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Nail Color and Texture Analysis for Disease Detection

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Abstract

In this paper we are elaborating the concept of disease detection in the human body using the nail image of human fingers and analyzing the data from the image on the basis of nail color and texture. Fingernail has to be detected from the entire hand region using distribution density of the nail color pixels on the surface of nail. The methodology for creating a finger nail detection system involves removing the skin area from shiny/glossy nail portion; this is known as image segmentation concept that separates the specific object. Image segmentation is the method of dividing the image pixels into homogenous region.

Keywords: *Color Analysis, Image Segmentation, Texture Analysis*

1. Introduction

Medical science has progressed in innumerable ways and has developed various methods for diagnosis of diseases in human body and one of the ways to identify disease is through nails of the human palm. There are various testing techniques for diagnosis of disease which are followed by medical practitioners using pathological tests as basis .Mostly these test involves taking blood samples which are quite painful and require the presence of the patient. The proposed system that is being developed is focused on image recognition based on color and texture analysis. In the field of healthcare, study of human nail has its own significance. Many diseases can be diagnosed by scrutinizing nails of the hand. As human eyes have limitation to scrutinize texture and distinction in color. This proposed system has algorithm which will automatically extract nail area and scrutinize this nail part for disease detection based on texture and color of nail. The pathological tests are cumbersome to perform as their results can vary and these tests can take more than 24 hours by the examiner to establish name of the disease. Even it requires patient to be present for test, but our proposed system requires only the image of patient's hand that can be obtained easily and it is not cumbersome to perform [7].

To examine the nail the following steps have to be followed:

1. Image of the nail must be taken.
2. Extract the area to be examined.
3. Examine the nail texture.
4. Examine the nail color.
5. Compare the nail with the pre-defined range.
6. Note the condition of the nail.
7. Reach on a conclusion and specify the diagnosed disease.

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Figure 1. General Texture and Color Analysis

2. Need for the System

Following reasons can be considered for requirement of the system:

1. Computer can easily classify more than 16 million colors; whereas human eye capability has limitations while identifying colors and also some people face the problem such as color-blindness. So performing nail color analysis through computer is a superior technique as compared with human eye [5].

2. Human eyes have limited resolution, finding deviations in nearby pixel intensity are not possible for human eye, but computer vision can detect every pixel meticulously.

3. Pathological test are complex and painful, patient must be available for pathological test, while analysis performed by the system is tranquil.

This system would be helpful for the patient, as patient need not to be present in person or if the doctor is not available for consultation purpose therefore just by receiving patient's nail image the doctor can diagnose the symptoms and write appropriate prescription for the disease that is being diagnosed.

3. Literature Survey

Nail texture and color analysis:Disease symptoms

- Beau nail indicates: Myocardial infarction, Hypotension, shock, Hypocalcaemia, severe infection. (Figure 2:a)[10]
- Nails pitting indicates: Psoriasis, Alopecia areata, Eczema and Lichen planus. (Figure 2:b)[10]
- White nail indicates : Anemia, Chemotherapy, Renal failure, Cirrhosis, Diabetes mellitus, Hereditary (rare)(Figure 2:c).[10]
- Red nail indicates: Polycythemia (dark), Systemic lupus erythematosus, Carbon monoxide (cherry red), Angioma, Malnutrition (Figure 2: d) [10].
- Yellow nail indicates: Diabetes mellitus, Amyloidosis, Median/ulnar nerve injury, Thermal injury, Jaundice (Figure 2:e)[10].
- Green or Black indicates: Chronic*Pseudomonas* spp infection,Topical preparations, including chlorophyll derivations, methyl green, & silver-nitrate(among others), Trauma (Figure 2: f) [10].

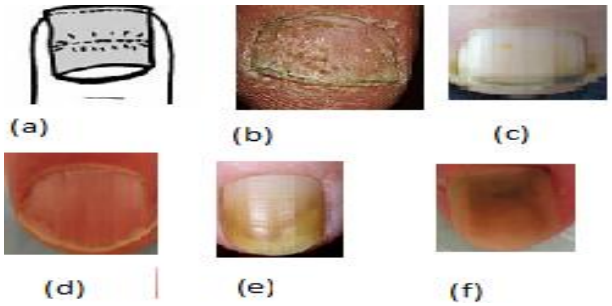


Figure 2. Images of Nails

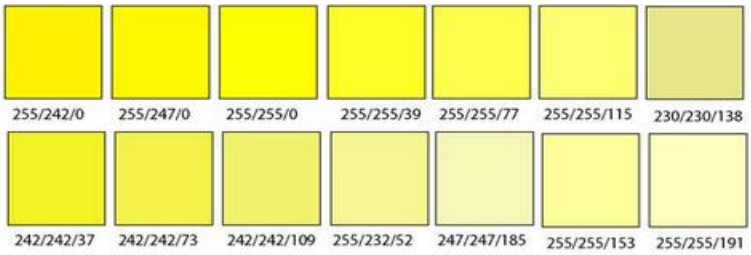


Figure 3. Samples of Yellow Color Palette [8]

