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Analysis of Fingernail Images for Detection and Diagnosis of Diseases

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ABSTRACT

Many disorders are detected at an early stage of diagnosis by analyzing the human hand nail. In the medical field, analysis of a person's hand nail color aids in the diagnosis of a specific condition. The technology will analyze a nail image and extract nail properties that are useful for diagnosing diseases. The human nail has a variety of characteristics. Nails are the body component farthest from the heart and receive the last oxygen. As a result, the nail is the first part of the human body to display illness symptoms. Fingernails can be quickly and easily photographed for diagnosis. Unlike other testing and scanning processes, nail images do not need to be taken under difficult conditions or with complicated equipment. Ayurveda typically uses nails as a physical investigation tool since they are a good predictor of potential bodily ailments. Based on their shape, texture, and color, human nails provide helpful information regarding complaints or any nutritional imbalances. Changes in nail color, texture, or shape are indicators of numerous disorders that primarily affect nails. And if we successfully detect these alterations in the human nail using digital image processing techniques, we can quickly predict many diseases and obtain more accurate findings. In this survey paper, a state-of-the-art review has been presented.

1. Introduction

Image processing is a technique for converting a physical image into a digital format and applying various operations to it to produce an improved image or extract relevant information. Computers can easily categorize more than 16 million hues, but the human eye has limitations when it comes to doing so, and some people also struggle with issues like color blindness. Therefore, using a computer to analyze nail color is better than using your eyes. Because of the limited resolution of human vision, human eyes can't discern variations in close-by pixel intensity, but computer vision can do so. Pathological tests are difficult and uncomfortable, and patients must be available when the system is calmly performing its analysis. The patient would benefit from this method since the doctor could diagnose the patient's symptoms and issue the necessary prescription for the ailment identified without the patient's physical presence or if the doctor was unavailable for consultation [1].

The color of a human's nails can predict several disorders in the healthcare field. Doctors observe the patient's nails to help diagnose the condition. Your nails may display symptoms of liver, lung, or heart issues. Pink nails typically suggest a healthy human being. The need for a system to analyze nails for disease prediction is due to the human eye's subjectivity concerning color schemes, resolution limitations, and the fact that small amounts of change in color in just a few pixels on nails would not be highlighted to the human eye, potentially leading to an incorrect result [2]. An indication of sickness in the body could be a white spot here, a pink stain there, or some winkles or projections.

The proposed method will extract color characteristics from an image of a human nail for disease prediction. The technique focuses on image recognition using human nail color analysis as a foundation. Human hand nails can be analyzed to help diagnose a variety of diseases. This technology uses a camera to record an image of a human nail. The captured image is submitted to the system, and a manually picked section from the nail area is made. The chosen area is then further processed to extract nail properties like nail color. The technique helps predict diseases in their early stages in this way. The selected area is then processed further to extract features of the nail, such as nail color. Finally, this nail color feature is matched using a simple training data set for disease prediction. In this way, the system is useful in predicting their initial stages.

2. Nail Components

The nail plate, the hard outer layer of the nail, is supported and formed by various soft tissue components [3]. The gross structure is shown in the attached Figure 1 below.

Distal edge: The front edge of the nail plate that corresponds to the abrasive or cutting edge of the nail is known as the free edge or distal edge.
Epithelium: The epithelium known as the hyponychium is situated beneath the nail plate at the point where the free margin and skin of the fingertip converge.
Lunula: Usually, the base of the nail plate has a moon-shaped appearance.
Cuticle: The flat, thin tissue covering the base of the nail plate is referred to as the cuticle.
Nail Root: the nail's proximal end is hidden by a skin fold.
Nail Plate: Light pink, smooth, and curved describe the nail plate. It is the portion of the nail that is visible.

