MEETCON- X

4. INTERNATIONAL CONGRESS ON SCIENTIFIC RESEARCH



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EDITOR:

Assoc. Prof. Dr. Nazlı Deniz CERİDHAN

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MEETCON - X

IV. INTERNATIONAL CONGRESS ON SCIENTIFIC RESEARCH

September 01-04, 2026 / Ankara, Türkiye

Editor

Assoc. Prof. Dr. Nazlı Deniz CERIDHAN

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Authors	Affiliation	Presentation Title
Mikail ASLAN	**MICROSTRUCTURAL CHARACTERIZATION, HARDNESS, AND DENSITY EVALUATION OF Mg-MnO2 COMPOSITES**	**Gaziantep University, Türkiye**
Mikail ASLAN	**THE MICROSTRUCTURE, HARDNESS AND DENSITY INVESTIGATION OF Mg COMPOSITES REINFORCED WITH Fe2O3**	**Gaziantep University, Türkiye**
Ferdi DOĞAN **Melek DEMİR PERÇİN**	**COMPARISON OF DEEP LEARNING MODELS FOR CORAL BLEACHING DETECTION AND THE CorefNet ARCHITECTURE**	**Adıyaman University, Türkiye**
Melek DEMİR PERÇİN	**BIOCHEMICAL AND CHEMOTAXONOMIC EVALUATION OF FATTY ACID PROFILES IN ORNITHOGALUM SPECIES**	**Adıyaman University, Türkiye**
Canan TASTIMUR	**AUTOMATED NAIL DISEASE CLASSIFICATION USING DEiT-TINY**	**Erzincan Binali Yildirim University, Türkiye**
Canan TASTIMUR	**SEMICONDUCTOR WAFER PATTERN RECOGNITION USING GHOSTNET: BALANCING ACCURACY AND PARAMETER EFFICIENCY**	**Erzincan Binali Yildirim University, Türkiye**

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AUTOMATED NAIL DISEASE CLASSIFICATION USING DEiT-TINY

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ABSTRACT

Various dermatological disorders manifest as changes in the shape and structure of the nails. Accurate diagnosis of these disorders by a specialist is influenced by the physician's experience and prior knowledge of similar conditions. The advancement of this process using artificial intelligence has become increasingly popular recently. In this study, six different types of disorders were automatically identified using a lightweight transformer architecture, DeiT Tiny Transformer. Various data enhancement techniques were applied to the model during training to improve its generalization capabilities under different lighting conditions. Experimental results showed that the proposed model completed the diagnosis of nail diseases with 99.50% training accuracy and 97.15% validation accuracy. The proposed model learns data from its existing version with high performance and has a strong generalization ability on data it has not previously encountered. Furthermore, in this study, in addition to classification, the model's focus on diseased nails was visualized using Transformer-CAM, ROC curve, and confusion matrix results.

Keywords: Nail diseases, deep learning, Vision Transformer, DeiT-Tiny, image classification, explainable artificial intelligence, Transformer-CAM.

INTRODUCTION

Nails are an important anatomical structure that holds clues about the health of the human body. Various deformities on the nail surface can be considered indicative of both dermatological disorders and systemic diseases. Therefore, early detection of certain changes on the nail surface is very useful in determining which disease they belong to. The similarity of changes on the nail surface in the early stages of the disease and the dependence on physician experience create uncertainty. Traditional disease assessments rely on physician experience, laboratory tests, and physical examinations. The high patient load and limited number of specialists make the diagnostic process difficult. The visual similarity of some nail diseases makes diagnosis quite challenging. Indeed, different diagnoses can be made by different specialists and in different hospitals. Considering these reasons, the development of an automated image-based diagnostic system kit is beneficial. At this stage, various AI-supported diagnostic systems have been created with the aim of providing decision support and assisting in the pre-evaluation phases, rather than replacing the physician.

In recent years, convolutional neural network (CNN) based approaches have been used in the automated analysis of medical images. With the help of CNN, edge shapes and texture patterns in images have been examined in detail, producing successful results in medical image classification. However, due to the high computational capacity and high memory requirements of CNN-based approaches, alternative methods have also been developed. One of these is the Vision Transformer architecture. In addition, since the computational capacity of the classic Vision Transformer architecture remains high for some applications, the Data Efficient Image Transformer (De-IT) has emerged to lighten this architecture. In this study, this model was preferred due to its computational efficiency and lightweight structure. Many nail disease detection approaches exist in the literature.

