FOOD DETECTION AND CALORIE CLASSIFICATION

Bhavana A[1], MCA student, PES Institute of Technology and Management, Shivamogga, Karnataka, India.

Mr. Ajith G L[2], Assistant Professor, MCA, PES Institute of Technology and Management, Shivamogga, Karnataka, India.

Abstract

The intake of sufficient daily calories, healthy food choices, and a wise diet are all elements that confirm the leading of a healthy lifestyle. Calorie approximation and food identification will open the space to supplement these habits by informing the user about the food that he is intaking. The user can capture or upload the image directly within a website, without needing a separate app or device feature It relies on deep learning which scans the food on the image and on calculating the portion of the calorie content and other nutritional contents like carbohydrates, proteins, and fats. It will help these individuals watch their food in a more efficient manner and will make healthier choices. Searching of food in an image may be challenging in that several types of food are available in the market, shapes and sizes of food differ, lighting and presentation vary. In the same manner, one cannot very easily estimate calories depending on different portions, ingredients, and cooking methods. Despite the above challenges, effective implementation of deep learning algorithms can be realized given training against images in massive repositories of foods. The systems are further easy to use, in which tracking what is being consumed by the users is not considered a challenge. Describes the ability to identify food and estimate its nutritional value, which leads to the user acquiring healthier food habits and it is also more in control over the food consumption patterns of its user.

Keywords: Food Detection, Calories, CNN, Healthy Eating, Food Image Analysis, Web-Based Application, Health and Wellness, Food Identification, Diet Management

1. Introduction

Food is the main source of energy for the human body, composed of necessary nutrients such as proteins, carbohydrates, fats, vitamins, and minerals that ensure overall health, growth, and daily functioning. When individuals consume additional calories than the body requires, the surplus energy is deposited as fat, which makes individuals gain weight and develop overweight or obesity. Obesity has emerged as a leading world health issue due to increasing rates associated with poor eating patterns, inactivity, and higher intake of high-calorie fast foods. Poor eating habits and high calorie consumption can create more than a change in one's look far more importantly, they increase the chances of developing severe diseases like diabetes, heart disease, high blood pressure, and increased cholesterol levels.

Help people eat healthier food and track their calories in an effortless way, the project suggests an intelligent and effortless system based on deep learning. After recognizing the food, it calculates the calories and shows important nutritional data, like the amount of protein, fat, and carbohydrate, through a pre-existing food nutrition database. Tracking food intake with traditional methods like a food diary or estimation of calories by hand can be tedious and even inaccurate. Today, thanks to technology, consumers can snap a picture of what they eat and immediately receive accurate nutritional information. By marrying convenience with health awareness, the system spurs wiser eating habits and helps users make better food choices.

2. Literature survey

A literature review is an extensive read on literature which has already been published on a certain subject. An example of these includes books by authors, journals and any other material which can be related to the topic under study. The greatest advantage of the literature review is that one would be able to appreciate the pool of knowledge that has been gathered around the subject matter being reviewed.

[1] In the article authored by Mohammed and Al Garni (2020), the authors provide an informative overview of two approaches to food image classification: conventional feature-based and the current modern deep learning techniques. It discusses various datasets used to train the models, discusses the various architectures of the CNN (Convolutional Neural Network) and outlines the common problems like resemblance of various foods and differences in the same type of food. The application of the techniques in areas like food safety and calorie measurement is also reviewed thereby making the article useful to researchers involved in the project of developing a food detection system.

[2] Saranya et al. wave the technique that can detect food in the image and identify its calories with the aid of deep learning. It also makes projections of Body Mass Index (BMI) of an individual based on what he/ she consumes. This strategy applies a Convolutional Neural Network 3 (CNN) classifier to identify several types of food, not to mention the determination of the nutrition rates, namely the count of calories. The purpose of this method is to help users maintain a healthy lifestyle by tracking their food intake, which impacts their BMI.

[3] Paulus, Fu, and Meyers (2017) introduced a new type of deep learning model using Convolutional Neural Networks (CNNs) to differentiate food items in pictures, especially those ones that were clicked by mobile phones. It was fed one of the customary Food-101 datasets that consists of numerous food images. Determining food items in the real world using deep learning as show in the study outlined in the present paper, deep learning could be leveraged to establish food items in the real world, which can be translated into the mobile health setting as well as food monitoring.

