Calculation of Calories in Food and Body Mass Index Prediction Using Deep Learning

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Abstract
Obesity is a major public health issue worldwide, and it is closely linked to the consumption of excess calories. Therefore, accurately estimating food calorie intake and predicting body mass index (BMI) is crucial in managing and preventing obesity. Traditional methods for estimating food calorie intake, such as self-reported food diaries, are often unreliable due to human error and biases. In recent years, advances in computer vision and machine learning have enabled the development of automated food calorie estimation systems using food images. However, these methods still have room for improvement in terms of accuracy and practicality. This project aims to address these challenges by developing a robust and accurate system for food calorie estimation and BMI prediction using deep learning and machine learning techniques. The proposed system can have practical applications in nutrition, healthcare, and fitness, enabling individuals to track their calorie intake and manage their weight more effectively. This project aims to develop a model for food calorie estimation and BMI prediction using deep learning and machine learning techniques. The proposed system will use a dataset of food images and their corresponding calorie information to train a convolutional neural network (CNN) to recognize the food items and estimate their calorie content. The system will also use additional demographic information, such as age, gender, height, and weight, to predict the user's BMI using a regression model. The accuracy of the models will be evaluated using metrics such as mean absolute error and root mean square error. The results will demonstrate the feasibility of using deep learning and machine learning techniques for accurate food calorie estimation and BMI prediction, which can have practical applications in nutrition and healthcare.

Key Words
Diet Assistance, Machine Learning, Diet Recommender System, Food Recognition, Image processing, Feature Extraction.

I. Introduction

Obesity has increased two-fold since 1980 and became the fifth highest cause of death in each year. WHO (World Health Organization) noted that about 2.8 million adults every year to experience deaths caused by obesity. That is because humans consume food without regard to the needs of calories and nutritional content. Some application had been developed in purpose to monitor caloric and nutritional needs. However, that applications are not easy to use because before users can use that applications they must know the name of the food. The aim of the project "Web based Nutrition and Diet Assistance using Machine Learning is to create a tool that can accurately identify and classify food items based on images, measure their calorie and nutrition values, calculate the user's BMI, and generate personalized diet recommendations.

II. Related Work

The existing system enables users to track their food intake and exercise. It has a large database of food items and can calculate the calorie and nutrient content of meals. it provides users with a personalized meal plan and support from a community of other users. It assigns points to foods based on their calorie, protein, fat, and fiber content. It provides users with prepackaged, portioncontrolled meals and snacks. It offers several different meal plans to meet different dietary needs..it generates personalized meal plans based on users' dietary preferences and goals. It also provides recipes and grocery lists to make meal prep easier. It can be helpful in providing guidance and support for individuals looking to improve their nutrition and dietary habits.
The authors propose a food recognition system that uses feature extraction and ensemble learning techniques. The system takes as input an image of a meal and uses feature extraction techniques to extract features such as color, texture, and shape. The system then uses ensemble learning techniques to combine the output of multiple classifiers to predict the food items present in the meal. The algorithm used in this project is Feature Extraction and Ensemble Learning Techniques.

III. Proposed System

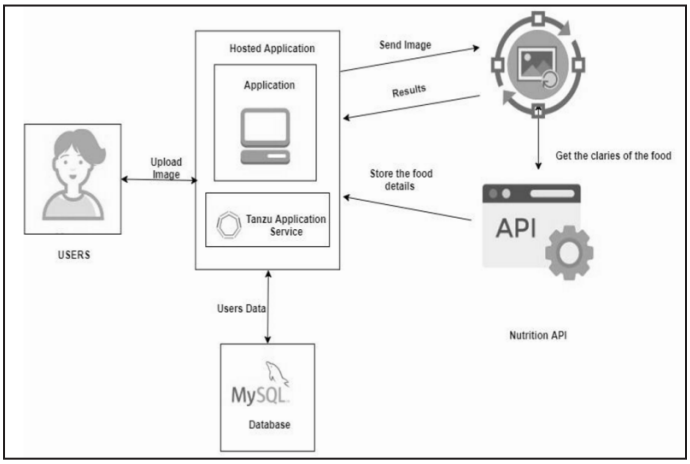
To overcome the limitations of existing system, the proposed system "Diet Assistance" is a web-based food item prediction system that aims to provide users with a convenient and efficient way to track their calorie and nutrition intake, as well as calculate their BMI and receive personalized diet plans. The system makes use of various computer vision techniques, such as preprocessing, region proposal network (RPN), gray-level co-occurrence matrix (GLCM) feature extraction, and convolutional neural network (CNN) classification. The system takes an input image of food items, preprocesses it using various techniques such as RGB to grayscale conversion, resizing, noise removal using a Gaussian filter, and binarization. Then, RPN is used to detect food in the image and GLCM is used to extract features of the food items such as shape, size, color, texture, and patterns. The extracted features are then fed to a CNN model that classifies the food items into categories such as apple, banana, tomato, and others. The system also measures the calorie and nutrition values of the provided image using a food database and provides a diet plan based on the user's BMI. The user's BMI is calculated using their height and weight, which they can provide during registration. The system also provides users with the ability to track their progress by allowing them to input their daily food intake and exercise routines. Overall, the proposed system aims to provide users with a comprehensive tool to manage their diet and achieve their health goals in a convenient and efficient way.

