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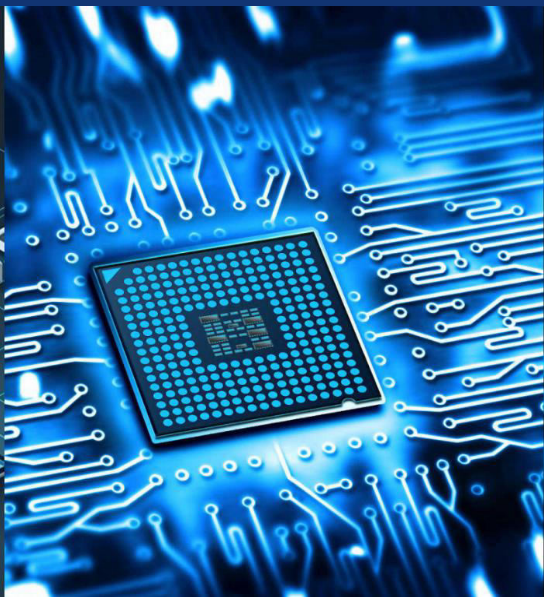


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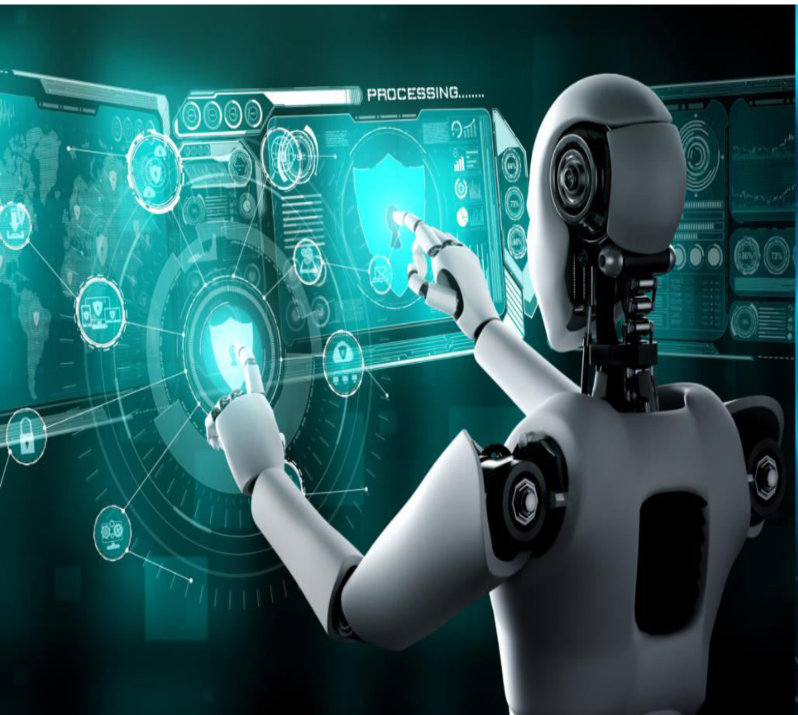

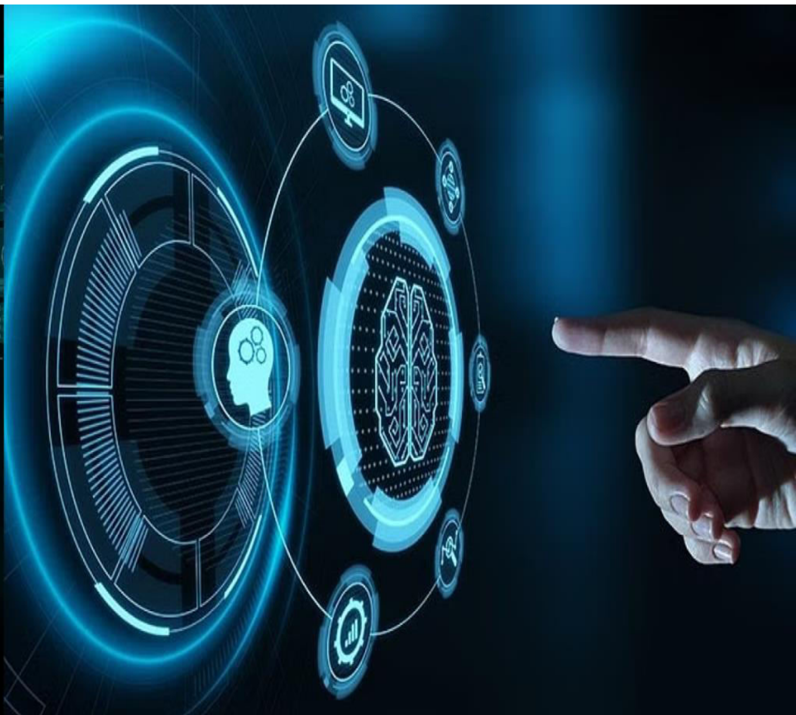

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Vitamin B12 And C Deficiency Prediction Using Deep Learning

