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A Review on Non-Invasive Smart App for Human Fingernail Photography-based Disease Detection

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Abstract - Abnormalities in a person's nails may be signs of underlying systemic disorders. Various systemic diseases have been connected to various nail abnormalities. The main objective of this project is to create a mobile application that allows users to utilize the camera on their phone to take pictures of their nails. The Custom Vision API is employed in the study to analyze the nail images and find certain nail flaws. The App shows the systemic diseases that may be connected to the reported nail anomalies when the investigation is complete. This study culminates with evidence that chronic diseases can potentially be addressed by means of abnormalities in the nails. The end result is a user-friendly smartphone application that makes it simpler to analyse fingernail pictures and offers suggestions for suspected systemic illnesses.

Key words: Custom Vision, smart application, nail abnormalities, systemic diseases.

1. INTRODUCTION

Our health and physical fitness are more important to us. However, we detect diseases that affect our bodies in their later stages or at their most severe. A proper examination of our body is therefore necessary, and it must be included in our everyday routine. When a disease is first diagnosed, many sections of the human body are examined to forecast the likelihood of the condition based on the symptoms, color, pattern, or other characteristics. The many human body parts, including the eye, hair, teeth, skin, nail, and breath, have all been employed at various phases of the disease process to determine the nature and source of the illness [1].

One method of diagnosing disease in the human body involves the examination of human fingernails. The body parts that acquire oxygen last are the nails, since they are the furthest from the heart. As a result, the first part of the human body to display symptoms of illness is the nail [2]. In traditional therapies including Siddha medicine, Ayurveda, Yunani, and Chinese medicine, irregular nails are thought to be symptoms of some ailments [3]. In the traditional Ayurvedic method of disease diagnosis, the disease prognosis was accomplished by examining the signs in the eyes, hand nails, and pulse rate [1].

The colour and texture of human nails can be used to forecast numerous disorders in the healthcare industry [4]. A computer-based study is required since it can categorise more than 16 million colours with clarity, the human eye has some limits, and some persons have ophthalmological illnesses. Additionally, due to the

human eye's poor resolution, it is impossible to detect changes in pixel brightness in close proximity [5].

Analysing the colour and texture of the nails is one approach to spot or confirm the presence of a disease. Different disorders will be indicated by distinct nail colours, such as: pink nails are typically a sign of health. An indication of anemia, heart failure, starvation, and liver dysfunction are faded pink nails. The presence of a white nail with dark borders can indicate serious liver damage, such as hepatitis. A fungus infection is indicated by the colour yellow. The nail thickens and becomes more brittle as the infection worsens. Yellow nails can occasionally be a sign of a serious illness like thyroiditis, lung disease, diabetes, or psoriasis. Blue nails can occur when there is a lack of oxygen. But other potential causes include cardiac abnormalities or lung infections like pneumonia [6].

There are various invasive and non-invasive methods available for diagnosing different types of diseases. In this article, we are proposing a smart phone app named HEKEMORA, which has the capability to detect diseases with human nail photography. The user has to take pictures of the nail using their smartphone app; the app will process the pictures taken by the user. The system will compare the user's nail image with the pre-trained data, and depending on the matching of the image with the pre-trained data, the result will be displayed. The datasets are collected from the open-source website Kaggle.com.

The paper is structured as follows: Section II gives the description of the various nail components. Problem statement given in Section III.The primary goal of the proposed app is given in Section IV. Section V provides a summary of the various methods available for diagnosing different diseases with the use of human nails. Section VI gives an idea of the methods used in the proposed system.

2.FINGERNAILS STRUCTURE

This section provides a description of the various nail components.

FIG 1: Parts of Nail

1) Mantle

The skin that covers the nail plate's matrix and base is known as the mantle.

2) Nail Folds

The lateral and proximal borders of the nail plate are shielded by the nail folds, which are soft tissue structures. The majority of the nail matrix is shielded from damage and UV radiation by the proximal nail fold.