A. Image Segmentation

Image segmentation process is used for scrutinizing the image in image analysis. Image segmentation is the process of segregating the Digital Image into different parts, each part consisting homogeneous pixels and distinguishing the object or other information in Digital Image [3, 9].

B. Texture Analysis

Texture analysis refers to the characterization/classification of regions in an image by their texture content. Texture analysis attempts to quantify intuitive qualities described by terms such as rough, smooth, silky, or bumpy as a function of the spatial variation in pixel intensities.

C. RGB Color Model

RGB color model is an color model in which the three primary colors *i.e.*, red, green, blue are mixed with each other to produce an Array of colors. The name of the model (RGB) is based on the initials of the three primary colors red, green, and blue. The main motive of the RGB model is representation of images in electronic equipments, such as televisions and computers, it has also been used in traditional photography. Earlier the electronic age, there is strong theory behind RGB color model,which is based on human perception of colors. As RGB model is device dependent the RGB values are differently produced and represented by different devices, since the color elements (such as phosphors or dyes) and their response to the individual R, G, and B levels may be different for different manufacturer, or vary even in the same device over time. Therefore RGB color value does not gives the exactly same color until there is some kind of color management. RGB input devices are color TV, image scanners, video cameras, digital cameras and video games. Typical RGB output devices are TV sets of various technologies (such as CRT, LCD, plasmaetc.), computer and mobile phone displays, video projectors, multicolor LED displays, and large screens such as JumboTron. On the other hand,Color printers are not RGB devices, but subtractive color devices (typically CMYK color model) [5].

D. Grayscale Image

Grayscale is a range of monochromatic shades from black to white. Therefore, a grayscale image contains only shades of gray and no color. While digital images can be saved as grayscale (or black and white) images, even color images contain grayscale information. This is because each pixel has a luminance value, regardless of its color. Luminance can also be described as brightness or intensity, which can be measured on a scale from black (zero intensity) to white (full intensity). Most image file formats support a minimum of 8-bit grayscale, which provides 2^8 or 256 levels of luminance per pixel. Some formats support 16-bit grayscale, which provides 2^16 or 65,536 levels of luminance [5].

E. Binary Image

A binary image are also called bi-level/two level it means that every pixel has 2 possible values for each pixel (0 or 1).Typically black and white these 2 colors are used for binary image. [1] the foreground color indicates the object and background color indicates the rest of the image.In this concept monochrome or monochromatic generally used for this concept but it may also include the images that have one sample per pixel. In Photoshop, a binary image is the same as an image in "Bitmap" mode. In digital image processing binary image is the result of certain operations like Dithering, Image segmentation and thresholding.Some input/output devices, such as laser printers, fax machines, and bi-level computer displays, can only handle bi-level images [6].

F. Indexed Image

An indexed image is a image consists a data matrix, X, and a color map matrix, map. The map is an m-by-3 array of class double containing floating-point values in the range [0, 1]. In map each row indicates the red, green and blue component of each color. In indexed image there is "direct mapping" of pixel values to color map values. By mapping the color of each pixel is determined by using the corresponding value of X as an index. since Values of X must be integers. The value 1 indicates first row in map, the value 2 indicates the second row, and so on [6].

G. MATLAB Image Formats

The Proposed system will only cater to file formats such as BMP, GIF, JPEG, PNG & TIFF. Other formats will not be considered and for the same a logical code will be written to eliminate all other formats.

