FOOD INSIGHTS AND ANALYSIS BASED RECOMMENDATION USING CONVOLUTIONAL NEURAL NETWORK METHOD

21_22-J-058

Jayapalan Abishek Prashanthan

IT18228618

BSc (Hons) in Information Technology
Specialization in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

June 2022

FOOD INSIGHTS AND ANALYSIS BASED RECOMMENDATION USING CONVOLUTIONAL NEURAL NETWORK METHOD

21_22-J-058

Jayapalan Abishek Prashanthan
IT18228618

Supervised by
Ms. Anjalie Gamage

BSc (Hons) in Information Technology
Specialization in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

June 2022

DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to Sri Lanka Institute of Information Technology, the nonexclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Name	Student ID	Signature
J. A. Prashanthan	IT18228618	

The above candidate has carried out research for the bachelor's degree Dissertation under my supervision.

Signature of the supervisor: Date:

ABSTRACT

Diabetes affects an estimated 387 million people (8.3 percent of adults) worldwide, with more than 10% of Sri Lankan adults affected. The number of diabetics is expected to reach 592 million by 2035. Diabetes is a chronic health condition, which means that, while it can be managed, it lasts a lifetime. If left untreated, it can lead to a wide variety of disabling and potentially fatal complications, including heart disease, kidney failure, blindness, and nerve damage.Diabetes claims one leg every 20 seconds somewhere in the world. Diabetes increases a person's risk of death by at least doubling. It is an expensive disease, not only for you and your family, but it also consumes an increasing portion of the national health budget.This research contributes to understanding the risks associated with diabetes and how to prevent or diagnose it.

Making food decisions is important in our daily lives due to the obvious wide range of products, cuisines, and personal tastes available. In the majority of cases, selecting the appropriate food for a specific type of person appears to be a difficult task almost entirely for dietitians.I propose a research project to develop a food suggestion system that will help people choose acceptable meals on their own. The system will generate meals based on the user's preferences as well as the image uploaded to the app. This allows the user to keep track of the various components that have been incorporated into his meals. Everyone couldn't afford a personal dietitian or a caregiver to make sure their eating habits were consistent. So we created a service to keep track of what they should eat and avoid in order to maintain their health while also taking their preferences into account.As a result, we use machine learning technology to analyze their specific medical documents and provide them with an accurate meal advice list that includes both the benefits and drawbacks of certain foods. Image processing technology will help us recognize specific substances and the nutritional information associated with them.

Tags : Convolutional Neural Network, Image Processing, Machine Learning, Food Detection

ACKNOWLEDGMENT

This project would not have been possible without the support of many. Special thanks to my supervisor, Anjalie Gamage, who read through my numerous revisions and helped me make sense of it all. Also with regard to project-related official matters. I'd like to express my heartfelt gratitude to my sister-in-law, Dr. Harinee Hansika, for guiding me for a year in medical research, specifically diabetes and correlated medical advice. My friends and family were extremely helpful in keeping me self-balanced and motivated. Their advice and assistance greatly aided me in meeting my objectives.

TABLE OF CONTENT

LIST OF FIGURES

1. INTRODUCTION

1.1 BACKGROUND LITERATURE

Food is defined as any substance consumed to provide nutritional support for a living being. Food is typically composed of carbohydrates, fats, proteins, vitamins, and minerals derived from plants, animals, or fungi. An organism consumes a material that is digested by the organism's cells to provide energy, preserve life, or promote growth. Food selection is an important part of our daily activities due to the enormous variety of ingredients, foods, and personal tastes. Many people appear to find it difficult to choose the right food at the right time. With so many options, selecting food is a daily chore. We can't tell how something was made just by looking at it. However, with the help of image processing, we were able to achieve something that humans could not. People are still unaware of the nutritional value, benefits, and drawbacks of their food choices when making healthcare decisions.

Food has a calorie nevertheless, in most meals, the consumer has no idea how many calories are in the food being provided. It is necessary to identify food. In a food picture, there are usually multiple varieties of food served, and it is possible to tell what food is served from just one picture. Food selection is essential for specific purposes, such as a diet grading system, to prevent obesity, diabetes and others. Food references can be found through the food classification. Image classification is a challenge because the food image dataset is not linear; for example, There is a food which has more similarities in look and taste, which is not the same, and there is also a food with another food which has similarities in types and forms of food.

A doctor, a dietitian, or a nutritionist are all knowledgeable about these topics and highly recommended. [11] However, how many of us seek professional advice and have the financial means to hire them? Numerous studies have found that diet has a significant impact on our life span. Diabetes, which is caused by a high carbohydrate intake, affects the majority of the Asian continent's population. A doctor suggests a diet, but only after we make an appointment with them. So, how about we have a caregiver with us every day, making suggestions and informing us by reading and analyzing our medical statistics on a daily basis, as well as keeping track of everything we're going through?

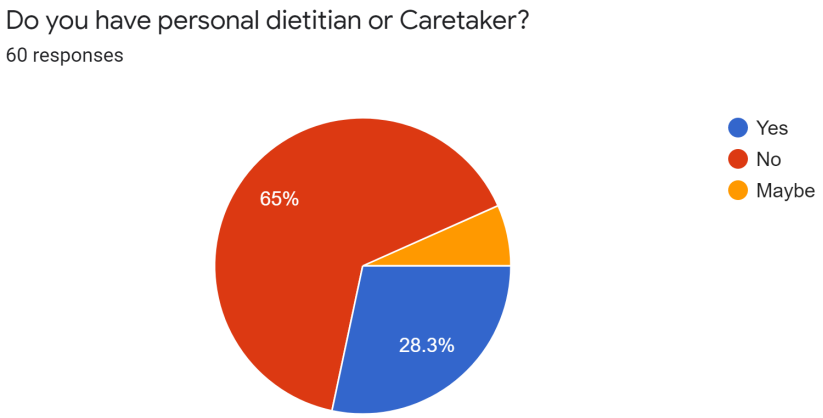

Figure 1.1 People interested in a caregiver or personal dietitian

According to [Figure 1.1], the majority of us lack a personal caregiver or nutritionist who can monitor our health and well-being. This is another factor that no one gives much thought to. They would prefer, however, to have someone look after them.