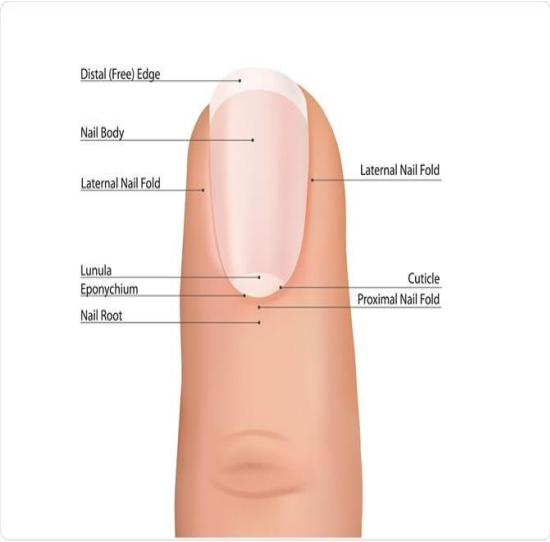

Figure 1: Nail Components

3.

4. Impact of Nail Color

Pink Nails: Healthy nails, indicated by their pink tint, are signs of excellent health.

White Nails: White nails are caused by an iron deficiency and poor circulation, which prevents blood from getting to your fingertips. It suggests anemic circumstances.

Red-purple Nails: Red-purple nails result from an upset digestive system brought on by an excess of sweets, medications, fruits, and juices.

White spots in nails signify high sugar content and a deficiency in zinc, which is needed for digestion.

Table 1: Diseases based on nail color and shape [4]

Sr. No.	Nail Type	Image	Possible Diseases
i.	White Nails		i. Jaundice ii. liver trouble iii. Anemia.
ii.	Yellow Nails [13]		i. lung disease ii. diabetes or psoriasis iii. thyroid disease
iii.	Bluish Nails		i. heart problems ii. emphysema
iv.	Pale Nails [13]		i. Anemia Congestive heart failure ii. Liver disease iii. Malnutrition
v.	Dark Lines Beneath the Nail		i. melanoma(dangerous type of) skin cancer
vi.	Beau's Lines		i. systematic disease

5. Methodology

Several techniques to diagnose diseases, including various tests (blood, urine, etc.) and symptoms present in multiple bodily sections that serve as indicators. We are developing a technology that will use a nail image as an input and predict potential ailments based on color changes. The suggested system will use the image of a nail as input and process the image. Finally, it will forecast likely ailments. Both patients and doctors can use this technology in the healthcare industry. In this step-by-step approach, first, it will take an

image of the nail, then the image will be pre-processed, then in the third part, the image will be segmented to get the region of interest, and in the last step, it will classify different ailments as shown in Figure 2.

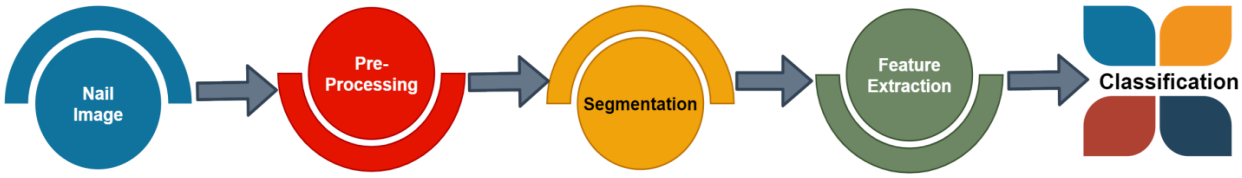

Figure 2: Methodology for Nail Image Processing for Disease Detection

6. State-of-the-art Review

Below is a review of numerous research studies on nail image analysis for disease identification and related methods used to identify leaf disease. Based on nail image processing, Indi Trupti presented early stage disease diagnosis; in this case, the nail plate is used in the ESDD system. GAR and FAR is used to calculate the ESDDS system's performance. The ratio of matching samples to the total number of tests are known as the true acceptance rate or GAR. The ratio of the number of matched samples that do not match is known as the false acceptance rate, or FAR, according to the system and overall test count. Weka tool trains patient-provided input images. For this, they classified and trained patient data using the J48 classifier (C4.5 algorithm). Then, decision trees are built using the C4.5 algorithm. C4.5 can be referred to as a statistical classifier because the decision trees it produces can be used for categorization. This technique examines a person's nails and predicts potential diseases in healthy and diseased cases. Nail feature extraction uses the nail color's average RGB value [5]. This model outperforms human vision in terms of accuracy because it can see beyond the subjectivity and resolution power of the human eye.