Format Name	Description	Recognized Extensions
BMP†	Windows Bitmap	.bmp
CUR	Windows Cursor Resources	.cur
FITS†	Flexible Image Transport System	.fts, .fits
GIF	Graphics Interchange Format	.gif
HDF	Hierarchical Data Format	.hdf
ICO†	Windows Icon Resources	.ico
JPEG	Joint Photographic Experts Group	.jpg, .jpeg
JPEG 2000†	Joint Photographic Experts Group	.jp2, .jpf, .jpx, j2c, j2k
PBM	Portable Bitmap	.pbm
PGM	Portable Graymap	.pgm
PNG	Portable Network Graphics	.png
PNM	Portable Any Map	.pnm
RAS	Sun Raster	.ras
TIFF	Tagged Image File Format	.tif, .tiff
XWD	X Window Dump	.xwd

4. Proposed Methodology

A set of methods or principles or rules for regulating the process is called Methodology.

The Proposed Model has four major steps:

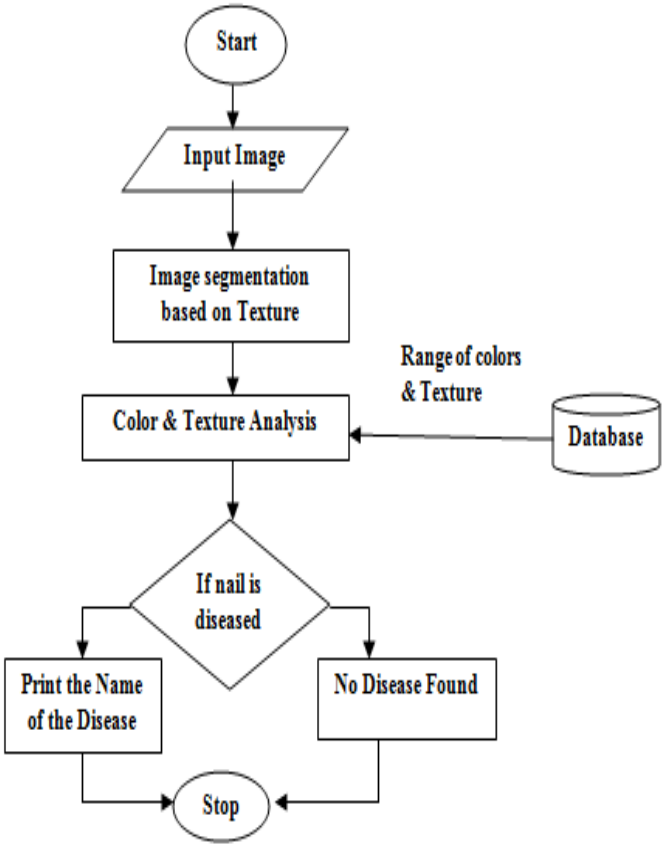
- Input to the model: Scanning the image containing fingers, back side of palm region in appropriate brightness.
- Extraction of the cropped Nail region from the entire Palm: Applying segmentation method on the image to extract the nails region from the entire image.
- Analysis of the Nail region, Color and Texture: The segmented nail image is now being processed on the basis of color and texture and we will determine the health of the nail by comparing the segmented image with the dataset present.
- Disease Prediction using Knowledge base: The result will be generated on the basis of analysis and the disease would be predicted if present.

Process	Method Name	Description
Image Segmentation	imsegfmm(W, seedpointC, seedpointR, thresh)	BW=imsegfmm(W,C,R,thresh returns a segmented image, with seed locations specified by the vectors C) and R, which contain column and row indices. C and R must contain values which are valid pixel indices in W.
Return Pixel values	Impixel(I)	Impixel(I) returns the value of pixels in the specified image I, where I can be a grayscale, binary, or RGB image. impixel displays the image specified and waits for you to select the pixels in the image using the mouse. If you omit the input arguments, impixel operates on the image in the current axes.
Region of Interest	roicolor	Select region of interest (ROI) based on color.
Create mask within Image	createMask(h) *parameter : **getColor — Get color used to draw ROI object.*** *color = getColor(h)*	**Returns** a mask, or binary image, that is the same size as the input image with 1s inside the ROI object h and 0s everywhere else. The input image must be contained within the same axes as the ROI. **Gets** the color used to draw the ROI object h. The three-element vector color specifies an RGB triplet.
Texture Analysis	BW2 = bwareaopen(BW, P) IM2 = imclose(IM,NHOOD) BW2 = imfill(BW,'holes') BW2 = bwperim(BW1)	**Removes** from a binary image all connected components (objects) that have fewer than P pixels, producing another binary image, BW2. This operation is known as an area opening. The default connectivity is 8 for two dimensions, 26 for three dimensions, and conndef(ndims(BW), 'maximal') for higher dimensions. **Performs** closing with the structuring element strel(NHOOD), where NHOOD is an array of 0's and 1's that specifies the structuring element neighborhood. **Fills** holes in the binary image BW. A hole is a set of background pixels that cannot be reached by filling in the background from the edge of the image. **Returns** a binary image containing only the perimeter pixels of objects in the input image BW1. A pixel is part of the perimeter if it is nonzero and it is connected to at least one zero-valued pixel. The default connectivity is 4 for two dimensions, 6 for three dimensions, and conndef(ndims(BW), 'minimal') for higher dimensions.
Specific Problem: For Nail Pitting.	bwpropfilt(BW,attrib,range)	BW2=bwpropfilt(BW,attrib,range) extracts all connected components (objects) from a binary image BW that meet the criteria specified by attrib and range. attrib is a text string that identifies a particular property of the objects, such as their area. range is a 2-by-1 vector that specifies the range of values (low and high) of the property. bwpropfilt returns a binary imageBW2 containing only those objects that meet the criteria.