Indi and Patil (2019) applied various processes such as pre-processing and segmentation to nail images. Color, shape, and texture features were extracted to determine the disease. After obtaining features such as standard deviation, skewness, and kurtosis, and generating values such as entropy and energy, classification was performed using various machine learning techniques such as Support Vector

Machine, k-Neighbour Nearest, and Random Forest. Abdulhadi et al. (2021) classified four different nail disease conditions: nail hyperpigmentation, normal nails, nail clubbing, and nail fungus, using transfer learning models. Using AlexNet, VGG16, GoogLeNet, ResNet50, and DenseNet201 architectures, the lowest result was obtained with the VGG16 model at 87.50% accuracy, while the highest result was achieved with ResNet50 and DenseNet201 at 96.39% accuracy.

Aishwarya and Nijhawan (2019) used the VGG19 transfer learning model for the automatic detection and classification of onychomycosis, a common nail disorder. Various machine learning architectures such as Decision Tree, Random Forest, and AdaBoost were tested to compare the classification performance. However, the highest results in onychomycosis detection were obtained with a deep learning-based architecture. Alzahrani et al. (2023) in their study... The dataset, which includes 821 nail images, contains diagnoses of eczema, normal nails, Beau's lines, and melanoma. Feature extraction was performed using VGG16, InceptionV3, and DenseNet201 transfer learning architectures. Stochastic Gradient Descent was then used in the classification phase. The highest result was obtained with DenseNet201 + SGDClassifier, achieving 94% accuracy.

Nijhawan et al. (2017) trained a CNN network from scratch on 11 different nail diseases: onychomycosis, subungual hematoma, Beau's lines, yellow nail syndrome, psoriasis, hyperpigmentation, koilonychia, paronychia, pincer nail, leukonychia, and onychorexis. The samples in the dataset were trained. This study was tested and trained using several different scenarios. In the first scenario, all nail images were trained from scratch on the CNN network. In the second scenario, the nail... The image was divided into upper and lower halves, and two different features were extracted using CNN and then classified using Random Forest during the classification phase. In the third scenario, CNN features from the upper, lower, and full nail images were combined, and the image was classified using Random Forest. In the final scenario, features were extracted from the upper-left, upper-right, lower-left, and lower-right images using CNN, and then the classification phase was again carried out using Random Forest. While an accuracy of 84.58% was obtained in Scenario 3, approximately the same accuracy was achieved in Scenario 4, although the training time for the model was approximately 4 hours longer.

Singhe et al. (2025) designed a hybrid model based on deep learning and machine learning for the automatic diagnosis of various nail infections and disorders. Acral Lentiginous Melanoma, healthy nail, onychogyrphosphatase Yamaç et al. (2022) established a hybrid architecture using the VGG16 model and SVM for 6 different nail diseases: Onychogryphosis, Blue Finger, Clubbing, and Pitting. The experimental performance yielded a total of 3835 images with 94.36% accuracy. They classified 5 different nail disorders: Blue Nail, Clubbing, Muehrcke's Lines, Splinter Hemorrhage, and Onycholysis. Using data augmentation techniques, they generated 1309 total images from a public nail disorder dataset containing 234 original images. VGG16, DenseNet169, MobileNet, Xception, InceptionResNetV2, and ResNet101V2 were used in this transfer learning model. Through testing, they achieved the highest accuracy of 89% with the ResNet101V2 architecture.

Nijhawan et al. (2026) used a Stable Diffusion-based text-to-image model for binary classification to classify diseases in visually diverse nail images. They applied few-shot learning to a specific nail dataset, using MobileNetV2 and Vision Transformer together. The acuradcy increase was 3.26% compared to using only MobileNetV2. Marulkar and Narain (2023) used CNN and Random Forest together to classify 11 different nail diseases—Beau lines, hyperpigmentation, onychomycosis, subungual hematoma, yellow nail syndrome, psoriasis, koilonychia, paronychia, pincer nails, leukonychia, and onychorexis—with 87.33% accuracy.

