A Unique Comprehensive Analysis for Detecting Vitamin Deficiencies using Picture Analysis through Image Processing

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***Abstract*— Vitamins are indispensable constituents of our daily intakes, also their consumption plays a pivotal role in maintaining overall health. Inadequate intake of vitamins can lead to the development of deficiencies, which can have serious health consequences. This project presents an innovative solution for the early diagnosis of vitamin insufficiencies through the use of artificial intelligence (AI).Specifically, it introduces a user-friendly, free desktop application that leverages images of patient's eyes, mouth, tongue, and nails to identify potential vitamin deficiencies without the need for traditional blood samples. The application offers users a comprehensive report on any potential vitamin deficiencies they may have, accompanied by recommendations on dietary adjustments to enhance their vitamin intake and mitigate deficiencies. The AI software is trained to distinguish between images of individuals with healthy features and those displaying signs of vitamin deficiency, making it a valuable tool for early identification.**

***Keywords*—ECG, Machine Learning, Deep Learning, Concurrent Neural Network, ECG Signals, Arrhythmia.**

I. Introduction

A lack of vitamins contributes to hundreds of health problems that we face on a daily basis. Many of these health difficulties result from inadequate nutrition and mineral acquisition. Accurately monitoring our dietary requirements is challenging, particularly when people lack medical guidance and are unaware of the specific type of shortage they may be experiencing. Almost 2 billion people globally experience vitamin deficiencies. Every year, half a million people who are zinc deficient die, numbering over 1.2 billion. In a similar vein, anemia brought on by an iron shortage claims the lives of over 100,000 individuals. Locally, deficits in several vitamins affect about 90% of the population in the United Arab Emirates. The proposed system introduces an automated image processing system for accurate detection and classification of various vitamin deficiencies in human tissue or skin images, aiming for non-invasive early diagnosis. [1]

The methodologies encompass data collection, preprocessing, feature extraction, deep learning model selection, training, anomaly detection, and continuous monitoring. The anticipated results involve a web application for image uploads, utilizing a deep learning model for segmentation, predicting vitamin deficiencies, and providing detailed information on type, causes, and necessary resources. It's likely that something is lacking even in the case of the ideal diet being consumed. While 90% of Americans of color and 70% of older Americans lack enough vitamin D, Mostly half of the them were lacking magnesium, vit A, and vit C. When asked if they were aware that they had a vitamin deficit earlier this year, a sample of 100 university students responded "no" in a poll. Although this little study's sample size is insufficient to accurately reflect the population, it may nevertheless be able to provide an estimate of the true level of social awareness.

The project's scope also includes the application of traditional and deep learning techniques in healthcare, utilizing diverse datasets. The organized report comprises sections on introduction, methodology, results, scope, and conclusion, ensuring clarity and coherence. Even though there isn't a famine crisis affecting the entire nation, data gathered on American soil indicates that over 92% of people have at least one vitamin or mineral deficit. [2]Because cheap, readily available processed junk food is so widely available, nutrient rich meals are now seen as expensive and have shifted from being the usual daily food intake to more of a status symbol. Micronutrient deficiencies in the soil itself have been discovered by researchers. When Canadian scientists compared the nutrient content of vegetables in 2003 with data from fifty years earlier, they discovered that the mineral richness of cucumbers, spinach, broccoli, lettuce, and cabbage had decreased from 400 mg to < 50 mg, indicating a deteriorating nutrients tendency.

II. Background

Researchers from the United States assessed blood samples from 235 hospitalized COVID-19 patients and then monitored the patients to see how they were doing.

Individuals with sufficient levels of vitamin D had a lower risk of dying from COVID-19. According to recent research published on May 18, 2020, keeping a healthy blood level of vitamin D can help prevent COVID-19 infection and the need for an intensive care unit. He investigated the relationship between variations in death rates in different nations and vitamin D insufficiency. In one of the most recent investigations, vitamin D insufficiency affected about 80% of 200 COVID-19 hospitalized patients. Patients' blood levels of vitamin D were also elevated. However, the researchers did not discover any connection between low D levels and the severity of the illness. According to current research, getting the right amount of vitamins can help lower the chance of developing serious medical issues. Therefore, it's critical to identify vitamin deficiencies. We need to include vitamins in our diets. [3] Hence vitamins must be a part of our diets. Inadequate consumption of the recommended amount of vitamins will lead to a deficit. An artificial intelligence (AI) system for the early identification of vitamin insufficiency is presented in this paper.