3) Nail Bed

The nail bed starts distal to the lunula and ends at the hyponychium. It is linked to the ventral surface of the nail plate. Through longitudinal epidermal ridges, the nail plate is joined to the nail bed. In addition to the ridges on the nail bed, which serve to enhance the surface area of the nail plate's attachment to the underside of the nail bed, these ridges on the ventral nail plate surface also serve to increase the adhesion between these two surfaces. Since the keratins required for the production of this layer of the epidermis are absent, the stratum corneum does not form in the nail bed. On the other hand, if onycholysis, or the removal of the nail plate, takes place, the nail bed loses the longitudinal ridges and

starts to express the keratins required to create the stratum corneum. A thin layer of collagenous dermis lies beneath the nail bed and is attached to the distal phalanx's periosteum. When a nail
infection is present, the absence of subcutaneous fat can raise the risk of osteomyelitis of the distal phalanx.

4) Nail Plate

The firm, keratinized nail plate is made up of compact onychocytes arranged in a lamellar pattern. The nail plate's dorsal surface is ridged longitudinally but otherwise smooth. The nail matrix and nail bed are located underneath the nail plate. The nail folds and nail bed serve as solid attachment sites that permit the free edge of the nail to serve as a tool without damaging the nail plate or inflicting discomfort.

5) Nail Matrix

Deep to the proximal nail fold and nail plate is where the nail matrix is situated. Between the distal interphalangeal joint and the proximal nail fold, the proximal nail matrix begins. The lunula, a white half-moon structure that represents the distal nail matrix, can be seen through the nail plate. The nail matrix, the only component of the nail unit that includes melanocytes, is what creates the hard nail plate. To create the nail plate, the onychocytes, or nail cells, are pushed superficially and distally. Sections of the nail plate are formed by various components of the nail matrix. Typically, the distal nail matrix is used to generate the ventral nail plate, whereas the proximal nail matrix is used to form the dorsal nail plate. The proximal nail matrix, however, makes up 80% of the nail plate. Therefore, the nail plate will only sustain minor damage from a biopsy or surgical procedure on the distal nail matrix.

6) Cuticle

The proximal nail bed gives rise to the cuticle, also known as the eponychium, which attaches to the nail plate. The cuticle and proximal nail fold work together to create a seal that guards against any irritants that might disturb the matrix below.

7) Onychodermal Band

The onychodermal band, which is graphically depicted in a contrasting colour, is a component of the distal nail bed. It serves as the initial line of defence along the free edge of the nail and resembles the cuticle in function. Variations in vascular supply or illnesses can be indicated by changes in colour.

8) Hyponychium

The region beneath the free border of the nail plate and distal to the nail bed is known as the hyponychium.

3. PROBLEM STATEMENT

The degree of severity of nail conditions can vary, from trivial issues like fungal infections to much more catastrophic cancers like melanoma. Early and accurate identification of disease is essential for swift treatment and optimal patient outcomes. But existing diagnostic techniques sometimes entail intrusive procedures or trips to medical institutions, which delays diagnosis and could cause discomfort for patients.

This programme makes use of cutting-edge visual machine learning technology and depends on images supplied by users. The main objective of this programme is to provide customers a quick and effective way to identify nail problems without the need for invasive procedures. Our main goal is to

develop an approachable and user-friendly system that gives consumers complete control over healthcare administration. With this app, we want to revolutionise how nail illnesses are found and improve everyone's access to healthcare by making it easier and more proactive.

4. OBJECTIVE

1. To develop a user-friendly mobile application that allows users to capture images of their nails using their mobile camera.
2. To explore and identify different nail abnormalities associated with various systemic diseases by analyzing a diverse set of nail images.
3. To integrate the Custom Vision API into the mobile application to process and analyze nail images for identifying potential systemic diseases.
4. To assess the accuracy and reliability of the application's suggestions in identifying systemic diseases based on nail images.
5. To evaluate the user experience and usability of the developed mobile application through user feedback and testing.
6. To provide educational resources and information within the application to raise awareness about the relationship between nail health and underlying systemic conditions.