Chuanchit et al. (2023) Six different classes were found, and an accuracy of 84.6% was obtained with the DenseNet121 architecture on a dataset containing Beau's lines, Melanonychia, Nail Clubbing, Onycholysis, Terry's nail, and normal nails. The dataset used contained a total of 756 nail images, and its use in training was divided into 76% training, 14% validation, and 10% testing. Nasra and Gupta (2025) performed classification on a dataset containing six different nail diseases: Acral Lentiginous Melanoma, Healthy Nail, Onychogryphosis, Blue Finger, Clubbing, and Pitting, using the ResNet18 architecture. As a result of this approach, which involved the application of various data enhancement techniques, they achieved approximately 91% accuracy. Kaushik and Sharma (2024), in their study on

6 different nail diseases with a total of 3,835 nail images from the same dataset, achieved 89% accuracy with the DenseNet121 architecture.

Dora et al. (2025) completed the training of models with the ResNet101, VGG16, and InceptionV3 architectures using a transfer learning approach on a public nail disease dataset. With a total of 8536 nail images from a dataset of 17 different nail diseases, they achieved 99.94% accuracy in the ResNet101 architecture. Hadiyoso and Aulia (2022), using the VGG16 architecture, Adam optimizer, and 10 epoch training, achieved 96% accuracy for 3 different nail disease classes: Koilonychia, Beau's Lines, and Leukonychia. Rajan et al. (2022) similarly achieved 95% accuracy using the AlexNet transformer learning architecture with a total of 185 nail images. In this study, unlike other studies, classification was done binary (healthy-diseased) instead of multi-class disease classification. Boopathi et al. (2025) obtained 97% accuracy by applying fine-tuning to the MobileNetV2 architecture with 10 different diseases including Acral Lentiginous Melanoma, Healthy Nail, Onychogryphosis, Bluish Nail, Clubbing, Onychomycosis, Pitting, Psoriasis, Splinter Hemorrhage and Yellow Nail, containing a total of 5,730 labeled nail images from a public nail database.

Table 1. Literature review for nail disease classification

Study	Method	Dataset	Accuracy
Abdulhadi et al. (2021)	AlexNet, VGG16, GoogleNet, ResNet50, DenseNet201	280 images, 4 classes	96.39%
Alzahrani et al. (2023)	VGG16, InceptionV3, DenseNet201 + SGD	821 images, 4 classes	94.00%
Nijhawan et al. (2017)	Hybrid CNN + Random Forest	11 classes	84.58%
Singhe et al. (2025)	VGG16 + SVM	6 classes	94.36%
Yamaç et al. (2022)	VGG16, DenseNet169, MobileNet, Xception, InceptionResNetV2, ResNet101V2	234 images → 1,309 augmented images, 5 classes	89.00%
Marulkar and Narain (2023)	CNN + Random Forest	11 classes	87.33%
Chuanchit et al. (2023)	DenseNet121 + Transfer Learning	756 images, 6 classes	84.60%
Nasra and Gupta (2025)	ResNet18 + Data Augmentation	6 classes	>91.00%
Kaushik and Sharma (2024)	DenseNet121 + Transfer Learning	3,835 images, 6 classes	89.00%
Dora et al. (2025)	ResNet101, VGG16, InceptionV3 + Transfer Learning	8,536 images, 17 classes	99.94%
Hadiyoso and Aulia (2022)	VGG16 + Adam Optimizer + Transfer Learning	3 classes	96.00%
Rajan et al. (2022)	AlexNet + Transfer Learning	185 images, binary classification	95.00%
Boopathi et al. (2025)	MobileNetV2 + Fine-tuning	5,730 images, 10 classes	99.69%

METHODOLOGY

A lightweight vision transformer model was used to automatically identify which disease symptom is present in nail images. Morphological features were automatically extracted from color, texture, and shape characteristics of nail images using a highly accurate and lightweight model. In the first stage, the images in the dataset were automatically scanned according to class folders, and each image was matched with a label belonging to the relevant disease class. The dataset used was a public dataset obtained from Kaggle (Gurov, 2024), with data separated as 70% training, 15% validation, and 15% test. Figure 2 shows which diseases nail disorders might be indicative of. Various data augmentation techniques were also applied to this dataset, which consisted of 224x224 pixel nail images taken under different lighting conditions. DeiT-Tiny is a lightweight Vision Transformer architecture that divides images into small 16x16 pixel image patches and processes these patches as Transformer tokens. A 224x224 input image is divided into 196 image patches and transferred to Transformer layers along with a custom token used for classification. Thanks to its self-attention mechanism, the model can learn the relationships between different regions of the nail image and evaluate distinctive visual patterns related to the disease within a global context. The model's original classification layer was restructured according to the six-class problem in the study, and the output size was set to six.