IV. Methodology

A. Developing basic web app

The design of the project can be divided into several modules, each serving a specific purpose. Here is a highlevel overview of the modules:

User Interface (UI) Module :
This module is responsible for handling the user interface of the web application. It includes the design and implementation of the user interface, which allows users to interact with the application, input their information, and receive results. This module is developed using HTML, CSS, and JavaScript.



Backend Module :
This module is responsible for processing user inputs and generating appropriate outputs. It includes the development of algorithms for food item prediction, calorie and nutrition value measurement, and BMI calculation. This module is developed using Python and uses various libraries such as TensorFlow, Keras, and NumPy.

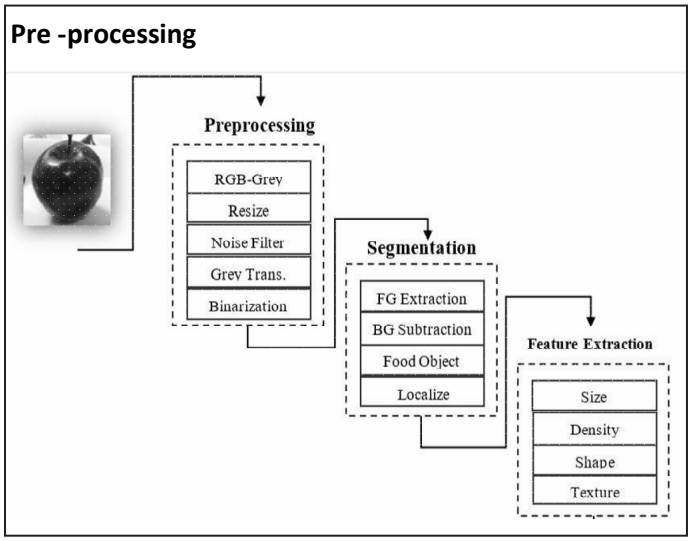
Database Module:
This module is responsible for storing and retrieving data from the application's database. It includes the design and implementation of the database schema and the development of functions to access the database. This module is developed using MySQL.

User Authentication:
This module allows users to create an account, log in, and log out of the application. It also ensures that only authorized users can access certain parts of the application.

B. Training the model
The Diet Assistance web application uses a Convolutional Neural Network (CNN) to classify food images and extract their features. The Diet Assistance web application uses the TensorFlow and Keras libraries to build and train the CNN model. The model is trained on a dataset of food images and their corresponding labels. The trained model is used to predict the food items present in a given image and measure their calorie and nutrition values.

Import Dataset and View Images:
This module is responsible for importing and preprocessing the dataset for training the CNN model. This module is implemented using Python libraries such as NumPy, Pandas, Matplotlib, and OpenCV. The following is a brief description of the main steps involved in this module: Importing the dataset:
The module reads the dataset from the local system or cloud-based storage using Pandas library.

Visualising the dataset:
The module uses Matplotlib library to display a few sample images from the dataset. This helps in understanding the nature and characteristics of the dataset, such as the variety of food items, and the quality and resolution of images.
Overall, this module is very essential for ensuring the quality and integrity of the dataset, which is a key factor in the accuracy and reliability of the CNN model.



The pre processing module of the this project performs several image processing techniques on the food images provided by the user. The following is the description of the pre-processing modules:

Convert RGB to Grey:
This module converts the input RGB image into a grayscale image. This is done to reduce the number of color channels and simplify the image, making it easier for further processing.

