VITAMIN DEFICIENCY DETECTION USING CONVOLUTIONAL NEURAL NETWORK WITH ADAM OPTIMIZATION

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ABSTRACT

Vitamin deficiency is very common worldwide that causes various types of diseases. Vitamins are an important part of our diet. Without vitamins, a deficiency occurs. In this paper we are introducing Deep Learning CNN model for diagnosing vitamin deficiency at early stage of deficiency. For this we had considered different types of input datasets such as nails, tongue, instead of Blood. In this paper, A wide spectrum of vitamin deficiencies can show one or more visually distinguishable symptoms and indications that appear in multiple locations in the human body. The platform also allows medical experts to assist in improving the range of detection and accuracy of the application through the contribution and verification of visual data of their patients allowing for more refined image analysis and feature extraction capabilities using Deep CNN (Convolutional neural network). Training is performed using a dataset comprising of images of finger nails, Tongue and eyes. Deep Learning is used to classify the images on the basis of color and textures and gives the probable cause for the same. *In this proposed method we will develop and effective methodology for detecting vitamin deficiency using Adam optimizer with more accurate results with reduced MSE (Mean Square Error). The testing results of accuracy for all the cases are above 90%. This also shows the performance evaluation metric values are better that many state of art methods. This is a useful methodology for people to overcome a global problem that affects millions of people worldwide mainly as a result of inadequate nutritional awareness, and it will help healthcare workers in the long term in obtaining more accurate diagnoses in a simple way and is also cost effective without pain.*

Keyword: - *Vitamins, Convolutional neural network, Mean Square Error, Deficiency, Diagnosis*

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1. INTRODUCTION

Around two billion people on the Earth demonstrate the troubles with vitamin deficiency, an issue. Vitamin deficiency in children, one-third of the global population, is reported in World Health Organization according to the latest research. Lack of vitamin A is suffered by 33% of small children below five years. Low immunity and night blindness are two symptoms of vitamin A deficiency. All age groups are vulnerable to vitamin lesser levels, which frequently associated with mineral (zinc, iron and iodine) shortages.

The most common deficiency is that of vitamin A, vitamin B, folate and vitamin D. Massive programs of supplementation have dramatically reduced the cases of diseases like scurvy and pellagra [10]. The multiple health problems that we encounter daily can be signified by vitamin deficiencies. Several of these problems are caused by people's lack of ability to get those necessary minerals and nourishment. In comparison, the number of people that lose their lives globally due to the iron deficiency anemia during the same period is 100,000. Among the UAE’s population, the overwhelming majority of about 90% of people suffer from many vitamin deficiencies in their basic nutrition. However, popular and media reports that contain data reported from the United States show that at least 92% of the population has one or the other deficiency in their mineral or vitamin intake. To begin with, even if there was an ideal diet that is suited for consumption, it will still render some that are lacking. Half of the people on earth suffer from magnesium, vitamin A, and vitamin C deficiency; however 90% of them have a vitamin D deficiency. Nevertheless, this small study generated the estimated level of social consciousness that is present on the ground/in the community [11], since the sample size is insufficient to reflect the exact population.

2. LITERATURE SURVEY

In their paper, Archana Ajith, and Vrinda Goel [6] suggest that the disease detection process through image processing can be automated. The technology is mobile and hence very accessible even in remote regions too. It is moreover non invasive to the complexities of skin. The patient will give a picture of this particular infected segment as an input to the prototype.

Sri Winiarti, Sri Kusumadewi, Izzati Muhimmah, Herman Yuliansyah [7] could release the sole result of integrated works which is categorized to 3 nutrition statuses which are good nutrition, malnutrition and better nutrition. Mobile apps are the means by which the nutritional values or ingredients of food items and packaging can be recalled while consuming food. Results from system testing indicate validation of 80% as for the application of FCM algorithm in this mobile app.

Shih-Hsiung Lee, Chu-Sing Yang [8] are authors of their research paper, where the method of image preprocessing, that tries to segment different fragments of nail, lunula and nail plate. Cheap image quality may not allow the lunula to be shown clearly. Along with the nail image quality maintenance, microscope is used for taking nail images by this paper. Other than nail details, such as free edge, cross striation and longitudinal striation, can be viewed easily as they are captured in the image with microscope.