[4] The research article by Srilatha Puli et al. is one of those when a certain technique is applied: number of calories in food is approximated based on the image. It starts by including a photograph regarding the food, after which it identifies them with the use related to object detection technique. Upon determining the kind of foodstuffs, the system will estimate the volume of foods and determine the equivalent number of calories of such kind of food. The practice leads to the automatic and rapid calculation of calories in foods, which might be taken to help maintain diet and health under control.

[5] The study conducted by Sophia et al. (2023) presents the case of an AI system that allows detecting food based on a photo and approximating its calorie amount. It goes through a convolutional neural network named MobileNetV2, and object detection to deliver an accurate identification of food in the image. After the system identifies the food, the food is given access to nutrition database through an outside API to determine the calories and other stuff. Through this method, quantification of food consumption and nutrients becomes simpler through the assistance of a simple image.

[6] Horea Muresan and Mihai present the dataset Fruits-360 that comprises more than 590,000 images depicting 131 vegetables and fruits. Based on the dataset they trained and evaluated a 3-Convolutional Neural Network (CNN) which they demonstrated to identify several types of fruits when used with pictures. As their work reveals, the dataset is unbelievably valuable as it may be utilized in the field of computer vision as food classification and applied in enhancing fruit recognition systems.

3. Proposed Methodology

The approach to the research implies the creation of an efficient image classification system which can group images of food into various categories according to the pre-programmed labelling's. The preprocessing tasks that are implemented on the food image database are resizing, normalization and removing the noises the only difference is that it is conducted using and surrounding the topic under review. already fairly and well-known dataset hence making the images higher quality and the data usable in the next stage that is feature extraction. Once model represents, the model functionality and accuracy are then evaluated by using the test data. This approach provides the right and standardized response to the automatic food identification, which is the most crucial factor in facilitating approximation of calories and nutritional range of discovery.