This free desktop tool detects vitamin inadequacies by analyzing pictures of nailbeds, lips, mouth, and eyes of the patient rather than plasma testers. The app will provide users with a report on any potential vitamin deficiencies they may have as well as dietary suggestions to help them up their vitamin intake and prevent deficits.

The program has been trained to distinguish between snapshots of the tongue, lips, eyes, and nails of individuals in faultless well-being and the individuals who remain vit D scarce. Early detection of vitamin deficiencies can prevent major issues such as anemia, deaths from infectious diseases, deaths in mothers or during childbirth, and issues with cognitive and physical development.

III. Literature review

Ajith Archana and Vrinda Goel (2017) this research suggests an image processing-based approach for the diagnosis of skin diseases. This technique is entirely noninvasive to the patient's skin and is mobile based, making it very accessible even in distant locations. As input for the prototype, the patient submits a photograph of the skin infection.

Roy Kyamelia, Chaudhuri Sheli Sinha (2023) Skin is the outermost integument of the human body. Individual differences in skin pigmentation mean that people might have combination, dry or oily skin types. The diverse range of human skin types provide a rich environment for bacteria and other microbes. Human skin cells called melanocytes create melanin, which has the ability to absorb UV rays from sunlight and cause damage to Human skin cells called melanocytes create melanin, which has the ability to absorb UV rays from the sun and cause skin damage and skin cancer.

Anutosh Maitra, Nataraj Kuntagod, and Rambhau Eknath Rote(2017) This study argues that managing malnutrition calls for an integrated digital strategy that considers data accessibility as well as the links between different programme indicators and the socioeconomic status of the area as well as the demographics of the family.

Herman Yuliansyah, Izzati Muhimmah, Sri Winiarti, and Sri Kusumadewi (2017) Three clusters on nutritional status will be produced as a result of the decision: improved nutrition, malnutrition, and excellent nutrition. When consuming food, mobile applications serve as a helpful reminder of the components or nutritional value listed on the packaging. An 80% validation rate was obtained from the system testing conducted for the FCM algorithm's implementation in this mobile application.

Chu-Sing Yang, Shih-Hsiung Lee (2017) This research attempts to separate distinct portions of the nail using an image preprocessing approach. nail plate with lunula. The lunula might not be visible in the data with poor image quality. This article employs a microscope to take nail images in order to retain the quality of the images. In addition to the lunula and nail plate, the microscope picture makes evident the intricacies of the nail, including the free edge, cross striations, and longitudinal striations.

Cynthia Hayat and Barens Abian's (2018)study was divided into two stages: the training phase, which used feed-forward of the activation function to build the ANN weight, and the testing phase, which assessed the output of the previous stage.

Bambang Lareno, Liliana Swastina, and Husnul Maad Junaidi(2018) The goal of this work is to identify an IT application model that can be utilised to map the relationship between the rate of posyandu utilisation and the possibility of malnutrition issues. The end product is a cross-platform information model that consists of a web-based core system and a support system based on mobile applications.

Sambit Bakhshi(2019) Using a deep convolutional neural network (CNN) that has already been trained, the authors of this research suggest an automated technique for treating face skin diseases. Initially, the pictures are created utilizing To increase the size of our database, the photos are first regenerated using a few preprocessing image algorithms. They are then gathered from various sources and scaled to match the network. After that, these pictures are put to use for validation and training.

Tanzina Rimi Afroz (2020) This study is a hybrid of machine learning and photo processing techniques. where the picture that CNN is using to schedule the classes was created using picture preparation. The preparatory information includes the five skin give classes discussed above. By using our system to actualize 500 images of different illnesses from the Dermnet collection, our project has achieved a 73% accurate rate. If the final improvements are made with a larger datasets.

Ahmed Saif Eldeen (2022) focused on employing Convolutional Neural Networks (CNN) and image processing, achieving an impressive 89.8% accuracy in vitamin deficiency detection. However, the model's dependency on high-resolution images poses a practical limitation.

In the study by K Elvarasi (2020) Support Vector Machine (SVM) and Recurrent Convolutional Neural Network (RCNN) algorithms were utilized, demonstrating high accuracy in diagnosing dermatological-type diseases linked to vitamin deficiencies. Nonetheless, its specialization may limit effectiveness in detecting diseases manifesting outside the skin.

Jayroop Ramesh (2018) explored Support Vector Classifier, K-Nearest Neighbors (KNN), and Logistic

Regression for classifying vitamin A deficiency with higher accuracy. However, its specificity to Vitamin A deficiency makes it less suitable for detecting other types of deficiencies. These studies collectively underscore the potential of machine learning in vitamin deficiency detection, each offering unique strengths.