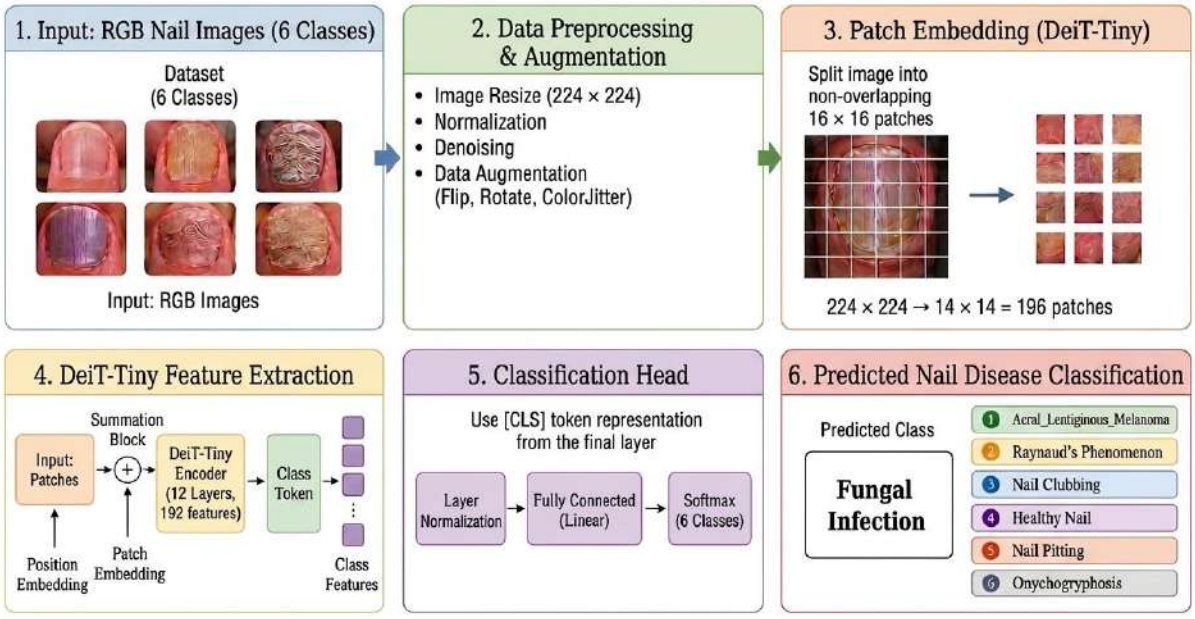


Figure 1. Nail disease detection for proposed arcitecture

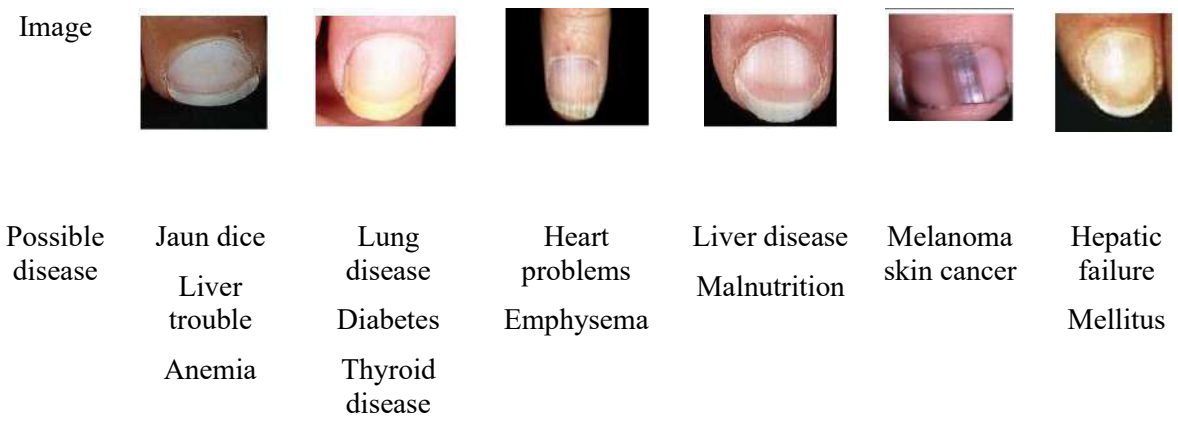
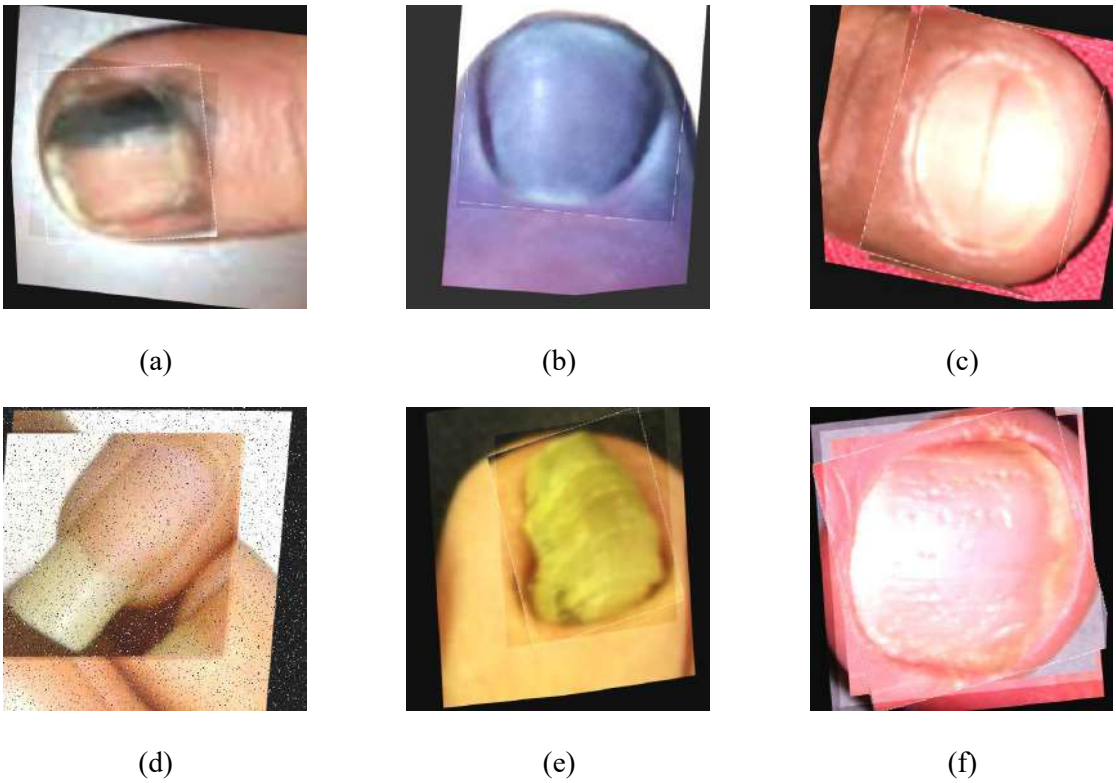


Figure 2. Nail diseases based on color and shape

EXPERIMENTAL RESULTS

In this study, classification metrics, complexity matrix, ROC curve, and classification score for each class were evaluated to assess the performance of the proposed model. This study was conducted on a system with a 13th generation Intel Core i7-13620H central processing unit (CPU) and an NVIDIA GeForce RTX 4060 Laptop GPU graphics processing unit (GPU). Figure 3 shows an example visualization of the public nail disease dataset used in this study. The training and validation accuracy curves and loss curves of the proposed model are shown in Figure 4. It is clear that the model successfully completed the training and did not experience overfitting. The ROC curve presented in Figure 5 supports this. In the confusion matrix in Figure 6, only 16 test samples were mislabeled, while all other classes were correctly labeled. The t-SNE visualization space presented in Figure 7 shows how well the model differentiated and grouped the sample test images.



