]. Soil texture determines the rate at which water drains through a saturated soil; water moves more freely through sandy soils than it does through clayey soils. Once field capacity is reached, Soil texture also influences how much water is available to the plant; clay soils have a greater water holding capacity than sandy soils [2].

2. METHODOLOGY AND MATERIAL
The retrieval methodology is categorized into 4 steps. 1. Apply any transformation on the original image 2. Use some statistical measurement to analyze the features like color, texture and shape on both original image and transformed image.3. Find the difference with the help of Euclidean formula and sort it. 4. Find the accuracy from which we can determine the number of retrieval from the database search. In this paper, three methods have been tested. Fig 1 shown above is resized into 128x128 and used as test image collected from Tirunelveli region. The multimodal images are used as training image shown in fig 2.

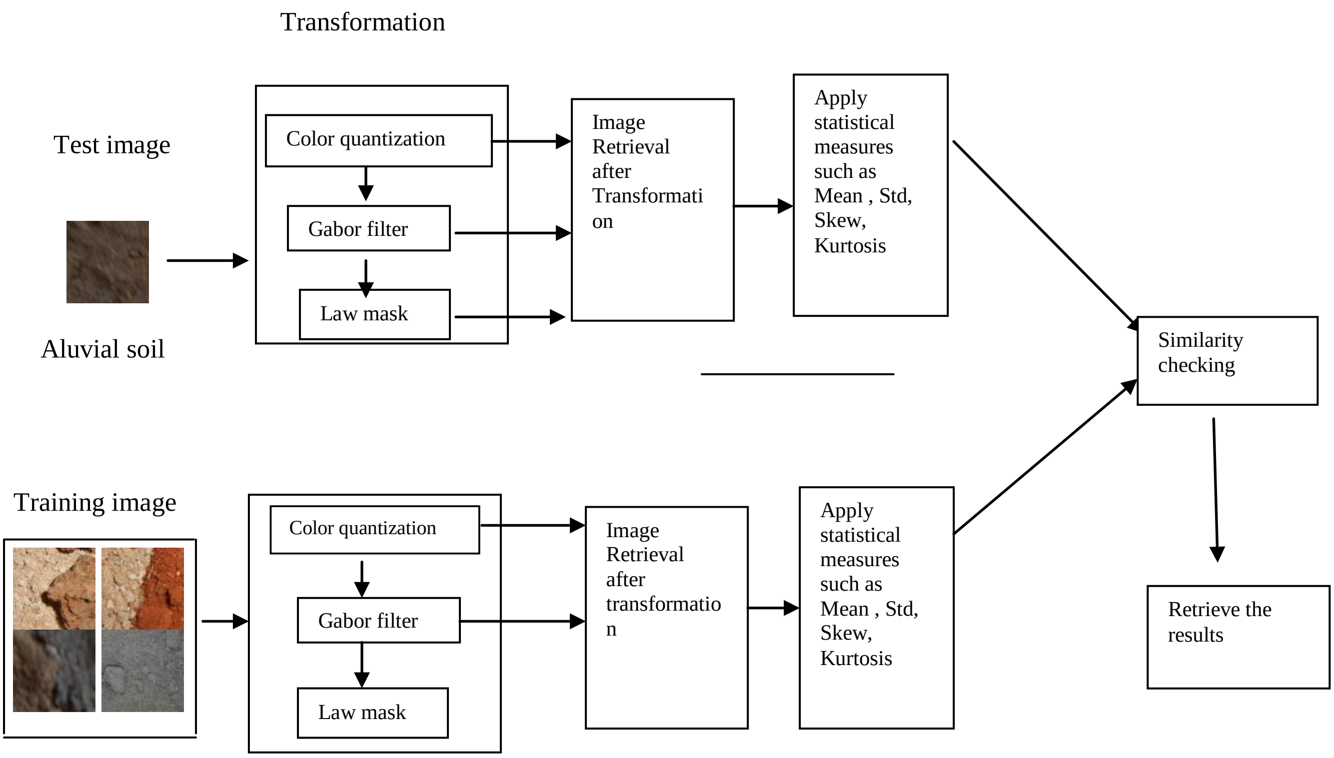

Fig 2. Block Diagram

The followings are the Statistical parameter applied to the image (after transformation) of above three methods and find the retrieval results

