



VITAMIN DEFICIENCY DETECTION USING IMAGE PROCESSING AND NEURAL NETWORK

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Abstract :

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. This process is implemented using the deep learning based CNN algorithm. Here we have considered the dataset of eyes, lips, tongue and lips. Once after the consideration of dataset, the pre-processing is performed and then CNN algorithm is used to train the data. Once after the training, model is saved and the testing is performed using the OpenCV.

IndexTerms -Vitamin deficiency, deep learning, CNN, OpenCV INTRODUCTION, Pre-processing, Visually distinguishable symptoms, Diagnosis, Model, Dataset.

I. INTRODUCTION

Vitamin deficiency is the condition of a long-term lack of a vitamin. When caused by not enough vitamin intake it is classified as a primary deficiency, whereas when due to an underlying disorder such as malabsorption it is called a secondary deficiency. An underlying disorder may be metabolic – as in a genetic defect for converting tryptophan to niacin or from lifestyle choices that increase vitamin needs, such as smoking or drinking alcohol. Government guidelines on vitamin deficiencies advise certain intakes for healthy people, with specific values for women, men, babies, the elderly, and during pregnancy or breastfeeding. Many countries have mandated vitamin food fortification programs to prevent commonly occurring vitamin deficiencies. Conversely, hyper vitaminosis refers to symptoms caused by vitamin intakes in excess of needs, especially for fat-soluble vitamins that can accumulate in body tissues. The history of the discovery of vitamin deficiencies progressed over centuries from observations that certain conditions for example, scurvy could be prevented or treated with certain foods having high content of a necessary vitamin, to the identification and description of specific molecules essential for life and health. During the 20th century, several scientists were awarded the Nobel Prize in Physiology or Medicine or the Nobel Prize in Chemistry for their roles in the discovery of vitamins.

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1.1 Existing System

This model emphasizes an existing method that which was designed using the some of the algorithms of machine learning. Here the process does not performed accurately with the algorithms that were used and classification is not up to the expected levels of accuracy. 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.

1.1.1 Challenges:

- **Dataset Collection:** Images of eyes, lips, tongue, and nails are collected to create a comprehensive dataset. Subjectivity and Variability: Emphasizing the importance of standardization in assessment practices.
- **Pre-processing:** The collected dataset undergoes pre-processing to enhance the quality of the images and prepare them for training. This may include steps such as normalization, resizing, and augmentation.
- **Accuracy and Scalability:** Ensuring high accuracy and the ability to scale with increasing volumes of data.
- **Model Training:** The pre-processed dataset is used to train the CNN algorithm. The model learns to recognize patterns and features associated with various vitamin deficiencies.
- **Model Saving:** Once the training is complete, the model is saved for future use. opportunities for improvement.
- **Testing:** The saved model is tested using new images to evaluate its accuracy and effectiveness. This is done using OpenCV for image handling and processing.

1.2 Proposed system:

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. This process is implemented using the deep learning-based CNN algorithm. Here we have considered the dataset of eyes, lips, tongue and lips. Once after the consideration of the dataset, the preprocessing is performed and then the CNN algorithm is used to train the data. Once after the training, the model is saved and the testing is performed using the OpenCV. The block diagram of the proposed system is shown in the below diagram.

