NUTRIENT ANALYSIS AND RECOMMENDATION SYSTEM FOR HEALTH AND FITNESS USING AI AND IOT

A PROJECT REPORT

submitted by

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BONAFIDE CERTIFICATE

Certified that this Project report titled **"NUTRIENT ANALYSIS AND RECOMMENDATION SYSTEM FOR HEALTH AND FITNESS USING AI AND IOT"** is the bonafide work of **"SRI SAI B -2116210701258, SURENDHAR S -2116210701271, TARUNVISHAAL L -2116210701285"** who carried out the work under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

Our proposed system proposes a nutrient analysis and recommendation system designed to empower individuals in their specific health and fitness goals. Nutrients plays a major role in regulating the bodily functions. These are essential for tissues repair, growth and development. This project employs AI algorithms to analyze nutritional content, leveraging data from IoT devices. By using CNN algorithm the input image either a fruit or vegetable that has been received from the user through IoT device has been predicted. This system provides users with comprehensive insights into their nutrient consumption, including macronutrients, vitamins, and minerals. This project is designed to provide dietary recommendations based on individual user profiles, incorporating personal information such as age, height, weight, Body Mass Index (BMI), and fitness objectives. This enhances healthier eating habits and promote nutritional awareness among the people.

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In our proposed system a nutrient analysis and recommendation system designed to empower individuals in their specific health and fitness goals. Nutrients plays a major role in regulating the bodily functions. These are essential for tissues repair, growth and development. This project employs AI algorithms to analyze nutritional content, leveraging data from IoT devices. By using CNN algorithm the input image either a fruit or vegetable that has been received from the user through IoT device has been predicted. This system provides users with comprehensive insights into their nutrient consumption, including macronutrients, vitamins, and minerals. This project is designed to provide dietary recommendations based on individual user profiles, incorporating personal information such as age, height, weight, Body Mass Index (BMI), and fitness objectives. This enhances healthier eating habits and promote nutritional awareness among the people.

1.1 PROBLEM STATEMENT

To Create an Al-powered nutrition analyzer for fitness enthusiasts, revolutionizing dietary tracking and personalizing nutritional insights to optimize health and fitness goals. By harnessing AI algorithms and IoT devices this system analyze the nutrients in the received fruit or vegetable image and providing a real time dietary recommendation.

1.2 SCOPE OF THE WORK

In our proposes system the scope of the work is this Image Recognition of fruits and vegetable image and it is achieved by CNN algorithm. By integrating ESP32 camera with Arduino input image is captured and predicted. By providing the detailed description of nutrients present in the fruits or vegetable the user can make the important decisions in their dietary management. By calculating BMI value from the user input this system recommend the amount of nutrients to be consumed which helps them to achieve their fitness goals.

1.3 AIM AND OBJECTIVES OF THE PROJECT

The main aim of our proposed system is to construct the bridge between technology and healthy eating so that it creates social-awareness about nutritional insights among the people. By analyzing the nutrients users can make the important decisions in their nutrition. With the help of this algorithm this system offers a comprehensive approach for diet management to achieve the fitness goals

The main objectives of our proposed system is to create social-awareness of the importance of nutritional insights in maintaining healthy life and achieving fitness goals. Despite this awareness, many individuals are struggling in tracking their dietary intake and understanding their unique nutritional needs. This system empowers users to make informed dietary choices, leading to improved health outcomes, enhanced fitness levels, and overall well-being. By providing nutritional recommendations the users can make the important decisions in diet management, enhancing their ability to make informed dietary choices.

1.4 RESOURCES

The following prospectus details a list of resources that will play a primary role in the successful execution of our project:

- A properly functioning workstation (PC, laptop, net-books etc.) to carry out desired research and collect relevant content.
- Unlimited internet access.
- Unrestricted access to the university lab in order to gather a variety of literature including academic resources (for e.g. Prolog tutorials, online programming examples, bulletins, publications, e-books, journals etc.), technical manuscripts, etc.