1. Mean $\mu = \frac{\Sigma N \text{ neighboring pixels}}{N}$
2. STD $\sigma = \sqrt{\frac{\Sigma N(\text{neighboring pixels})^2}{N}}$
3. Skew $v_1 = \frac{\mu_3}{\mu_2 \sqrt{(\mu_2)}}$

   Where $\mu_i = E(X - \mu_i)^2$
4. Kurtosis $v_2 = \frac{\mu_4}{\mu_2^{\,2}} - 3$

The query image is transformed into an image using Gabor filter, Law mask (S5S5) filter and color quantization method. From the resultant image find the Mean, Standard deviation, Skew and Kurtosis. Find the average. Then, compare the results with the training image of same by using Euclidean formula. Retrieve the similar images which are very closer to the test image.

2.1 Laws' Mask Texture Analysis

"Laws' Mask can produce the texture energy measurement for the analysis of the texture property of each pixel [7]. The two 2-d convolution kernels, generated from different combinations of the 5 masks such as L5 =[1 4 6 4 1], E5 = [1 −2 0 2 1], S5 = [−1 0 2 0 −1], W5 =[−1 2 0 −2 1], R5 =[1 −4 6 −4 1] are applied onto the converted gray scale image. The image I (i, j) is assumed to have a size of M rows and N columns. After the filtration, say by a 2D mask S5S5, the image is recognized as a texture image T1 and will have an image dimension of M+1 X N+1. The texture image is described in Equation (1)

$$T1_{S5S5} = I_{i,j} \times (S5S5) \quad \text{-------------------(1)}$$

Laws [6] identified the following properties to describe texture: uniformity, density, coarseness, roughness, regularity, linearity, directionality, direction, frequency, and phase. Laws texture energy measures determine texture properties by assessing average Gray Level, Edges, Spots, Ripples and Waves in texture".

2.2 Color quantization

"Color quantization reduces the number of colors used in an image; this is important for displaying images on devices that support a limited number of colors and for efficiently compressing certain kinds of images [9]. Color quantization can be viewed as a subset of the field of vector quantization. Stated simply vector quantization is the problem of selecting K vectors in some N dimensional space to represent N vectors from that space where K<<N and the total error incurred by the quantization is minimized. The process of color image quantization is often broken into four phases [10].

1. Sampling the original image for color statistics.
2. Choosing a color map based on those statistics.
3. Mapping the colors to their representative in the color map.

4. Quantizing and drawing the new image.

In general algorithms for color quantization can be broken into two categories: Uniform and Non-Uniform.

1 Uniform: Here the color space is broken into equal sized regions where the number of regions, N_R is less than or equal to K.

2. Non-Uniform: Here the manner in which the color space is divided is dependent on the distribution of colors in the Image "[9-10]

2.3 Gabor functions and Wavelets

"A 2D Gabor function g(x, y) and its Fourier transform G (u, v) can be written as

$$g(x,y)=\frac{1}{2\Pi\sigma_x\sigma_y}\exp\left[\frac{-1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)+2\Pi jw_x\right] \quad (2)$$

$$G(u,v)=\exp\left[\frac{-1}{2}\left(\frac{(u-w)^2}{\sigma_u^2}+\frac{v^2}{\sigma_v^2}\right)\right] \quad (3)$$

Where $\sigma_u=\frac{1}{2\Pi\sigma_x}$ $\sigma_v=\frac{1}{2\Pi\sigma_y}$

then this self-similar. Gabor filters can be obtained by appropriate dilations and rotations of g(x, y) through the filter generating function given below

$$g_{m,n}(x, y) = a\, G(x', y')$$

$$x' = a^{-m}(x\cos\theta+y\sin\theta)\quad y' = a^{-m}(-x\sin\theta+y\cos\theta) \quad (4)$$

Where $\theta = \frac{n\Pi}{k}$ and k is the total number of orientations. The scale factor is meant to ensure that the energy is Independent of m" [7-8].