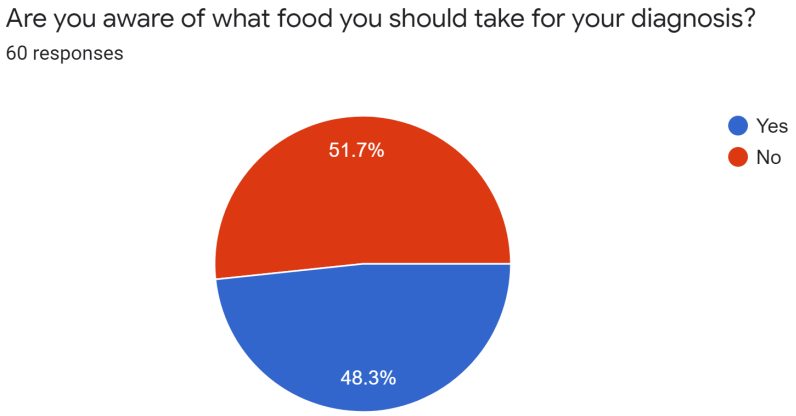

Figure 1.2 People's interest in food consumption based on diagnosis

Despite the fact that many of us are afflicted with various diseases. We do not take care of those the majority of the time. We are concerned about maintaining our mental and physical health. Individuals are completely unaware of the foods they consume. Some people eat because they are hungry, while others eat because they enjoy it or because they like it. This graph shows that they have adequate guidance and understanding of food and related topics, with a near 50-50 chance of being correct.

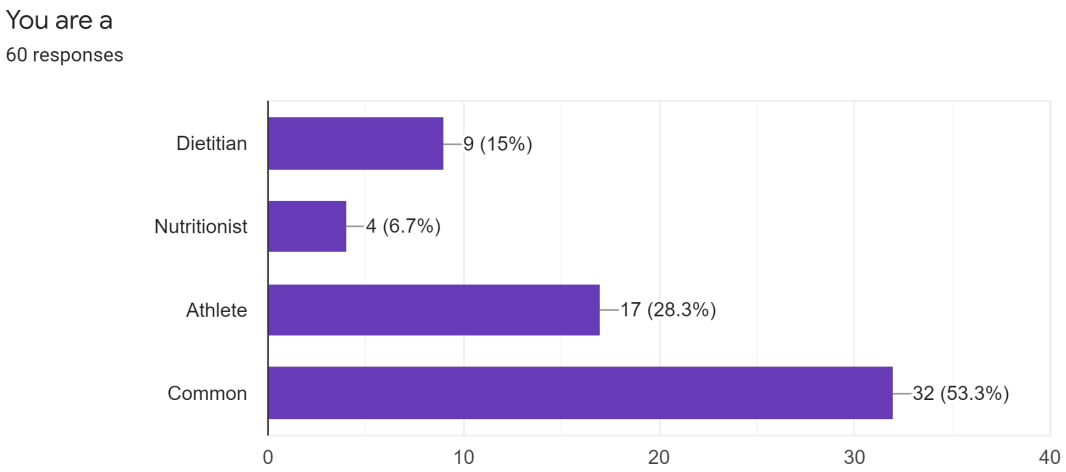

Figure 1.3 who seek food-related statistics and information

This graph demonstrates that 53.3 percent of the population is interested in learning about food-related topics. Athletes like to be as precise as possible with their nutrition and fitness measurements. Dietitians and nutritionists need precise findings in order to be successful in their careers. Many of us are intrigued by the prospect of discovering what is contained within a specific object. As a result, this piqued interest will lead to the realization that this application will be beneficial to many people in the near future.

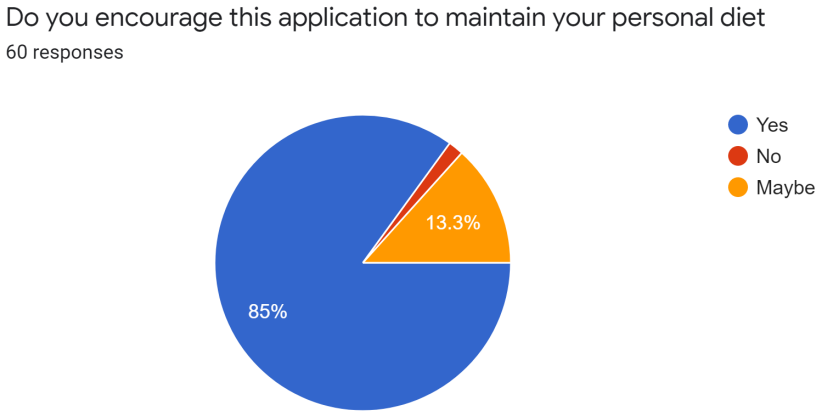

Figure 1.4 Absolutely liked understanding their personal diet.

This graph clearly shows that consumers value innovative technology that meets their needs in an efficient and cost-effective manner. They are curious about the variety of meals available around the world, as well as the quality of those meals, and they want to sample every morsel of that goodness. A healthy way of life is something that modern society prioritizes above all else.

