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Vitamin Deficiency Detection Using Image Processing and Neural Network

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Abstract: In this project, a cost-free Artificial intelligence-based application for smartphones built to detect vitamin deficiencies in humans using pictures of specific body organs is introduced. Recent vitamin deficiency detection methods require costly laboratory analysis. 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 application provides individuals with the capability to diagnose their possible vitamin deficiencies without the need to provide blood samples through the analysis of photos taken of their eyes, lips, tongue, and nails. The application then suggests a list of nutritional sources to fight the detected deficiency and the expected complications through nutritional micro-correction. The intelligent software was trained to distinguish and differentiate vitamin deficiencies with high confidence from imagery inputs of the selected body parts that are known to show different symptoms in terms of changes in the tissue's structure when the human body suffers a nutritional deficit. 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 with the potential to surpass human's ability to diagnose medical conditions. This application is a useful tool 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.

Keywords: Detect Vitamin deficiency, CNN, Food suggestion, Mobile application.

I. INTRODUCTION

Vitamin deficiency is a problem that affects over two billion people around the world. The World Health Organization [WHO] said that one in three children do not get enough vitamin. Vitamin deficiency is a global problem that affects over two billion people around the world. The WHO said that one in three children do not get vitamin. 33% of children under the age of five have a deficiency of vitamin A.

This deficiency causes low immunity and night blindness. Vitamin deficiencies affect all ages and frequently co-exist with mineral (zinc, iron, iodine) deficiencies. The groups most susceptible to vitamin deficiencies are pregnant women, and children, because of their needs for these compounds and susceptibilities to their absence. Most common deficiencies relate to vitamin A, vitamin B, folate, and vitamin D. Supplementation programs have made diseases like scurvy and pellagra rare.

Many deficiencies are preventable through the consumption of a healthy diet containing diverse foods, as well as food fortification and supplementation, where needed. Most vitamin and mineral deficiencies can be picked up with a blood test, like a venous blood test and finger-prick blood test. In venous blood test, a trained professional will use a needle to puncture a vein, usually in your arm, to collect a blood sample, and in finger-prick blood test using a lancet, you can prick your own finger and collect blood samples. In hospitals, these blood tests can be done or we can also order home vitamin and mineral test kits online and do it ourselves. The cost of venous blood tests and finger-prick blood in India is on an average of Rs.1000 and Rs.800 respectively. Home vitamin and mineral test kits cost around Rs.8000.

We proposed a cost-free android application that can give instant results using user's images of body parts only and there is no need for blood samples for the test.

II. RELATED WORK

S. Eldeen, M. AitGacem, S. Alghlayini, W. Shehieb and M. Mir, "Vitamin Deficiency Detection Using Image Processing and Neural Network" 2020 The article discusses the approach that allows self-diagnosis in a short time without the need for blood sample. The accuracy of the diagnosis can be exponentially improved by including more data with the direct contribution from medical practitioners, researchers, and experts through exclusive access to the database.

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The proposed solution's capabilities are not limited to vitamin deficiencies, but they can be extended to include early detection of other health problems using more resources besides the camera.

Priyanka Sharma, Preeti Arora "Image Processing and Neural Network based vitamin Deficiency Detection: A comprehensive Survey", 2020 Provides a comprehensive survey of image processing and neural network techniques for vitamin deficiency detection, covering various applications and challenges. Limited discussion of explainable AI methods for ensuring the reliability and trustworthiness of neural network models.

Rutuja Moholkar, Mansi Kamble, Gauri Bobade, Saijyoti Shinde "Vitamin Deficiency Detection Using Image Processing and Neural Network", (IJARIIE 2023) This article discuss the application capable of providing a diagnosis of selected vitamin deficiency spectrum from photos of the user's tongue, lips, eyes, and nails using Artificial Intelligence has been implemented. The application used a combination of Machine Learning to achieve the extraction of certain features and attributes from the images and a Fuzzy Logic decision-making algorithm to specify the type of deficiency.