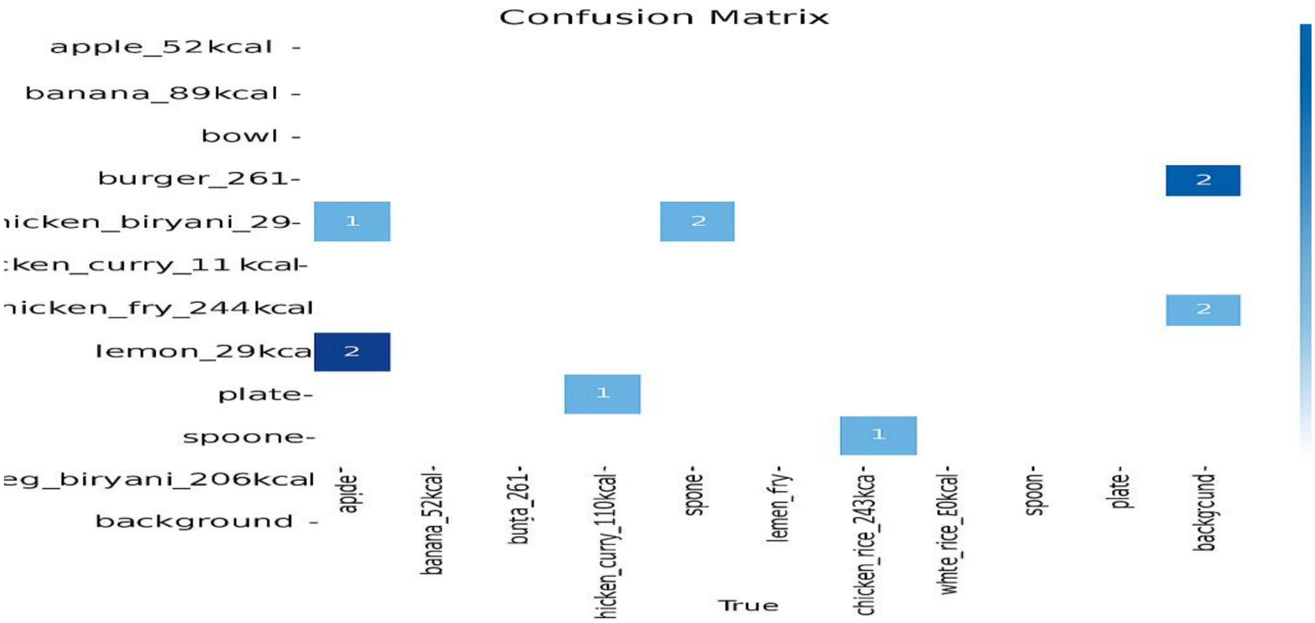

Figure 3.1 Calories Estimation

3.1 Proposed model diagram

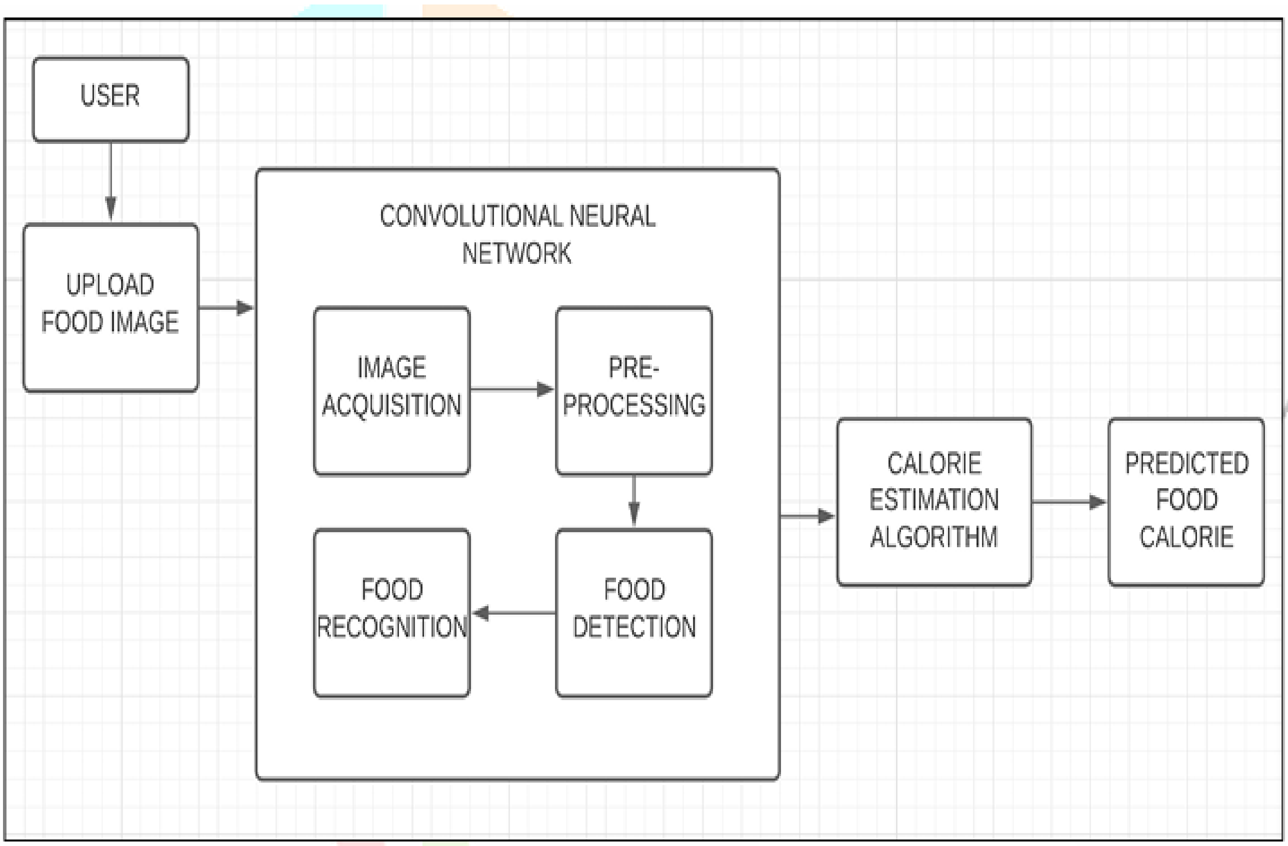

Figure 3.1.1 Proposed Model Diagram

The plan is that of an entire mechanism of a Food calorie predicting system with convolutional neural networks. The user is the first user of the system as he presents the system with a photo of a food item. This image gets fed into the CNN module and calculations made. The first is reception regarding the image to gather and store the input. It is then pre-processed meaning that it could be improved with regards to its image quality such as either resizing, normalization and noise clean up to ensure the rest of the process could be done with precision. It then transfers the food object look by conducting food detection, in which actual food items in image are allocated, and food recognition, where the food is identified as a pizza, rice, or burger. It then conducts a calorie approximating algorithm after proper recognition of the food has been determined. Based on nutrition-based data which can be found in a related database, such an algorithm could be made to estimate the estimated percentages of calories in the familiar piece of food at average per-gram percentages. The system will subsequently estimate and give the user figure on the calories of the food. It is an automatic drive, an intelligent and simple mode of people monitoring the amounts of calories they consume without generating extra efforts, the healthy mode of lifestyle, and the awareness of being healthy to consume.