1.5 MOTIVATION

The motivation of our model "Nutrient Analysis and Recommendation System for Health and Fitness Using AI and IoT" is to create social-awareness of the importance of nutritional insights in maintaining healthy life and achieving fitness goals. Despite this awareness, many individuals are struggling in tracking their dietary intake and understanding their unique nutritional needs. This system empower users to make informed dietary choices, leading to improved health outcomes, enhanced fitness levels, and overall well-being.

CHAPTER 2

2.1 LITERATURE SURVEY

[1] "**Improved classification approach for fruits and vegetable using deep learning by Mira Medanach,2019"** , provides a analysis of the use of CNNs in different automatic fruit image processing tasks, such as detection, quality assurance, and classification. It draws attention to the notable developments and growing application of CNNs for these goals in the last several years, showing good outcomes for transfer learning with both fresh models and pre-trained networks.

[2] **"Fruit detection and recognition based on deep learning: An automatic harvesting by A. K. Aggarwal, S. K. Saini, 2019"**, provides a deep learning, in particular CNNs, to fruit recognition and detection for automated harvesting is the main topic of this paper. In order to increase the precision, speed, and resilience of fruit vision identification systems, it addresses current issues such dataset shortages and fruit detection in obscured situations and makes recommendations for future research approaches.

[3] **"Image based nutrients estimation for Chinese dishes using deep learning by M. U. Mustafa, A. Z. Abidin, and M. A. M. Aris,2019"** ,the author analyse different deep learning models for image recognition and categorization from photos, including CNNs. It looks at how well various architectures like RNN, LSTM, and CNN—handle the difficulty of fruit recognition tasks

[4] **"A review on food recognition technology and health applications by N. K. Chand, S. K. Gupta, and N. Prasad,2019"** investigates various deep learning techniques such as CNNs applied to the classification of fruits and vegetables. It gives a broad review of the developments, difficulties, and potential directions for employing deep learning techniques in this subject, with an emphasis on their performance and practical application.

[5] **"Deep learning in food category by S. K. Prajapati and A. Sharma,2020**" conducted various deep learning techniques such as CNNs applied to the classification of fruits and vegetables. It gives a broad review of the developments, difficulties, and potential directions for employing deep learning techniques in this subject, with an emphasis on their performance and practical application.

[6] **“Recognition of food type and calorie estimation using neural network by Harold Robinson, Golden julie,2020**” provides a thorough summary of current developments in artificial intelligence (AI)-based nutritional analysis. The authors conduct a thorough evaluation of the literature on AI-based techniques for nutrient analysis, portion control, and food identification and calories estimation.

[7] **“Advancement in AI based nutritional analysis by Emily Jhonson and Michael ,2021**” examines cutting-edge methods for segmenting, estimating portions, and identifying food images while stressing the benefits and drawbacks of each strategy.

[8] **“Food calories measurement and recognition of food images by S Mohideen, S Kother, 2021**” conducted comprehensive overview of the literature critically looks at the prospects and problems in the field of AI-based nutritional analysis. The authors point out significant methodological flaws and research gaps in previous works, such as the absence of benchmark datasets and consistent assessment measures for contrasting various algorithms.

[9] **“Wearable Devices and Mobile Applications for AI-Powered Nutritional Analysis: A Review by Ryan smith and Jessica brown ,2021”,** The authors examine cutting edge wearable sensors, including activity trackers and smartwatches, that can gather physiological information on food consumption, like glucose levels and heart rate variability. They also go over smartphone apps that use AI algorithms to identify foods, calculate calories, and provide individualized dietary advice.

[10] **“Natural Language Processing Techniques for Dietary Assessment: A Literature Review by Kevin Wang, 2022**”, provides a Named entity recognition (NER), sentiment analysis, semantic parsing, and other NLP tasks pertinent to nutritional evaluation are covered in the study, along with difficulties such data sparsity and domain adaptability. The survey's conclusion offers suggestions for combining natural language processing (NLP) with additional modalities, like computer vision and sensor data, to raise the precision and thoroughness of nutrition analysis systems.