5. LITERATURE REVIEW

1. Khaleef Afdal Azman, Wan Nur Hafsha Wan Kairuddin (30 June, 2022)[7] This study focuses on picture recognition utilising four different fingernail colour analysis: yellow, white, light pink, and pink. These analyses are used to determine the type of disease where changes in nail colour are a sign of a number of disorders that predominantly affect the skin.To classify diseases such as liver disease from a white nail, lung disease from a yellow nail, and anemia disease from a pale nail, image processing techniques are used to convert the image into a digital form and extract features of a fingernail. These features are then compared to a healthy pink nail to determine the disease.First, each fingernail image will be uploaded into the GUI for image preprocessing, binary image processing, and segmentation. These methods identify the sort of colour that is being detected and isolate it. The type of disease found will be presented in the GUI system once the colour has been identified. In order to analyse the colour of fingernails and identify diseases, the red, green, and blue (RGB) value is utilised as a nail characteristic. The RGB value of the input image is used in this study to categorise the disorders, but other fingernail aspects, including the pattern, may also be taken into consideration.

2. Juna V. V. (June 6, 2021)[5] Early diagnosis of diseases in humans is crucial to maintaining good health, and a system based on nail analysis can achieve just that by forecasting illnesses based on the traits that can be derived from our nails. This image has been segmented using the OTSU method of thresholding. The ANN (Artificial Neural Network) classifier makes the prediction and searches for the colour, shape, and texture characteristics of the segmented image. Image processing using nails can outperform human ocular restrictions and increase the precision of predictions. In the medical industry, it can play a significant role.

3. Thahira Banu.V., Dr. M. Renuka Devi (March 3, 2021)[3] Diagnostic testing of the nails can be used to foretell the likelihood of numerous systemic disorders and organ failures. In ancient medical systems including Siddha medicine, Ayurveda, Yunani medicine, and Chinese medicine, irregular nails are seen as symptoms of specific disorders. This article examines the

effectiveness of current SVM and KNN classifier algorithms and contrasts them with the suggested approach. The figures Calculated and compared are accuracy, precision, recall, and F-measure. The 100 photos had been taken for research, and the most accurate segmentation approach is the one that has been suggested. The trial employs 480 photos, increasing the number of eight distinct abnormalities in the dataset. Training accounted for 70% of the photographs utilized, while 30% of the images were for testing purposes.

4. Sholomon L. Pinoliad, Duanne Austin N. Dichoso, Arlene R. Caballero, and Erlito M. Albina (2020)[8] Discovering a person's underlying systemic problems may often be done quite well by looking at their nails. Different nail abnormalities are linked to various systemic disorders. The study's goal is to use a portable camera that will allow users to take a picture of a nail. This will allow the application to identify a number of systemic illnesses discovered in light of the uploaded user-submitted nail art. The procedures used in this study cover applying the Custom Vision API to image processing and examining some irregularities in nails. This study has found that Nail abnormalities can be used to diagnose systemic illnesses, so the advocates created a programme that will assess a picture of a fingernail and list suggestions for systemic disorders.

5. Juna V.V., Dinil Dhananjayan (2019)[2] The human body's many components are examined in order to determine their diverse effects. One method of detecting sickness in the human body is through the study of human fingernails. The body part that receives oxygen the longest because of its distance from the heart is the nail. As a result, the first part of the human body to display symptoms of illness is the nail. There is no big machinery or complicated techniques required to simply catch fingernails for diagnosis. In certain circumstances, using a nail image to diagnose a disease is necessary, just like in tests and the scanning process. One of the physical tools used in investigations that is typically used in Ayurveda is a person's nail, which can serve as a powerful signal of potential concerns.

6. Rajiv Kumar, S. V. Marulkar (2017)[9] In their paper, the author uses nail shape and texture to detect disease. They use several techniques (image acquisition,preprocessing , segmentation, feature extraction, and comparison with disease, etc.) to identify the various diseases related to our human body, and the authors explained that our nails are indirectly connected to our heart for us to detect disease.