Sarah M. Williams, James R. Davis, "Multi-modal Deep Learning for Vitamin Deficiency Detection: Integrating Clinical and Imaging Data"(2021) Integrated clinical data and imaging information through a multi-modal deep learning model for comprehensive vitamin deficiency detection. The model combined patient history, laboratory results, and diagnostic images to improve accuracy. Remarks: This approach highlighted the importance of leveraging diverse datasets for a more holistic understanding of vitamin deficiencies, aiming for a more accurate and personalized diagnostic framework.

Jessica N. Lee, Brian T. Wong, "VitaScan: A Mobile Application for Vitamin Deficiency Screening using Smartphone Images"(2022) Developed VitaScan, a mobile application utilizing deep learning to screen for vitamin deficiencies using smartphone-captured images of the skin and eyes. The app provided real-time feedback and recommendations for further medical consultation. Remarks: VitaScan demonstrated the potential for accessible and user-friendly tools in vitamin deficiency detection, highlighting the role of mobile technology in preventive healthcare.

III. PROPOSED SYSTEM

This involves leveraging advanced neural network architectures to analyze medical imaging data and identify potential signs of vitamin deficiencies. The system will utilize convolutional neural networks (CNNs) to process images of relevant biological samples, such as blood smears or tissue sections, extracting features indicative of specific vitamin deficiencies. Training the model on diverse datasets will enable it to recognize patterns associated with various deficiencies. The system will offer a user-friendly interface for healthcare professionals to upload images, receive prompt analyses, and access detailed reports highlighting potential deficiencies. Continuous improvement through feedback loops and periodic model updates will ensure the system's accuracy and adaptability to evolving medical knowledge. Integration with existing healthcare infrastructure and adherence to privacy regulations will be prioritized in the system design.

The main objectives of the proposed system are as follows:

1. Develop an image dataset containing samples of individuals with various vitamin deficiencies.
2. Implement preprocessing techniques to enhance image quality and standardize data.
3. Investigate feature extraction methods to capture relevant information from images.
4. Create a deep learning neural network architecture for vitamin deficiency classification.
5. Train the neural network using labeled image data to achieve high accuracy.
6. Explore different convolutional neural network (CNN) architectures for optimal performance.
7. Implement transfer learning with pre-trained models to improve classification results.
8. Investigate the impact of various image augmentation techniques on model robustness.
9. Evaluate the model's ability to detect specific vitamin deficiencies (e.g., vitamin D, vitamin B12).
10. Assess the generalization of the model across different demographics and skin tones.

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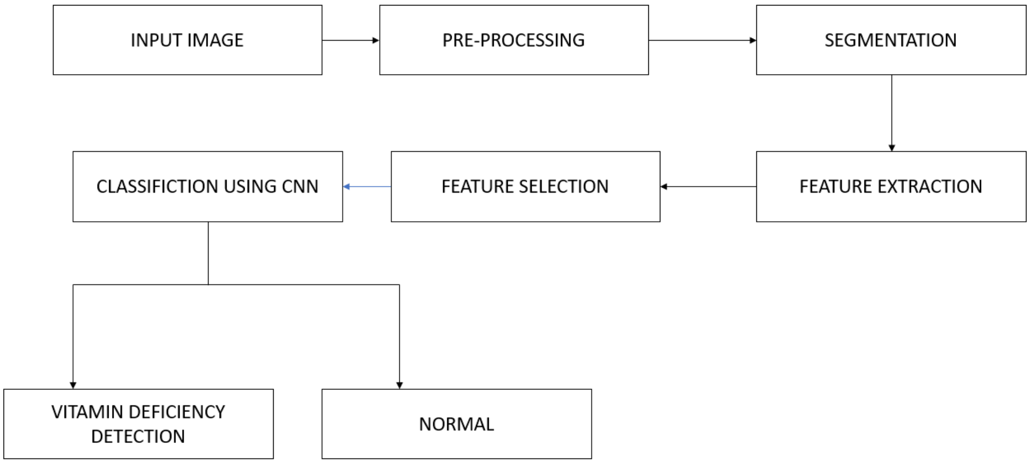

Fig. 1: System Architecture

IV. METHODOLOGY

1. Data Acquisition:

➢ The data set is collected from a source and a complete analysis is carried out.