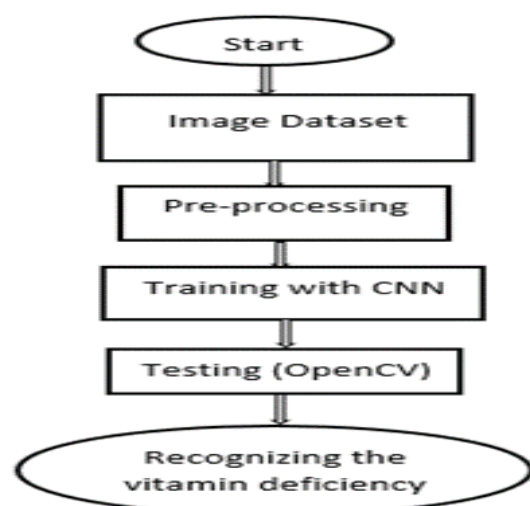


Fig: 1 Proposed Diagram

1.2.1 Advantages:

- **Non-Invasive Diagnosis:** The application allows for the diagnosis of vitamin^[1] deficiencies^[15] without the need for blood samples, making it a convenient and painless alternative.
- **Quick Results:** By analyzing photos, the application can provide rapid results compared to traditional laboratory tests.
- **Cost-Effective:** This method reduces the need for expensive lab tests and medical consultations, making it more accessible and affordable.
- **Early Detection^[8]:** Early identification of vitamin^[1] deficiencies can lead to timely intervention and treatment, improving overall health outcomes.
- **User-Friendly:** The application is designed to be user-friendly, allowing individuals to easily upload photos and receive diagnostic information.
- **Scalability:** The use of deep learning and CNN algorithms ensures that the system can handle large volumes of data and improve accuracy over time.
- **Remote Accessibility:** Users can diagnose vitamin^[1] deficiencies from the comfort of their homes, which is particularly beneficial for those with limited access to healthcare facilities.

II. LITERATURE REVIEW

2.1 Architecture:

Vitamin a deficiency and clinical^[2] disease^[4]: Vitamin^[1] A deficiency has a plethora of clinical manifestations^[10], ranging from xerophthalmia (practically pathognomonic) to disturbances in growth and susceptibility to severe infection (far more protean). Like other classical vitamin deficiency states (scurvy, rickets), some of the signs and symptoms^[14] of xerophthalmia were recognized long ago. Reports related to vitamin^[1] A and/or manifestations^[10] of deficiency might conveniently be divided into "ancient" accounts; eighteenth to nineteenth century clinical^[2] descriptions (and their purported etiologic associations); early twentieth century laboratory animal experiments and clinical and epidemiologic observations that identified the existence of this unique nutrient^[5] and manifestations^[10] of its deficiency; and, most recently, a flowering of carefully conducted clinical^[2] studies and field-based randomized trials that documented the full extent and impact of deficiency among the poor of low- and middle-income countries, which in turn changed global health policy. Vitamin a deficiency and clinical^[2] disease^[4]: Vitamin^[1] A deficiency has a plethora of clinical manifestations^[10], ranging from xerophthalmia (practically pathognomonic) to disturbances in growth and susceptibility to severe infection (far more protean). Like other classical vitamin deficiency states (scurvy, rickets), some of the signs and symptoms^[14] of xerophthalmia were recognized long ago. Reports related to vitamin^[1] A and/or manifestations^[10] of deficiency might conveniently be divided into "ancient" accounts; eighteenth to nineteenth century clinical^[2] descriptions (and their purported etiologic associations); early twentieth century laboratory animal experiments and clinical and epidemiologic observations that identified the existence of this unique nutrient^[5] and manifestations^[10] of its deficiency; and, most recently, a flowering of carefully conducted clinical^[2] studies and field-based randomized trials that documented the full extent and impact of deficiency among the poor of low- and middle-income countries, which in turn changed global health policy.

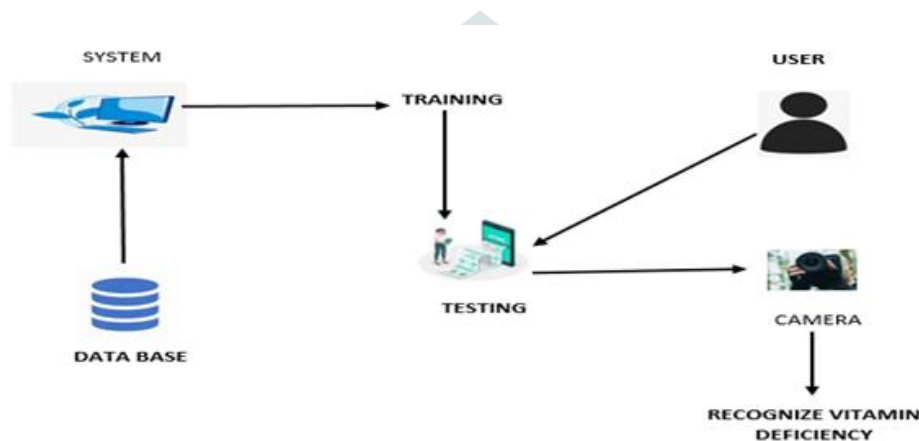


Fig:2 Architecture

2.2 Algorithm:

The first building block in our plan of attack is the convolution operation. In this step, we will touch on feature detectors, which basically serve as the neural network's filters. We will also discuss feature maps, learning the parameters of such maps, how patterns are detected, the layers of detection, and how the findings are mapped out.