Tanzina Afroz Rimi [9] in her expertise on image handing strategies and machine learning fill the gap of the research paper. This is also the case where picture preparation was the process of showing the picture which CNN had already prepared for arranging the classes. The instructions on five types of the skin condition that were discussed previously make up this section of preparation of information. From the dermatological perspective, this project is admirable as the framework is 73% precise on the dermnet dataset of 500 images with different diseases visualized. This proves itself to be a superb thing to accomplish if the developer makes more improvements using bigger datasets as a whole.

3. METHODOLOGY

3.1 Dataset usage

The Vitamin deficiency detection dataset is taken from kaggle data science community, comprising over deficiency scan images. Each image in nails data set is of 224 x 224 pixels, tongue dataset is of 224 x 224 pixels, eyes dataset is of 150 x 300 pixels, making them to be compatible for various pre-trained models. The division and distribution of images are illustrated in the flowchart depicted in “Fig 1”.

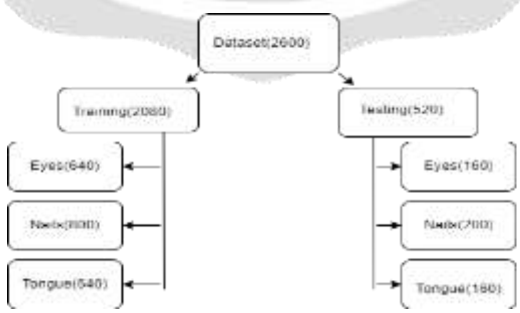

Fig -1: Dataset Flowchart

3.2 Deep Learning

The basics from data collection to deployment, Deep learning offers a powerful set of tools for identifying patterns and features in complex datasets that might not be immediately apparent to humans or through traditional statistical methods. These capabilities allow deep learning to improve performance as more data becomes available, making it highly scalable and effective across various domains.

3.3 CNN Architecture

A convolutional neural network (CNN) is a type of machine learning model and deep learning algorithm helps in better understanding of the parameters in the form of dividing the images into layers such that each individual layer is scrutinized and can be more perfectly analyzed when compared to the conventional analysis procedure depicted in "Fig 2".

LAYERS
1. Input layer
2. Batch Normalisation layer
3. Hidden layers: Including ReLU layer, Average pooling2d layer, fully connected layer, Softmax layer
4. Classification layer

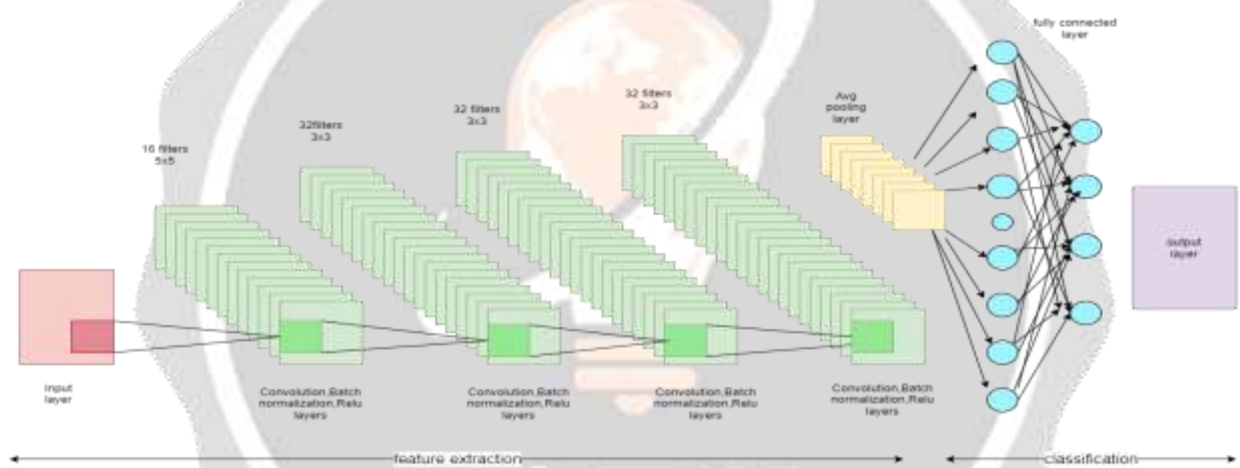

Fig -2: CNN architecture

3.4 Adam Optimization

Adam (Adaptive Moment Estimation) is actually a deep learning optimization algorithm that is used more often than others for neural networks training. Adam amalgamates the virtues of the AdaGrad and RMSProp algorithms in one to get better sparse dependencies in noisy problems.
It can be a good one for making your deep learning model fit well, especially when the data or your model are very complicated to a degree of adaptive learning rate adjustments; also, it leads your model drastically to converging much faster and effectively to the minimum loss, thereby, making training more efficient and possibly more accurate.