Budhilrawan, Laura Safira, and Casi Setianingsih (2023) The dataset used in this investigation was obtained from Google and a few publications that address nail anomalies. The acquired nail images are unique from all other sources. Consequently, just one finger should be clipped in the image. Because Terry's nail disease often affects every nail when it is detected. I can thus utilize one finger. The images of a nail that have been subjected to GLCM extraction features will then undergo KNN classification. In this instance, the class will be split into Terry's and healthy courses.

Yini Pan, Jie Zhao, Li Zhang, and Hongfeng Li,(2021) The author of this study reviews deep learning techniques and how they may be used to treat skin conditions. The author also lists a number of publicly accessible skin datasets and provides a quick overview of dermatology's image gathering techniques and skin illnesses. After that, I've explained the idea behind deep learning and gone over some well-known deep learning architectures and frameworks that make it easier to use deep learning algorithms.

However, the choice of method should be tailor-made to the specific type of deficiency, considering factors such as image resolution and the location of disease manifestation. As the field continues to evolve, addressing these methodological nuances will be crucial for advancing accurate and versatile vitamin deficiency detection systems.[4]

IV. OBJECTIVES OF THE PROPOSED METHODOLOGY

- Prompt Discovery: Establish a method that can detect vitamin deficiencies in individuals before they result in serious health issues.
- Precise Findings: Ensure an elevated level of accuracy in identifying the specific vit deficit (viz., vit B12, vit C, or vit D) permissible to provide customised treatment recommendations.
- Non-Invasive Analysis: Create a minimally invasive or non-invasive method that assesses vitamin levels without requiring blood investigations or supplementary hostile actions.
- Acute Examination Study: Make a reasonably priced examination process available to a wide range of individuals, especially those living in low-resource situations.
- Custom-made Management Strategies: Provide advice for dietary adjustments, dietary supplements, or lifestyle adjustments based on each person's unique deficiencies.
- Data Assimilation: To improve the precision of deficiency identification, combine data from many sources, including food plans, biomarkers, and medical records.
- Real-Time Checking: Allow vitamin levels to be continuously or sporadically monitored in order to monitor progress and modify treatment programmes as necessary.
- Machine Learning Prototypes: To increase accuracy and generalizability, create reliable machine learning prototypes that can acquire from big datasets.
- Comprehensible Edge: Provide a user-friendly interface so that people and healthcare professionals can enter data and get results.
- Principled and Confidentiality Acquiescence: To safeguard sensitive health information; make sure the project conforms to ethical guidelines and data privacy laws.
- Edification and Cognizance: To increase public understanding of the significance of sustaining appropriate vitamin levels for general health, incorporate an educational component.[5]

V. RESEARCH METHODOLOGIES

The primary aim is to select best algorithm for the model building. On studying about features and implications of various we chosen multiple models. And the Evaluation Metrics defined in different papers are also carefully studied and examined and consider it for the evaluation for our model.

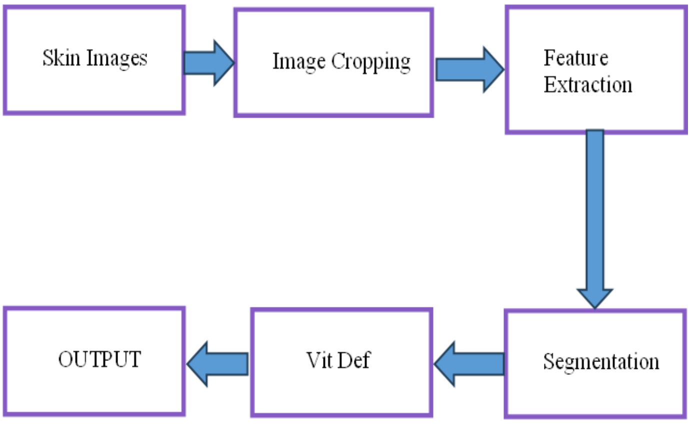

Fig. 1. Proposed Model

A. *Data Collection*

Data collection begins with the acquisition of a diverse vitamin deficiency image dataset from reputable sources, encompassing a wide spectrum of vitamin deficiency for comprehensive analysis. Subsequently, a meticulous data quality check is conducted to identify inconsistencies, missing values, or potential data quality issues. Addressing these anomalies is crucial to ensure data consistency and reliability for subsequent analysis, establishing a robust and high-quality dataset as the basis for all following tasks.