2.2 PROPOSED SYSTEM

The dataset used for image prediction consist of 30000 images each of size 250x250 pixels encompassing a wide array of 50 distinct fruits and vegetables. After collecting the dataset Data Preprocessing technique must be done for resizing, augmentation to enhance the model robustness. Next we need to split the dataset into training, testing and validation in the appropriate ratio to avoid overfitting and underfitting issue. By using convolutional Neural network algorithm the corresponding model can be trained with the help of the training dataset.

Finally the model can be evaluated by giving the input as currency image. With the help of ESP32 camera images are received from the user and predicted with the help of CNN algorithm. Our proposed system provides users with comprehensive insights into their nutrient consumption, including macronutrients, vitamins, and minerals. Also it is designed to provide dietary recommendations based on individual user profiles, incorporating personal information such as age, height, weight, Body Mass Index (BMI), and fitness objectives. This enhances healthier eating habits and promote nutritional awareness among the people.

CHAPTER 3

SYSTEM DESIGN

3.1 GENERAL

In this section, we would like to show how the general outline of how all the components end up working when organized and arranged together. It is further represented in the form of a flow chart below.

3.2 SYSTEM ARCHITECTURE DIAGRAM

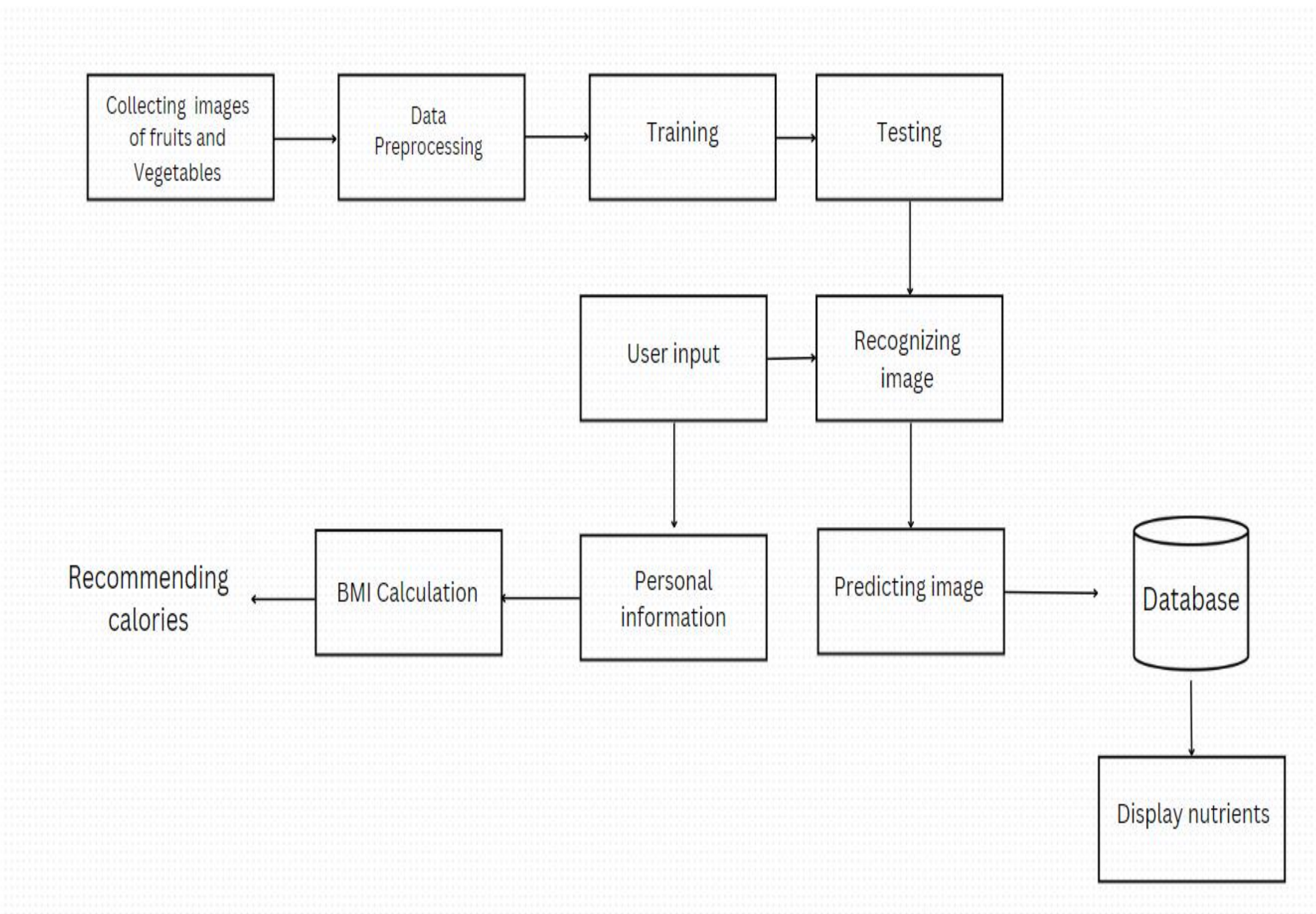

Fig 3.2.1: System Architecture

3.3 DEVELOPMENTAL ENVIRONMENT

3.3.1 HARDWARE REQUIREMENTS

The hardware requirements may serve as the basis for a contract for the system's implementation. It should therefore be a complete and consistent specification of the entire system. It is generally used by software engineers as the starting point for the system design.

Table 3.3.1 Hardware Requirements

COMPONENTS	SPECIFICATION
PROCESSOR	Intel Core i5
ARDUINO	UNO
ESP32 MODULE	4 MB PSRAM
RAM	8 GB RAM
GPU	NVIDIA GeForce GTX 1650
MONITOR	15" COLOR
HARD DISK	512 GB
PROCESSOR SPEED	MINIMUM 1.1 GHz

3.3.2 SOFTWARE REQUIREMENTS

The software requirements document is the specifications of the system. It should include both a definition and a specification of requirements. It is a set of what the system should rather be doing than focus on how it should be done. The software requirements provide a basis for creating the software requirements specification.

Table 3.3.2 Software Requirements

S.NO	REQUIREMENT
1	Jupyter Notebook
2	Scikit-learn
3	TensorFlow
4	Xampp

3.4 DESIGN OF THE ENTIRE SYSTEM:

3.4.1 SEQUENCE DIAGRAM:

A sequence diagram simply depicts the interaction between the objects in a sequential order.An sequence diagram is used to show the interactive behavior of a system.