3.5 Proposed system

The proposed system addresses vitamin deficiency detection through a deep learning Convolutional Neural Network (CNN) model using the highly efficient algorithm. This customized approach aims for earlier diagnosis compared to traditional methods. Unlike blood tests, the system analyzes images from non-invasive areas like fingernails, tongue, eyes, and lips. These body parts often exhibit visual signs of vitamin deficiencies. After completion of division of dataset during the training process, the model would be trained to connect the dataset images with their corresponding labels, in order to compare with the signs of deficiencies. This can be done by using several functions such as split Each Label, train Network. Moreover, the popularized optimization Adam algorithm used to improve the models performance over many training cycles which comprises of several layers. With increase in the epochs, the model gets better trained to give high accuracy with low mean square error. At testing and validation, we access the performance using testing dataset, which are not trained but to analyze the metrics like accuracy, precision, recall, and F1-score, through these we can assess the model's effectiveness in detecting vitamin deficiencies from several images. Additionally, the model will be validated on a separate dataset to ensure its generalizability. “Fig-3” represents the block diagram of processing.

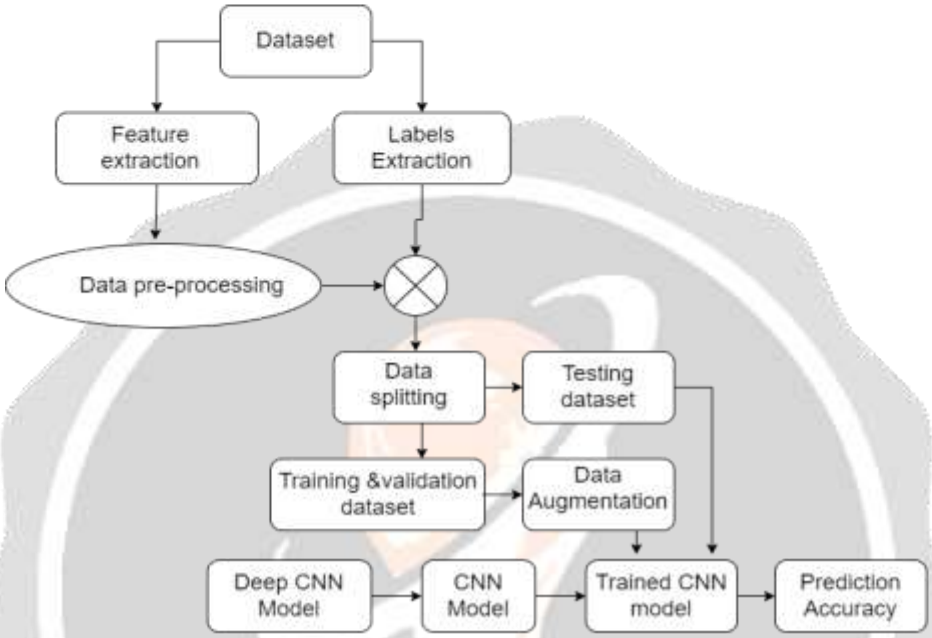

Fig-3: Block diagram of proposed method

4. RESULTS AND DISCUSSIONS

In getting results from the processing of an image we have used MATLAB. The code utilizes several built-in functions and toolboxes for image processing and deep learning:
Image Processing Toolbox provides functions such as imread, rgb2gray, image filtering (imbinarize, imerode), and imshow. Whereas Deep Learning Toolbox offers functions for building and training deep learning models, some specific functions used are imageDatastore, several CNN layers, SplitEachLabel, Layergraph, training options, trainNetwork and other common functions such as gpuDevice, input, sum, numel, diag, mean etc., which results in robust learning, efficient in Performance Analysis, highlighting the model’s proficiency in classification task. Below “Fig 4” illustrates the layers included, training progress and the testing outputs. The architecture described above is visually represented in “Fig 5”, which likely illustrates the connections and flow of operations within the CNN layer, including the skip connections.