➢ The image is selected to be used for training/testing purposes only if it matches our requirements and is not repeated.

2. Pre-Processing the Data Set:

➢ This involves converting the image from the RGB format to greyscale to ease processing, For converting RGB to grey we use formulae 0.2986*R+0.587*G+0.1140*B

➢ The use of an averaging filter or Median filter(non-linear digital filtering technique) to filter out the noise.

➢ Global basic thresholding to remove the background and consider only the image.

➢ A high- pass filter to sharpen the image by amplifying the finer details. it is enhancement technique that highlights edges and fine details in an image, Increasing yields a more sharpened image.

3. Feature Extraction:

➢ Feature extraction is a process of dimensionality reduction by which an initial set of raw data is reduced to more manageable groups for processing.

➢ Here, we use a method called Histogram Orientation Gradient (HOG) to extract the features from the preprocessed image received as input.

➢ It involves multiple steps like finding Gx and Gy, which are gradients about each pixel in the x and y axes.

➢ Then, these gradients are substituted in relevant formulae to get the magnitude and gradient of the pixel's orientation.

➢ Then, the angles and their respective frequencies are plotted to form a histogram, which is the output of this module.

4. Classification and detection:

➢ In CNN, we take the output from the high-pass filter as input.

➢ Leaving out feature extraction, as CNN is a classifier which simply has a feature extracting process of its own, using convolution, rectification and pooling as the 3 sub-modules.

➢ Which work in iterations to give out a final comparison matrix, which is then classified by classifying algorithms like Softmax.

➢ In deep learning, a convolutional neural network (CNN, or ConvNet) is a class of deep neural network most commonly applied to analyzing visual imagery.

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- They are also known as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics.
- When CNN is used for classification, we don't have to do feature extraction.
- Feature Extraction will also be carried out by CNN.
- We feed the preprocessed image directly to CNN classifier to obtain the type of weapon if present.
- By considering all the features in the output layer which gives the result with some predictive value.
- These values are calculated by using SoftMax activation function.
- SoftMax activation provides predictive values. Based on the predictive value the final result will be identified as weapon.

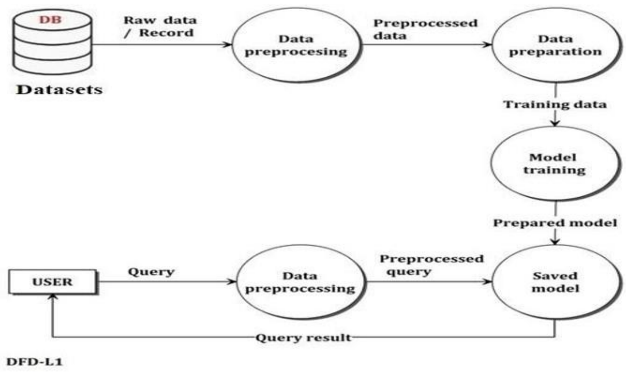
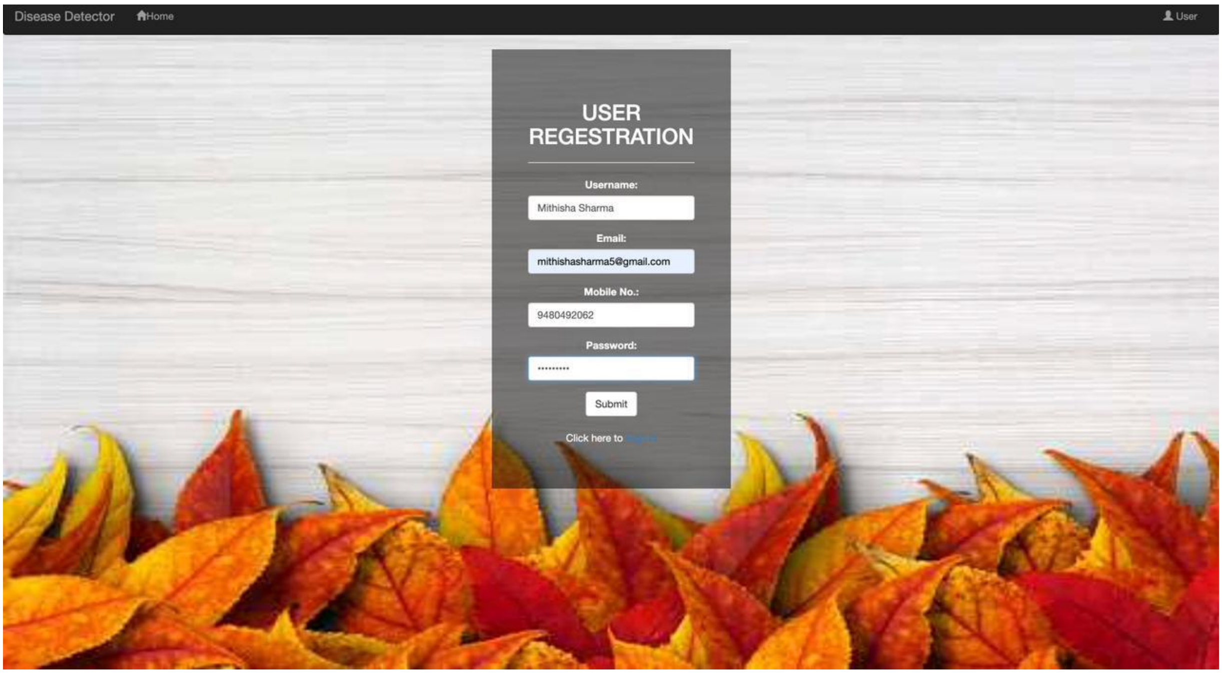