Resize:
This module resizes the input image to a specified size. Resizing is necessary because the size of the input image can vary greatly, and the CNN model expects input images of a specific size.

Remove Noise using Gaussian filter:
This module applies a Gaussian filter to the input image to remove noise and smooth out the image. This is necessary because noisy images can negatively affect the performance of the CNN model.

Binarization:
This module converts the grayscale image into a binary image using a threshold value. This is done to simplify the image further and make it easier to detect food items in the image.
All these pre-processing modules together help to extract the relevant features from the food image and prepare it as input for the CNN model to predict the food items and calculate their calorie and nutrition values.

Food Object Detection
In the context of the Diet Assistance web application, the RPN (Region Proposal Network) is used to detect food in the input image. Here is a brief overview of the modules involved in food detection using RPN:

RPN Network Architecture:
This module defines the network architecture of the RPN, which takes an image as input and generates a set of region proposals, which are likely to contain food items.

Pretrained Model:
A pre-trained model such as VGG or ResNet is used as the base network for the RPN.

Training Data:
A set of training images are used to train the RPN. The training data is annotated with bounding boxes around the food items.

Loss Function:
The loss function measures the difference between the predicted locations of the food items and their actual locations in the training data. The loss function is used to optimize the network parameters during training.
Overall, the RPN module in this project uses a combination of deep learning techniques and computer vision algorithms to accurately detect food items in the input image.

GLCM Feature Extraction
The feature extraction module of the this project uses GLCM (Gray Level Cooccurrence Matrix) to extract features from the food items detected in the input image. GLCM is a texture analysis method that computes the co-occurrence matrix of the gray-level values in an image.
The GLCM feature extraction module includes the following steps:

- Convert all the food items detected in the input image to grayscale.
- Calculate the GLCM of the grayscale image with a specified distance and angle.
- Normalize the GLCM to get the probabilities of cooccurring pixel intensities.
- Extract texture features such as contrast, homogeneity, energy, and correlation from the normalized GLCM.

These extracted features are then used as input to the CNN layers to classify the food items detected in the input image. The GLCM feature extraction module is implemented using the NumPy library in Python.

Build and Train Model
The CNN Build and Train modules of this project system is responsible for building the CNN model architecture and training it using the pre-processed dataset. This module involves the following steps:

Train the model:
The model is trained using the preprocessed dataset. The dataset is split into training and validation sets to measure the model's performance. The model is trained using the backpropagation algorithm and updates the weights to minimize the loss function.

Evaluate the model:
Once the model is trained, it is evaluated using the test dataset. The model's accuracy, precision, recall, F1 score, and other metrics are measured to assess the model's performance.

Save the model:
Finally, the trained model is saved in a file format that can be used for predictions in the prediction module.
Overall, the CNN Build and Train modules aim to build an accurate and robust CNN model that can classify food items with high accuracy and generalize well to new images.

C. Food Predictor
The prediction module of the Diet Assistance web application is responsible for taking an input image and using the trained CNN model to predict the food item(s) in the image, as well as their names. The module involves several steps:

1. Load the trained CNN model that was built and saved during the training module.
2. Pre-process the input image using the same preprocessing techniques as in the training module, including converting the image to grayscale, resizing it to a fixed size, removing noise using a Gaussian filter, and binarizing it.
3. Use the RPN model to detect the presence of food in the pre-processed image.
4. If food is detected, use the GLCM feature extraction technique to extract the shape, size, color, texture, and pattern features of the food item present in the image.
5. Pass the extracted features through the CNN classification layers to predict the type of food item present in the image, along with its name.
6. Return the predicted food item name and its type to the user.

D. Food Calorie and Nutrition Calculator
The module responsible for calculating the calorie and nutrition values of the predicted food image in this project would involve the following steps:
Retrieval of nutritional information: This step involves accessing a pre-existing database of nutritional information for various food items. This information would be used to calculate the calorie and nutritional values of the predicted food item.
Calculation of calorie and nutrition values: Using the nutritional information and serving size of the predicted food item, the system would calculate the calorie and nutrition values for the food.
Display of results: The system would display the calculated calorie and nutrition values for the user, allowing them to make informed decisions about their dietary choices.

