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Computer Aided Disease Detection using Finger Nail Image Processing Technique

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Abstract: *Human analysis is a method that can identify various diseases by examining different parts of the body. One of these is the fingernail, as it is the last organ in the body that receives oxygen. Because of this, it can sometimes exhibit early signs of a disease. More accurate findings may be produced by using digital image processing techniques to examine changes in human nails, making it possible to anticipate many illnesses with simplicity. The main focus of this study is on the role that nail colors, textures, forms, and flexibility play in illness prediction. Due to the limitations of human vision in differentiating minor colour changes, clinicians must rely on visual inspections of patients' nails in traditional illness detection procedures, which can be laborious and less reliable. Nail characteristics are detected using image analysis and digital image processing techniques include image capture, pre-processing, segmentation, and feature extraction. Normal healthy nails are glossy, pink, and smooth. However, this study examines multiple approaches used to analyse nail photos and find disorders. The objective is to advance beyond conventional observation-based methodologies and improve the precision and effectiveness of illness prediction.*

Keywords: Nail image processing, early detection, Fingernail analysis,Fingernail, Nail body, Nail texture

I. INTRODUCTION

In the medical field, the possibility of predicting various diseases by observing the color of human nails is noteworthy, and medical professionals regularly analyze patients' nails to help identify diseases. The presence of pink nails usually indicates good health. However, changes in nail growth or appearance may indicate an abnormality. Human nails provide valuable information about possible problems and imbalances due to their texture, shape, and color. The need to implement nail analysis systems to predict disease arises from the inherent subjectivity of human color perception. The resolution of the human eye is limited, and subtle changes in nail color indicate that the disease may go unnoticed. Conversely, computers can detect even slight color changes. The proposed system aims to extract color features from human nail images to predict diseases. This system focuses on image recognition by analyzing the color of nails. Many diseases can be detected by examining human fingernails.

This process involves taking images of human nails with a camera, uploading these images to the system, and manually selecting areas of interest within the nail area. Subsequent editing extracts nail features including color. A simple algorithm then matches the color features to predict disease. This approach has proven beneficial in identifying early-stage disease. In healthcare, diseases can be predicted by observing the color of a person's nails, opening up a new dimension in diagnosis. Traditionally, doctors have performed nail examinations to help detect disease. Apart from the common belief that pink nails indicate good health, changes in nail growth and appearance can also reveal potential abnormalities or underlying medical conditions. The complex interplay of nail texture, shape, and color provides rich insights that reveal underlying disease or nutritional imbalances.

II. PROBLEM DEFINITION

Detects various diseases at an early stage without the need for heavy equipment or conditions such as blood tests or scans.

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III. ANATOMY OF NAILS

An essential component of the digital tip is the nail organ. It is a highly adaptable instrument that safeguards the fingertip, enhances tactile perception by correcting the fingertip pad, and supports further thermoregulation through glomus bodies in the nail bed and matrix. Anomalies in the nail unit have an impact on both decorative and functional difficulties because of its shape and usefulness. Nails are known as the skin's embellishments and are situated on the distal portion of each number. Keratin, a type of protein, is used to make nails.