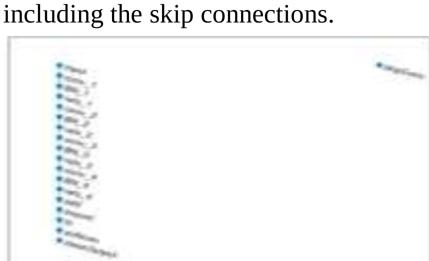

Fig -4: Layers graph of deep CNN

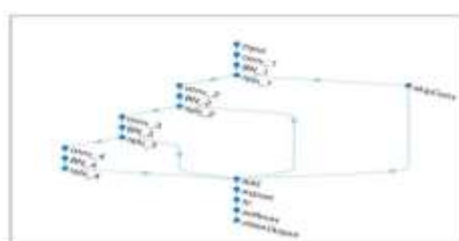

Fig -5: Nodes in CNN layers

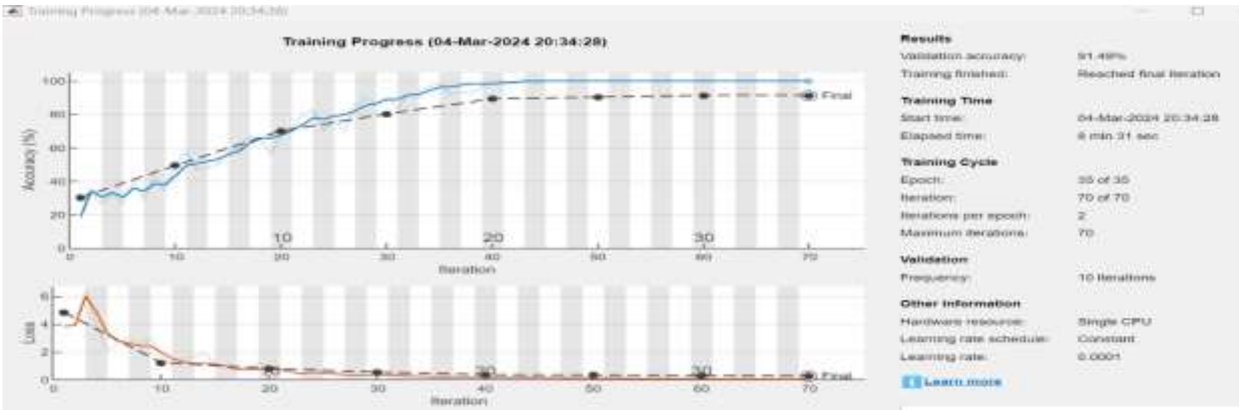

Fig -6: Training plot of iteration

In “Fig 6”,through the pluse of measuring accuracy and loss parameters during training, it will be clear if the model is able to discriminate among various class of images used as the illustration of different nutrient deficiencies or not. Adequately, the accuracy should go up and the loss should be low at each period, which signifies well learned.

EYES:

The eye classification process involves four key stages represented by figures. “Fig 7” shows the input image of the eye, while “Fig 8” depicts the extracted features. The final classified output is illustrated in “Fig 9”, and “Fig 10” presents the confusion matrix evaluating the model's performance in eye classification. Together, these figures provide a comprehensive understanding of the classification process and the model's accuracy.

Fig -7: Input image of eye

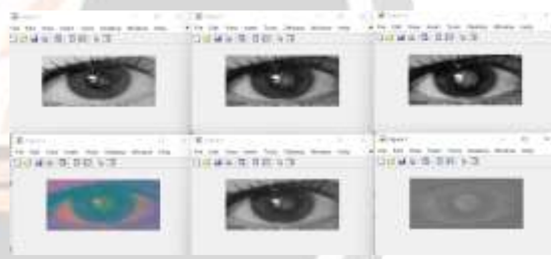

Fig -8: Features Extracted (Eye)

Fig -9: Final classified output

Fig -10: confusion matrix of eyes

TONGUE:

“Fig 11” and “Fig 12” exhibit the feature extraction process and a scatterplot graph for tongue classification, respectively. “Fig 13” showcases the confusion matrix, assessing the model's performance, while “Fig 14” illustrates the final classified output. These figures collectively provide insights into the classification process for tongue images and evaluate the model's accuracy in distinguishing between different classes.