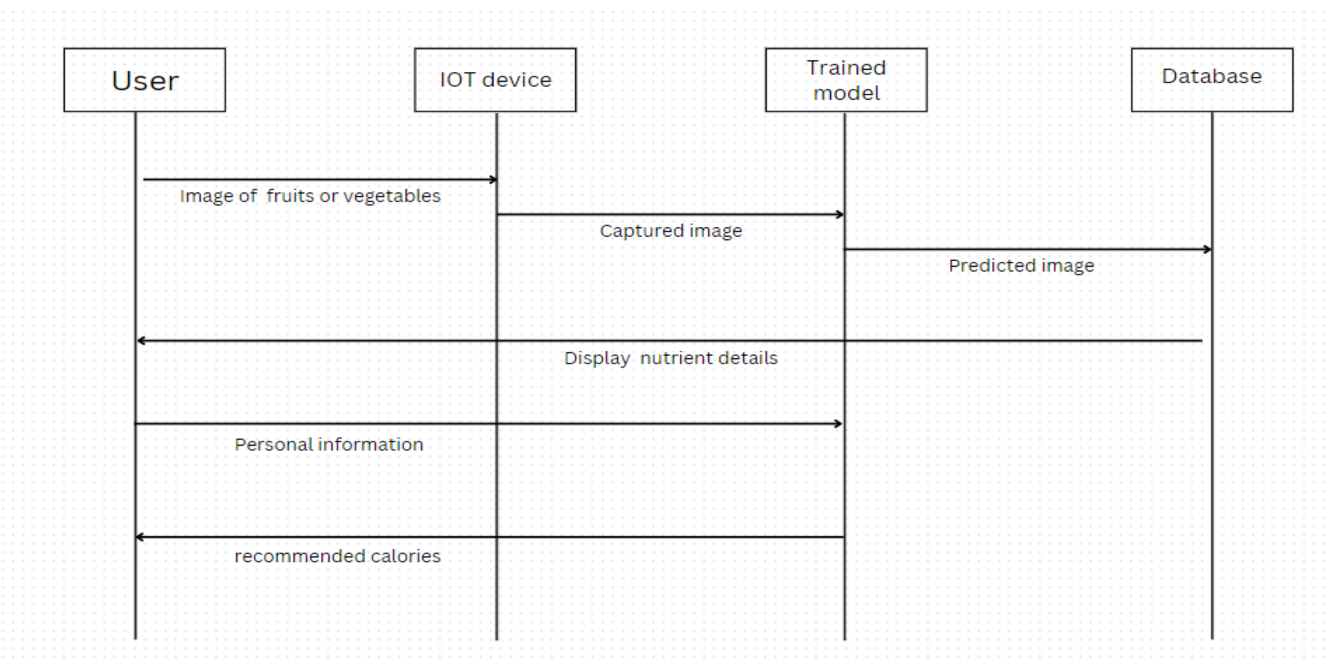

Fig 3.4.1: Sequence Diagram

CHAPTER 4

PROJECT DESCRIPTION

4.1 METHODOLODGY

The image of fruit or vegetable that has been shown by the user has been captured with the help of ESP32 camera integrated with Arduino. Data collection is the next step to predict the fruits and vegetables . It is the process of collecting the images of different categories of fruits and vegetables from the google and stored in the respective categories. Only the image of the fruits and vegetables is extracted from the collected image. Background of the image is removed .Finally we get only the fruits or vegetable image with no background image so that it is easy for the model to predict the image. First the input image is converted into grayscale. The images of grayscale contains only the sensitive information. The mathematical function is used to acquire the gray value of the pixel. Finally we get the segmented image of fruits or vegetables. Image classification technique is done with the help of CNN algorithm with the help of the dataset where the dataset is split into training, testing, validation set. 70% of the images are used for training,15% for testing,15% for validation. Thus our model predict the images received grom the user gather the personal information from the user such as weight, height and calculate BMI value. Based on BMI value the system recommend the amount of calories to be consumed to the user.

4.2 MODULE DESCRIPTION

Data acquisition and preprocessing, which is the first module's responsibility, gathers data from a variety of sources, including food databases, nutrition labels, and Internet of Things devices. This module covers methods for assuring the quality and consistency of the data acquired for subsequent analysis by cleaning, standardizing, and structuring it. The second module is devoted to the development of machine learning models, wherein algorithms are taught to assess patterns of food consumption, forecast dietary trends, and produce customized recommendations according to the preferences and health objectives of users.

To improve the precision and efficacy of the recommendation system, this module incorporates AI techniques including sequence modelling and deep learning for feature representation learning. The project also includes modules for Ethical and Privacy Considerations, Deployment and Monitoring, Assessment and Validation, Personalized Recommendation Engine, and IoT Integration. Machine Learning Model Development, is pivotal for the system's intelligence and functionality. In this module, machine learning algorithms are trained to analyze users' dietary habits, predict nutritional intake patterns, and generate personalized recommendations based on their health goals and preferences. Techniques such as supervised learning, unsupervised learning, and reinforcement learning may be employed to extract insights from the data and iteratively improve the recommendation engine's performance.