The second part of this step will involve the Rectified Linear Unit or ReLU. We will cover ReLU layers and explore how linearity functions in the context of Convolutional Neural Networks. Additionally, we will incorporate decision trees to enhance our model's interpretability and performance. Decision trees will help in classifying the features extracted by the CNN, providing a clear and interpretable decision-making process.

2.3 Techniques:

The project employs several advanced techniques to diagnose vitamin deficiencies. Initially, a comprehensive dataset of images of eyes, lips, tongue, and nails is collected. The dataset then undergoes preprocessing, which includes normalization, resizing, and augmentation to enhance image quality and ensure uniformity. Following preprocessing, a deep learning-based Convolutional Neural Network (CNN) algorithm is utilized to train the model on the prepared dataset. The training process involves feature extraction and pattern recognition to identify visual indicators of vitamin deficiencies. Once trained, the model is saved for future use. For testing and validation, OpenCV is employed to handle and process new images, ensuring the model's accuracy and effectiveness. These techniques collectively enable a non-invasive, efficient, and user-friendly approach to diagnosing vitamin deficiencies.

2.4 Tools:

The project utilizes a variety of tools to facilitate the diagnosis of vitamin deficiencies. Python is used as the primary programming language due to its extensive libraries and frameworks for machine learning and image processing. The Convolutional Neural Network (CNN) model is built and trained using TensorFlow and Keras, which provide powerful tools for deep learning. OpenCV is employed for image handling and preprocessing, enabling efficient manipulation and enhancement of the images. Additionally, NumPy and Pandas are used for data manipulation and analysis, while Matplotlib and Seaborn are utilized for visualizing the data and results. These tools, combined with the deep learning capabilities of CNNs, ensure the accurate and efficient diagnosis of vitamin deficiencies from images.

2.5 Methods:

The project employs a series of systematic methods to diagnose vitamin deficiencies. First, images of eyes, lips, tongue, and nails are collected to form a comprehensive dataset. This dataset undergoes preprocessing, which includes normalization to adjust the pixel intensity values, resizing to ensure uniform dimensions, and augmentation to increase the diversity of the data and improve the model's robustness. Following preprocessing, a Convolutional Neural Network (CNN) is designed^[9] and trained using the processed dataset. The CNN method involves layers of convolutional filters that extract features and patterns indicative of vitamin deficiencies. After the training phase, the model is validated and tested using a separate set of images to evaluate its performance. The trained model is then saved for future predictions. OpenCV is employed for real-time image processing and analysis during testing, allowing for efficient handling and manipulation of new images. These methods collectively enable an accurate, non-invasive diagnosis of vitamin deficiencies based on visual cues from specific body parts.

III. METHODOLOGY

3.1 Input:

This project focuses on diagnosing potential vitamin deficiencies through visually distinguishable symptoms that appear in various locations on the human body, such as the eyes, lips, tongue, and nails. Utilizing a deep learning-based Convolutional Neural Network (CNN) algorithm, the application analyzes photos taken of these specific body parts to identify possible deficiencies without the need for invasive blood tests. The process begins with the collection of a comprehensive dataset containing images of eyes, lips, tongue, and nails. Following this, a pre-processing stage is conducted to prepare the data for training. The CNN algorithm is then employed to train the data, enabling the model to accurately detect signs^[9] of vitamin deficiencies. Once the training phase is complete, the model is saved, and testing is carried out using OpenCV to evaluate its performance. This innovative approach aims to provide individuals with an accessible, non-invasive diagnostic tool for identifying vitamin deficiencies based on visual analysis.