Human Nail

- **The Nail Bed:** This is often the portion of skin upon which the nail plate rests. It truly has a strong force of blood and lymph vessels to maintain healthy nails. The nail bed's purpose is to nourish and protect the skin.The epidermis' technical component, the nail bed, is located at the points of our fingers and toes. Since our fingers and toes are the body's farthest extremities and the area that experiences the most mechanical stress, the nail body, which develops on the nail bed, protects their tips.
- **Nail Plate:** The nail plate is the visible, hard portion of the nail that protects the tips of our cutlets. It is an advanced evolutionary structure built of the keratin protein. This creates a protective sub caste to protect against harm and provide a smooth look on the nail plate face. Our integers are protected below this by blood vessels with skin all around it. The nail bed, which is made up of a bed of towels, contains the nail's root. This aids in giving the polish or natural look for our nails an unchanging hue and appearance. Several layers of keratinized skin cells make up the nail plate. Layers are packed almost alongside fat but with little to no water. The nail plate lacks the presence of blood vessels or jitters. The blood arteries that run beneath the nail plate give it its pink color. The primary purpose of the nail plate is to protect the toes' and fingers' live nail beds.
- **The Free Edge:** The nail plate extends from the cutlet's top and is referred to as the free edge. This is white and linked to the nail bed. The free edge's purpose is to protect the fingertip, and this is the area that we file and shape!
- **The Hyponychium:** The skin that creates a seal between the nail plate and the nail bed, where the free edge starts, is known as the hyponychium. Avoid forcefully sketching beneath the free edge with tools since this area is extremely vascular and delicate. In addition to being uncomfortable and likely to bleed profusely if the skin is cut, McCormick notes that harming the hyponychium can result in onycholysis, or the lifting of the nail plate from the nail bed, leaving the region vulnerable to fungus and infections. Under the free edge of the nail plate, the epidermis typically resides in this area. Its purpose is to prevent infection of the nail bed.
- **The Nail Grooves:** The nail grooves are located next to the nail plate's sting. The little depressions or crowds of skin on either side of the nail plate are referred to as nail grooves, sometimes known as side nail grooves or side nail crowds. These grooves, known as the side nail fold, are deposited between the nail plate and the girding skin and run parallel to the length of the nail. The nail grooves contribute to the general well-being and preservation of the nails in a useful and protective way.The nail groove's purpose is to prevent the nail from developing in a line.
- **The Matrix:** In The Matrix This is often where the nail grows and is occasionally referred to as the nail root. The size and form of the matrix affect the nail's consistency. The matrix's epidermal cells undergo keratinization, which results in the formation of the firm towel on the nail plate. The matrix produces new skin cells, pushing away the old, dead skin cells that eventually become your nails. As a result, disorders that damage the matrix or injuries to the nail bed might have an impact on how your nails develop. The matrix's job is to produce new nail cells.

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- **The Nail Mantle:** The skin that covers the nail plate's matrix and base is known as the mantle. The subcaste of epidermis at the base of the nail, before to the cuticle, is known as the nail mantle. The sensitive nail matrix is protected from the outside environment by the crucial nail mantle.The nail mantle's purpose is to protect the matrix from harm.
- **The Lunula:** The caps of live nail cells that are emerging from the matrix give the lunula, or the white "small moon," at the base of the nail its hue. These cells become less viable as the nail develops, and the caps fall apart, leaving the nail clear. It's a frequent misconception that a large lunula indicates a healthy nail. However, the appearance of a customer's lunula is actually mostly determined by their genetics. This typically lies on top of the matrix at the base of the nail. It seems to be a partial moon and is white in hue. The nail is relatively brittle in this region and might easily be destroyed.
- **The Cuticle:** As the nail develops, the cuticle, a sub caste of transparent skin, exfoliates from the base of the proximal nail fold. Since much of this towel is dead, you may safely cut or file it off – and you should! By doing this, polish and improvements will adhere better. The cuticle is the lapping epidermis that surrounds the base of the nail. The cuticle's job is to protect the matrix from contamination.
- **The Nail Walls:** The skin bordering either side of the nail plate is known as the "nail wall," which is sometimes referred to as the "side nail fold." It runs parallel to the nail groove and spans the whole length of the nail. The fragile structures under the nail plate require support, protection, and a buffer against implied infections, all of which are provided by the nail walls. These are the masses of skin that are rubbing on the nail's margins. The nail wall's purpose is to protect the margins of the nail plate.
- **The Perionychium:** The swollen portion of skin at the bottom of both toenails and fingernails is known as the eponychium in nail anatomy. Its purpose is to keep germs from entering the space between the nail and the epidermis. The pattern of vascularization resembles that of the perionychium.
- **The Eponychium:** The visible "lip" of the proximal nail fold is known as the eponychium. It creates a seal with the nail plate to protect the matrix from harmful microorganisms. Because many individuals incorrectly associate the eponychium with the cuticle, the phrase "noway cut the cuticle!" is frequently used, although being strictly inaccurate. The eponychium is live skin, hence it must never be severed. Instead, moisturize and firmly press the eponychium back for a symmetrical look. You should also advise visitors to keep the area around the nail regularly moistened between moving objects. At the base of the nail plate, where the nail plate emerges from the matrix, the cuticle is usually extended in this manner. The eponychium's job is to protect the matrix against infection.