Vipra Sharma suggested a system that uses an algorithm to segment an image of the back of the hand, remove the nail region from the surrounding area, and then perform color and texture detection on the segmented nail area to determine whether the nail is healthy or not. The system receives input in the form of photographs of human nails. An analysis is used to develop the outcome; if a disease is present, it will be anticipated. Since MATLAB is being used to create this model, the proposed work falls under image processing. The method starts by segmenting the input image and then analyses the segmented nail region. They only handle the BMP, GIF, JPEG, PNG, and TIFF image formats in this. Only 2 or 3 diseases can be detected by it [7]

In his method for segmenting fingernails, fingernail plates with lunula and the distal free edge of the nail plate were identified as distinct nail components by Kumuda N. S. As the fingernail plate's fixed region and lunula are structurally constant, the research focused on these areas. , but the distal nail edge lengthens and undergoes structural changes with time. The suggested method has two steps. First, a color image is transformed to grayscale, and adaptive histogram equalization is used to apply contrast enhancement. Next, perform segmentation in the second stage using the marker-controlled watershed principles' maxima and minima attributes. Finally, a confusion matrix was built with an assessment using ground truth to confirm the algorithm's results.

Additionally, the segmented objects from both approaches were considered for evaluating quality measures. Regarding accuracy and similarity, the fingernail plate watershed result is 84.0% correct. Fingernail segmentation's preliminary findings are encouraging, supporting its use in biometric applications [8]

Sneha Gandhat proposed an algorithm that automatically extracts the nail region and examines this nail section for illness identification based on the color of the nail. The proposed method requires an image of the patient's hand, which is simple to get and straightforward to carry out. The nail must be photographed. Extract the region for inspection. Look at the nail's shade. It was comparing the nail to the established range. This work defines DDS as a digital image processing and analysis application. This can be applied to the healthcare industry to forecast ailments like diabetes and jaundice in people based on their nails. Using digital image processing techniques, the system then employs MATLAB software to extract certain features from the input photos. It analyses the aspects in the image and forecasts linked diseases using a database of medical palmistry expertise. [6]

A model put out by Hardik Pandit scans the hand using a scanner before applying digital image processing and analysis methods to obtain color information. While doing this, the piece of the palm should be extracted from the scanned image first, and then the palm color, which may vary in different regions of the palm, is to be identified. C# and ASP.Net are used to implement the model in A Forge. To obtain more image processing filters, the internet was employed. Each palm is examined from the front and back, or its two sides. We could determine the color of the palms' front sides and backs. The model correctly isolates the palm section and provides the typical color of a human palm. Based on medical palmistry, these values would be used to predict diseases. The model functions well on human palms with various skin tones. Suppose the palm's margins are darker than the palm itself. Hence you might not get the precise palm boundaries. This could have an impact on how the average palm hue is determined. Techniques for image enhancement can be applied to solve this issue. Moreover, results may differ if the scanner's surface is dirty with stains. [11]

Line and curve detection were the essential techniques that Indra Kumar S.S. attempted. Apply the Sobel filter first to eliminate image noise before using the Canny Algorithm to locate edges effectively. The suggested solution for the palm eye issue can be seen in the image by using Canny Edge detection to extract the hand's contour and the lines on the palm from the provided image. The process is divided into five main steps: acquiring the image, choosing the ROI (Region of Interest) for detection, using the Sobel Filter to reduce noise, and using the Canny Algorithm to detect edges and lines, if there is a circle on the Sun's mount, the sample will have vision issues [9]

V. Saranya presented several image processing methods to identify the nail area automatically. It is suggested to excise the aberrant region. The findings are then compared to see how much the nail region has been affected by form parameters like Area, Perimeter, and Diameter. Digital camera photos of the supplied RGB nail photographs are saved in JPEG format. The input image should be the infected nail selected with a different background, as the major goal of this research project is to remove the damaged portions of the nail. The input image is pre-processed using a combination of median and average filters to improve the image's accuracy and clarity. The image is transformed into a grayscale image for greater computing efficiency once the noise particles have been removed. In this research, three alternative segmentation techniques—Watershed segmentation, Thresholding, and K-means clustering—are proposed to extract the aberrant region of the nail. [10]