Diabetes is a long-term health condition that affects how your body converts food into energy. [2] The majority of the food you eat is converted into sugar (also known as glucose) and released into your bloodstream. When your blood sugar rises, your pancreas sends a signal to release insulin. Insulin functions as a key, allowing blood sugar to enter cells and be used as energy. [12] Diabetes can be divided into several types. Diabetes is classified into three types: type 1 diabetes, type 2 diabetes, and gestational diabetes. Type 1 diabetes is most commonly diagnosed in children and adolescents. Because type 1 diabetes can run in families (Genetics). Experts recommend routine testing for type 2 diabetes if you are 45 or older, between the ages of 19 and 44, overweight or obese, and have one or more other diabetes risk factors, or if you are a woman who has had gestational diabetes. Type 2 diabetes is most common in adults, but it can also affect children. Experts recommend testing children aged 10 to 18 who are overweight or obese and have at least two other diabetes risk factors.

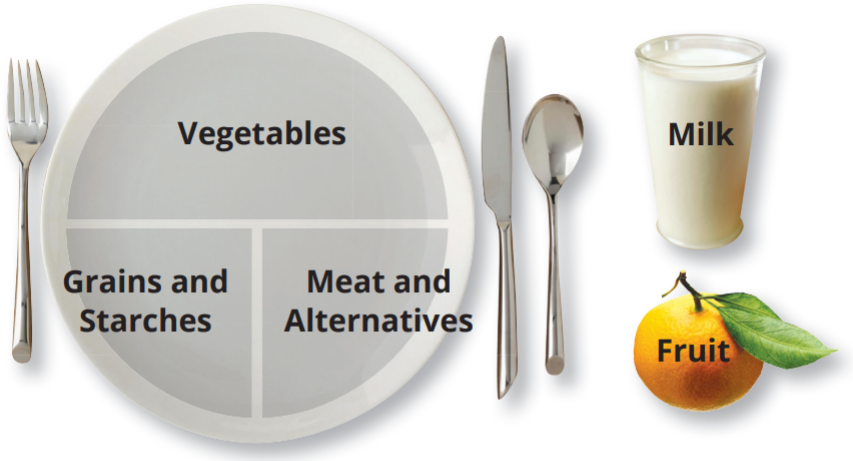

Figure 1.5 : The Plate Method. Using standard dinner plate

Some carbohydrate-containing foods and beverages contain so little carbohydrate that they lack a GI value. [8] This does not preclude them from being a part of a healthy diet. Green vegetables, lemons, and some low-carbohydrate drinks are examples. Diabetes Canada refers to these foods and beverages as "free" because they have no effect on the blood sugar of diabetics. You can put free foods in the green category, but they don't have a GI and aren't on the food lists.

The A1C test, also known as the hemoglobin A1C or HbA1c test, is a straightforward blood test that measures your average blood sugar levels over the previous three months. It is one of the most commonly used tests for diagnosing prediabetes and diabetes, as well as the primary test for assisting you and your health care team in managing your diabetes. Higher A1C levels have been linked to diabetes complications, so achieving and maintaining your personal A1C goal is critical if you have diabetes.

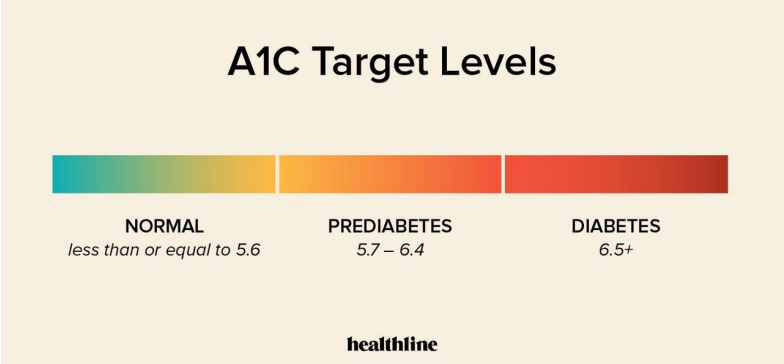

Figure 1.6 A1C Target Levels

According to the International Diabetes Federation (IDF), the prevalence of diabetes among adults in Sri Lanka is 8.5 percent. Diabetes affects one in every twelve adults in the country, a total of 1.16 million people.

People with diabetes can manage their blood sugar levels by eating certain foods and avoiding others. A diet high in vegetables, fruits, and lean proteins can provide significant health benefits. Blood sugar levels can be raised by both sugary and starchy carbohydrates. However, in the right amounts, these foods can contribute to a well-balanced diet. Many factors, including a person's activity level and medications, such as insulin, can influence the appropriate amount and type of carbohydrates.

1.2 RESEARCH GAP

There are several methods and applications for keeping track of what you consume, but in most cases, this information must be entered manually each time. Some programs suggest foods that the user dislikes and that are also out of reach for the majority of people. In our case, however, we recommend foods that the user has selected. When a user selects the wrong food for their meal, This program will suggest meal options based on the user's grade level; however, the user will have complete control over which food to select from the suggested options. Using this application, they will be given recommendations for more beneficial ingredients. There are numerous technologies available for detecting and obtaining information about objects. Image processing will be essential for identifying and segmenting components. In addition, we will use machine learning technology to analyze those elements and recommend meal plans, as well as evaluate and process medical report data.

1.3 RESEARCH OBJECTIVES

These issues were discovered after a detailed investigation.

There is insufficient personalized counseling or meal recommendations based on the user's diagnosis. For a long time, some were considered myths. No precise measures have been taken to assist users based on their diagnosis.

Image processing was useful in calculating preprocessing and segmentation level items in order to conduct fundamental research. However, no practical application existed that enabled users to combine recipes based on their inputs.

This component will receive an initial feed of the users' most recent medical statistics, analyze those data, and generate a digital report of the users' prints. This program will also categorize users based on their ability to decipher.

