RESEARCH ARTICLE

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AUTOMATED DIAGNOSTIC SYSTEM FOR THE HUMAN SKIN TEXTURE USING DIGITAL IMAGE PROCESSING

KU.ANITA N. MALI[1], Dr. .S.Y.AMDANI[2],Prof.AMOL DUDHE[3]

[1]ME Student,[2,3]Faculty

Department of CSE, BNCOE, Pusad

ABSTRACT

Skin texture analysis is one of the challenging issues in the field of medical diagnosis. Various types of skin diseases are affecting human life like skin dryness, fungus, and allergic symptoms. The objective of this paper is to analyze the skin disease using texture analysis of skin image and by comparing the test image to a defined images or reference images.In the existing scenario, the skin images are analyzed in frequency domain. However, it is observed that the skin color in texture images does not vary over a wide range. Hence, the histogram profile of the skin texture remains almost flat. In the proposed work, we have shifted the skin texture analysis towards the gray level profile analysis. In the proposed thesis work, Gray Level Co-occurrence Matrix of the skin image is computed. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. Further, the image entropy and energies are also computed in order to correlate the skin symptoms to the skin texture images.

Keywords: GLCM, Gray Level Co-occurrence Matrix

1. INTRODUCTION

Texture analysis is one of the fundamental aspects of human vision by which we discriminate between surfaces and objects. In the digitalimage-processing field, computer vision techniques can take advantage of the cues provided by surface texture to distinguish and recognize skin. Texture refers to visual patterns or spatial arrangement of pixels that regional intensity or color alone cannot sufficiently describe. Researchers have proposed numerous methodologies to automatically analyze and recognize textures, from deriving texture energy measures. In recent years, computer vision methodologies have been applied to the health informatics and telemedicine fields to help automatically diagnose diseases. [4] The huge collection of medical images generated every day all over the world has helped fuel interest in automated health diagnosis.

According to dermatologist, the skin texture has close relation with the individual's diet, hormones, hydration and any allergic symptoms. Therefore, by analyzing the skin texture by acquiring the skin texture image by exposing the human skin to imaging devices, the skin's health may be defined. Texture analysis in image processing is an important tool in analyzing

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the image of textural nature.The deterioration is also accompanied by a darkening of skin color for an over absorption of the natural coloring pigment, melanin, by the top most cell layer in skin. The skin texture also depends on its body location.[2]In the case of image processing, we have to consider the fact that texture appearance is changing with image recording parameters, that are camera, illumination and direction of view, a problem common to any real surface. The task to have a quantitative evaluation of the skin features is quite complex, as in all the cases where image analysis must be applied to surfaces with irregular nonperiodic patterns.[5]

In the digital image processing, several methods have been developed to classify images and define statistical distances among them, with the aim to decide whether, in a set of many images, there exist some which are close to any arbitrary image previously encountered. The texture discrimination can be obtained by choosing a set of attributes, the texture features, which account for the spatial organization of the image.

2. Related Works

A practical skin color and texture analysis/synthesis technique is introduced for this E-cosmetic function. Shading on the face is removed by a simple color vector analysis in the optical density domain as an inverse lighting technique. The image without shading is analyzed by a previously introduced technique that extracts hemoglobin and melanin components by independent component analysis. The comparison shows an excellent match between the synthesized and actual images of changes due to tanning and alcohol consumption. We also proposed a technique to synthesize the change of texture in pigment due to aging or the application of cosmetics.[1]

1. IMAGE TYPES
There are three type of image, which is described below.

1.1 Binary image

Logical array containing only 0s and 1s, interpreted as black and white,
respectively.

1.2 Grayscale image
It is also known as an intensity, gray scale, or gray level image. Array of class uint8, uint16, int16, single, or double whose pixel values specify intensity values. For single or double arrays, values range from [0, 1]. For uint8, values range from [0,255]. For uint16, values range from [0, 65535]. For int16, values range from [-32768, 32767].