B. *Data Preprocessing*

In the context of the automated image processing system for vitamin deficiency detection, the data preprocessing phase is a crucial step aimed at ensuring the quality and suitability of the dataset for subsequent analysis. This process involves cleaning and preparing the data through various techniques tailored to medical image analysis.[6]

Given the diverse and extensive dataset collected, cleaning involves the removal of irrelevant or redundant information, ensuring that the dataset is well-organized and free from inconsistencies. In the case of medical images, this may include removing artifacts or irrelevant structures that do not contribute to the accurate detection of vitamin deficiencies. To enhance the robustness of the dataset, image cropping may be employed to focus on relevant regions of interest within the images. This ensures that the model is trained on pertinent information, optimizing its ability to detect vitamin deficiencies accurately. Moreover, normalization techniques may be applied to standardize pixel values across images, facilitating model convergence during training and enhancing overall model performance.

Noise reduction is another critical aspect of data preprocessing, especially in medical image analysis where noise can distort the diagnostic features. Techniques such as filtering or denoising algorithms may be implemented to minimize unwanted variations in the images, thus improving the model's ability to discern subtle patterns indicative of vitamin deficiencies.

Overall, the data preprocessing stage in this project plays a vital role in refining the dataset, making it conducive for the subsequent application of deep learning models. By incorporating techniques such as cleaning, cropping, normalization, and noise reduction, the system aims to optimize the quality of input data, ultimately enhancing the accuracy and reliability of vitamin deficiency detection.

C. *Feature Extraction-AlexNet Architecture*

This design was the first to leverage GPU acceleration to improve training efficiency. Five convolution layers, three max-pooling layers, two normalized layers, two fully linked layers, and one softmax layer make up AlexNet. A convolution filter and a non-linear activation function known as "ReLU" make up each convolution layer. Because there are completely linked layers in the pooling layers, the max-pooling function is carried out, and the input size is fixed. Although the input size is stated as 224x224x3 in most places, it really comes out to be 227x227x3 because of some padding. Above all, there are more than 60 million parameters in AlexNet.

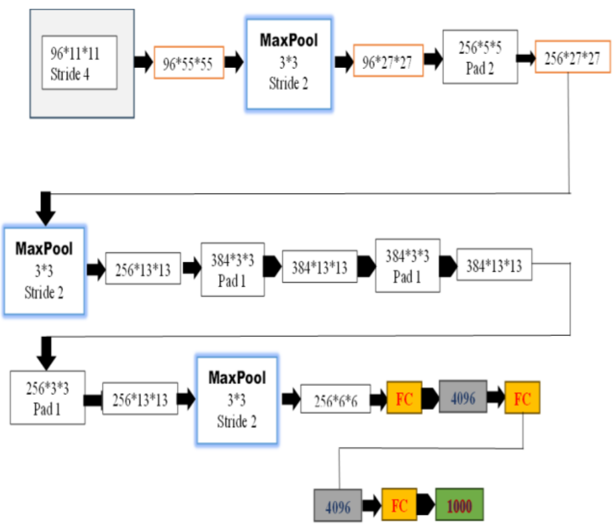

Fig. 2. Architecture of AlexNet

The Important Features of AlexNet are: "ReLU" is utilized as an activation function instead of "tanh." 128 SGD batch size is used. Entire batch size is 128 SGD. An algorithm for learning is called momentum. A variety of data augmentation techniques are used, including cropping, flipping, jittering, and colour normalisation. The complete network could not fit on a GTX 580 GPU with 3 GB of RAM, which was used to train AlexNet. Thus, the network was divided into two GPUs, with each GPU housing half of the neurons (or feature maps).

Maximum Pooling: One characteristic that Convolutional Neural Network (CNN) designs frequently use is max pooling. A pooling layer's primary goal is to "accumulate" characteristics from maps created by superimposing a filter over an image. Formally, it serves the purpose of gradually shrinking the spatial size of the representation in order to minimize the amount of network calculations and parameters. The most typical In the feature extraction phase, deep learning models, specifically AlexNet automatically extract meaningful features from the preprocessed vitamin deficiency detection images. Encapsulating essential characteristics that describe the vitamin deficiency. This step simplifies the data and enhances its suitability for classification tasks, condensing complex image information into more manageable structured data.

A portion of the purpose of max pooling is to mitigate over-fitting by offering an abstracted version of the representation. Furthermore, it offers fundamental translation invariance to the internal representation and lowers the computational cost by lowering the number of parameters to learn. Applying a max filter on (typically) non-overlapping sub-regions of the original representation is how max pooling is carried out.