- app.py

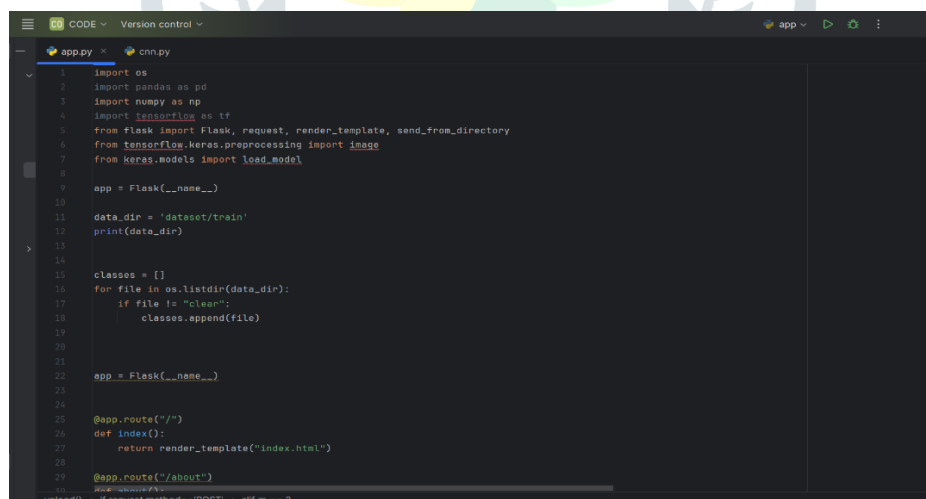
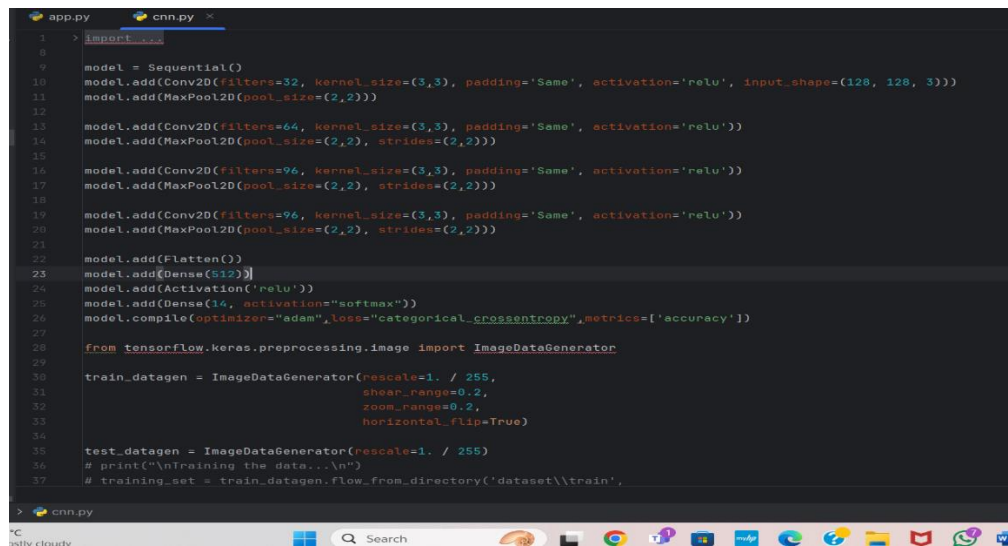