IV. RELATIONSHIP BETWEEN HUMAN HEALTH AND FINGER NAIL

4.1 Pail Nails

Normal healthy nails have a pinkish colour. However, pale nails might be a sign of a number of medical conditions, including anaemia, congestive heart failure, or liver disorders. This illness can also be exacerbated by poor diet. Even more severe illnesses like anaemia or congestive heart failure might be indicated by pale nails.

4.2 White Nails

The presence of white nails with darker borders might indicate liver issues like hepatitis. White nails can occasionally be accompanied by jaundiced fingers, a sign of possible liver problems.

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4.3 Yellow Nails

Fungal infections are frequently linked to yellow nails. This may result in the nail bed retracting, thickening, and becoming brittle. Sometimes, more serious illnesses like thyroid, lung, diabetes, or psoriasis might be indicated by yellow nails.

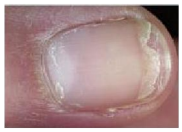
4.4 Bluish Nails

A lack of oxygen in the body may be indicated by blue-tinged nails. This could be a sign of heart problems or lung conditions like emphysema.

4.5 Rippled Nails

Unbalanced nail surfaces including ridges may be a precursor to diseases like inflammatory arthritis or psoriasis. Additionally, discoloration is possible, frequently exposing a reddish-brown tone underneath the nail.

4.6 Split Nails



A thyroid health problem may be indicated by nails that break or fracture easily. This might indicate a fungal infection when combined with a yellowish tinge.

4.7 Dark lines beneath the nails

Dark nail lines should cause alarm and require immediate care. Among the most serious types of skin cancer, melanoma, may be present in these lines.

4.8 Gnawed Nails

Though it can appear to be a simple practise, nail biting might have deeper implications. For some people, it's merely a ritual, but for others, it may be an indication of continuing anxiety that needs medical treatment. The possibility that nail biting has links to mental health is highlighted by the fact that it has occasionally been linked to obsessive-compulsive disorder (OCD).

The fingers and the internal functions of your body are connected in an interesting way because each of our fingers has been connected to a particular group of organs:

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- The Thumb: This digit corresponds to essential systems such as the brain, excretory system, and reproductive system. While it might seem like an unlikely connection, this finger symbolizes the intricate interplay of these vital functions.
- Index Finger: The index finger is associated with the liver, gall bladder, and the nervous system. Within its grasp lies a representation of these crucial aspects of your body's functioning.
- Middle Finger: Positioned at the center, the middle finger represents the heart and the circulatory system. It serves as a reminder of the pulsating life force that flows through your veins.
- Ring Finger: The ring finger is intertwined with the reproductive and hormonal system. This finger's significance goes beyond jewelry; it's a testament to the intricate balance of reproduction and the hormonal symphony within.
- Little Finger: As the smallest member, the little finger corresponds to the digestive system. It highlights the essential role of digestion in nourishing your body.

Finger Name	**Organ**
The Thumb	Brain,excretory system and reproductive system
Index Finger	Liver,gall bladder or nervous system
Middle Finger	Heart and circulatory system
Ring Finger	Reproductive and the hormonal system
Little Finger	Digestive System

The analysis of nails and disease symptoms are:

Nail color analysis:

Nail colour can be a quiet sign of underlying health problems. Different nail colours can be linked to certain illness symptoms, offering vital information into a person's health:Black Nails: Black nails can indicate a variety of illnesses such as chronic kidney disease, cancer, anaemia, bacterial infections, adrenal gland problems, liver disease, B-12 insufficiency, silver deposits (heavy metals), and trauma.