3. EXPERIMENTAL RESULTS

The features of Query image and the training images are extracted using the color quantization; Gabor filter and Law mask S5S5. Then, the Query image of the soil is matched with the training images in database. Based on the matching of Query image and training image the soil with highest matching ratio is given as output. Mat lab R2008A is used for Simulation purpose. The database images that are considered for the simulation of the proposed work is shown in Fig.4. The dataset which consists of more than hundred soil images such as alluvial soil, Clay soil, Black soil, red soil, river soil, sea soil.

The chart shows the number of retrieval of matched soil images from the database. Fig 5 described that the number of soil retrieved is 111 for the measured value 2.0 using Gabor filter. Fig 6 described that the number of soil retrieved is 37 for the measured value 2.0 using Law mask of S5S5. Fig 7 and fig 8 shows the Retrieval Efficiency before and after color quantization. From the above analysis, the proposed method using Gabor filter is an efficient method to retrieve more number of similar images. Table 1 shows the proposed method using Gabor filter. It is an efficient method to retrieve more number of similar images.

The fig 3 shows the filtered image of clay and alluvial soil. The first row images are clay soil, color quantized clay soil, Law mask filtered image and Gabor filtered image. Second row shows the same of alluvial soil.

Fig 3 a) original image of clay soil b) color quantized c) S5S5 law mask filter d) Gabor filter e) original image law masks of alluvial soil f) color quantized alluvial soil g) S5S5 h) Gabor filter alluvial soil

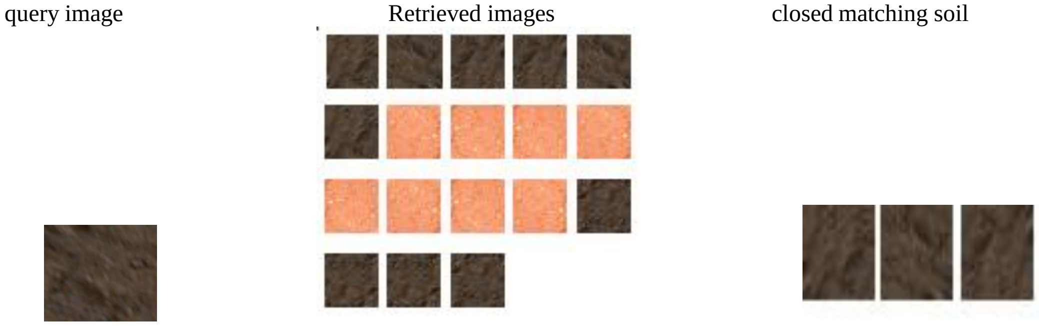

Fig.4 The image in the left side is the original query. The center column is the retrieved images. The rightmost columns give the final best match.(a) Alluvial soil rotated left 180° b) Alluvial soil rotated right 180° c) Alluvial soil rotated left 90 °