(a) (b) (c)

(d) (e) (f)

Figure 3. Sample drug images belonging to the categories (a) Acral_Lentiginous_Melanoma, (b) blue_finger, (c) clubbing, (d) Healthy_Nail, (e) Onychogryphosis, (f) pitting .

Table 3. Class-wise performance analysisof the proposed model

Classes	Precision	Recall	F1-Score	Support
Acral_Lentiginous_Melanoma	0.9908	0.9730	0.9818	111
Healthy_Nail	1.0000	0.9583	0.9887	48
Onychogryphosis	1.0000	0.9804	0.9901	102
Blue_finger	0.9556	0.9556	0.9556	90
Clubbing	0.9262	0.9826	0.9536	115
Pitting	0.9789	0.9688	0.9738	96

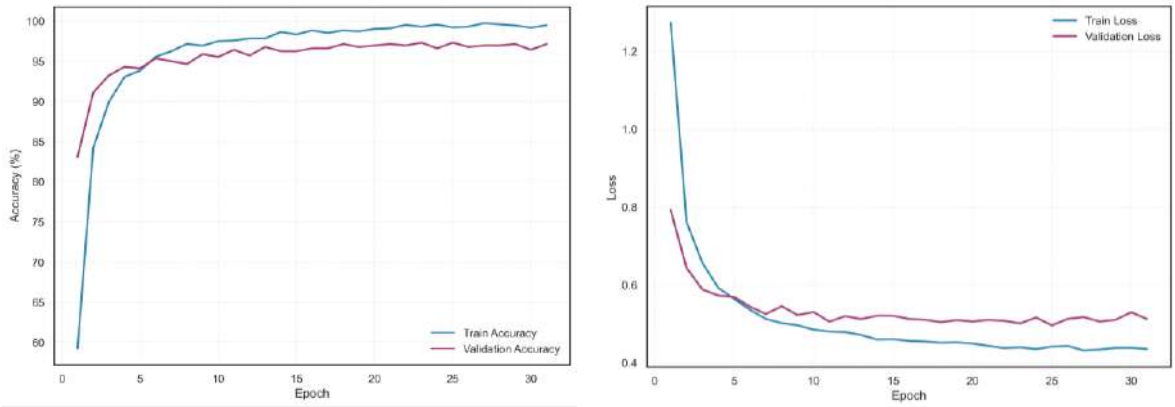


Figure 4. Training and validation curve of the proposed model

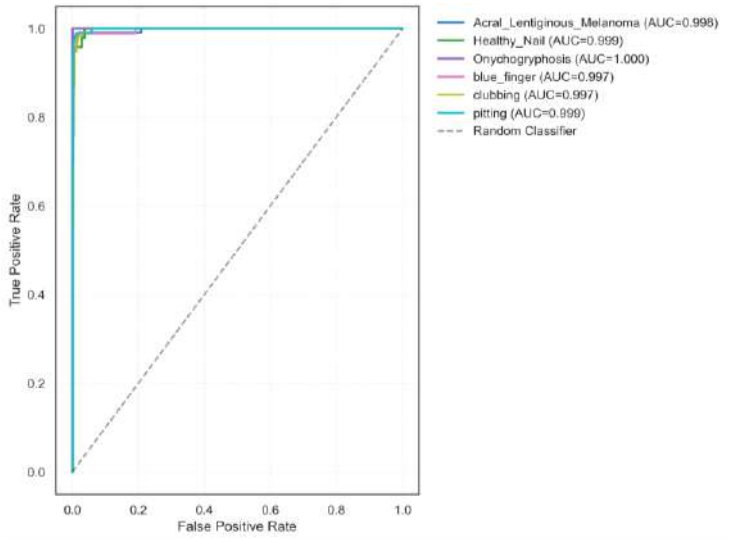


Figure 5. ROC curve of the proposed model

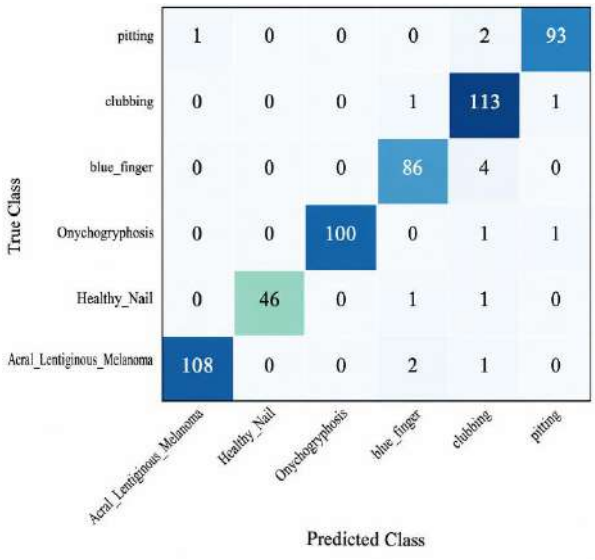


Figure 6. Confusion matrix of the proposed model

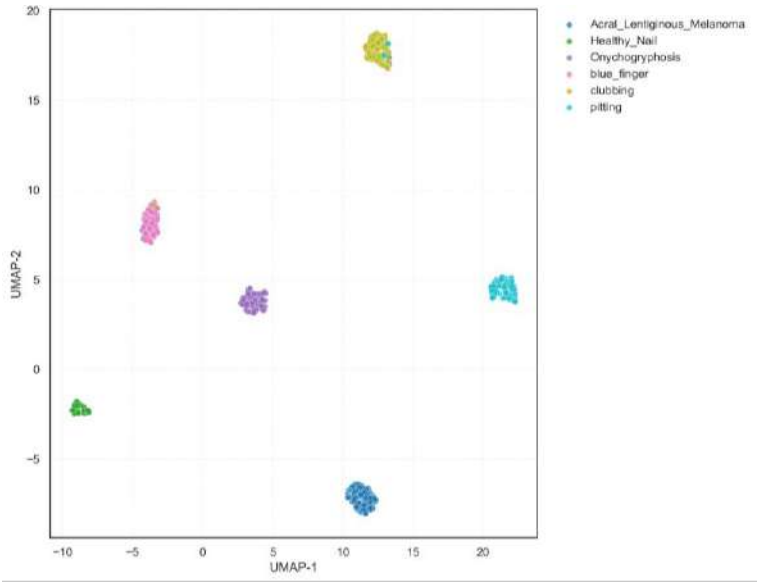
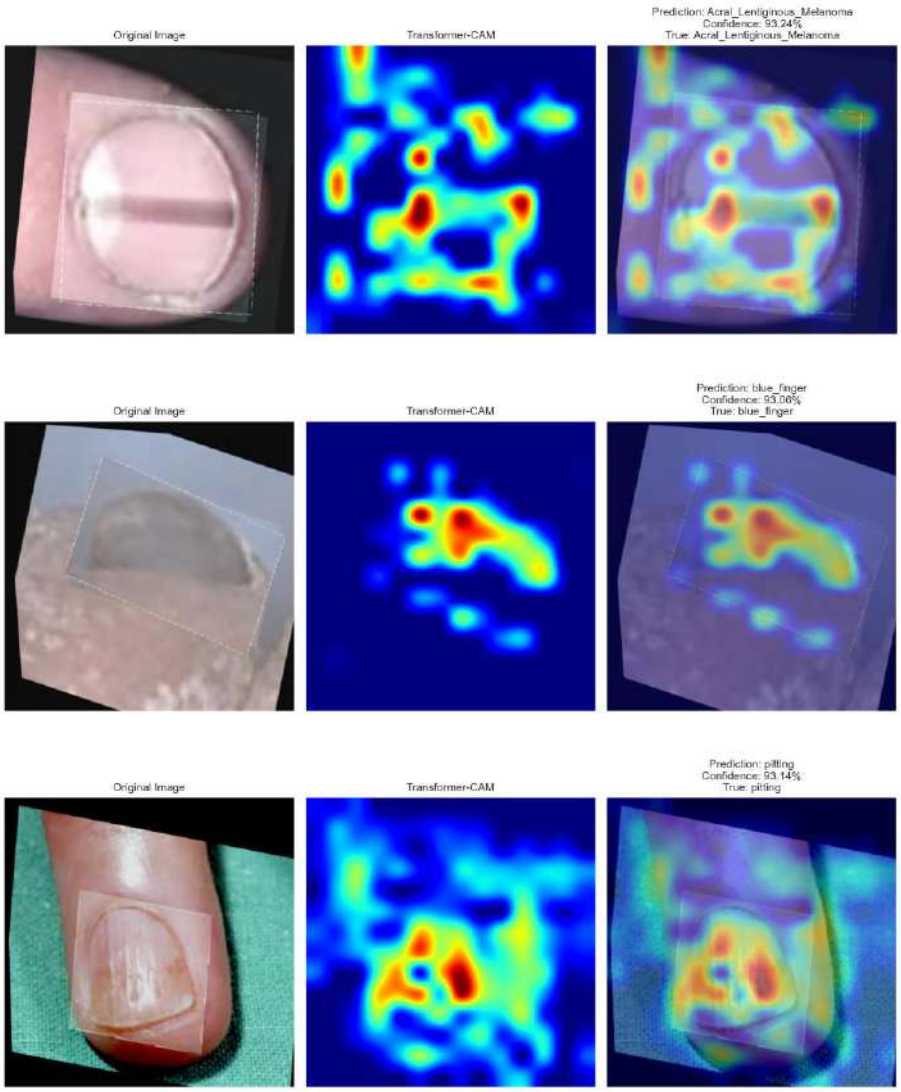