Fig -11: Feature Extraction of Tongue

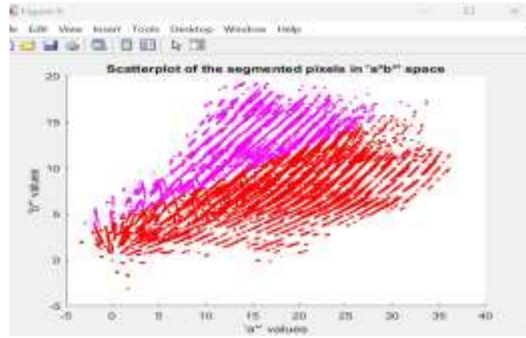

Fig -12: Scatterplot graph

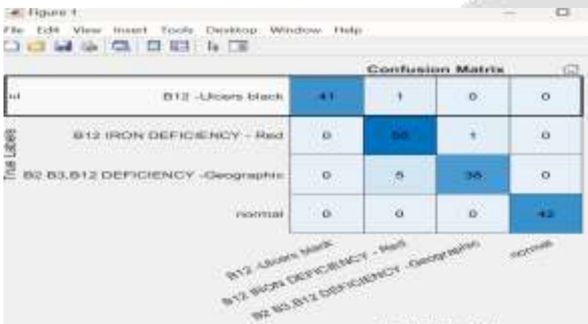

Fig -13: Confusion matrix of Tongue

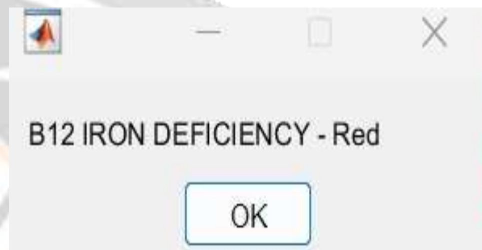

Fig -14: classified output

NAILS:

"Fig 15" and "Fig 16" represent the input image of a nail and the feature extraction process, respectively, in nail classification. "Fig 17" displays the confusion matrix, evaluating the model's performance while "Fig 18" illustrates the labeled predictions. These figures collectively offer an understanding of the nail classification process and assess the model's accuracy in distinguishing nail images.

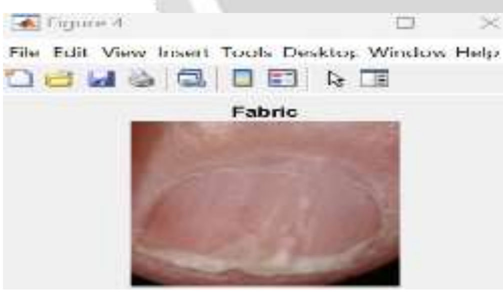

Fig -15: Input image of nail

Fig -16: Feature extraction

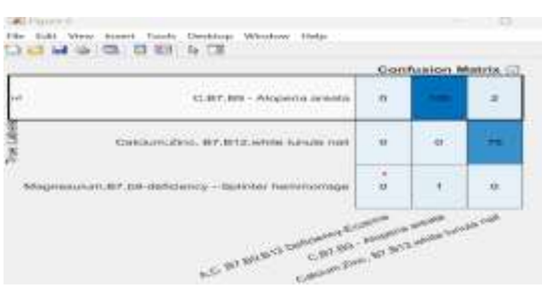

Fig -17: Confusion matrix of nail

Fig -18: Labelled Predictions

Class	Accuracy	Precision	Recall	F1-score
Eyes	0.91	0.91	0.92	0.91
Nails	0.96	0.95	0.96	0.96
Tongue	0.96	0.96	0.96	0.93

Table-1: Evaluation metrics

Accuracy indicates how many pictures the model classified properly as a percentage. The precision means that the times when the model showed positive diagnoses, those predictions were true. Recollect serves as the metric for how well the model found all the real cases of vitamin deficiency in the test data. In the end, F1-score, combines precision and recall into a set score, an overview of the model performance that is balanced. By these indicators can evaluate how the model is adept at identifying various vitamin deficiencies from the input given.

5. CONCLUSION

The tentative solution goes further than just nutrient deficiencies and can be expanded to include some features that run on various resources apart from the camera. The software called Vita-Cam is not a replacement for a doctor consult, but it is the means to inform more members of our community that live their own lives in a way that those vitamin needs are not fulfilled and help them get the healthy diet that eventually will avoid further complications of their untreated vitamin deficiencies. This systematic review covered the effects of vitamin deficiencies; the corresponding risks in various populations; the methods in the prevention and control, possible social, political, and other contributing factors currently being undertaken; the gaps and progress; some emerging issues and some conclusions. In general, women's health and nutrition among the elderly and children and adolescents would continue to be even a top priority and in fact if we look at the system as a whole, we would notice that there is an emphasis throughout one's life. The system is a novel approach that relies on individuals' self-diagnosis in a short span without the use of a blood sample. The precision of the system proposed can be increased by adding more data such as Doctors', medical researchers' and experts' contributions. The solution will not only be able to spot the condition of vitamin deficiency but also could be extended furthermore to identify other health complications.

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