3.2 Block Diagram of Food Identification and Calories Classification

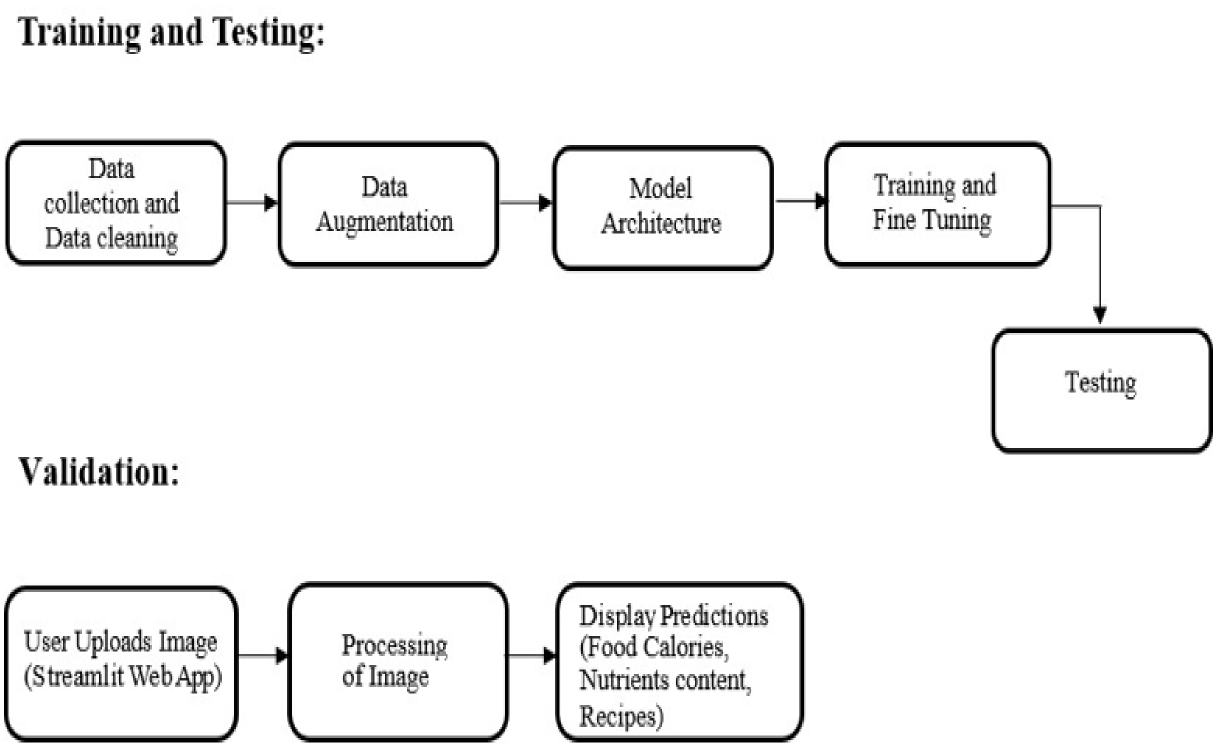

Figure 3.2.1 Block Diagram of Food Identification and Calories Classification

The figure represents the general scheme of development of the food calorie predicting system with the major focus on the training, test, and real-time test stages. The procedure entails generation of pictures of the foods and purifying the data sets through deletion of duplicate and low-quality ones. A proper model architecture, i.e., a CNN, is chosen or generated onto which to train. It is learnt here where the food items get to be recognized and categorized into its several types as it refines its internal parameters in the quest of gaining accuracy.

The real-world implementation of the system will also be through sitting through a validation exercise and shall take the form of an intuitive web application founded on stream lit within which it can be applied among other applications. The users can feed the pictures of foods into the system, which will be pre-processed already to normalize and resize picture types as it refines its internal parameters in the quest of gaining accuracy. to the trained model. It provides the image to the system, which analyses and identifies the nature of food and the count of calories and offers associated dietary data. The application may also be applied to access other functionalities such as the suggestions of the recipes by the identified food, and the outcome of this is that the system is interactive in addition to being informative.