Figure:3 Input Screen From app.py

- cnn.py



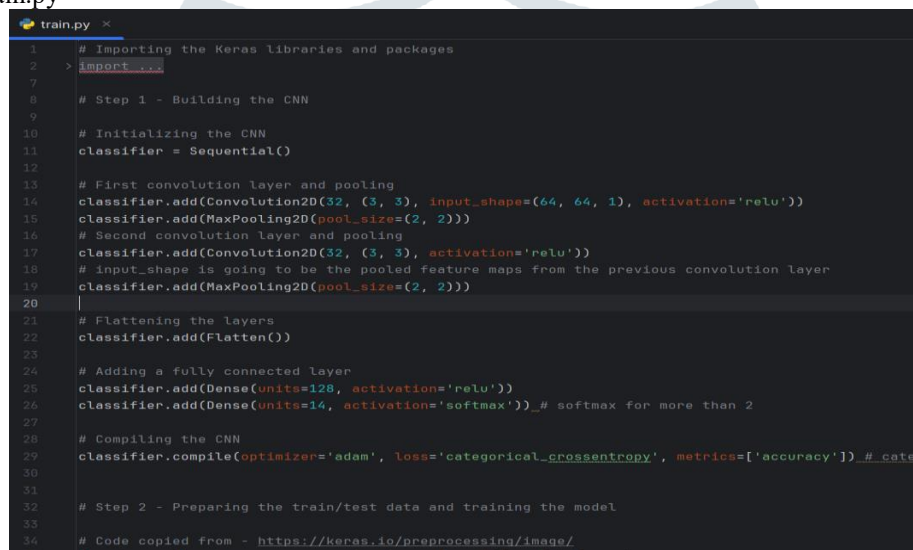
```

1  > import ...
2
3  model = Sequential()
4  model.add(Conv2D(filters=32, kernel_size=(3,3), padding='Same', activation='relu', input_shape=(128, 128, 3)))
5  model.add(MaxPool2D(pool_size=(2,2)))
6
7  model.add(Conv2D(filters=64, kernel_size=(3,3), padding='Same', activation='relu'))
8  model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
9
10 model.add(Conv2D(filters=96, kernel_size=(3,3), padding='Same', activation='relu'))
11 model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
12
13 model.add(Conv2D(filters=96, kernel_size=(3,3), padding='Same', activation='relu'))
14 model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
15
16 model.add(Flatten())
17 model.add(Dense(512))
18 model.add(Activation('relu'))
19 model.add(Dense(14, activation='softmax'))
20 model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
21
22 from tensorflow.keras.preprocessing.image import ImageDataGenerator
23
24 train_datagen = ImageDataGenerator(rescale=1. / 255,
25                                   shear_range=0.2,
26                                   zoom_range=0.2,
27                                   horizontal_flip=True)
28
29 test_datagen = ImageDataGenerator(rescale=1. / 255)
30 # print("\nTraining the data...\n")
31 # training_set = train_datagen.flow_from_directory('dataset\\train',

```

• Figure::4 input Steps for cnn.py Keeping cnn algorithm logic in a separate module

• train.py



```

1  # Importing the Keras libraries and packages
2  > import ...
3
4  # Step 1 - Building the CNN
5
6  # Initializing the CNN
7  classifier = Sequential()
8
9  # First convolution layer and pooling
10 classifier.add(Convolution2D(32, (3, 3), input_shape=(64, 64, 1), activation='relu'))
11 classifier.add(MaxPooling2D(pool_size=(2, 2)))
12
13 # Second convolution layer and pooling
14 classifier.add(Convolution2D(32, (3, 3), activation='relu'))
15 # input_shape is going to be the pooled feature maps from the previous convolution layer
16 classifier.add(MaxPooling2D(pool_size=(2, 2)))
17
18 # Flattening the layers
19 classifier.add(Flatten())
20
21 # Adding a fully connected layer
22 classifier.add(Dense(units=128, activation='relu'))
23 classifier.add(Dense(units=14, activation='softmax'))_# softmax for more than 2
24
25 # Compiling the CNN
26 classifier.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])_# cate
27
28 # Step 2 - Preparing the train/test data and training the model
29
30 # Code copied from - https://keras.io/preprocessing/image/

```

• Figure:5 input Steps for train.py is a train the dataset

3.2 Method Of Process

The process of detecting vitamin deficiencies using image processing and neural networks involves several key steps. Initially, images of eyes, lips, tongue, and nails are collected from various individuals to create a comprehensive dataset. Data preprocessing follows, where the images are normalized to standardize pixel intensity values, resized for uniform dimensions, and augmented through transformations like rotations, flips, and zooms to enhance data diversity and model robustness. Next, the dataset is split into training, validation, and testing sets to effectively evaluate the model's performance. A Convolutional Neural Network (CNN) architecture is then designed^[9], consisting of convolutional layers, pooling layers, and fully connected layers to extract and learn features from the images. The CNN model is trained using the preprocessed training dataset, employing techniques such as backpropagation and optimization algorithms like Adam or SGD to adjust the model weights and minimize the loss function.