E. BMI Calculator
The Users BMI (Body Mass Index) Calculator Module of this project is responsible for calculating the BMI of the user based on their input height and weight. The module will take the user's height and weight as input and then calculate the BMI value using the following formula:

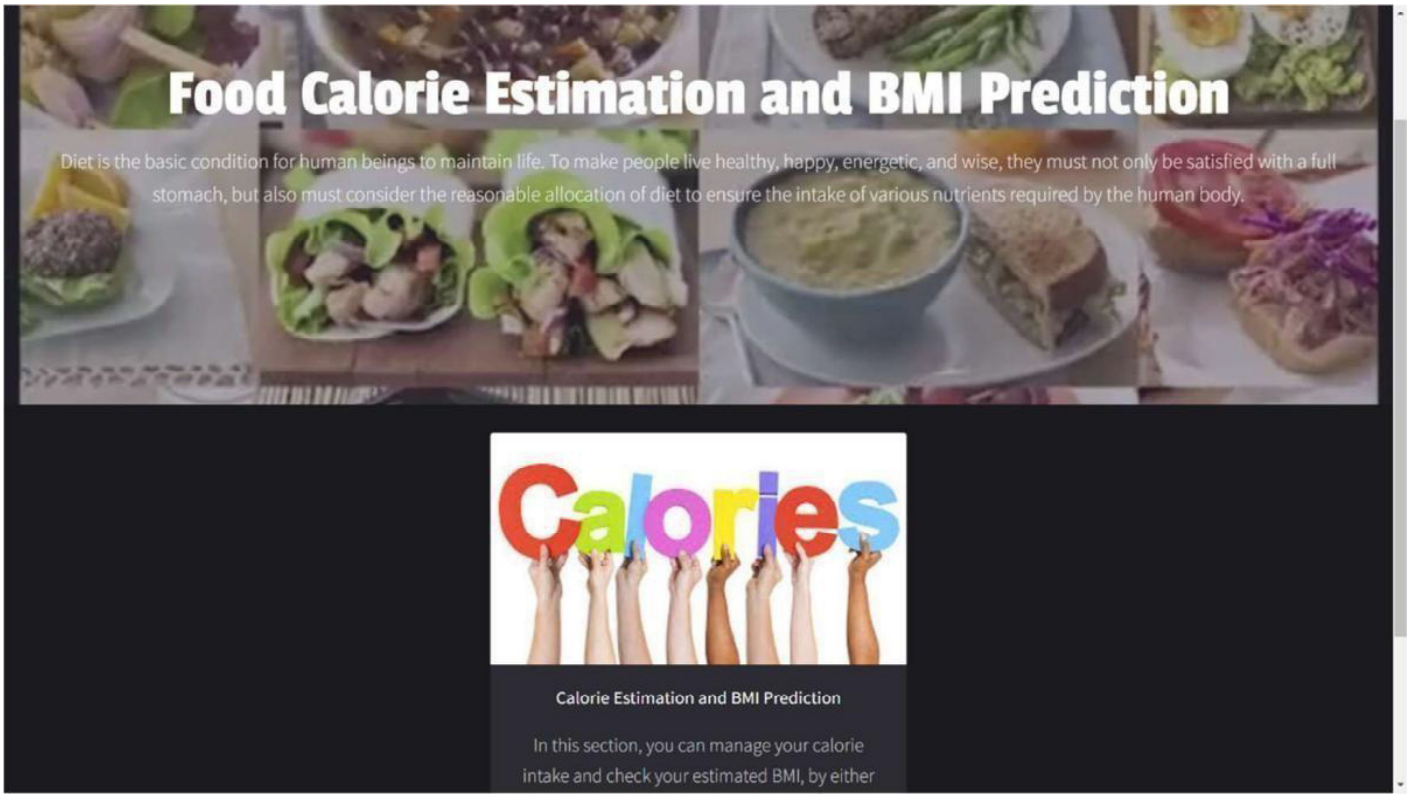
$$\text{BMI} = \text{weight(kg)} / (\text{height(m)})^2$$