7. Anuradha Thakare (2017)[10] employed a technique based on the Noval Bicluster method in the automated medical support system she presented for identifying human health issues. Dermnet.com and Medicinenet.com provided the dataset, which was then categorised using decision trees, neural networks,and support vector machines. Based on an investigation of the color and texture of the nails, the GLCM method and the Bicolor algorithm were utilized,respectively. A multilayer perceptron was utilized to identify the data after the input photos were trained using neural network technique. For nail texture analysis, a Gray Level Co-occurrence Matrix (GLCM) is employed. This consists of contrast, energy, entropy, homogeneity, and utilization in both horizontal and vertical directions. This system's accuracy with the neural network is 88%.

8. In order to boost processing efficiency, Saranya (2017)[6] developed an image segmentation technique to identify nail abnormalities. This preprocessing was carried out using a mix of median and average filters, followed by the conversion of the picture into grayscale. To determine the shape of a nail, they used the

Watershed, Threshold, and k-means segmentation algorithms. Then, nail diseases are diagnosed using the retrieved nail image.

9. A study on eye issues using palm prints and image processing techniques was suggested by Indrakumar S.S. (2016)[11]. They choose a region of interest from an image for the purpose of detecting disease, and then they use the Sobel filter to reduce noise and the Canny algorithm to find edges and lines.

10. Sneha Gandhat (2016)[12] suggested that in order to analyse patient nail images, features should first be extracted, and then feature vectors should be created using the Haar Transforms Matrix. Prior to employing similarity metrics like MSE and absolute difference to compare the reduced feature vector with the query feature vector stored in the template dataset, they employed row means to decrease the feature vector. Then they calculate the GAR (Genuine Acceptance Ratio), decide whether the results agree, and provide the result.

11. Indi Trupti (2016)[13] proposed a system for early disease detection that analyses nail images and extracts characteristics for disease diagnosis. The Weka tool is used to prepare the training dataset from patient nail photos. A decision tree is generated using the C4.5 algorithm, and a colour-detecting algorithm is applied. In the trial, they saw that 65% of the outcomes matched the training data set accurately.

12. Vipra Sharma (2015)[14] suggested analysing the colour and texture of nails. Based on the texture of the photos, the segmentation was done, and after that, the analysis was done using both colour and texture. This analysis's findings were put to use in a number of sectors, including transitory biometrics and medicine.

13. Nityash Bajpai (2015)[15] Human nails and palms are analysed to create a proposed automated prediction method for a variety of health issues. The human palms are scanned from both sides, and the ROI is collected by extracting features. They worked on disease prediction using symbols found on the palm and nail colour. They applied several neural network back propagation algorithms to identify the symbols on human palms, resulting in a 90%–95% effective disease prediction method. For nail image processing, they employed back truncation code to create either a training vector or an input image vector, and then they obtained results by comparing the two.In order to process palm photos, they first transformed RGB colour to a grayscale image and then used the Frichen edge detection technique. Applying morphological methods like erosion and dilation on a smooth image, principal component analysis was used to produce vectors, and similarity metrics were then used to produce the desired outcome.

14. Human fingernail segmentation was proposed by Kumuda N. S. (2015)[16]. For the experiment, a grayscale image was created from a colour image, and adaptive equalisation was used to boost the contrast.

15. By examining the colour and texture of fingernails, Vipra Sharma (2015)[17] suggested an approach for illness diagnosis that segments the image and then looks at the back side of the palm. The actual nail region may be seen in the segmented image. They examine the nail's colour and texture, compare these values to those for healthy nails that have been established in advance, and then make a diagnosis. They only processed images in the following formats for this experiment: BMP, GIF, JPEG, PNG, TIFF, etc.