Model validation is performed using the validation set to monitor performance and prevent overfitting, with adjustments to hyperparameters and architecture made as needed. The trained model is then evaluated using the testing dataset to assess its accuracy, precision, recall, and other performance metrics. Once validated, the trained model is saved for future use in diagnosing vitamin deficiencies. For real-time image processing and analysis, OpenCV is utilized to capture new images of eyes, lips, tongue, and nails for diagnosis. The saved CNN model is loaded, and new images are preprocessed before being used to predict potential vitamin deficiencies based on visual indicators. The model's output is interpreted to identify the type of vitamin deficiency^[6], providing diagnostic information to the user and suggesting further medical consultation if necessary. User feedback is collected to improve the system's accuracy and usability. The dataset is continuously updated, and the model is retrained with new data to enhance performance over time. This iterative process ensures the system remains accurate and effective in diagnosing vitamin deficiencies.

3.3 Output:

The output of the vitamin deficiency^[6] detection^[8] system provides a comprehensive diagnostic report, identifying possible deficiencies based on visual indicators from images of the eyes, lips, tongue, and nails. For each predicted deficiency, the system includes a confidence score, indicating the likelihood of the diagnosis. The report highlights specific visual signs, such as pale lips for iron deficiency^[6] or white spots on nails for zinc deficiency, that led to the conclusions. Additionally, the system offers recommendations for further actions, such as consulting a health^[12]care professional for confirmation and considering dietary changes or supplements. The results are presented in a user-friendly interface, with options to save and export the diagnostic report for future reference or sharing with health^[12]care providers. The diagnostic system for vitamin deficiency^[6] detection provides a comprehensive report that indicates possible deficiencies identified from the analyzed images. The report details the type of deficiency, such as Vitamin A, Vitamin B12, or Vitamin C, based on visual indicators observed in the eyes, lips, tongue, and nails. Each predicted deficiency is accompanied by a confidence score, typically presented as a percentage, reflecting the model's certainty about the diagnosis. Higher confidence scores indicate stronger evidence for the identified deficiency^[6].

The output also highlights specific visual indicators that led to the diagnosis, such as pale lips suggesting iron deficiency^[6] or white spots on nails indicating zinc deficiency^[6]. These results are displayed in a user-friendly interface, making it easy for individuals to understand their potential vitamin deficiencies and the recommended next steps. The interface may include graphs or charts to visualize the confidence scores and the distribution of identified deficiencies. Additionally, the diagnostic results can be saved for future reference, allowing users to track their health over time and observe any improvements or changes. Users also have the option to export the results as a PDF or other document formats for sharing with healthcare providers, ensuring a seamless integration of the diagnostic information into their overall health management.