Fig 2: Data Flow Diagram

V. EXPERIMENTAL RESULTS

Snapshot 1: User Registration Page



In the above snapshot, You visit the Vitamin Deficiency Detection website, click "sign up", fill in your details with username, email, mobile number, and password, and submit it. A message confirms that registration is successful.

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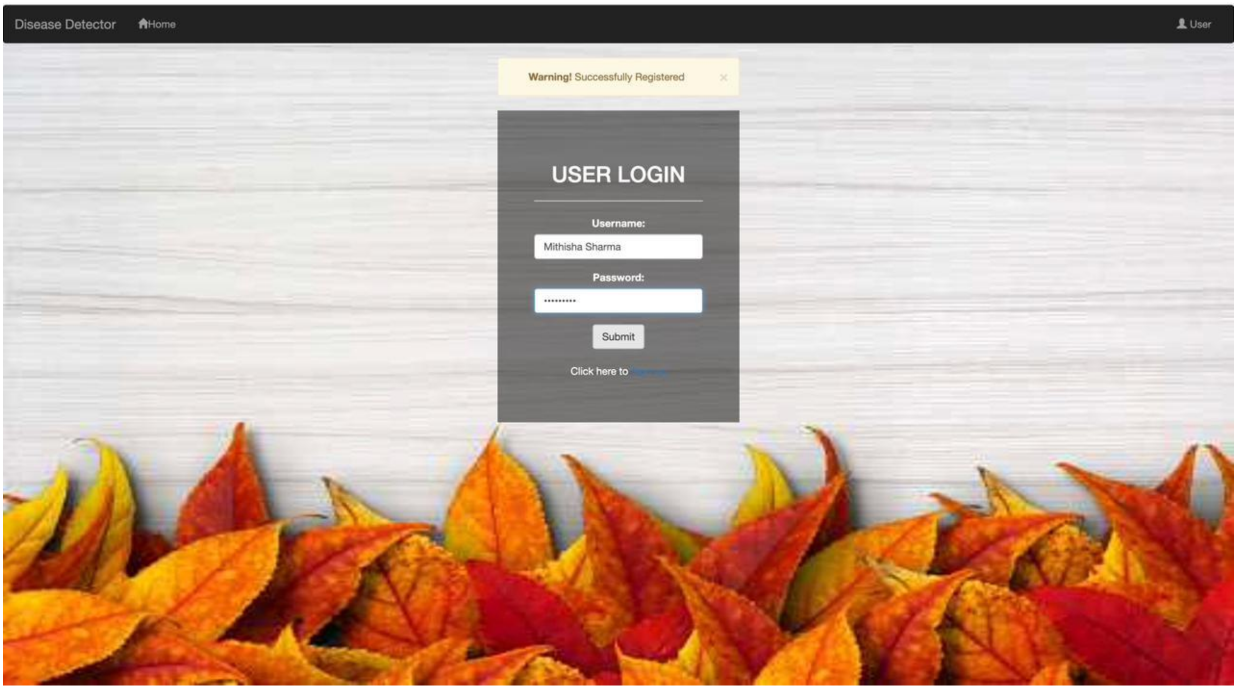