The user will be provided with a meal suggestion system that uses image processing technology to identify meals while taking log data into account.

2. METHODOLOGY

The user must first provide [5] medical data to this system, which will then analyze and process the data to determine the user's ailment or diagnosis. [3] Based on the information they have provided, it will then generate some meal alternatives. [6] Users of this program have complete control over the ingredients they use in their meals. It will generate a healthy meal plan for the user based on the food components and preparation techniques gathered, as well as the user's medical conditions. It will also keep tabs on their health. The general public, as well as athletes, dietitians, and nutritionists, will benefit from this.

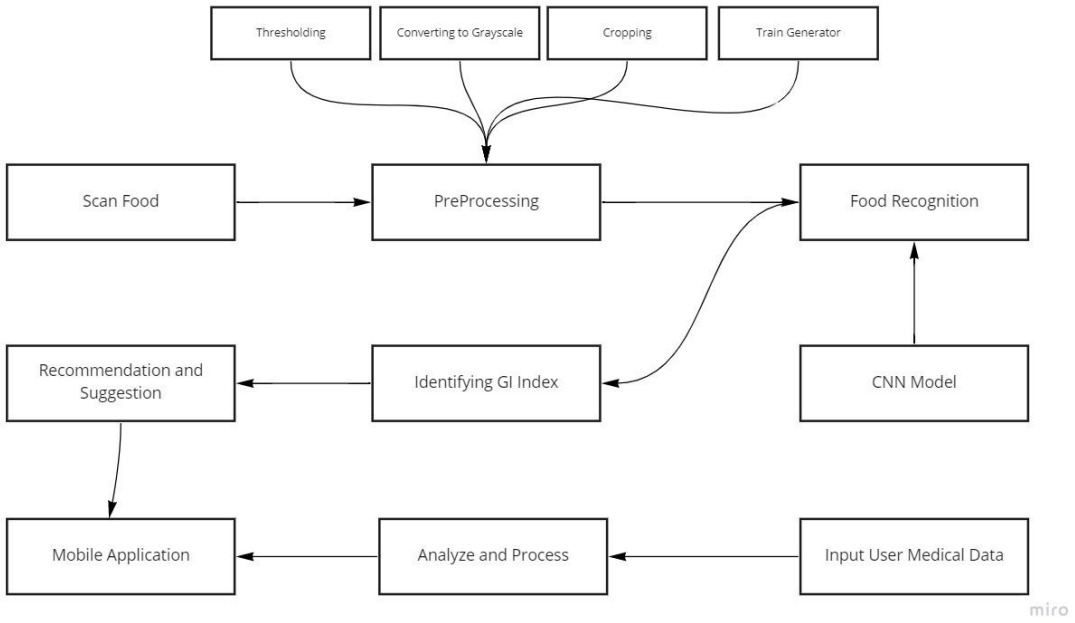

Figure 2.1 Individual System Architecture

The glycemic index (GI) [1] is a scale that ranks carbohydrate-containing foods and beverages based on how much they raise blood sugar levels after consumption. High GI

foods raise blood sugar levels higher and faster than low GI foods.

Figure 2.2 : Shows how GI index vary and works

Foods in the high GI category can be substituted for foods in the medium and/or low GI categories to reduce GI.

A convolutional neural network (CNN) is a type of artificial neural network that is specifically designed to process pixel data in image recognition and processing. CNNs are powerful image processing, artificial intelligence (AI) systems that use deep learning to perform both generative and descriptive tasks, frequently utilizing machine vision, which includes image and video recognition, recommender systems, and natural language processing. A CNN employs a system similar to a multilayer perceptron that has been optimized for low processing requirements. A CNN has three layers: an input layer, an output layer, and a hidden layer with multiple convolutional layers, pooling layers, fully connected layers, and normalization layers. The removal of constraints and increased efficiency for image processing results in a system that is far more effective, simpler to train, and more efficient for image processing and natural language processing.

Transfer learning is a machine learning research subject that focuses on storing and transferring knowledge learned while addressing one problem to a different but related problem. For instance, skills learned when learning to recognize vehicles could be applied to recognizing trucks.