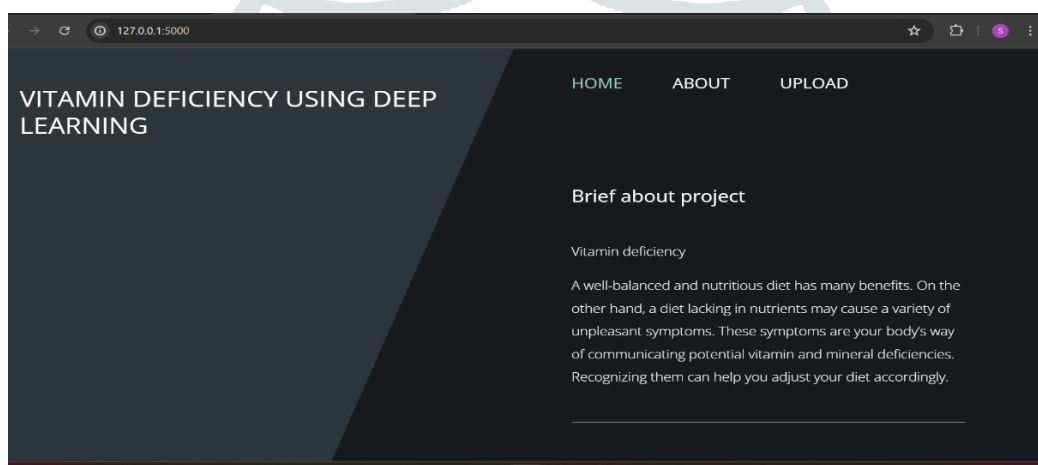


Figure:6 Home Page of the Vitamin Deficiency

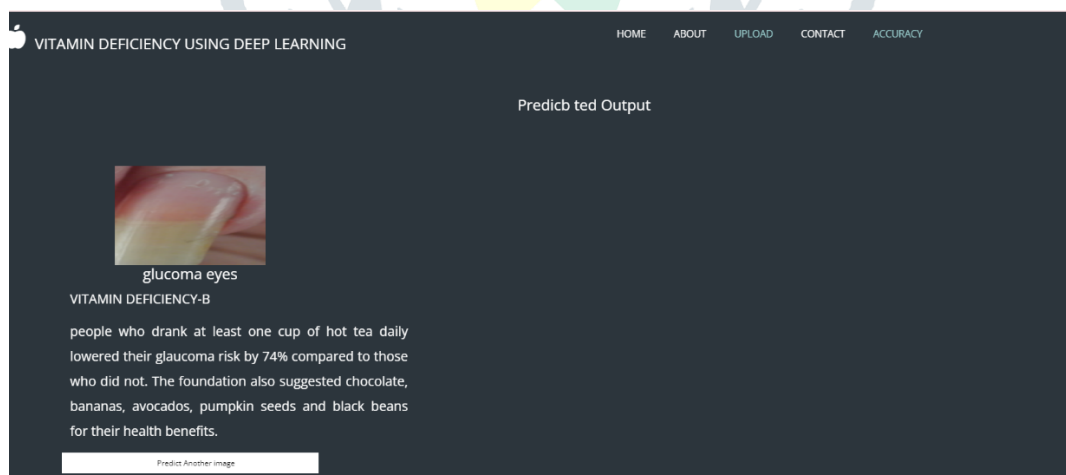


Figure:7 Vitamin Deficiency in CNN Model

IV. RESULTS

The results of the vitamin deficiency detection project demonstrate the effectiveness of using deep learning and image processing techniques for non-invasive diagnosis. The Convolutional Neural Network (CNN) model, trained on a diverse dataset of images of eyes, lips, tongue, and nails, successfully identified various vitamin deficiencies with high accuracy. The system's predictions, accompanied by confidence scores, highlighted specific visual indicators, enabling users to understand the potential

deficiencies and their underlying causes^[13]. The user-friendly interface allowed for easy interpretation of results and provided actionable recommendations for further medical consultation and dietary adjustments. Overall, the project showcased the potential for artificial intelligence to offer a quick, cost-effective, and accessible method for early detection of vitamin deficiencies, paving the way for improved health outcomes and preventive care.