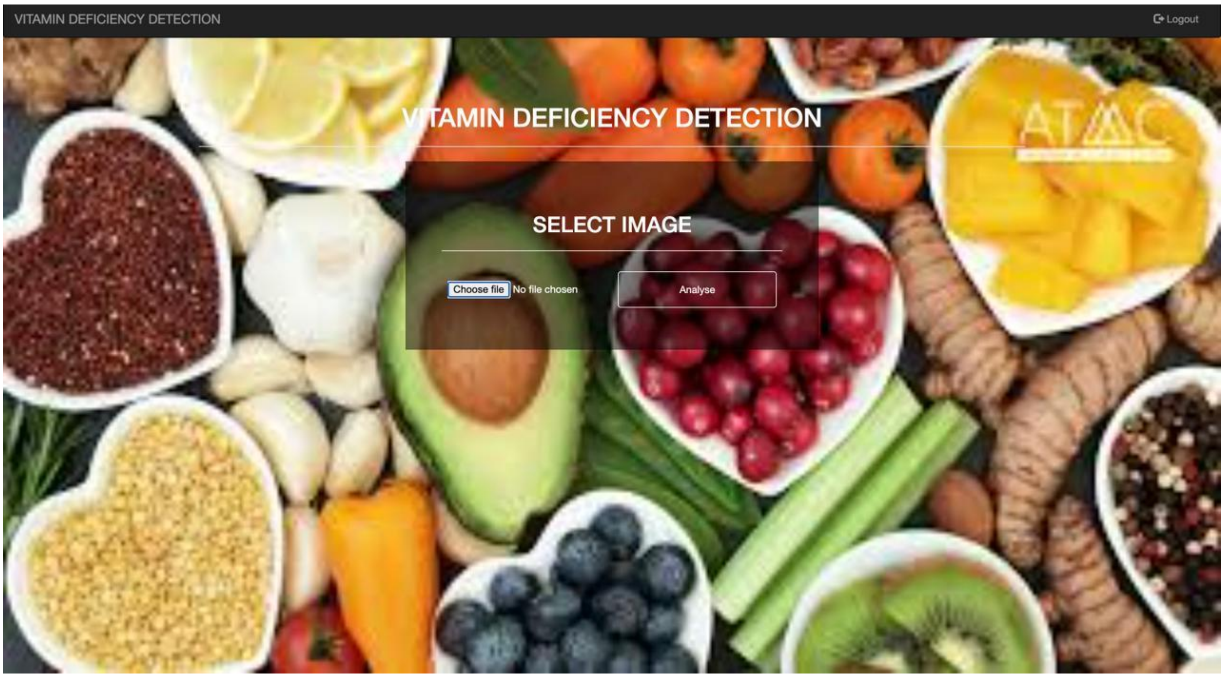
Snapshot 2: User Login Page



In the above snapshot, Navigate to the login page. Enter the credentials - username and password.
Submit the login form by clicking the submit button.

Snapshot : 3 Home page



In the above snapshot, Welcome Screen: After logging in, you are redirected to the home page, which might include a welcome message and an overview of the site.