16. The model of nail colour analysis was first proposed by Hardik Pandit in 2013[18]. In this experiment, the

backside of a human palm is scanned, and the nail region is then extracted from the cropped image of the palm using an algorithm that analyses the RGB components and provides the average as well as pixel-by-pixel nail colour for each finger. They collected 50 reference photographs for each colour to compare. After determining the mathematical mean, a reference colour was fixed. They fixed a percentage of pixels in each nail with a certain colour to help determine the disease's stage.

17. In order to increase accuracy, Noriaki Fujishima (2013)[19] suggested a method for detecting fingernails from hand photos, including palms, using distribution density and color continuity. Only fingernails are detectable from -90 to -40 degrees and from 40 to 90 degrees with at least 85% probability.

18. Using colour processing, a model put out by Hardik Pandit (2012)[20] can be utilised to extract a section of a given image. They employed it in the experiment using the input of a palm image, separating the palm area from picture composition, RGB component analysis, picture restoration from nail colour, and palm reading from the retrieved image's colour.

19. An innovative method for hand analysis employing image processing techniques was proposed by Vishwaratne Nigam in 2010[21]. They employed a Canny filter for edge identification in the experiment, and the outcome was compared with the database. Future work was assessed to have >70% matching. Palm width, length, finger length, and their ratio were calculated using the Hough transform and pixel distance computation. Next, the output was compared to the database. They take into account a ratio-based system method and a finger length comparison-based approach for hand examination.

20. Lean Karlo Tolentino and others [22], This investigation focuses on using nail analysis to find signs of circulatory conditions like coronary occlusion, congestive heart failure, and congenital heart disease. Shape analysis, colour thresholding, and image segmentation are all part of the image processing system that was employed. Artificial neural networks (ANNs) are employed to categorise the fingernail database. Six patients were identified by the suggested detection system as having the six disorders (three with congenital heart failure, two with congenital heart disease, and one with a coronary occlusion). All of the observations and conclusions made by the attending professionals agreed with it. This led to a 100% success rate in identifying circulatory disorders.

6. PROPOSED METHOD

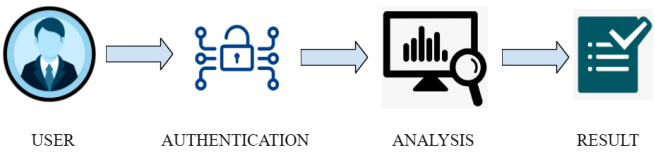
With the use of imperfections in the nails, the approach suggested hopes to create a useful application to identify systemic disorders. This method comprises of several crucial processes that guarantee the functionality of the program and, over time, improve its accuracy through ongoing learning

1. User Authentication: The process begins with the user accessing the application. To ensure security and user identity verification, the application directly authenticates the user using the Firebase service provided by Google(Any other can be Suggested). Firebase securely manages user logins and sessions.

2. Data Processing and Training: Once the user is authenticated, the application collects data, which, in this case, refers to the nail images captured by the user using their device's camera. To analyze these images and identify any nail abnormalities, the gathered data is processed and trained using **Custom Vision service** to learn and understand different nail conditions.

3. System Output: After processing and analyzing the data through Custom Vision, the application generates potential suggestions regarding systemic diseases associated with the observed nail abnormalities. These results are then sent back to the user's device for display.

4. Continuous Learning: The application is designed to continuously improve its performance and accuracy in suggesting systemic diseases. To achieve this, all captured images by the user are automatically uploaded to Firebase Storage. These collected images are then used to re-train the Custom Vision system periodically. By doing so, the application can stay up-to-date with new patterns and variations in nail abnormalities, enhancing its ability to provide more precise suggestions over time.



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CONCLUSION

As a result, the proposed technique offers a thorough and effective means of identifying systemic disorders based on nail anomalies. The programme prioritizes user authentication and data protection, uses Custom Vision for precise nail irregularity recognition, and embraces continuous learning to guarantee its efficacy and dependability. This technique has the potential to have a huge influence on healthcare by offering early identification and possibly prevention of systemic disorders through straightforward nail image analysis.

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