- Blue Nails: Blue nails may be a sign of heart disease, hepatitis, atherosclerosis, thickened blood, liver disease, COPD (lung disease), copper or silver poisoning, low haemoglobin levels, drug reactions, high platelet counts, inflammation, gas poisoning, lupus, previous strokes, elevated cholesterol, rheumatoid arthritis, clogged kidney arteries and blood clotting.
- Green Nails: Green nails may indicate sensitivities to cleaning solvents, Bacillus infections, localised fungal infections, or even severe instances of emphysema.
- Brown or Copper Nails: Nails with brown or copper colours may indicate poisoning from arsenic or copper, and also fungal diseases.
- Gray Nails: Grey nails may be associated with arthritis, malnutrition, post-operative complications, glaucoma, lung issues, emphysema, and cardio-pulmonary ailments.
- Yellow Nails: Yellow nails may be associated with blood disorders, diabetes, digestive troubles, Vitamin E insufficiency, liver illness, lymphatic problems, nail fungus, poor circulation, hyperthyroidism, respiratory problems, or lymphatic fluid retention.
- Pale or White Nails: Anaemia, an infection with Candida (yeast), low life force, general mineral insufficiency, heart or lung issues, liver disease, hookworm infestations, renal illness, malnutrition, or ulcers can all cause pale or white nails.
- Purple Nails: Nails with a purple hue might be a sign of oxygen deprivation, circulatory problems, or congenital issues.
- Red Nails: Red nails may indicate dangerous illnesses such as a lung disease,, high blood pressure, heart disease, stroke, or even carbon monoxide poisoning.

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Our nails can express much more than just their appearance. A small change in nail colour might provide important information about our bodies' health. Regular examination and contact with medical specialists are essential for decoding the possible messages our nails offer about our general health.

Nail Texture and marking analysis:

The texture and lines on our nails might also reveal important information about our health. Various nail textures and marks can be linked to certain illness symptoms, allowing us to gain a better understanding of our health:

- Vertical Ridges and Split Nails: Vertical ridges and split nails may indicate a vitamin A deficiency, nervous system issues, digestive and small intestine problems, arthritic tendencies, chronic fatigue, inflammation, kidney problems, chronic stress, depression, emotional trauma, excretory system conditions, hyperactivity, iron deficiency, laryngitis, exposure to chemicals from food, diet, and emotional trauma.
- Horizontal Dips: Horizontal dips along the nails may be a sign of stress, trauma, heart disease, poor circulation, nail bed picking, or a lack of vital nutrients.
- Red Bands at the Tips: The presence of red bands at the tips of nails might be related to allergies, an overloaded liver, or inflammation of the gastrointestinal tract.
- Yellow Tips: Yellow nail tips may be a sign of melanoma, liver disease, or digestive difficulties.
- White Spots: White spots in the nails may be a sign of a vitamin A deficiency, renal or hormone abnormalities, a zinc or calcium deficit, or even a kidney or hormone imbalance.

In conclusion, there is a lot more to our nails than catches the eye. Texture and marks provide information about possible health problems, allowing for early discovery and action. By paying periodic attention to our fingernails nails and following medical advice, we may keep a better grasp on our general health.

Nail Shape analysis:

Our nail shapes can potentially reveal crucial details regarding prospective medical issues. Various nail forms are associated with particular illness symptoms, providing a unique view on our health:

- Short Small Beds: Heart disease may be indicated by nails having short and tiny beds. This specific nail form may be a covert indication of cardiovascular problems.
- Wide Clubbed Nails: Emphysema and lung illness, as well as asbestos exposure, may be linked to wide, clubbed nails. This particular nail form may be a sign of potential respiratory issues.
- Clubbed Nails: Clubbed nails, in which the nail curls around the fingertips and the fingertips swell, may indicate a number of medical issues. Liver disease, Heart disease, and lung disease are a few of these. The presence of clubbed nails may require further medical testing.