1.3True color image
It is also known as an RGB image.true color image is an image in which each pixel is specified by three values one each for the red, blue, and green components of the pixel scalar. M by-n-by-3 array of class uint8, uint16, single, or double whose pixel values specify intensity values. For single or double arrays, values range from [0, 1]. For uint8, values range from [0, 255]. For uint16, values range from [0, 65535].

The skin color image is decomposed to the four texture components by multi-resolution analysis using wavelet transform. A variety of skin images with different conditions of skin color and texture are created in a linear combination of the texture components. Experimental results show good separation of skin textures by wavelet analysis and realistic synthesized images. [3]

Texture refers to visual patterns or spatial arrangement of pixels that regional intensity or color alone cannot sufficiently describe. Researchers have proposed numerous methodologies to automatically analyze and recognize textures, from deriving texture energy measures using a set of simple masks to using Gabor filters, for several image analysis applications, including texture classification and segmentation. [5] To be adaptive to the dynamic illumination and chrominance, face detection is used to customize the skin color model to each image. The proposed method has achieved promising performance over our dataset, which is a challenging set with a great part of hard images. Our True Positive Rate is 81.2% under False

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Positive Rate 8.2%, which out performs all eight state-of the- art algorithms. [6]

The filtering method introduced here is applied to dermoscopic skin image in a non-linear manner and allows selective image filtering. This feature is highly desirable due to the fact that in most cases of computer aided diagnostic, input images need to be pre-processed (e.g. for brightness normalization, histogram equalization, contrast enhancement, color normalization) and this can results in unwanted artifacts or simply may require human verification. Introduced method was developed specially to recognize one of the differential structures (pigmented network texture) used for calculating the Total Dermoscopy Score (TDS) of the ABCD rule. [7]

A method is proposed that tracks the skin's recovery optically from an initial strain made using a mechanical indentor, diffuse side-lighting and a CCD video-capture device. Using the blue color plane of the image it is possible to examine the surface topography only, and track the decay of the imprint over time. Two algorithms are discussed for the extraction of information on the skin's displacement and are analyzed in terms of reliability and reproducibility. [8]

Anil Kumar Mittra et. al. This paper proposes an automated system for recognizing disease conditions of human skin in context to health informatics. The disease conditions are recognized by analyzing skin texture images using a set of normalized symmetrical Grey Level Cooccurrence Matrices (GLCM). GLCM defines the probability of grey level I occurring in the neighborhood of another grey level j at a distance d in direction θ. The system is tested using 180 images pertaining to three dermatological skin conditions viz. Dermatitis, Eczema, Urticaria. An accuracy of 96.6% is obtained using a multilayer perceptron (MLP) as a classifier. [8]

The geometric, random field, fractal, and signal processing models of texture are presented. The major classes of texture processing problems such as segmentation, classification, and shape from texture are discussed. The possible application areas of texture such as automated inspection, document processing, and remote sensing are summarized. A bibliography is provided at the end for further reading. [1].

The relation between the nonlinear results by Monte Carlo simulation (MCS) and the modified Lambert Beer's law (MLB) is also clarified, emphasizing the importance of the absolute values of skin pigments and their influence on the mean path-length used in MLB. Images of oxygenated hemoglobin with a newly-developed four wavelength camera are presented to demonstrate the advantages of a multi wavelength system. [1]

3. Methodology

A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix.