4. Mathematical Formulas

The performance related to food calorie estimation system is measured; here, there are a few measures of performance that are achieved in three of the key sites that involve identification of food items, portion size estimation and estimation of calories per se. The classification power of the model under discussion is determined because of the measurement of the quality of the object recognition of the eleven kinds of food since identification of the food starts with the first level of it. The accuracy i.e., of all the predictions made by the system, what percentage of correct predictions are there, is one of the most crucial actions executed here. This will ease determining the percentage confirmation in relation to the model's detection of food items from an image prior to portion and calorie estimation.

$$\text{Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Total Predictions}}$$

In addition, accuracy defines the ratio of correctly predicted positives to all predicted positives:

$$\text{Precision} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

The recall measures how many right specific food items that the model can recognize. It identifies the positive instances; in other words, it does not miss out the positive cases. The greater the value of recall, the greater will be the number of the right food items that are to be determined inside the image, and this represents a significant importance in the effort to describe food and provide calorie estimations fully and accurately.

$$\text{Recall} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

The F1-score yields a single value in which the two measures (precision or the recall) are the harmonic mean of two measures. It gives an equitable evaluation of the model's performance; hence, it is highly instrumental in the instance where the pertinent class distributions of the data set collections applied are skewed. The significance of it is paramount when false negatives must be avoided and false positives as a result, and, simultaneously, the model should be as fair and consistent with every category.

$$\text{F1-Score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

The calculation of portion size is a regression question; thus, it is investigated on a single metric which can be Mean Absolute Error (MAE) or the Root Mean Squared Error (RMSE). MAE is an estimate of the average of the absolute differences between quantities predicted and amount of portion sizes and is a direct reading of how close the estimates were by the model to actuals. The above measure is an appropriate measure because it determines the precision of the model in predicting the portion size and hence can be applied to determine the ability to estimate the quantity of food item.

$$\text{MAE} = \frac{1}{N}\sum_{i=1}^{N}|\hat{y}_i - y_i|$$

RMSE places greater importance on larger errors and is, therefore, valuable for the identification of large prediction failures:

:

$$\text{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\hat{y}_i - y_i)^2}$$

In the last step, take the last step of calculating calories. Root Mean Squared Error and Mean Absolute Error regression values are used in determining the error regarding the system's role in its prediction of calories values. When these measures have been utilized, it is possible to get the mean and squares between target and predicted values of calories. In addition to these, Mean Percentage Error is also utilized in calculating the average difference in percentages between the estimated calorie values and the actual calorie valuables and gives feedback in the inter-accuracy of prediction articulated within the familiarity of the people.

$$\text{MPE} = \frac{100\%}{N}\sum_{i=1}^{N}\left(\frac{\hat{y}_i - y_i}{y_i}\right)$$

5. Experimental Result

The comparison as presented on the sheet chart based on the value of the estimated and actual number of portions and calories of the various food articles and fruits i.e., apples, bananas, and pizzas are represented on the visualization sheet. There are two horizontal bar graphs. The former would result in the number of portions in grams, i.e., portion size, whereas the latter one will indicate the level of calories in kilocalories. The two graphs demonstrate actual information and estimated information, and, hence, it is just easy to look at the approximations being exceeded by the actual information. The above presentation assists in the conceptualization of just how dependable the system behind the calculation of the percentage of food and the nutritional value is supposed to be. This layout is horizontally oriented and thus readable due to the fielding visibility of the contents of the food and the comparative value of each of the groups of food could also be simpler.