Even the design of our nails might provide information about our health. To improve our general health, we should be aware of these subtle warning signs and seek medical help when necessary.

Nail Pliability analysis:

Our nails' pliability, or how they appear and function when bent, might also reveal information about our health.

Different nail pliability traits correspond to particular illness symptoms, providing important information about our heal th:

- Brittle or Cracked Nails: Fragile or easily cracked nails might be a sign of a number of health problems. These may include calcium and vitamin A and D inadequacy, impaired renal function, iron and protein deficiency, malnutrition, thyroid issues, and poor kidney function. Our nail health may be an indication of underlying nutritional deficiencies and associated health issues.
- Soft and Thin Nails: Protein and vitamin C deficiency may be indicated by soft and thin nails. These necessary vitamins and minerals are quite important for preserving our nails' health and strength. Our nails' pliability might provide us clues about any possible weaknesses.

Our nails' feel and pliability can provide important health information. We may contribute to better nails and general well being by focusing on these traits and correcting any potential shortcomings.

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V. LITERATURE SURVEY

Sneha Gandhat presented an algorithm that automated the extraction of the nail area and analyses it for illness identification based on nail colour. The suggested method requires simply a picture of the individual's hand, that is simple to get and perform. Capturing a photograph of the nail, separating the region for investigation, and analysing the nail colour by comparing it to a specified range are all steps in the procedure. The research given here examines the Digital Disease Detection System (DDS) as an example of digital image processing and analysis. By analysing human nail photos, this method has the potential to be used in the healthcare industry to anticipate ailments such as diabetes and jaundice. The device uses techniques for digital image processing to process photos of human nails.[1]

Indrakumar S.S. investigated line identification and curve detection approaches, beginning with the use of the Sobel filter to remove picture noise. They then used the Canny Algorithm to identify edges accurately, allowing them to extract hand shapes and palm lines. The proposed approach was designed primarily to discover ocular problems associated with the look of the palm. The procedure included five important stages: image acquisition, recognition of a region of interest (ROI), noise reduction with the Sobel Filter, edge and line detection with the Canny Algorithm, and diagnosis of eye issues by the appearance of a circle on the Sun's mount.[2]

Vipra Sharma devised a technique that examines the picture of the palm's backside using an algorithm. To separate the nail region from other parts of the picture, the algorithm conducted a segmentation phase. The segmented nail region was then subjected to colour and texture detection techniques to assess when the nail was infected. The analysis was used to create the output, which, if a disease was found, predicted its occurrence. For this work, that is included in the category of Image Processing, MATLAB was the preferred tool. With an emphasis on the JPEG, GIF, and PNG formats, the approach entailed segmenting input pictures and analyzing the isolated nail region. But just 2 or 3 particular illnesses were intended for the system's detection capabilities.[3]

The fingernail plate including lunula and the distal free edge of the nail plate are two different portions of the nail that Kumuda N. S. offered as a way for segmenting fingernails. In contrast to the distal nail edge, which varies structurally throughout time, the research focused on a constant region of the fingernail plate and lunula, which are structurally unaltered. The suggested procedure was divided into two steps. A colour image was initially converted into a grayscale version in the first stage, and contrast was improved using adaptive histogram equalization. The second step was segmentation utilizing the watershed approach, utilizing maxima and minima properties-based marker-controlled watershed principles. The evaluation process included creating a confusion matrix and contrasting the findings with actual data.The segmented items were also evaluated for quality criteria. For the fingernail plate, it was discovered that there was an 84.0% similarity and accuracy among the data from the ground truth and the watershed. Particularly for prospective biometric applications, the preliminary fingernail segmentation results were promising.[4]

An early-stage illness detection system that analyses nail photos and extracts attributes for disease diagnosis was launched by Indi Trupti (2016). The Weka tool was used to prepare the training dataset from patient nail pictures. A decision tree was created using the C4.5 algorithm and a colour detecting technique. They found that in their experiment, 65% of the outcomes corresponded to the training dataset.[5]