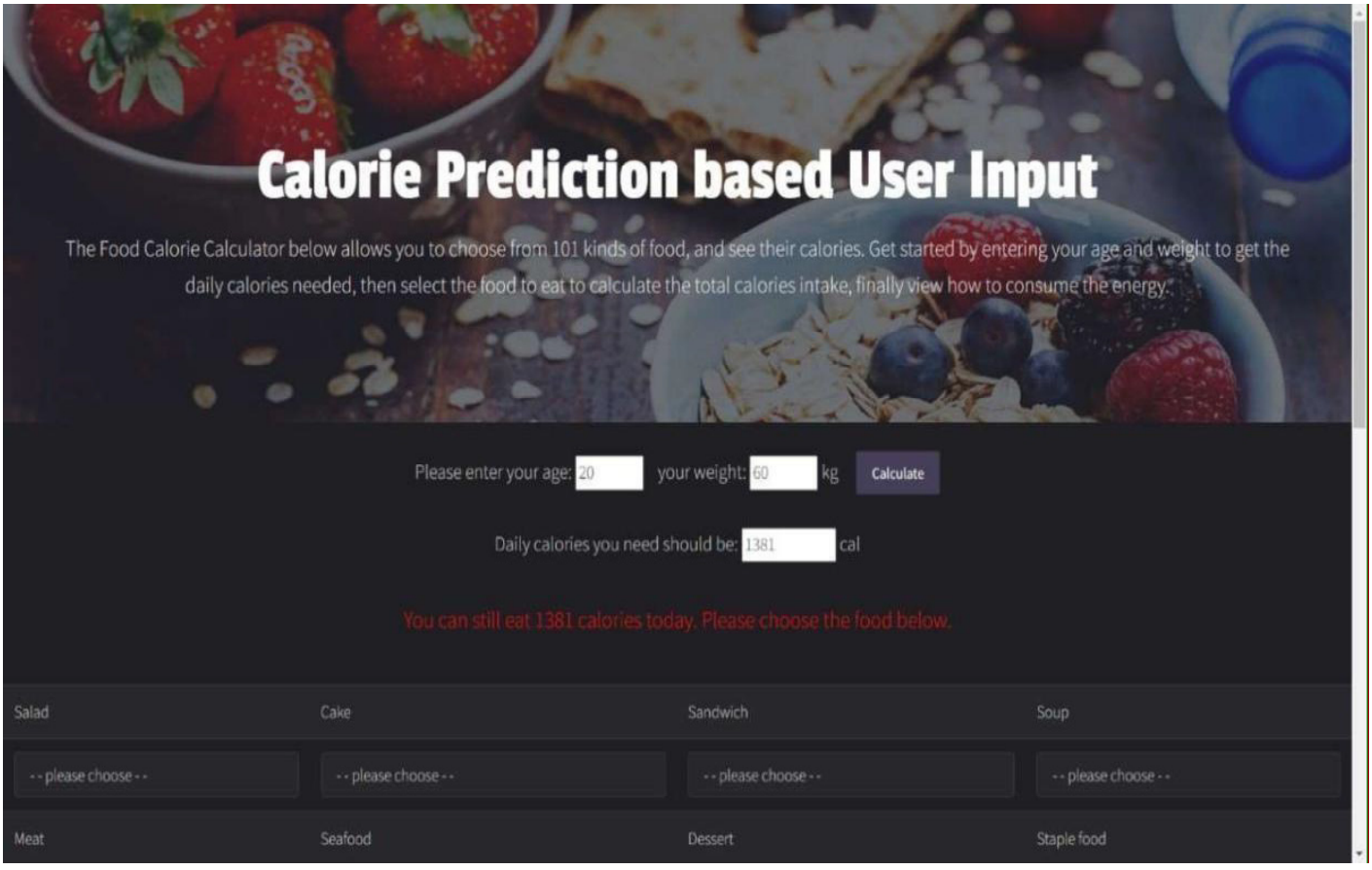
Once the BMI value is calculated, the module will return the calculated BMI value to the main program. This BMI value will then be used to suggest a diet plan for the user based on their weight goals and the predicted food items and their nutritional values.

