A Review: Fingernail Images for Disease Detection

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Abstract:
This paper gives idea about how the nail colors, texture, shape, and pliability are useful to predict diseases. In traditional system of disease detection doctors observe the nails of patients and then predict the disease. It requires more time and the prediction is not much accurate, because human eyes cannot differentiate the slight change in color. Various image analysis and digital image processing technique such as Image acquisition, Image pre-processing, Segmentation, Feature extraction etc are used to identify features of nail. Generally Smooth, pink and shiny nails indicate healthy human. This paper has reviewed the various techniques used to process the nail images for disease detection.
Keywords: Fingernail, Nail body, Lunula, Nail root, Eponychium, Gall bladder, Nail texture, Dermnet.com, C4.5.

1. Introduction

An image is defined as an array of matrix of square pixels arranged in rows and columns. Image processing is a technique in which image is converted into digital form and performs some operations on that image to get helpful information. Digital image processing has many applications such as medical image processing, signature recognition, face recognition, military applications, iris recognition etc. The process of analyzing digital image constitutes in the following phases:
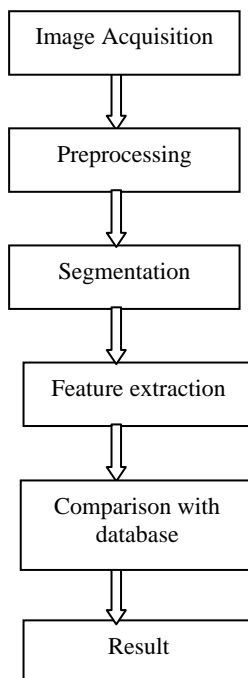
```
┌─────────────────────┐
│  Image Acquisition  │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│    Preprocessing    │
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          │
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┌─────────────────────┐
│    Segmentation     │
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          │
          ▼
┌─────────────────────┐
│  Feature extraction │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│   Comparison with   │
│      database       │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│       Result        │
└─────────────────────┘
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Figure 1: Block diagram of digital image processing

The nail images analysis includes following steps.

1. **Image Acquisition:** This is the first step in image processing. Commonly this involves preprocessing such as scaling etc. The image can be taken as an input through scanner or digital camera. High resolution images helps in accurate image analysis.

2. **Preprocessing:** In this step of image preprocessing the image data is improved enhance some image features for further processing. Enhancement, restoration, compression are methods of preprocessing.

3. **Segmentation:** In this step image is divided into regions with extracting features.

4. **Feature extraction:** This step constitutes finding and extracting the features that can be used to determine the meaning of image. Features of an image are various attribute or characteristics of image field. Natural and artificial are the types of features. Visual appearance of an image followed in natural while artificial features is result from some manipulations of an image. Natural features include gray scale textural region, brightness of a region of pixel, edge outline of object etc. and artificial features include image amplitude histograms and special frequency spectra.

5. **Comparison with database:** The output generated from the phase of feature extraction is compared with the database.

6. **Result:** By considering the result in previous phase disease detection is made.

Many ways are available to detect the disease in human body such as pathological test, observation of eyes, tongue and nails etc. In this paper images of nails are considered to identify diseases. Nails are the envelop of a finger tip and are the last to receive oxygen because they are farthest from the heart. Due to this they are often the first to show signs of disease. The structure of finger nail is shown below:
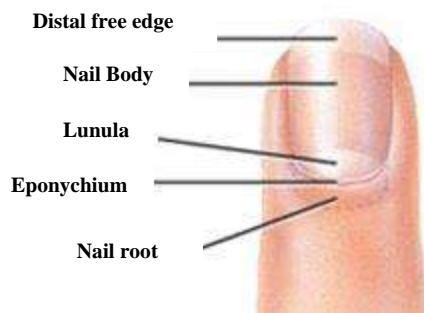
Figure 2: Fingernail Structure

Each finger represent group of organs which are summarized below:

Finger name	Organ
The Thumb	brain, excretory system and in the reproductive organs
Index Finger	liver, gall bladder or nervous system
Middle Finger	heart and circulation
Ring Fingers	reproductive organs and the hormonal system
Little Finger	digestive system

Generally smooth, pink and shiny nails indicate healthy human. The analysis of nails and disease symptoms are:

1. Nail color analysis:

Nail color	Disease symptoms
Black	Cancer, Anemia, chronic kidney disease, B-12 deficiency, bacterial infection, , adrenal gland problems, liver disease, melanomas, silver deposits (heavy metals), trauma