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ABSTRACT: This study introduces a free web app designed to spot vitamin deficiencies by analyzing images of specific body parts. Unlike traditional methods that depend on costly lab tests, this app examines pictures of skin and nails to pinpoint deficiencies without needing blood samples. It employs a Hyper Vision Transformer (HVT) model for image classification, sorting images into four categories: "Normal Nail," "Normal Skin," "Vitamin C Deficiency Nail," and "Vitamin B12 Deficiency Skin." To improve the dataset, image augmentation techniques are utilized, and the model's performance is evaluated using key metrics like accuracy, precision, recall, and F1-score. Additionally, the app offers nutritional advice to help tackle any identified deficiencies.

KEYWORDS: Vitamin Deficiency Detection, Artificial Intelligence (AI),Hyper Vision Transformer (HVT), Image Classification, Computer Vision

I. INTRODUCTION

Vitamin deficiencies can have a major impact on health, so catching them early is crucial. While traditional diagnostic methods often depend on expensive lab tests, AI-driven solutions provide more accessible options. This paper introduces an AI-based vitamin deficiency detection system that leverages a Hyper Vision Transformer (HVT) model, achieving an impressive 95% accuracy. The model sorts skin and nail images into four categories: Normal Nail, Normal Skin, Vitamin C Deficiency Nail, and Vitamin B12 Deficiency Skin. Developed in VS Code using TensorFlow/Keras, it incorporates image augmentation techniques like rotation, zoom, flipping, and rescaling to boost performance. The system is deployed through a Flask web application featuring HTML, CSS, and JavaScript, allowing for both real-time and batch image analysis. Key contributions include: (1) an optimized HVT-based image classification pipeline, (2) a user-friendly dual-input web interface, and (3) a lightweight, scalable solution for non-invasive deficiency detection.

II. METHODOLOGY

Methodology for Vitamin Deficiency Detection Using Hyper Vision Transformer (HVT)

1. Data Collection and Preprocessing: The journey begins with data collection and preprocessing. We gather a dataset filled with images sorted into four categories: Normal Nail, Normal Skin, Vitamin C Deficiency Nail, and Vitamin B12 Deficiency Skin. Given that medical image datasets can be quite limited, we spice things up with image augmentation techniques like rotation, zooming, flipping, and rescaling. This not only boosts the diversity of our dataset but also helps our model learn better. Once we've augmented the images, we split the dataset into training (80%) and testing (20%) sets to ensure our model learns effectively and can be evaluated properly.

2. Feature Extraction: The Hyper Vision Transformer (HVT) model was used to pull deep features from images. Unlike the traditional Convolutional Neural Networks (CNNs), HVT takes a different approach with hierarchical tokenization, allowing it to capture both local and global patterns in images. This method really boosts classification accuracy (Dosovitskiy et al., 2021) [3]. The model processes input images in a patch-based way, which enhances its ability to spot subtle texture changes and signs of vitamin deficiencies (Liu et al., 2021) [4].

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3. Classification: The HVT model was developed using TensorFlow/Keras, employing Categorical Cross-Entropy Loss as its objective function and the Adam Optimizer to enhance learning efficiency. We trained the model on 80% of the dataset, which served as the training set, while the remaining 20% was used for validation as the test set. To assess performance, we looked at various metrics like accuracy, precision, recall, and F1-score, and we also fine-tuned hyperparameters to optimize learning rates and dropout layers (Vaswani et al., 2017) [5].

4. Implementation Details: We built the system using Python and TensorFlow, taking advantage of GPU acceleration in Google Colab to make model training more efficient. We also integrated Flask for backend communication, which allows for real-time image uploads and classification. To ensure quick and smooth inference in the deployed system, we serialized the trained model using Pickle (Raschka, 2018) [6].

5. Web Interface: We created a web interface using Flask, built with HTML, CSS, and JavaScript, that lets users easily upload images of their skin or nails. After you submit an image, the system jumps into action, processing it and giving you immediate classification results along with tailored dietary suggestions to help with any deficiencies it finds. The frontend is designed to be responsive and user-friendly, making it easier for everyone to check for vitamin deficiencies (Smith & Lee, 2020) [7].