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 OUTPUT

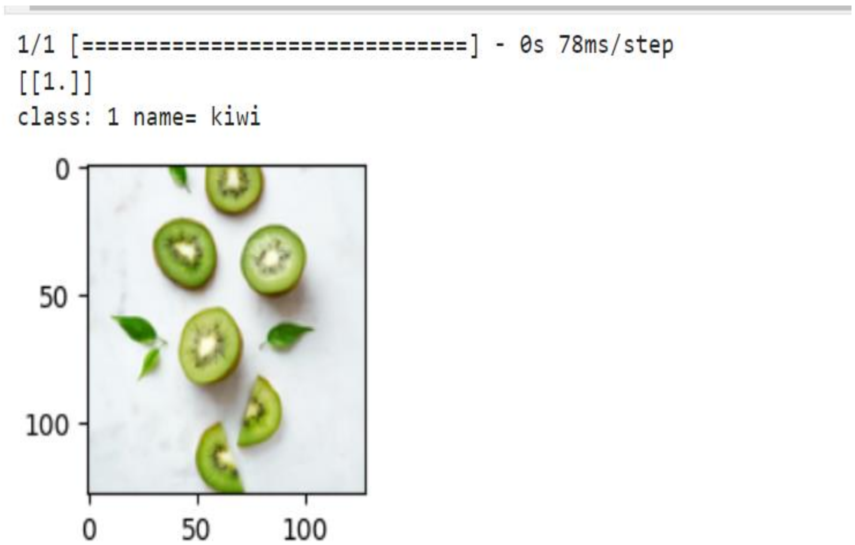

Fig 5.1.1: Predicted image

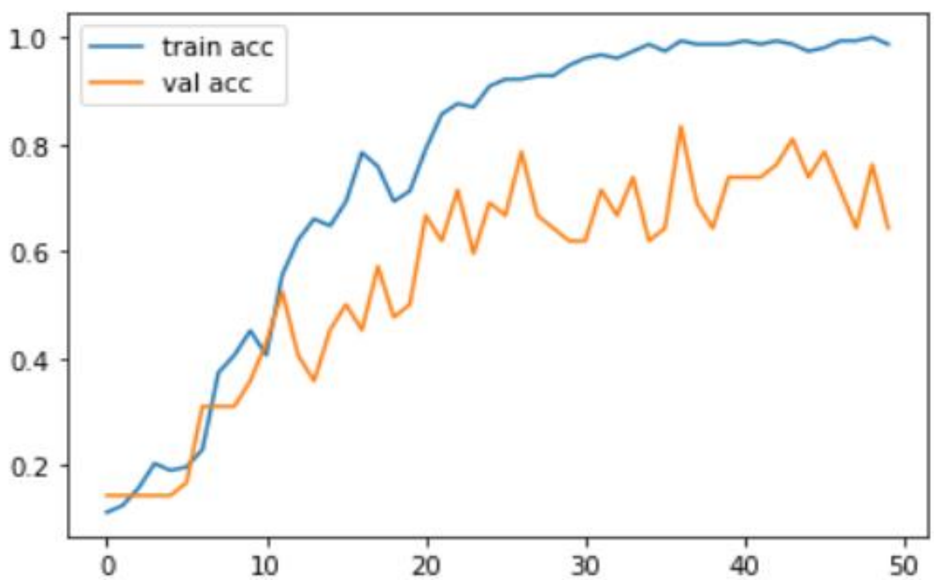

Fig 5.1.2: Graph of Training and validation accuracy

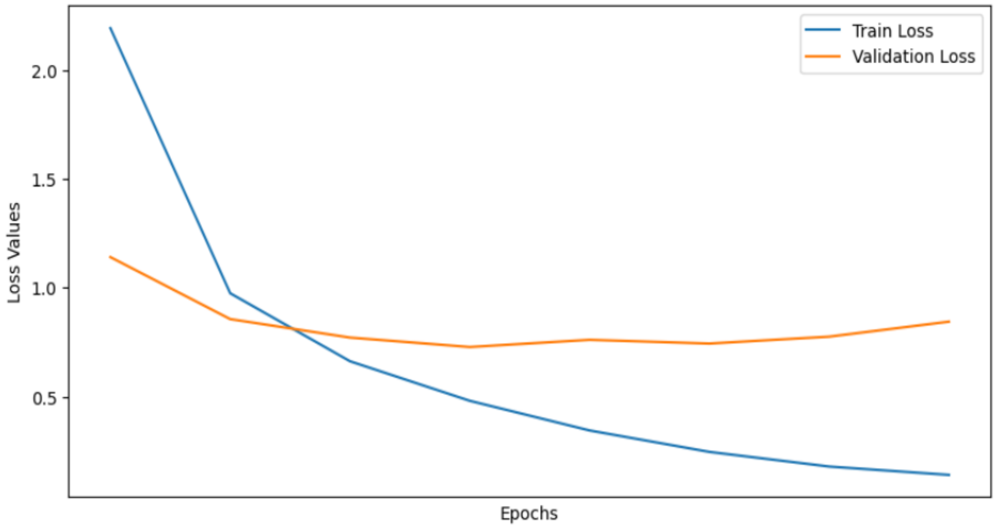

Fig 5.1.3: Graph of training and validation loss

('Kiwi', 'Calories 94', 'Fiber 36g' ,'Fat 0.44g','Protein 1g')

Fig 5.1.4: Nutrients of predicted image

5.2 RESULT

The outcomes of the Health and Fitness Nutrient Analysis and Recommendation System AI is shown to be effective in encouraging healthy lives and offering individualized food recommendations. The technology effectively assesses users' dietary intake patterns and pinpoints potential for enhancing nutritional balance and achieving personal health objectives through the integration of cutting-edge machine learning algorithms. The system can efficiently process vast amounts of data from many sources, such as food databases, nutritional labels, and user-generated inputs, by utilizing AI techniques like deep learning and data mining. This allows the system to produce actionable insights and customized suggestions.

High levels of satisfaction with the system's suggestions are also indicated by user comments and evaluations; numerous users report improvements in their eating habits, heightened awareness of nutritional needs, and improved general well-being. Personalized dietary advice can be effortlessly incorporated into everyday routines by users thanks to the system's easy-to-use interface and seamless connection with mobile and web platforms. All things considered, the Nutrient Analysis and Recommendation System is a noteworthy development in the use of AI technology to enable people to make educated dietary selections and meet their fitness and health objectives.

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

6.1 CONCLUSION

The Nutrient Analysis and Recommendation System for Health and Fitness concludes The application of AI marks a substantial advancement in the use of AI to encourage better living. By combining cutting-edge machine learning algorithms with Internet of Things technology, the system offers customized dietary analysis and suggestions based on user requirements and preferences. User evaluations and feedback have shown how well the system works to increase users' awareness of their nutritional intake and encourage a shift in behaviour toward healthy eating habits.

6.2 FUTURE ENHANCEMENT

Integration with Fitness apps: Sync with well-known fitness platforms and applications to offer a comprehensive picture of the health of the user by combining dietary analysis and exercise data.

Nutrient deficiency alert: Use AI to provide alerts and recommendations when it detects any nutrient imbalances or deficiencies based on dietary data that has been logged and user health profiles.

AI powered meal planning: Create AI-powered meal planning tools that make preparation guidelines based on each person's unique dietary requirements.