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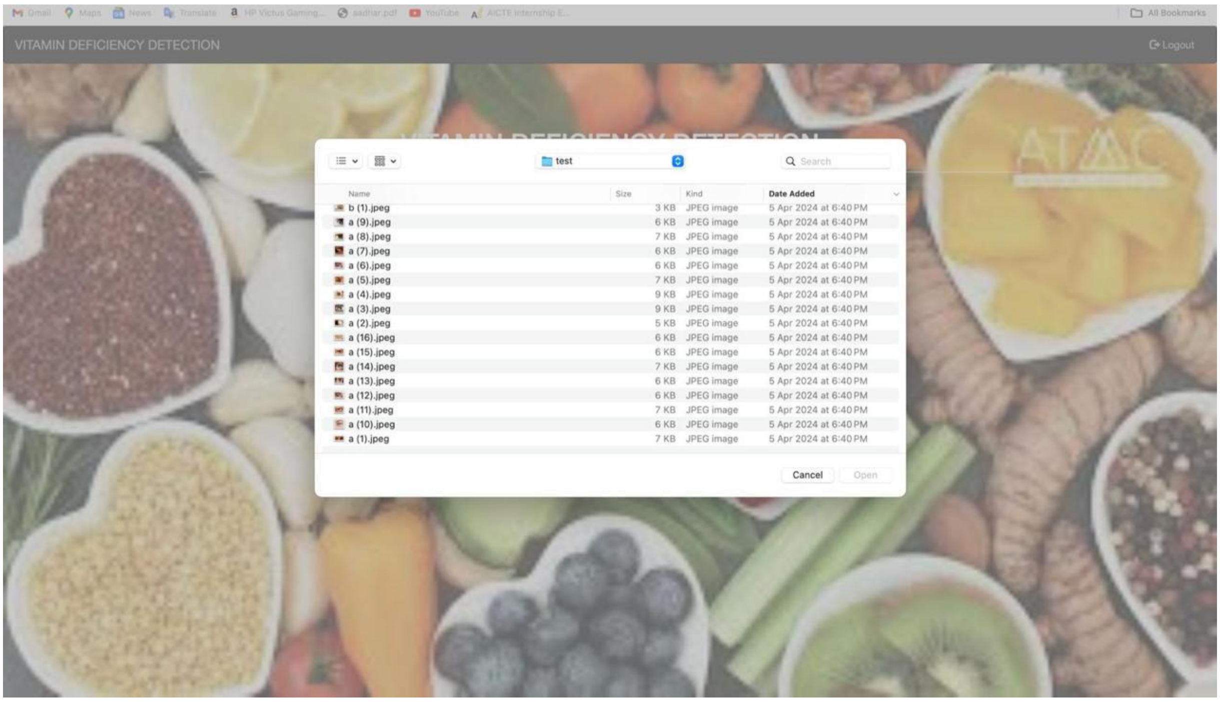
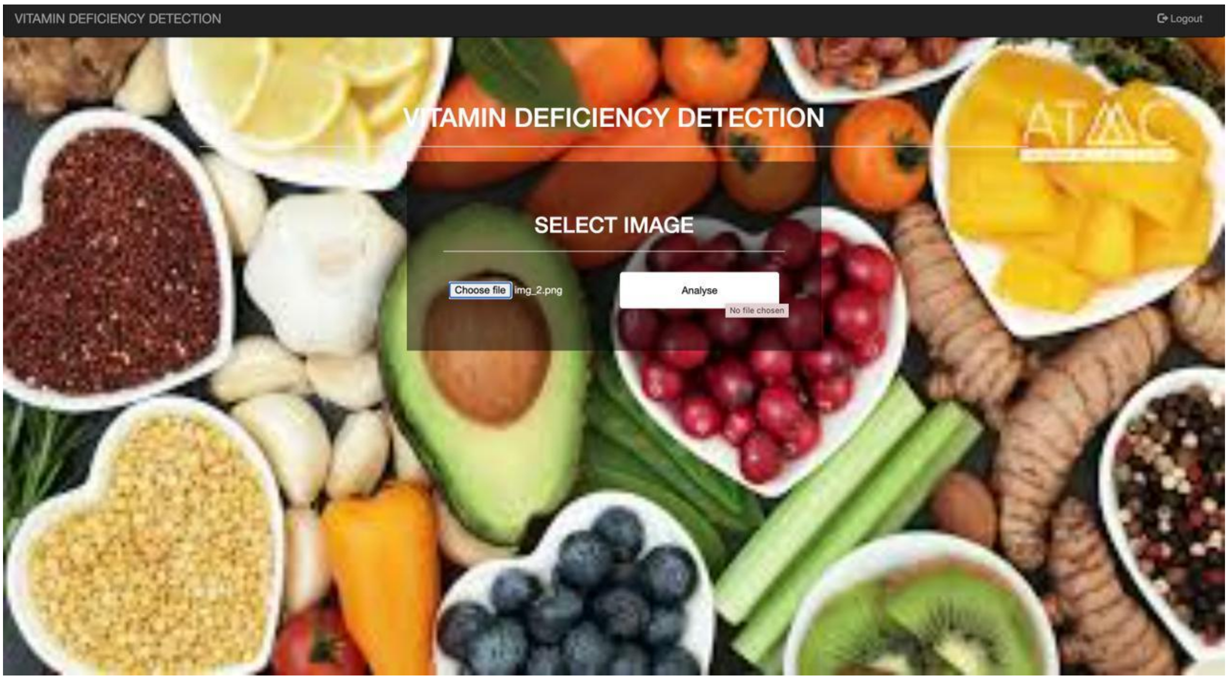
Snapshot 4: Select the input image