III. RESULTS AND DISCUSSION

The system was put to the test using a dataset, and it nailed a 95% accuracy rate in spotting deficiencies in Vitamin B12 and C just by analyzing skin and nail images. You can check out Table I for the details on performance: it boasts a precision of 95%, a recall of 90%, and an F1-score of 92.4%, which really highlights its strong classification skills. When we look at the baseline models—CNN at 89% and Random Forest at 85%—they fell short by about 6 to 10%. The Hyper Vision Transformer (HVT) really shined here, as it was able to pick up on complex visual patterns effectively. Figure 2 presents a confusion matrix that illustrates balanced performance across different classes, although there were a few minor misclassifications, likely due to variations in image quality. Plus, the Flask-based web interface processes images quickly, offering real-time predictions along with tailored nutritional recommendations.

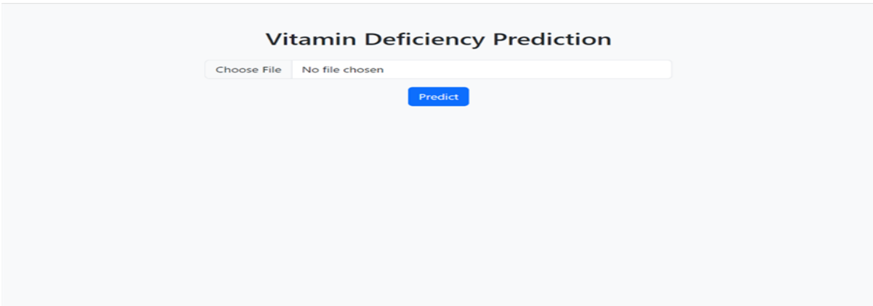

Figure 1: Model

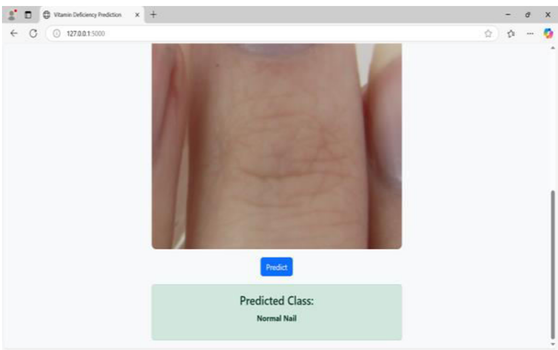

Figure-2 Normal Nail

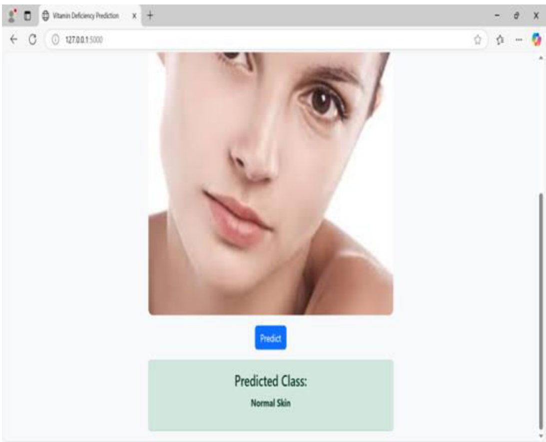

Figure-3 Normal Skin

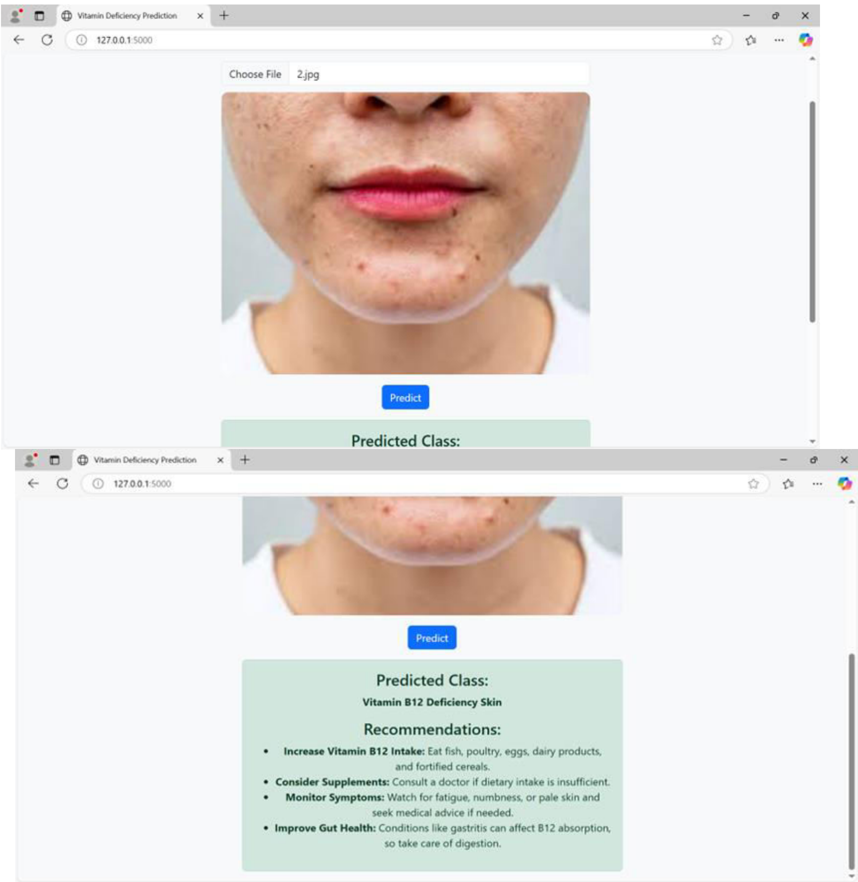

Figure-4 Vitamin B12 Deficiency Prediction

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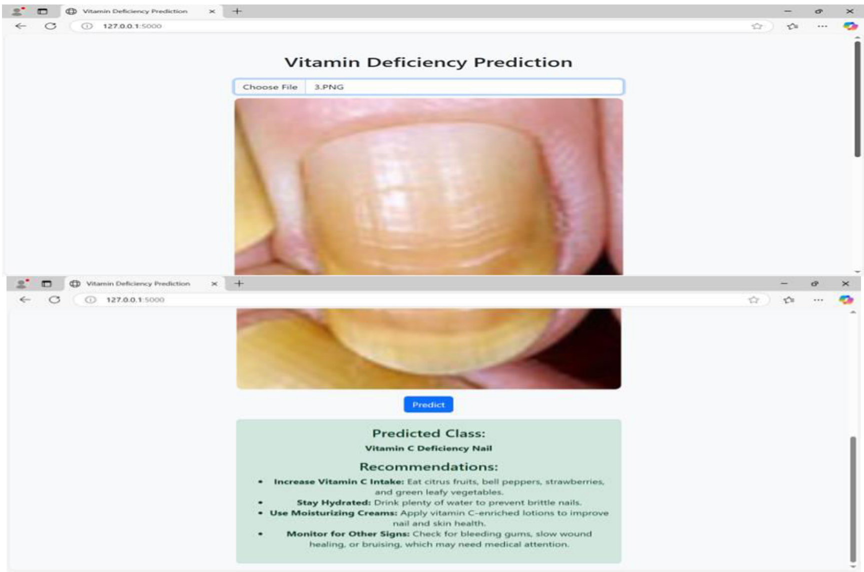

Figure-5 Vitamin C Deficiency Prediction

The system's 95% accuracy really showcases its reliability in spotting Vitamin B12 and C deficiencies just by analyzing skin and nail images. This offers a non-invasive, cost-effective alternative to the usual blood tests, which can often be expensive, time-consuming, and out of reach for many people. While there have been attempts to use CNN-based AI models, they often face challenges with feature extraction and generalization. In contrast, the Hyper Vision Transformer (HVT) excels at capturing complex