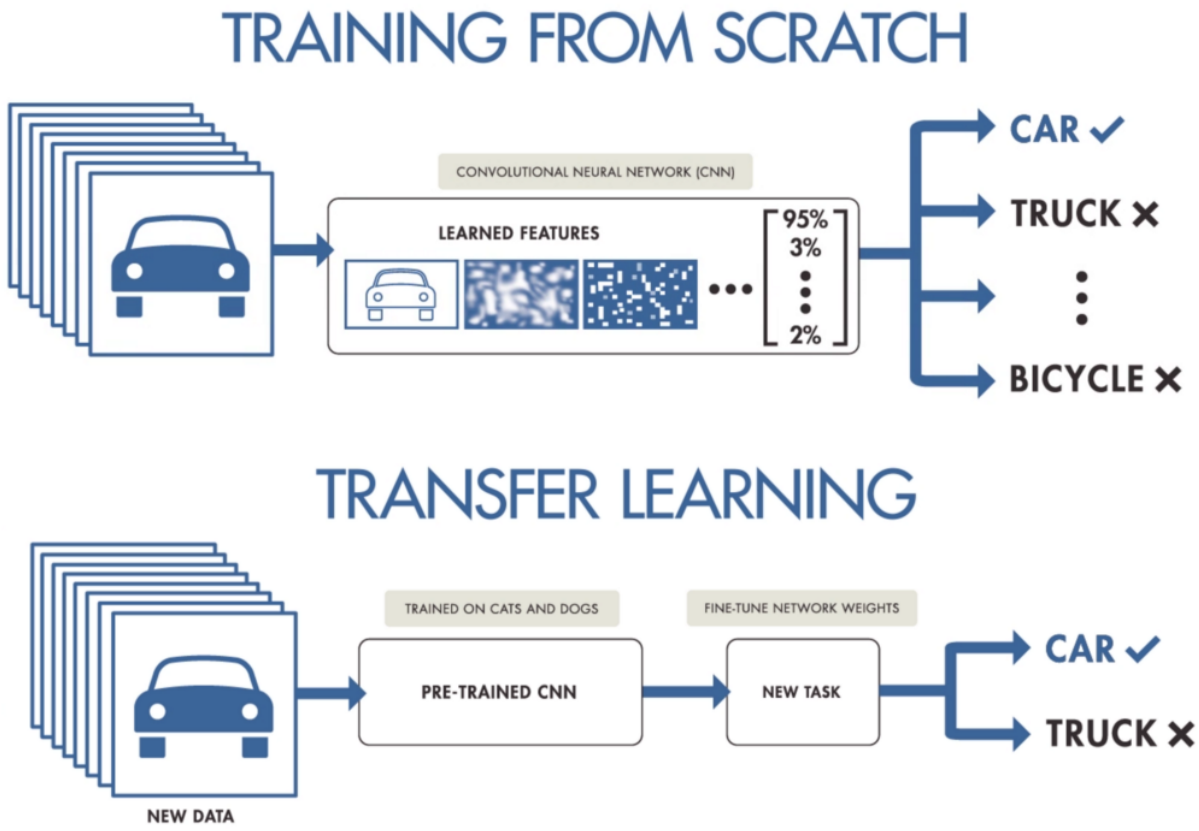

Figure 2.3 : Transfer learning Architecture

Keras is a Python interface for artificial neural networks that is open-source software. Keras serves as a front end for the TensorFlow library.

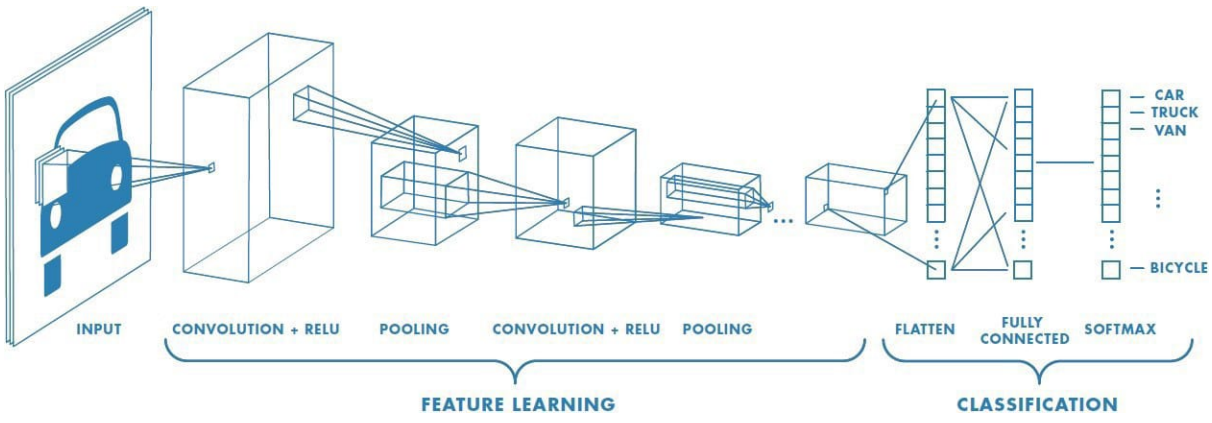

Figure 2.4 Convolutional Neural network architecture

CNN operates by extracting features from images. [4] A grayscale image serves as the input layer. [9] The output layer consists of binary or multi-class labels. [7] Convolution layers[10] , ReLU (rectified linear unit) layers, pooling layers, and a fully connected Neural Network comprise the hidden layers.

The Conv2D parameter specifies the number of filters from which convolutional layers will learn. It is an integer value that also determines the number of convolution output filters.

The max pool layer is similar to the convolution layer, but instead of performing convolution operations, we select the maximum values in the input's receptive fields.

Every negative value in the filtered image is removed and replaced with zero in the ReLU layer. This function is only activated when the node input exceeds a certain threshold. As a result, when the input is less than zero, the output is zero. Dense Layer is used to classify images based on convolutional layer output. A single neuron at work.

In neural network models that predict a multinomial probability, the softmax function is used as the activation function in the output layer.

Technologies, techniques to be used.

The major technological needs were examined in this section of the feasibility study. Some of the resources discovered during the study are listed below.

- Convolutional Neural Network
- Transfer Learning Architecture
- Python
- Kivy Python

Functional Requirements

- Image processing for food identification
- Analyze and train them based on the collected data.
- Produce output from the analyzed data.

Non-functional Requirements

- Security
- High Accuracy
- Availability
- Usability
- Performance
- Reliability

3. COMMERCIALIZATION ASPECTS OF THE PRODUCT

Because diabetes is a major chronic disease worldwide, this application will assist the majority of people in preventing and taking necessary precautions. Diabetes is entirely determined by the user's eating habits; if we can log their eating habits, this application will serve as their personal caregiver. In today's fast-paced world, everyone requires a caregiver to look after their health. atleast to take preventative measures in the future. The user will gain more knowledge about their health status as well as a better understanding of their diagnosis.

We can begin charging for the services provided once the app is successful. The app can be updated with more interesting features to entice users to purchase the premium version of the app.