In the above snapshot, Input Data Page: An interface for uploading your health data image.
Upload Image: Select Image: Click the "Choose file" button to select an image from your device.
This image might be a photo of your skin, nails, eyes, tongue, or nails of your body that show symptoms.
Submit Image: Once the image is selected, click the "Submit" or "Analyze" button.

Snapshot 5: Analyze the given input image



In the above snapshot, Analysis: The website processes your image using its algorithms.
Processing Image: The website uses image recognition and analysis algorithms to assess the uploaded image.
This might take a few moments, during which you might see a loading screen or progress indicator.

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Snapshot 6 : Receive output

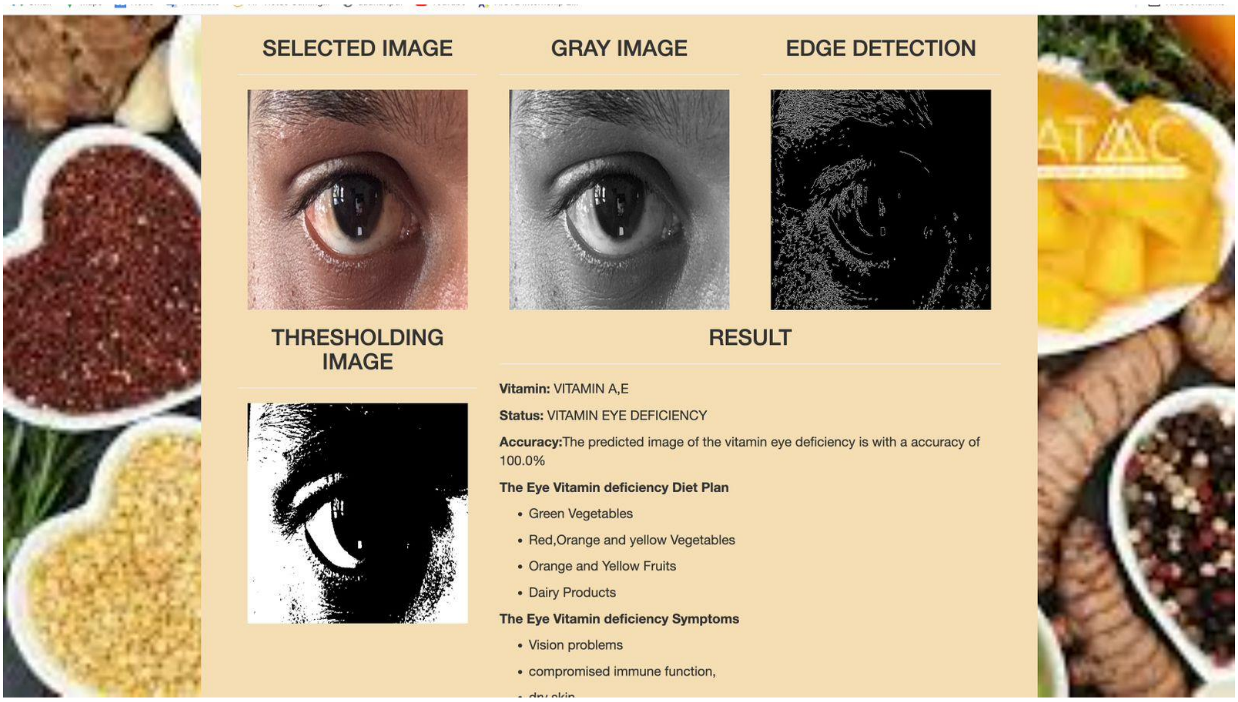

Fig 3: Vitamin deficiency detected

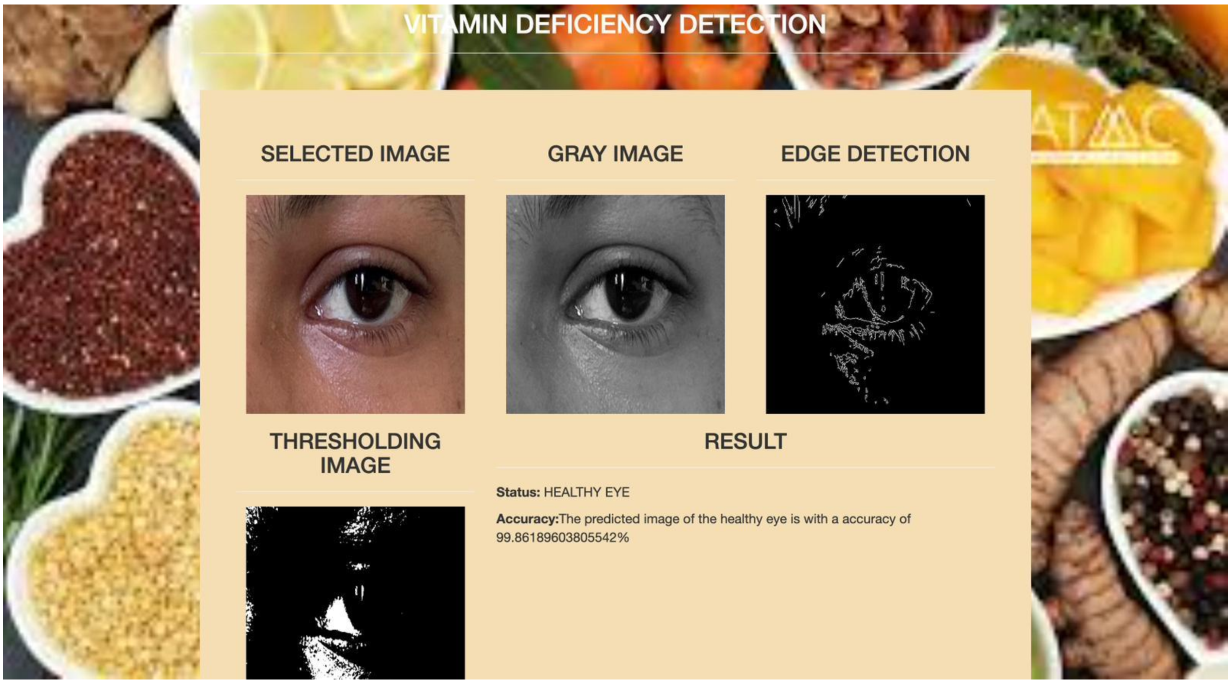

Fig 4: Healthy - no vitamin deficiency detected

In the above snapshot, Results Page: The website displays the results of the analysis.
Vitamin Deficiency Report: The system indicates whether any vitamin deficiencies are detected based on the image. Suggested vitamins or supplements or Diet plan and deficiency symptoms to address the deficiencies. Recommendations for dietary changes and lifestyle adjustments.
Health Status: If no deficiencies are detected, the system will indicate that you are healthy.

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VI. CONCLUSION

In conclusion, the application of deep learning in vitamin deficiency detection represents a promising frontier in healthcare. The accuracy and efficiency demonstrated by the deep learning models showcase their potential to revolutionize early diagnosis and intervention, contributing to improved public health outcomes. This innovative approach holds great promise for addressing nutritional deficiencies in a timely and precise manner.

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