Algorithm Pseudo code for the Proposed System

1. Input the hand image of the patient.
2. Perform Texture based segmentation which results in bifurcation of the Nail region from the entire Hand.
3. Segmentation the result by marking boundary.
4. Perform Color Analysis by comparing range values of the color stored in the database.
5. Texture identification and extracting features within the nail.
6. If color_of_nail= "Yellow"
   then "Diseased Nail"
   Else If color_of_nail= "Brown"||"Purple"
   then "Trauma Nail"
   Else "Healthy Nail"
   End.
7. If texture_of_nail= "Pitted"
   then "Nail Pitting Found"
   Else If texture_of_nail= "Beau"
   then "Nail is a Beau Nail"
   End.
8. Print the result in proper format.

Flow Chart



5. Pre-Conditions /Assumptions for the Dataset

Assumption(s)	Description
1.Distal Edge	Distal edge (free edges) of nails can affect the result of analysis, the color and texture of the nail part which is attached with the skin can give the symptoms of disease, therefore the nail's image is to be given as an input must be trimmed.
2.Nail Biting	The case of oral compulsive habit of nail biting will not be taken under consideration, these images can not be used for the data present as they can produce erroneous results. Pitted nail and bitted nail cannot be differentiated properly even by human eye. therefore the proposed system will not cater to this problem.
3. Nail Polish	Polished nail/dyed nail (using some kind of Ink generally the case of voting) will not be considered for the analysis, so before performing the analysis the nail must be cleaned properly such that nail must be translucent in appearance.
4. Hands Only	We will not consider the image of toe-nail for analysis purpose because toe-nail is not exposed to air so its color is not too natural when compared with finger-nail; also toe-nail is harder in comparison to the finger nail, so it is easier to detect the disease if present in human body through finger nail.
5.Illumination	The illumination in room must be proper or focus of the light on the nail must be adequate before taking an image.
6.Weather Conditions	The nail image must be taken in normal room temperature as color of nail can be affected in extreme cold temperature.

6. Future Work

Fingernails can be used for the purpose of personal identification and verification through biometrics system in the form of transient biometrics system [4].

Biometrics system generally concentrates on the constant attributes (like Iris/retina, fingerprint, face-recognition) but it may result in misuse; whereas using transient attribute such as finger-nail which usually have a lifetime of approximately two months can prove to be more beneficial as the misuse will be insignificant after stipulated period of time [1]. Certified Forensics Computer Examiner (CFCE) analyze the digitized data through various forensics tools such Helix (For scanning pictures, file recovery etc.) and testify in the code of law as witness experts [2].

7. Conclusion

Machines are made by man to make their lives easier and better. To solve problems which are beyond the capability of the humans and it is evident from the fact that the disease in the nail can be diagnosed easily with the help of the proposed methods in the paper which are applied using the Matlab tools. Nail Color and Texture analysis that are performed using Matlab tools can be regarded as the basis for determining the kind of disease that is present in the human body. The dataset of the images can be observed and verified using the image segmentation, color and texture analysis methods. Though there are some considerations that are required to be kept in mind before performing such tests and producing the results accordingly. Utmost care must be taken and all the conditions/ pre-assumptions must be adhered. The results of such analysis can be useful in the medical field and other branches of science such as biometrics in which fingernail analysis is treated as transient biometrics that can be used once and changes over a period of time making it secure as well as useful.

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