4. PERFORMANCE ANALYSIS

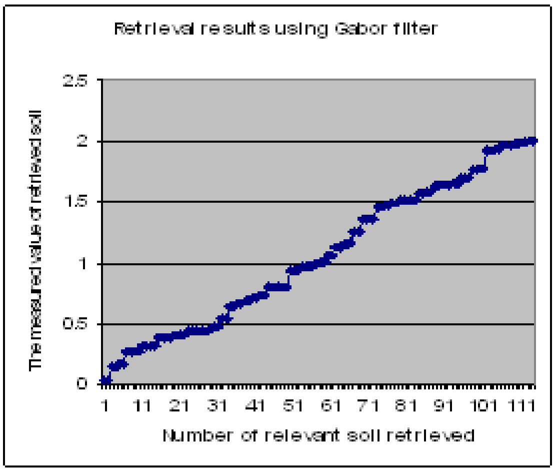

Fig 5. Retrieval after Gabor filter

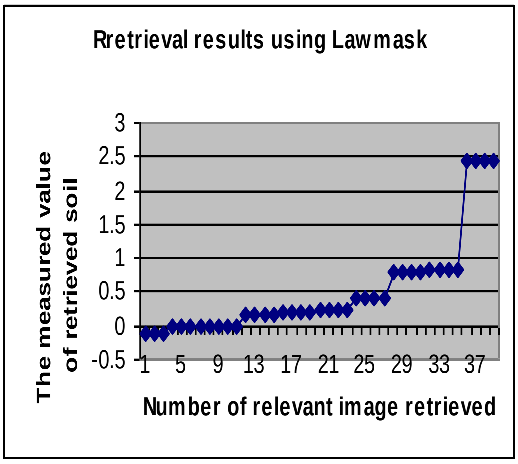

Fig 6. Retrieval using Law mask

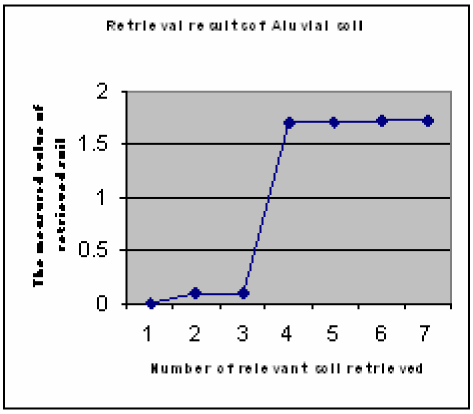

Fig 7. Retrieval after color quantization

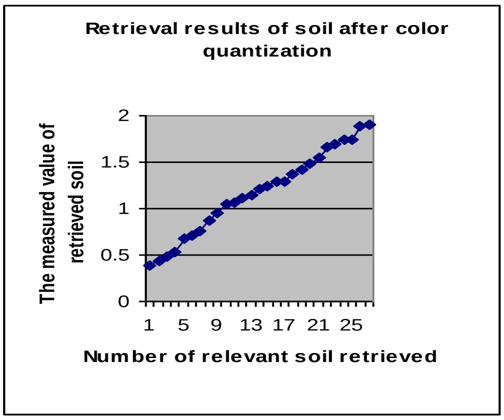

Fig 8 retrieval before color quantization

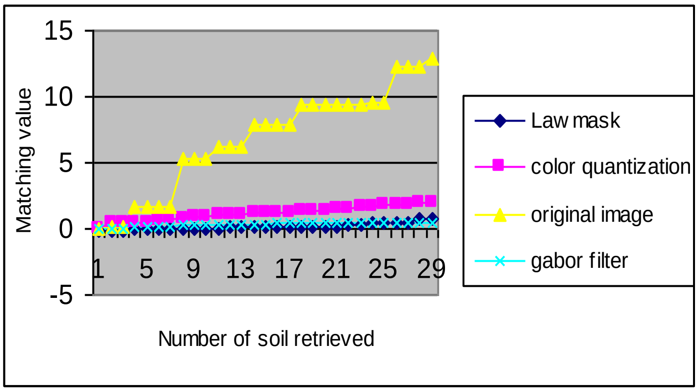

Fig 9 Over all Performance

Table 1. Performance Analysis of the proposed Method

Test Image	Final Matches Using Gabor	Final Matches Using Law mask	Final Matches using color quantization	Final Matches using before color quantization
Alluvial	111	37	25	7
Silt soil	139	34	11	3
Clay soil	172	28	7	3
Red soil	136	48	22	15
Sea soil	160	72	8	3
River Soil	175	48	21	13

5. CONCLUSION

A texture and color based soil retrieval system has been proposed to identify the needed soil from the database. The proposed algorithm uses the efficient feature extraction methods like color quantization for color based feature extraction and Texture based feature extraction is done by applying Gabor filter and Law mask (S5S5). Then the matching is achieved by applying statistical measurements like Mean, standard deviation, skew, kurtosis. The performance of the proposed method using Gabor filter is proved to be more efficient. Combining different color and texture features extracted from the images enhance the accuracy of the system. For the soil recognition the segmented soil image is taken as an input for simulation using Mat lab R2008a.

6. REFERENCES

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