For hand photos, including palm side images, Noriaki Fujishima suggested a two-stage search strategy combining color information and the distribution density of nail-color solid pixels. The prior approach for detecting fingernails was not very effective at removing some skin areas that contain nail color and shine, such as the finger side area. It could only detect fingernails with at least an 80% probability from -90 to -40 degrees and 40 to 90 degrees. Therefore, it is necessary to delete these areas using more information. Then, you can obtain information about color continuity. Thus, this study provides a brand-new fingernail identification technique that uses increased detection accuracy, color continuity, and distribution density of strong nail-color pixels in addition to solid-color pixels. In this work, we discussed the "color continuity" of fresh information. We developed a brand-new fingernail identification technique that uses color continuity and the density of nail-color solid pixels. In these tests, the percentages of correctly detected objects for three users were compared to wrist rotation angles [12]. As a result, we were able to validate that our suggested approach outperformed the old one in that it could only reliably identify fingernails from -90 to -40 degrees and 40 to 90 degrees.

The NIPS-McS input system, which Priya Maniyan proposed, uses the back of the palm against a white background. The nail region is then retrieved from the palm image using Canny's edge detection technique and the segmentation process. The nail's color, shape, and texture are then extracted and merged to create a feature vector compared with the database's existing examples of healthy and diseased nails. The suggested system uses the Multiclass SVM Classification Method to categorize and predict diseases. It is an excellent service to society to recognize many diseases in their early stages. The proposed approach, NIPS- McS, uses digital image processing to combine the nail's color, shape, and texture into a feature vector, which is then used to analyze and predict the nail's appearance using a Multiclass classifier SVM. The one-versus-rest (1VR) approach for Multiclass [13] SVM is employed in the suggested system. Although 1VR requires more training time than 1V1, its performance is superior. This model outperforms human vision in terms of accuracy because it can see beyond the subjectivity and resolution power of the human eye.

According to a technique by V. Ramya, prompt and correct diagnosis and classification of plant illnesses are essential to the growth of plants and the prevention of crop yield losses. While the color spread is comparable between affected and unaffected leaves, it is uneven on afflicted leaves. This is because the pixel values of the damaged leaves were completely different from those of the regular ones. The mean filter is then used to enhance the image quality. The image is segmented using Otsu's threshold method. After extracting features from the given leaf image, a recognizer is required to identify the illness in the leaf picture from the stored database. This study suggests a recognition technology that uses backpropagation networks (BPN). Multilayer feedforward networks with a forward pass and a backward pass can be trained using backpropagation. Calculated and chosen outputs are compared during the forward pass. Estimated errors from the preferred and actual output are used. This error is used in the backward pass to change the weights in the network and decrease the error's dimension. The user typically sets the acceptable error value, and the forward and backward passes are repeated until the error is low [14]. When NN is being trained, examples with inputs and desired outputs are fed into the network. Selecting the learning rate and momentum will assist in adjusting the weight. One neuron is present in the output layer. A supervised machine learning approach for classification is called the Support Vector Machine (SVM).

7. Conclusion and Future work

Non-invasive methods of disease diagnosis are becoming a crucial component of the healthcare industry. The different aspects of Human anatomy and mechanisms, such as the appearance of the nails, eyes, or breath, can be employed in non-invasive disease diagnosis procedures. Various image processing techniques, including image acquisition, image pre-processing, image segmentation, and feature extraction, are employed for nail image analysis on humans as one of the non-invasive procedures. This literature review discusses various methods for analyzing nail images to diagnose multiple diseases—including ANN classification, KNN classification, and SVM classification. Several disorders can be detected by using a non invasive technique called nail image analysis. The many nail characteristics, such as nail color, nail shape, and nail texture, are utilized to evaluate nail images. By deriving these features in terms of the area of the nail shape, the perimeter of the nail shape, etc., the nail features are extracted and measured, and the nail texture is derived in terms of entropy, energy, compactness, etc. The nail uses cutting-edge categorization technologies. Deep neural network and artificial

neural network classifiers are used in image processing systems. An SVM classifier, etc. In most of the work the RGB average value of the input image's nail color is used to classify the diseases, but in the future, other nail features can incorporate, such as nail pattern etc.

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