Blue	heart disease, hepatitis, Atherosclerosis, blood is too thick, liver disease, COPD (lung disease), copper or silver poisoning, decreased hemoglobin, drug reactions, gas poisoning, high platelet counts, increased cholesterol, inflammation, kidneys with clogged arteries, lupus, prior strokes, rheumatoid arthritis, blood clots

Nail color	Disease symptoms
Green	Allergies to cleaning agents, Bacillus infection, localized fungal infection, serious emphysema
Brown or Copper	Arsenic or copper poisoning, fungal infections
Gray	Arthritis, edema, malnutrition, post-operative effects, glaucoma, lung problems, emphysema, cardio-pulmonary disease
Yellow	Bleeding, diabetes, digestive problems, liver disease, hyperthyroidism, lymphatic problems, nail fungus, poor circulation, respiratory problems, Vitamin E deficiency, fluid retention in the lymphatic system
Pale or white	Anemia, Candida (yeast), low life force, overall mineral deficiency, heart or lung problems, hemorrhage, hookworm infestation, kidney disease, liver disease, malnutrition, ulcers
Purple	Oxygen deprivation, circulatory problems, congenital problems
Red	Brain hemorrhage, heart disease, high blood pressure, lung disease, stroke, carbon monoxide poisoning

2. Nail Texture and marking analysis:

Nail Texture and marking	Disease symptoms
Vertical Ridges and Split Nails	Vitamin A deficiency, nervous problems, poor digestion/absorption in the small intestine, Adrenal gland problems, arthritic tendencies, asthma, broken heart, bronchitis, calcium deficiency, chronic fatigue, chronic inflammation, chronic stress, depression, emotional trauma, excretory system conditions, hyperactivity or overexertion, iron deficiency, kidney problems, laryngitis, , chemicals from food, dieting, protein deficiency, respiratory problems, unhappiness, yeast and other fungi, lupus, chemo or radiation side effect
Horizontal Dips	less essential nutrients, Poor circulation, picking at the nail bed, heart disease, stress, trauma
Red Bands at the Tips	Allergies, liver overload, inflammation of the gastro-intestinal tract
Yellow Tips	Liver problems, melanoma, poor digestion
White Spots	Vitamin-A deficiency, Kidney or hormone imbalances, zinc deficiency, calcium deficiency

3. Nail Shape analysis:

Nail Shape	Disease symptoms
Short Small Beds	Heart disease
Wide Clubbed Nails	Asbestos exposure, emphysema, lung disease
Clubbed	Heart disease, liver disease, lung disease

4. Nail Pliability analysis:

Nail Pliability	Disease symptoms
Brittle or cracked nails	Calcium deficiency, weak function of kidney, iron deficiency, malnutrition, protein deficiency, thyroid problems, Vitamin A and D deficiency
Soft and Thin nails	Deficiency of protein and Vitamin-C, Adrenal Gland problems, can be associated with leg cramps, poor nutrition

2. Literature review:

A review on various research work based on nail image analysis for various disease detection and similar techniques used in leaf disease detection is given below.

1. Indi Trupti (2016) proposed early stage disease detection system which process nail image, extract the feature used for disease diagnosis. The training dataset is prepared using weka tool from nail images of patients. C4.5 algorithm is used to generate decision tree and color detection algorithm is used. In the experiment they observe 65% results are correctly matched with training data set.

2. Sneha Gandhat (2016) proposed analysis of nail images of patients in which features are extracted and then Haar Transforms Matrix is applied to generate feature vector. They applied row mean to reduce feature vector then compare a query feature vector stored in template dataset using similarity measures like MSE, absolute difference. And then they find out matching and calculate GAR (Genuine acceptance ratio) and produced result.

3. Vipra Sharma (2015) proposed system for disease detection by analyzing finger nail color and texture takes back side of palm region and then segment the image. The segmented image is the actual nail region. They analyze the nail color and texture and compare these values with the predefined values for healthy nails and diagnose the result. For this experiment they only processes image having format BMP, GIF, JPEG, PNG, TIFF etc.

4. V. Saranya (2017) proposed image segmentation technique to detect nail abnormality for this preprocessing was done by combination of median and average filters and then convert that image into gray scale to increase process efficiency. They used Watershade , Thresholding and k-means

segmentation techniques to identify shape of a nail. The extracted nail image is then used for diagnosis of nail disease.

5. The analysis of nail color and texture was proposed by Vipra Sharma (2015). The segmentation of images was made based on the texture of images and then the analysis was made on color and texture. The result of this analysis was used in various fields like medical and transient biometrics.