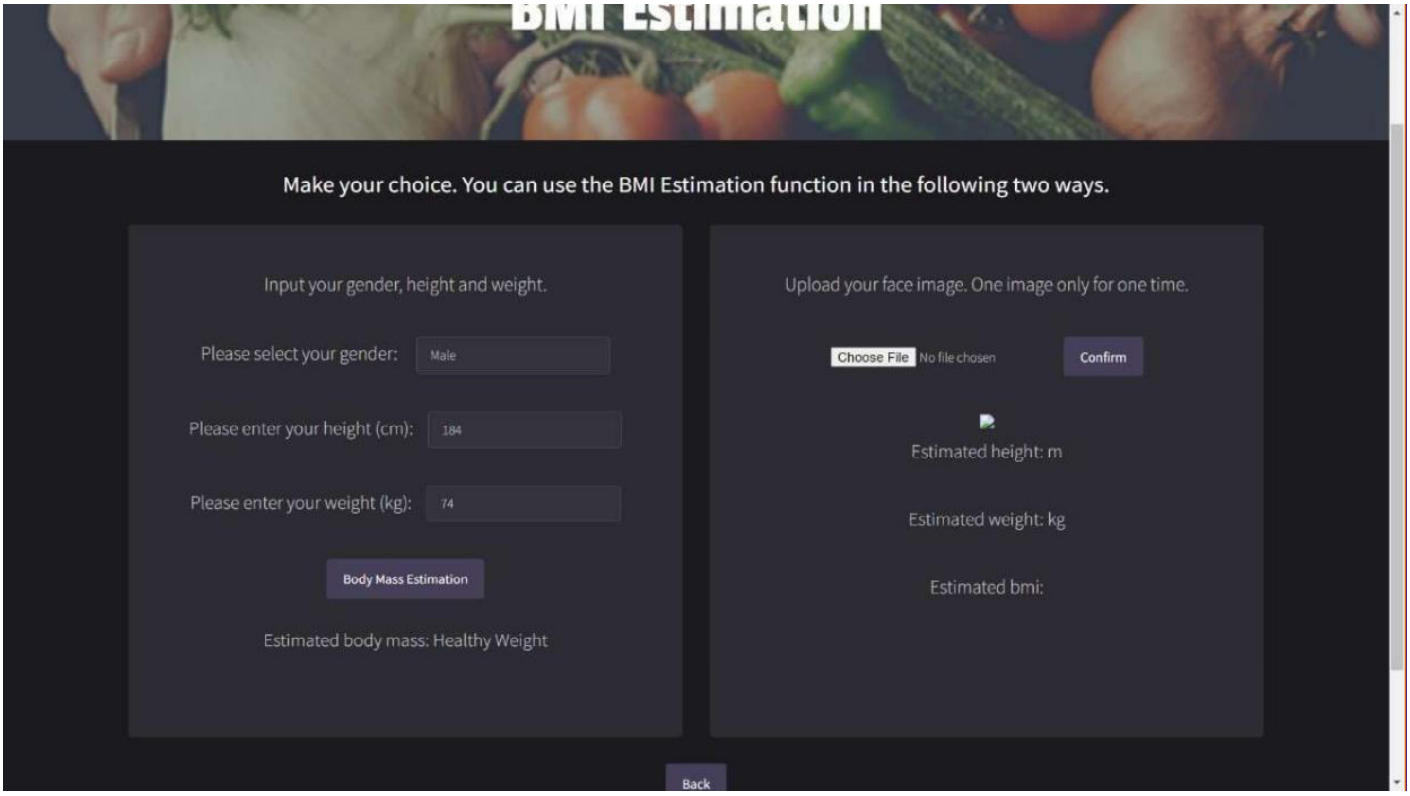
F. Diet Recommender
This module takes as input the predicted food item, its quantity, and the user's BMI. First, the module calculates the calorie and nutrition value of the food item using the food calorie and nutrition calculator module. Then, it suggests a suitable diet plan based on the user's BMI and the calorie and nutrition value of the food item. The diet recommender module takes into account various factors such as the user's age, gender, lifestyle, and medical conditions to suggest a personalized diet plan.

as accuracy, precision, recall, and F1-score being measured through the performance analysis module. The Diet Assistance module provides users with a personalized diet plan based on their BMI, making it a valuable tool for individuals seeking to maintain a healthy lifestyle. Overall, the "Diet Assistance" is a useful tool for those seeking to make informed dietary choices and maintain a healthy lifestyle.

V. Results







VI. Conclusions

This project gives us an estimation of calories present in a food and predicts BMI by using Machine Learning and Deep Learning. With this brief testing of food images dataset with Mask R-CNN, we can deduce that it is quite possible to achieve an application that is capable of estimating calories from food images. The application will have a tremendous impact on how people perceive a plate of food and will also impact the weight-loss and weight-management market. Since the images are taken from smartphones, and the image processing methods used here are well-developed, this proposed method can be easily integrated into health apps as an engineering solution. Also, we have successfully implemented a system to predict BMI from a small data set of photographic images of participants. This approach may lead to a public health screening tool to assist in supporting/measuring health initiatives in areas of endemic obesity or malnutrition. The use of silhouettes in our process offers the additional benefit of anonymity

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