The thesis work is divided into following stages:

- Image Acquisition
- Conversion to Gray Scale Image
- Image Enhancement using Histogram Equalization
- Histogram Computation of the enhanced image
- Computation of GLCM Matrix of skin texture image
- Computation of Contrast
- Computation of Entropy
- Computation of Energy
- Computation of Homogeneity
- Correlation with Skin Symptoms

4. Image Acquisition and Preprocessing

Preprocessing Skin images are acquired using the UV camera in order to get the deep skin images. The acquired image is in jpeg format and is read in matlab using the command imread().
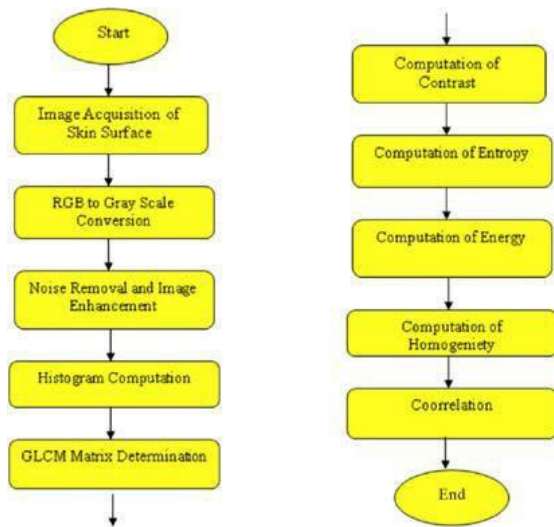
Fig 1.flow chart of GLCM

The image is now converted to gray image using rgb2gray() function. The gray image is enhanced using the histogram equalization algorithm. Following figure show the result of image preprocessing operations:
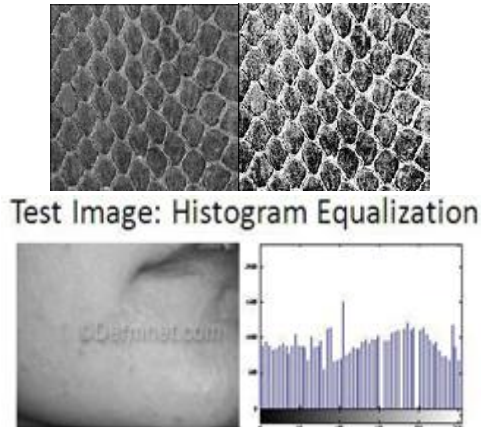
Original Image   HistograEqualized Image

Fig 2. Histogram equalization

5. GLCM Extraction

A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. The number of gray levels in the image determines the size of the GLCM. The gray-level co-occurrence matrix can reveal certain properties about the spatial distribution of the gray levels in the texture image. For example, if most of the entries in the GLCM are concentrated along the diagonal, the texture is coarse with respect to the specified offset.

To create a GLCM, use the graycomatrix function. The graycomatrix function creates a gray-level co-occurrence matrix (GLCM) by calculating how often a pixel with the intensity (gray-level) value i occurs in a specific spatial relationship to a pixel with the value j. By default, the spatial relationship is defined as the pixel of interest and the pixel to its immediate right (horizontally adjacent[7].

After you create the GLCMs, image contrast, energy, coorelation and homogeneity can be computed as:

Contrast - Measures the local variations in the graylevel co-occurrence matrix. Contrast is 0 for a constant image.

Correlation - Measures the joint probability occurrence of the specified pixel pairs. Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is NaN for a constant image.

Energy -Provides the sum of squared elements in the GLCM. Also known as uniformity or the angular second moment.

Homogeneity - Measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is 1 for a diagonal GLCM

The Gray-Level Co-occurrence Matrix (GLCM) considers the relationship between two neighboring pixels, the first pixel is known as a reference and the second is known as a neighbor pixel [8]. The GLCM is a square matrix with Ng dimension, where Ng equals the number of gray levels in the image. Each element of the matrix is the numbers of occurrence of the pair of pixel with value i and a pixels with value j. A co-occurrence matrix is a two dimensional array in which both rows and columns represent a set of possible image values. For example consider the 4 by 5 matrix of an image I

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Table 1.Image Matrix

1	1	5	6	8
2	3	5	7	1
4	5	7	1	2
8	5	1	2	5

Equivalent GLCM matrix for the above image I is

Table 2. GLCM Image Matrix

Element (1, 1) in the GLCM contains the value 1

1	2	0	0	1	0	0	0
0	0	1	0	1	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	1	0	0	0
1	0	0	0	0	1	2	0
0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0

because there is only one instance in the image where two, horizontally adjacent pixels have the values 1 and 1. Element (1, 2) in the GLCM contains the value 2 because there are two instances in the image where two, horizontally adjacent pixels have the values 1 and 2. Gray co matrix continues this processing to fill in all the values in the GLCM.