4. TESTING & IMPLEMENTATION

4.1 RESULTS & DISCUSSION

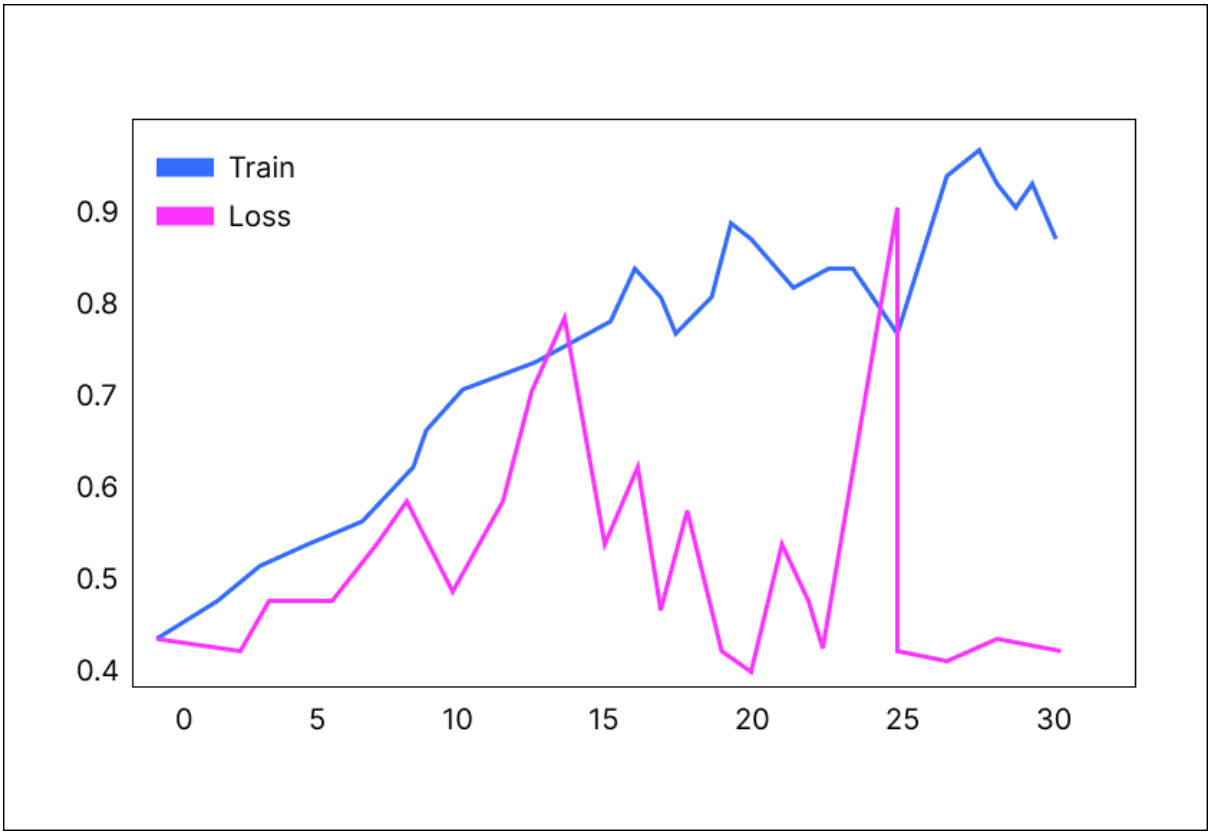

Figure 4.1 Train and loss accuracy diagram

The train and loss functionality of my CNN model trained for image processing is depicted in this figure. This model has achieved more than 85% overall accuracy, which is excellent for machine learning.

```
9/9 [==============================] - 9s 1s/step - loss: 0.7226 - acc: 0.7518
Epoch 14/30
9/9 [==============================] - 9s 987ms/step - loss: 0.5261 - acc: 0.7932
Epoch 15/30
9/9 [==============================] - 10s 1s/step - loss: 0.6401 - acc: 0.7431
Epoch 16/30
9/9 [==============================] - 9s 1s/step - loss: 0.4499 - acc: 0.8321
Epoch 17/30
9/9 [==============================] - 9s 1s/step - loss: 0.5140 - acc: 0.8029
Epoch 18/30
9/9 [==============================] - 9s 997ms/step - loss: 0.7067 - acc: 0.7981
Epoch 19/30
9/9 [==============================] - 10s 1s/step - loss: 0.3536 - acc: 0.8929
Epoch 20/30
9/9 [==============================] - 9s 994ms/step - loss: 0.4033 - acc: 0.8564
Epoch 21/30
9/9 [==============================] - 10s 1s/step - loss: 0.5154 - acc: 0.8175
Epoch 22/30
9/9 [==============================] - 10s 1s/step - loss: 0.4522 - acc: 0.8127
Epoch 23/30
9/9 [==============================] - 10s 1s/step - loss: 0.3571 - acc: 0.8832
Epoch 24/30
9/9 [==============================] - 10s 1s/step - loss: 0.2286 - acc: 0.8929
Epoch 25/30
9/9 [==============================] - 10s 1s/step - loss: 0.9990 - acc: 0.7421
Epoch 26/30
9/9 [==============================] - 10s 1s/step - loss: 0.2192 - acc: 0.9319
Epoch 27/30
9/9 [==============================] - 10s 1s/step - loss: 0.1839 - acc: 0.9270
Epoch 28/30
9/9 [==============================] - 10s 1s/step - loss: 0.3399 - acc: 0.8540
Epoch 29/30
9/9 [==============================] - 10s 1s/step - loss: 0.2341 - acc: 0.9197
Epoch 30/30
9/9 [==============================] - 10s 1s/step - loss: 0.3485 - acc: 0.8710
------------------ Disease Model Saved ------------------
```

Result

QR code details:

Name: Adam

Pregnancies: 0

Glucose: 137

BloodPressure: 40

SkinThickness: 35

Insulin: 168

BMI: 43.1

DiabetesPedigreeFunction: 2.288

Outcome: 1

Result

QR code details:

Name: Emiley

Pregnancies: 8

Glucose: 183

BloodPressure: 64

SkinThickness: 0

Insulin: 0

BMI: 23.3

DiabetesPedigreeFunction: 0.672

Outcome: 1

```
---------- Predicted Food ----------
Fried Rice
---------- Predicted Ingredients ----------
basmati rice 400g, chicken 400g, carrot 100g, leeks 75g, onion 100g, curry leaves, garlic paste, ginger paste, salt, cooking oil, chili paste, egg 1
---------- Predicted sugarLevel (Glycemic Index) ----------
55
Yellow
---------- Summary ----------
This food has more than 50% sugar! Prevent it!

Process finished with exit code 0
```

```
---------- Predicted Food ----------
White Bread
---------- Predicted Ingredients ----------
Flour 40g, sugar 30g, salt 1tsp, warm milk 240ml, yeast 1tbsp, butter 45g, beaten egg 1, coconut oil 1tsp
---------- Predicted sugarLevel (Glycemic Index) ----------
68
Yellow
---------- Summary ----------
This food has more than 50% sugar! Prevent it!
```

```
----------------- Predicted Food -----------------
Pittu
----------------- Predicted Ingredients -----------------
2 cup puttu flour, 1/4 tsp salt, 3/4 - 1 cup water, 1 cup coconut (grated)
----------------- Predicted sugarLevel (Glycemic Index) -----------------
58
Yellow
----------------- Summary -----------------
This food has more than 50% sugar! Prevent it!
```

5. RESEARCH FINDINGS

Pandas and Sklearn are data analysis and manipulation technologies. Matplotlib and Seaborn are used for graph and visualization, and Convolutional neural networks, Keras, and OpenCV are used for image processing tasks.

6. DISCUSSION & FUTURE WORKS

More work on hyperparameters and model aspects such as which layers to freeze versus make trainable during transfer learning would be done in the future. Due to limited computing resources and time, most model implementation decisions were made by examining model convergence and relative metrics from training versus validation, but an exhaustive hyperparameter search would have been a more empirical approach. Another option is to train models to recognize images within a subset of food (e.g., fruits, noodles, pastries), because many of the model's errors are caused by confusing similar food items

7. SUMMARY OF STUDENT CONTRIBUTION

- Post data preprocessing
- Research on appropriate algorithms
- Analyzing algorithms to find the best fit
- Post verification
- Mobile application development
- Document preparation such as project proposals, research papers, and theses

8. CODE IMPLEMENTATION

Food Prediction

```
import warnings
warnings.filterwarnings('ignore', category=FutureWarning)
import tensorflow as tf
classifierLoad = tf.keras.models.load_model('Food_model.h5')

import numpy as np
import pandas as pd
from keras.preprocessing import image

test_image = image.load_img('TestFood/Pitu/p2.jpg', target_size=(200, 200))
# test_image = image.img_to_array(test_image)
test_image = np.expand_dims(test_image, axis=0)
result = classifierLoad.predict(test_image)
print(result)
print("------------------ Predicted Food ------------------")
if result[0][0] == 1:
    print("French Fries")
    Predicted_Food = "French Fries"
elif result[0][1] == 1:
    print("Fried Rice")
    Predicted_Food = "Fried Rice"
elif result[0][2] == 1:
    print("Pittu")
    Predicted_Food = "Pittu"
elif result[0][3] == 1:
    print("White Bread")
    Predicted_Food = "White Bread"

print("------------------ Predicted Ingredients ------------------")

```

```
30
31  ingredientsData = pd.read_csv('DataSet/ingredients.csv', skipinitialspace=True)
32  ingredients_Value = ingredientsData[(ingredientsData["foodName"] == Predicted_Food ).tolist() ]
33
34
35  print(ingredients_Value['ingredients'].loc[ingredients_Value.index[0]])
36
37  print("------------------ Predicted sugarLevel (Glycemic Index) ------------------")
38
39  print(ingredients_Value['sugarLevel (Glycemic Index)'].loc[ingredients_Value.index[0]])
40
41  print(ingredients_Value['GI Index Range'].loc[ingredients_Value.index[0]])
42
43
44
45  print("------------------ Summary ------------------")
46
47  S_Value = (ingredients_Value['sugarLevel (Glycemic Index)'].loc[ingredients_Value.index[0]])
48
49
50  if (S_Value > 50):
51      print("This food has more than 50% sugar! Prevent it!")
52  else:
53      print("This food has less than 50% sugar! you have have it!")
54
55  # disbts stus
56
```

CNN Model

```python
from keras.models import Sequential
from keras.layers import Convolution2D
from keras.layers import MaxPooling2D
from keras.layers import Flatten
from keras.layers import Dense
from keras.models import model_from_json
from keras.optimizers import adam_v2

from keras.preprocessing.image import ImageDataGenerator
import tensorflow as tf
from tensorflow.keras.optimizers import RMSprop

batch_size = 48

# All images will be rescaled by 1./255
train_datagen = ImageDataGenerator(rescale=1 / 255)

# Flow training images in batches of 128 using train_datagen generator
train_generator = train_datagen.flow_from_directory(
    'DataSet/train/',  # This is the source directory for training images
    target_size=(200, 200),  # All images will be resized to 200 x 200
    batch_size=batch_size,
    # Specify the classes explicitly
    classes=['French Fries', 'Fried Rice', 'Pitu','White Bread'],
    # Since we use categorical_crossentropy loss, we need categorical labels
    class_mode='categorical')