6. Nityash Bajpai (2015) Proposed automated prediction system for various health conditions by analyzing human palm and nails in which human palms are scanned from both sides, ROI is captured by extracting features. They worked on symbols presented on palm and color of human nails for prediction of disease. For identifying symbols on human palm they used some neural network back propagation algorithm which brings 90%-95% efficiency of disease prediction system. For nail image processing they used Back Truncation Code and produced either Training Vector/Input Image vector and by using similarity measures they produced result. For palm Image processing first they converted RGB color to Grayscale Image then applied Frichen edge detection algorithm on palm images. Morphological techniques such as Erosion and Dilation applied to smooth image, then analyzing principal component they produced vectors and by applying similarity measures the result was generated.

7. Hardik Pandit (2013) proposed the model of nail color analysis. In this experiment they scan back side of human palm then extract nail region from cropped image of palm by RGB component analysis in which algorithm was designed which gives average as well as pixel by pixel nail color for each finger. For the comparison they took 50 reference images per color. After calculating arithmetic mean they fixed a reference color. For the identification of stage of a disease they fixed a percentage of pixels with given color in all nails.

8. A method based on Noval Bicluster method was used by Anuradha Thakare (2017) in the proposed automated medical support system for detecting human health conditions. For this the dataset was collected from Medicinenet.com and Dermnet.com and classified using Decision tree, Neural network and support vector machine. On the basis of nail color and texture analysis Bicolor algorithm and GLCM algorithm was used respectively. The input images were trained using Neural network algorithm and Multilayer perceptron used to classify the data. A Gray Level Co-occurrence Matrix(GLCM) is used for nail texture analysis. This consist of Contrast, Energy, Entropy and Homogeneity used in two ways horizontal and vertical. The accuracy provided by this system is 88% with neural network.

9. A model proposed by Hardik Pandit (2012) can be used for extracting a portion of a given image using color processing. For the experiment they used palm image as an input, separate the palm area from the rest of image, RGB component analysis, Image restoration from nail color, determination of palm color from extracted image.

10. Noriaki Fujishima (2013) proposed fingernail detection method from hand images including palm by using distribution density as well as color continuity to improve accuracy. They can detect only finger nails with at least 85% probability from -90 to -40 degrees and from 40 to 90 degrees.

11. Sujath R (2017) proposed leaf disease detection. In this experiment input image is first converted from RGB to HSI and then they perform k-means clustering algorithm and Support vector machine which is statistical learning based solver for accurate detection of leaf disease.

12. Darshana A. (2015) proposed Segmentation method for automatic leaf disease detection method. For this experiment they use they use region based image segmentation methods such as region growing, region merging, region splitting and clustering based such as Mean-shift, K-means, Fuzzy C-Means. After segmentation each diseased spot is considered to extract shape features and color features. According to the results generated during the experiment they found that region growing is the best region based segmentation method.

13. Jimita Baghel (2016) proposed K-means Segmentation method for Automatic leaf disease detection after segmentation the system returns k number of images based on color, then they consider only infected segments for next step. The percentage of infection is calculated. Machine vision technology is used for automatic detection of leaf of plant and disease.

14. Indrakumar S.S. (2016) proposed a study on eye troubles using palm print and image processing technique they select a region of interest for detection of disease from image, then apply sobel filter for noise reduction and canny algorithm to detect edges and lines.

15. Vishwaratne Nigam (2010) proposed a novel approach for hand analysis using image processing technique for the experiment they use canny filter for the edge identification, then result is compared with the database, >70% matching was considered for the future work. Hough transform and pixel distance computation was applied for the calculations of palm width, length, finger length and their ratio. Then the generated result was compared with the database. For Hand analysis they

consider ratio based system approach and finger length comparison based approach.

16. Sima Kumari (2015) proposed analysis of Apple fruit diseases using nural network. For experiment they use k-means clustering for segmentation and speeded up robust features for feature extraction and images was classified on their feature like color, area, perimeter, and boundary. Result was shows 85% accurate performance for detection of disease.

17. Hardik Pandit (2013) proposed a system for nail color analysis in healthcare. For the experiment they consider scanned images of back side of human palm and designed an algorithm which gives result as average values of nails of each finger as well as some irregular pattern and symbol on nails. The system was approximately 85% accurate.

18. Kumuda N.S. (2015) proposed human fingernail segmentation, for experiment gray scale image is produced from color image and adaptive equalization is applied for contrast enhancement.

3. Conclusion:

This paper is a review on identification of disease by observing features of nails such as color, texture, shape and pliability. For this training dataset is collected from weka tool, Medicinenet.com and Dermnet.com.C4.5 algorithm is used to generate decision tree. For Feature extraction can be used Haar transform matrix. Watershade, Thresholding and k-means segmentation. Frichen edge detection algorithm technique to identify shape of a nail.

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