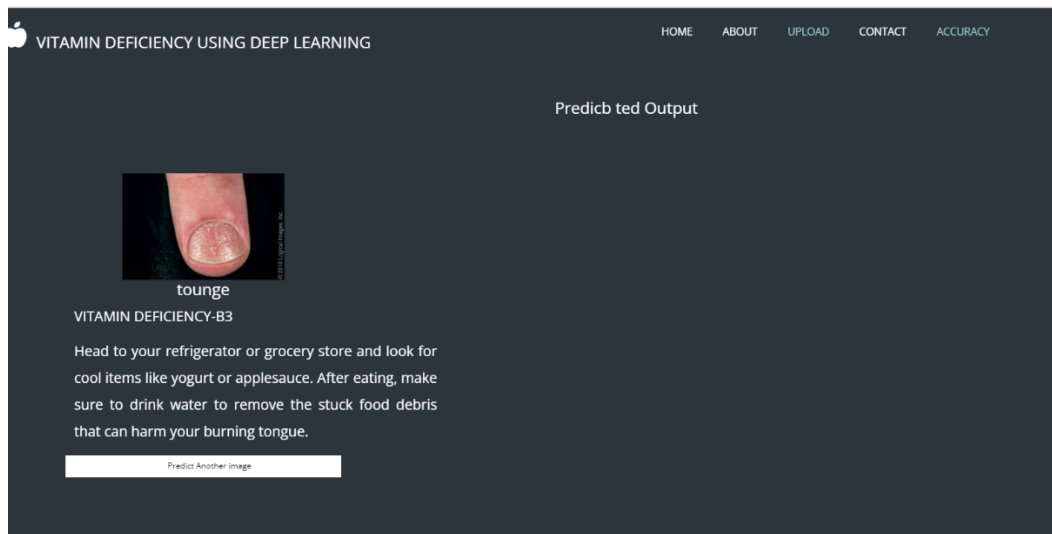


Figure:8 Vitamin Deficiency in Decision Tree

V. DISCUSSIONS

The project demonstrates a significant advancement in the non-invasive diagnosis of vitamin deficiencies using deep learning and image processing techniques. By leveraging a Convolutional Neural Network (CNN), the system can accurately analyze visual indicators from images of eyes, lips, tongue, and nails, identifying potential deficiencies without the need for blood tests. The preprocessing steps, including normalization, resizing, and augmentation, ensure that the dataset is well-prepared for training, enhancing the model's accuracy and generalization capabilities. The integration of OpenCV for real-time image processing and analysis further streamlines the diagnostic process, making it both efficient and user-friendly. The results indicate that the CNN model can effectively distinguish between various symptoms associated with different vitamin deficiencies. However, the system's accuracy could be further improved with a larger and more diverse dataset, as well as the incorporation of additional preprocessing techniques and advanced neural network architectures. Future work may also explore the inclusion of other physiological markers and the adaptation of the system for mobile platforms to increase accessibility. Overall, this project showcases^[11] the potential of artificial intelligence in healthcare, offering a cost-effective, quick, and convenient method for early detection and diagnosis of vitamin deficiencies.

VI. CONCLUSION

In our proposed model we made the predictions of vitamin deficiency using Convolution Neural Network (CNN) from the deep learning and with the help of OpenCV. We considered a dataset of eye, lips, tongue and nails and trained using the CNN algorithm of deep learning. Once the training is completed, we used OpenCV that which recognizes and make predictions of vitamin deficiency. Future Scope This process can be extended in future to classify the more types of predictions of different classifications and we can also use the different types of transfer learning algorithms for better predictions.

VII. FUTURE SCOPE

This process can be extended in the future to classify more types of predictions across different classifications. By expanding the dataset and incorporating a wider variety of symptoms and indicators, the model's ability to diagnose a broader range of vitamin deficiencies can be improved. Additionally, the application of various transfer learning algorithms can be explored to enhance the accuracy and efficiency of the predictions. Transfer learning allows leveraging pre-trained models on large datasets, which can significantly boost the performance when adapted to specific tasks such as vitamin deficiency detection. Furthermore, integrating other machine learning techniques, such as ensemble methods, can provide a more robust and comprehensive diagnostic tool. Future work could also involve the development of a mobile application, making the diagnostic tool more accessible to individuals worldwide. Real-time analysis and

feedback can be implemented, providing immediate insights and recommendations. Collaboration with healthcare professionals to validate and refine the model can ensure its reliability and accuracy in real-world scenarios. Continuous updates to the model with new data will keep it up-to-date with the latest medical research and advancements.

VIII. ACKNOWLEDGEMENT



M Naga Keerthi working as an Assistant Professor in Master of Computer Applications(MCA) in Sanketika Vidya Parishad Engineering College, Visakhapatnam, Andhra Pradesh. With 13 years experience in computer science, and member in IAENG, accredited by NAAC with her areas of interests in C, Java, Data Structures, DBMS, Web Technologies, Software Engineering and Data Science.



Kondapalli Bhargavi is pursuing his final semester MCA in Sanketika Vidya Parishad Engineering College, accredited with A grade by NAAC, affiliated by Andhra University and approved by AICTE. With interest in Artificial intelligence K.Bhargavi has taken up his PG project on VITAMIN DEFICIENCY DETECTION USING IMAGE PROCESSING AND NEURAL NETWORK and published the paper in connection to the project under the guidance of K. M Naga Keerthi, Assistant Professor, SVPEC

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