APPENDIX

main_app.py:

```
import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

import cv2

import os

import PIL

import pathlib

from sklearn.model_selection import train_test_split

import tensorflow as tf

from tensorflow import keras

from tensorflow.keras.models import Sequential

from tensorflow.keras.layers import Conv2D,Dense,Dropout, Flatten,Activation,
BatchNormalization,MaxPooling2D

from tensorflow.keras import datasets, layers, models

from tensorflow.keras.preprocessing.image import load_img

from tensorflow.keras.preprocessing.image import img_to_array
```

```
from tensorflow.keras.callbacks import EarlyStopping

import tensorflow as tf

from tensorflow import keras

from tensorflow.keras.preprocessing.image import ImageDataGenerator

import numpy as np

import matplotlib.pyplot as plt

apple = list(data_dir.glob('apple fruit/*'))

banana = list(data_dir.glob('banana fruit/*'))

cherry = list(data_dir.glob('cherry fruit/*'))

chickoo = list(data_dir.glob('chickoo fruit/*'))

grapes = list(data_dir.glob('grapes fruit/*'))

orange = list(data_dir.glob('orange fruit/*'))

strawberry = list(data_dir.glob('strawberry fruit/*'))

fruit_images_dict = {

    'mango': list(data_dir.glob('mango fruit/*')),

    'kiwi': list(data_dir.glob('kiwi fruit/*')),

    'apple': list(data_dir.glob('apple fruit/*')),
```

```
    'banana': list(data_dir.glob('banana fruit/*')),
    'cherry': list(data_dir.glob('cherry fruit/*')),
    'chickoo': list(data_dir.glob('chickoo fruit/*')),
    'grapes': list(data_dir.glob('grapes fruit/*')),
    'orange': list(data_dir.glob('orange fruit/*')),
    'strawberry': list(data_dir.glob('strawberry fruit/*'))
}
fruit_labels_dict = {
    'mango': 0,
    'kiwi': 1,
    'apple': 2,
    'banana': 3,
    'cherry': 4,
    'chickoo': 5,
    'grapes': 6,
    'orange': 7,
    'strawberry': 8
```

```
}
IMAGE_WIDTH=128
IMAGE_HEIGHT=128
IMAGE_CHANNELS = 3
X, Y = [], []


for fruit_name, images in fruit_images_dict.items():
    print(fruit_name)
    for image in images:
        img = cv2.imread(str(image))
        if isinstance(img,type(None)):
        #print('image not found')
            continue
        elif ((img.shape[0] >= IMAGE_HEIGHT) and  (img.shape[1] >=IMAGE_WIDTH)):
            resized_img = cv2.resize(img,(IMAGE_WIDTH,IMAGE_HEIGHT))
            X.append(resized_img)
            Y.append(fruit_labels_dict[fruit_name])
```

```
        else:
            #print("Invalid Image")
            Continue
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, random_state=0, test_size=0.1)
print(len(X_train),len(Y_train))
print(len(X_test),len(Y_test))
print(X_train.shape,Y_train.shape)
print(X_test.shape,Y_test.shape)
IMAGE_CHANNELS=3
model = Sequential([
Conv2D(32, (3, 3), activation='relu', input_shape=(IMAGE_WIDTH, IMAGE_HEIGHT,
IMAGE_CHANNELS)),
BatchNormalization(),
MaxPooling2D(pool_size=(2, 2)),
Dropout(0.25),
Conv2D(64, (3, 3), activation='relu'),
BatchNormalization(),
```

```
MaxPooling2D(pool_size=(2, 2)),

Dropout(0.25),



Conv2D(128, (3, 3), activation='relu'),

BatchNormalization(),

MaxPooling2D(pool_size=(2, 2)),

Dropout(0.25),

Flatten(),

Dense(512, activation='relu'),

BatchNormalization(),

Dropout(0.5),

Dense(1, activation='softmax'),

])

model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

model.summary()

classes =
["mango","kiwi","apple","banana","cherry","chickoo","grapes","orange","strawberry"]
```

```
from PIL import Image

fileImage = Image.open(r"C:\Users\saksh\Downloads\kaggle\input\fruits\pictures\kiwi fruit\Image_1.png").convert("RGB").resize([IMAGE_WIDTH,IMAGE_HEIGHT],Image.LANCZOS)

image = np.array(fileImage)

myimage = image.reshape(1, IMAGE_WIDTH,IMAGE_HEIGHT,3)

# prepare pixel data

#myimage = myimage.astype('float32')

#myimage = myimage/255.

plt.figure(figsize = (4,2))

plt.imshow(image)



my_predicted_image = model.predict(myimage)

print(my_predicted_image)

if (my_predicted_image < 0.40):

    y_class=0

else:

    y_class=1
```

```
 print("class:",y_class,"name=",classes[y_class])

import mysql.connector

mydb = mysql.connector.connect(

host="localhost",

user="root",

password=" ",

database="classify"

)

mycursor = mydb.cursor()

mycursor.execute("SELECT * FROM fruits where name=classes[yclass]")

myresult = mycursor.fetchall()

for x in myresult:

  print(x)
```

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