Figure 7. t-SNE visualization of the proposed model



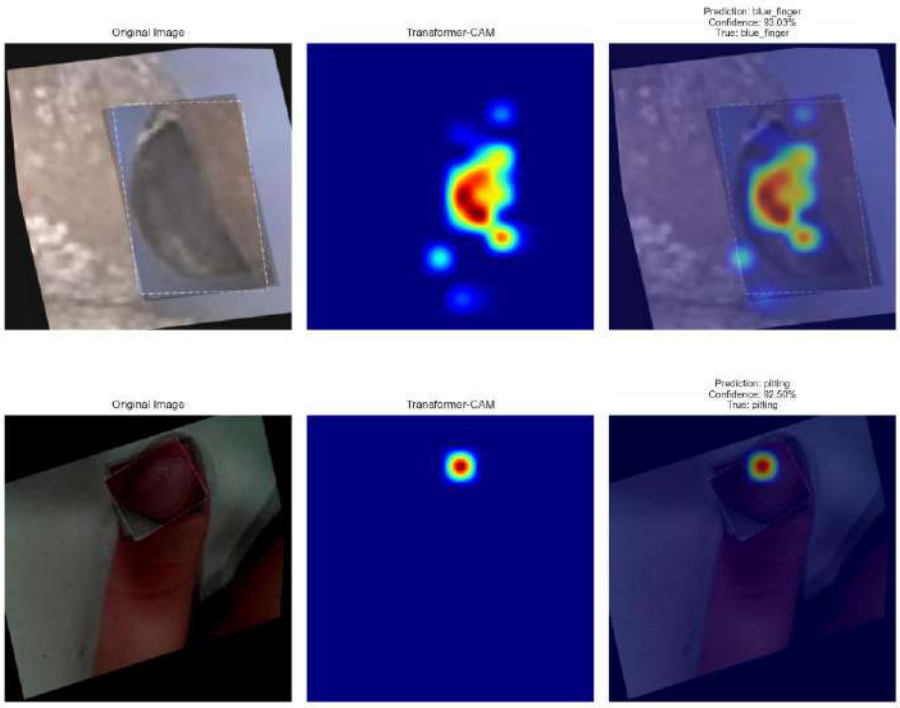


Figure 8. Transformer-CAM visualization of the proposed model

CONCLUSIONS

In this study, a lightweight DeiT-Tiny-based Vision Transformer model was developed for the automatic classification of six nail disease classes. Using ImageNet-pretrained weights and data augmentation, the proposed model achieved 99.50% training accuracy and 97.15% validation accuracy. The Transformer-based architecture enables effective learning of discriminative visual patterns from nail images while maintaining a lightweight structure. Model performance was evaluated using accuracy, precision, recall, F1-score, and confusion matrix analysis. In addition, Transformer-CAM was employed to visualize the image regions contributing to the model's predictions, improving the interpretability of the classification process. The results demonstrate that the proposed approach provides a promising balance between classification performance and interpretability for AI-assisted nail disease screening. Future work will focus on larger clinical datasets, external validation, and real-world smartphone-based applications.

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