Through the examination of human hands and nails, Nityash Bajpai (2015) suggested an automated prediction technique for a number of medical disorders. They scanned human hands from both sides and used feature extraction to capture Regions of Interest (ROI). The study concentrated on illness prediction using symbols found in the palm and nail colour. They used a neural network the backpropagation method to identify the symbols on the palm, and their illness prediction accuracy ranged from 90% to 95%. Back Truncation Code was utilised to create Training Vector/Input Image vectors for the processing of nail image. Results were obtained using similarity measurements. The RGB colour was changed to grayscale for palm image processing, and the Frichen edge recognition technique was used. The picture was smoothed using morphological techniques like erosion and dilation. Vectors were created using principal component analysis, and results were produced using similarity tests.[6]

A model for nail colour analysis was suggested by Hardik Pandit in 2013. The investigation includes scanning the rear of human palms and utilising RGB component analysis to separate the nail region from the cropped palm picture. Each finger's averaged and pixel-by-pixel nail colour was calculated using an algorithm. 50 photos per colour were selected as reference photographs for comparison. A reference colour was established using an arithmetic mean. A proportion of pixels in all nails with the specified colour was calculated to establish the illness stage.[7]

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A segmentation technique for automated leaf disease detection was presented by Darshana A. (2015). The experiment included clustering-based techniques including K-means, Mean-shift, and Fuzzy C-Means, as well as region-based picture segmentation techniques like region expanding, region merging, and region splitting. Diseased patches were taken into consideration after segmentation to obtain form and colour characteristics. The results of the experiment showed that region growth was the best technique for segmenting regions.[8]

In his research, Saranya used a variety of image processing algorithms to automatically locate the nail's area and remove aberrant parts. To determine the degree of nail region affectation, shape characteristics including Perimeter, Area, and Diameter were measured. The findings were compared. As input, JPEG-formatted RGB photos of nails taken with a digital camera were utilised. Images of diseased nails against various backgrounds were required because the research was focused on extracting afflicted nail areas. Pre-processing was done using a median and average filter combination to increase precision and clarity. For improved computing efficiency, the image was grayscaled after the noise was removed. Thresholding, K-means clustering and Watershed segmentation were suggested as three segmentation strategies to remove aberrant nail sections.[9]

Jimita Baghel (2016) suggested a K-means segmentation approach for automatically detecting leaf illness. Following segmentation, the system generated a series of pictures based on colour, with a concentration on infected segments. The infection rate was then computed. Machine vision technology was used to identify plant leaf disease automatically.[10]

VI. CONCLUSION

The healthcare industry nowadays focuses a lot of emphasis on non-invasive techniques for illness diagnosis. This strategy aims to reduce intrusion while accurately diagnosing diseases. A number of characteristics of the human body and its operations can be useful tools for non-invasive illness diagnosis. These characteristics include representations of the nail, the eye, the breath, and more. A notable non-invasive method is the study of photographs of human nails. Various image processing methods, including picture acquisition, segmentation, pre-processing, and feature extraction, are used in this procedure.

This extensive review paper provides a wide range of methods used in the field of nail image analysis for diagnosing various diseases. Different classification techniques, including Support Vector Machine (SVM), K-Nearest Neighbours (KNN), and Artificial Neural Network (ANN) classifiers, are investigated in this context. Nail image analysis has the potential to provide non-invasive illness diagnosis, and it may be used to identify a variety of disorders. For careful picture analysis, basic nail characteristics including colour, shape, and texture are used.

Critical nail characteristics are rigorously retrieved and measured during the nail image analysis process. Nail form features are evaluated using criteria such as area and perimeter, whereas nail texture attributes are evaluated using energy, entropy, and compactness. Advances in categorization technologies have had a significant impact on nail image processing systems. Artificial Neural Network classifiers, Deep Neural Networks and SVM classifiers are examples of cutting-edge techniques. Through the combination of these approaches, the area of non-invasive illness detection using nail image analysis keeps growing, making major contributions to the world of healthcare

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