6. Computation of Entropy

The expression of the information entropy of an image is given by:

$$H = -\sum_{i=0}^{L-1} p_i \ln p_i,$$

Where L denotes the number of gray level, pi equals the ratio between the number of pixels whose gray value equals i(0 i L _ 1) and the total pixel number contained in an image. The information entropy measures the richness of information in an image. If pi is the const for an arbitrary gray level, it can be proved that the entropy will reach its maximum.

7. Results

For texture characterization, we consider a set of features derived from GLCM matrix: contrast (C), homogeneity (H), mean (M), energy (N), and variance (V). Images are obtained from Dermnet Skin disease atlas. Dermnet is the largest independent photo dermatology source. Dermnet provides information on a wide variety of skin conditions.

The proposed algorithm produce a skin map of a given image and highlights patches of skin like pixels. The function reads an image file given using Matlab command imread. A skin map overlayed onto the image with skin pixels marked in blue color is generated by using the GLCM matrix. Following figures shows the output of the algorithm. Once the skin pixels are extracted,, than it is easier to analyze the skin diseases.
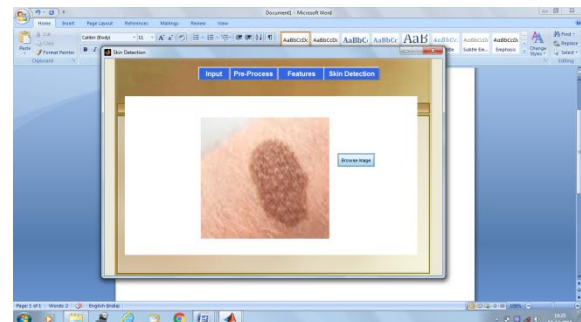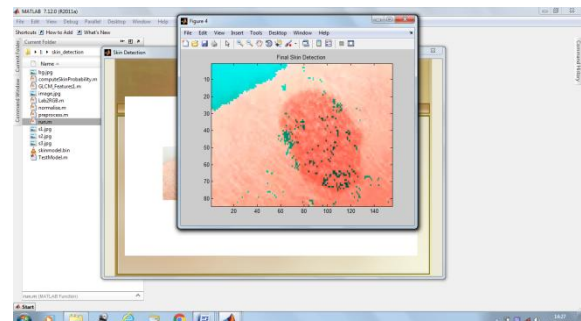

Fig 3.original image of skin texture

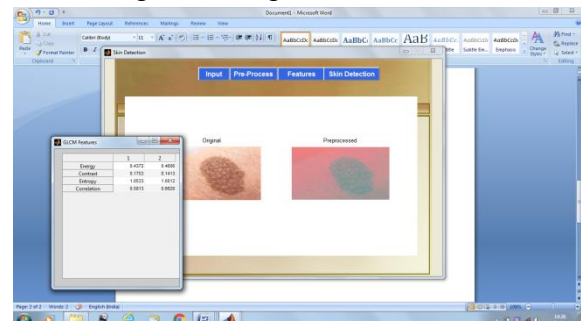Fig 4.final image of skin texture

Fig 5. Feture of skin texture

8. Conclusion

The main focus of this paper is on analyzing the texture of skin thereby using it to diagnose the skin diseases. Various skin diseases can be

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analyzed based on the combination of feature vector set of contrast, correlation, energy and homogeneity. From the experimental results discussed above, we infer that the multi-class classification can serve as an effective tool in identifying skin diseases. The future work will be based on developing algorithms to identify various other skin diseases, to improve the overall efficiency and also to further reduce the computational time.

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