Pooling windows, measuring 3 by 3 and having a stride of 2 between neighboring windows, were employed by the AlexNet authors. The top-1 mistake rate was decreased by 0.4% and the top-5 error rate by 0.3%, respectively, as a result of Max Pool's overlapping nature. When comparing this to the use of 2x2 non-overlapping pooling windows with a stride of 2, the result would be the same.

Non-Linearity: in ReLU AlexNet shows that deep CNNs can be trained substantially faster with saturating activation functions like Tanh or Sigmoid. The following figure shows that AlexNet can use ReLUs to achieve a 25% training error rate.

Data Enrichment: By displaying several versions of the same image to the neural net, over fitting may be prevented. It also helps to generate more data and forces the Neural Net to commit the key characteristics to memory.

Dismissal: During dropout, a neuron is eliminated from the neural network with a chance of 0.5. A neuron that is lost contributes nothing to the propagation in either direction. As demonstrated in the illustration below, a different Neural Network architecture processes each input. As a result, the obtained weight parameters are less prone to over fitting and more dependable.

Steps involved in architecture implementation are:

- Open the Dataset and Import Libraries
- preliminary processing
- Establish the Model.
- Configure the training settings to begin with.
- Make the model learn
- Forecasting[7]

D. Data engineering

Data engineering involves the transformation of feature vectors into structured, one-dimensional data, rendering it suitable for subsequent classification tasks. Data normalization standardizes the data to ensure that all features are on a common scale. This normalization optimizes model performance and facilitates interpretability, preventing any single feature from dominating the classification process. Data engineering streamlines the data, making it more amenable for machine learning models.[8,9]

E. Flowchart

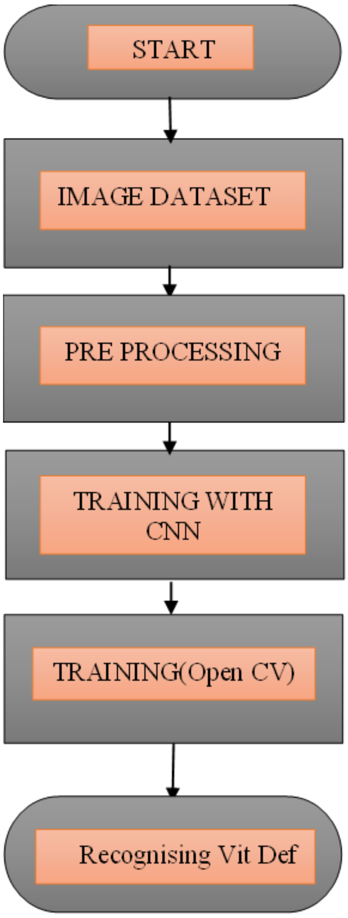

Fig. 3. Flowchart

F. Research Finding

Sample Data of the proposed model: AlexNet is used as a pertained deep learning model for feature extraction from ECG images. The learned features from AlexNet are then converted into structured data for analysis, enabling more accurate and efficient diagnosis of CVDs.[10,11]. By utilizing AlexNet as a feature extractor, this project aims to improve the accuracy and efficiency of CVD diagnosis using ECG images.

Fig. 4. Sample Data

Methodology	Top value 1	Top value 2	Top value 3
CNN 1	45%	30%	20%
CNN 5	42%	20%	19%
CNN 2	35%	25%	16%
CNN 7	30%	20%	12%

Table 1. Error Rate Comparison Chart

VI. CONCLUSION & FUTURE SCOPE

In conclusion, the use of image processing for the detection of vitamin deficiencies offers a promising avenue for early identification and preliminary screening. However, it's important to recognize that this approach should be viewed as a complementary tool rather than a replacement for established clinical diagnostic methods like blood tests. Detecting vitamin deficiencies through visual symptoms can be complex due to the wide variability in how these deficiencies manifest and the influence of other factors on the appearance of the skin, eyes, and other body parts. The success of such systems heavily depends on the quality and quantity of data available for training machine learning models, emphasizing the need for large, diverse, and accurately labeled datasets.[12,13].

Furthermore, ethical considerations are paramount in collecting and processing images of individuals for medical purposes. This includes obtaining informed consent and ensuring robust data security to protect individuals' privacy and rights. Any potential deficiency identified through image processing should always be followed up with clinical tests and medical evaluation to confirm the diagnosis and initiate appropriate treatment, given the inherent limitations and potential for false positives in image-based detection. As this field continues to evolve, ongoing research and technological advancements may enhance the accuracy and reliability of vitamin deficiency detection through image processing, making it a valuable tool in the healthcare domain.

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