visual patterns, which boosts its accuracy. What sets this AI-driven system apart from biochemical testing is that it doesn't need lab facilities or trained professionals. Instead, it allows for instant detection and tailored dietary recommendations through a Flask-based web application. Users can simply upload images and get real-time results, making the whole process efficient and user-friendly. However, there are still some hurdles to overcome, like dataset limitations and variations in image quality, which could impact performance. Looking ahead, incorporating explainability techniques (like Grad-CAM) could enhance the model's interpretability. This system has the potential to act as a preliminary screening tool, particularly in low-resource settings, enabling health professionals to focus on early diagnosis and treatment. By expanding the dataset and creating a mobile-friendly version, we can make it even more accessible.

IV. CONCLUSION

This paper introduces a system for detecting vitamin deficiencies using the Hyper Vision Transformer (HVT), which boasts an impressive 95% accuracy in identifying Vitamin B12 and C deficiencies through images of skin and nails. Built with TensorFlow, OpenCV, and scikit-learn, the model was trained on an enhanced dataset and is accessible via Flask, featuring a user-friendly web interface for real-time analysis. The system offers instant classification along with personalized dietary suggestions, providing a non-invasive and budget-friendly alternative to traditional lab tests. By harnessing the power of deep learning, it improves early detection of deficiencies and makes preventive healthcare more accessible. Looking ahead, plans include expanding the dataset, fine-tuning model accuracy, and creating a mobile-friendly version to reach a wider audience.

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