```

```
model = tf.keras.models.Sequential([
    # Note the input shape is the desired size of the image 200x 200 with 3 bytes color
    # The first convolution
    tf.keras.layers.Conv2D(16, (3, 3), activation='relu', input_shape=(200, 200, 3)),
    tf.keras.layers.MaxPooling2D(2, 2),
    # The second convolution
    tf.keras.layers.Conv2D(32, (3, 3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    # The third convolution
    tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    # The fourth convolution
    tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    # The fifth convolution
    tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2, 2),
    # Flatten the results to feed into a dense layer
    tf.keras.layers.Flatten(),
    # 128 neuron in the fully-connected layer
    tf.keras.layers.Dense(128, activation='relu'),
    # 5 output neurons for 5 classes with the softmax activation
    tf.keras.layers.Dense(4, activation='softmax')
])
```

```
model.summary()

model.compile(loss='categorical_crossentropy',
              optimizer=RMSprop(lr=0.001),
              metrics=['acc'])

total_sample = train_generator.n
print(total_sample)
n_epochs = 30

history = model.fit(
    train_generator,
    steps_per_epoch=int(total_sample / batch_size),
    epochs=n_epochs,
    verbose=1)


model.save('Food_model.h5')
print("------------------ Disease Model Saved ------------------")
```

9. REFERENCES

[1] Hasan, Towhid & Sultana, Marjia & Shill, Lincon & Purba, Nafisa & Sultana, Sara. (2019). Effect of Glycemic Index and Glycemic Load on Type 2 Diabetes Mellitus. 9. 259 - 266.

[2] Jyotismita Chaki, S. Thillai Ganesh, S.K Cidham, S. Ananda Theertan,Machine learning and artificial intelligence based Diabetes Mellitus detection and self-management: A systematic review, Journal of King Saud University - Computer and Information Sciences, 2020,

[3] M. M. Anthimopoulos, L. Gianola, L. Scarnato, P. Diem and S. G. Mougiakakou, "A Food Recognition System for Diabetic Patients Based on an Optimized Bag-of-Features Model," in IEEE Journal of Biomedical and Health Informatics, vol. 18, no. 4, pp. 1261-1271, July 2014, doi: 10.1109/JBHI.2014.2308928.

[4] I. Shchuka, S. Miftakhov, V. Patrushev, M. Tikhonova and A. Fenogenova, "Dish-ID: A neural-based method for ingredient extraction and further recipe suggestion," 2020 International Conference Engineering and Telecommunication (En&T), 2020, pp. 1-5, doi: 10.1109/EnT50437.2020.9431242.

[5] Dube, Sibusisiwe & Ndlovu, Siqabukile & Nyathi, Thambo & Sibanda, Khulekani. (2015). QR Code Based Patient Medical Health Records Transmission: Zimbabwean Case. 10.28945/2233.

[6] T. Mokdara, P. Pusawiro and J. Harnsomburana, "Personalized Food Recommendation Using Deep Neural Network," 2018 Seventh ICT International Student Project Conference (ICT-ISPC), 2018, pp. 1-4, doi: 10.1109/ICT-ISPC.2018.8523950.

[7] Q. Yu, M. Anzawa, S. Amano, M. Ogawa and K. Aizawa, "Food Image Recognition by Personalized Classifier," 2018 25th IEEE International Conference on Image Processing (ICIP), 2018, pp. 171-175, doi: 10.1109/ICIP.2018.8451422.

[8] N. Choosri and S. Anprasertphon, "Hospital dietary planning system using constraint programming," Fifth International Conference on the Innovative Computing Technology (INTECH 2015), 2015, pp. 17-22, doi: 10.1109/INTECH.2015.7173363.

[9] Kagaya, Hokuto & Aizawa, Kiyoharu & Ogawa, Makoto. (2014). Food Detection and Recognition Using Convolutional Neural Network. 10.13140/2.1.3082.1120.

[10] Y. Shimada, Y. Mizumori, T. Matsumoto and S. Kawaji, "A dietary menu-generating system to promote healthy life," 2006 SICE-ICASE International Joint Conference, 2006, pp. 2708-2712, doi: 10.1109/SICE.2006.315193.

[11] N. Choosri and S. Anprasertphon, "Hospital dietary planning system using constraint programming," Fifth International Conference on the Innovative Computing Technology (INTECH 2015), 2015, pp. 17-22, doi: 10.1109/INTECH.2015.7173363.

[12] D. Gupta, S. Khare and A. Aggarwal, "A method to predict diagnostic codes for chronic diseases using machine learning techniques," 2016 International Conference on Computing, Communication and Automation (ICCCA), 2016, pp. 281-287, doi: 10.1109/CCAA.2016.7813730.

[13] K. H. Yeap, Y. K. Cheong, H. Nisar and P. C. Teh, "A simple data storage system using QR code," 2014 5th International Conference on Intelligent and Advanced Systems (ICIAS), 2014, pp. 1-5, doi: 10.1109/ICIAS.2014.6869536.

[14] K. Hakuto, A. Kiyoharu, O. Makoto, "Food Detection and Recognition Using Convolutional Neural Network" ACM Multimedia, 2004.

10. APPENDICES

Do you find yourself as a good cook? *

1. Yes
2. No

Do you prefer to use a food recommendation system to plan what you cook for the next meal? *

1. Yes
2. No
3. May be

Do you have personal dietitian or Caretaker? *

1. Yes
2. No
3. Maybe

Are you aware of what food you should take for your diagnosis? *

1. Yes
2. No

You are a *

- [ ] Dietitian
- [ ] Nutritionist
- [ ] Athlete
- [ ] Common

Do you encourage this application to maintain your personal diet *

1. Yes
2. No
3. Maybe