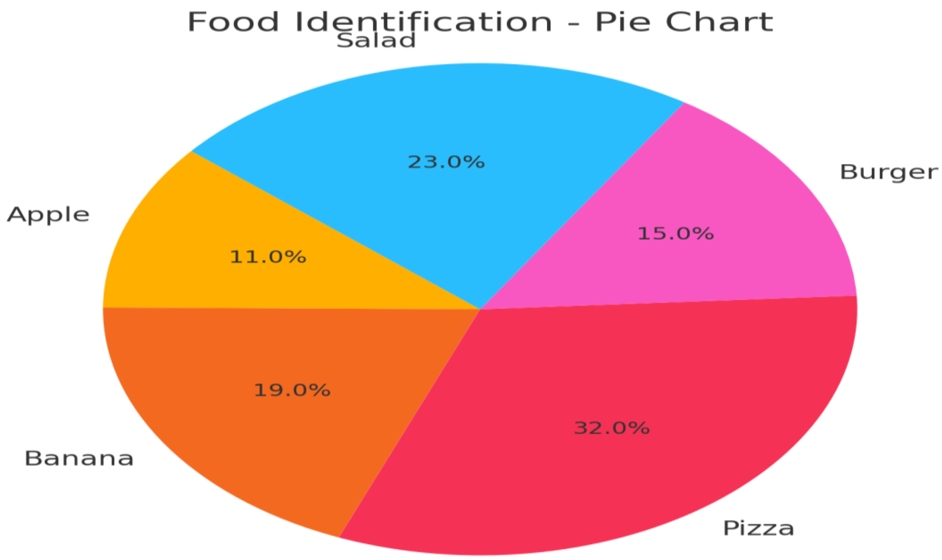

Figure 5.1 Food identification

The mentioned pie chart is the probability pie of identifications of various foods using a recognition system. Classes are in five levels with Apple, Banana, Pizza, Burger, and Salad. The portion of every pie will give the likelihood that the system catches a specific food item relying on its characteristics. According to the chart, pizza comes on the top, with the percentage being thirty-two, implying that with the identification of pizza, steps have been taken with the highest degree eighteen of assurance when the model identifies the same. The most salad as a 23 percent figure precedes a banana as 19 percent, burger as fifteen and apple as eleven. Thus, a person can easily identify which food items can be processed with greater recognition by the system or in which aspect the system must be enhanced.

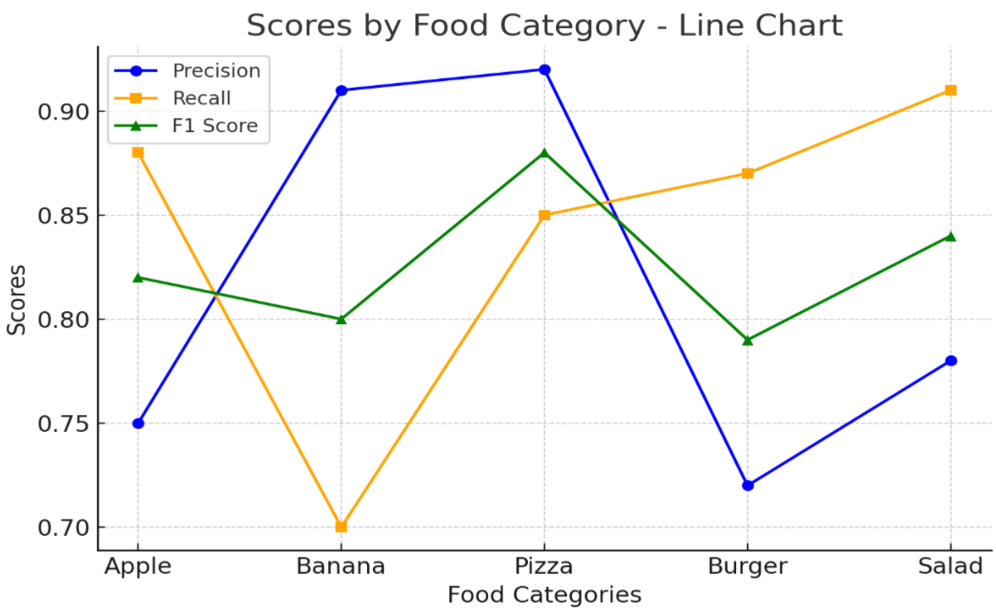

Figure 5.2 scores by food category

The line chart above shows performance scores of different food items like Apple, Banana, Pizza, Burger, and Salad measured in terms of three performance measures namely Precision, Recall and F1 Score. These are the criteria by which the performance of the system to detect each of the thirteen foods are going to be judged. According to the chart, pizza is precise and has excellent F1 score which indicates high and equally balanced detection performance. Banana is precise but less dependable; hence, it will be identified correctly but not always. Burger and Apple are imprecise yet have positive recognition i.e., they are more likely to be remembered but also inaccurately. Salad is quite even-handedly rated on all metrics with a more conservative bent. Such visualization will be useful when the model must be improved along with locations where the model is efficient, yet improvements are evident.

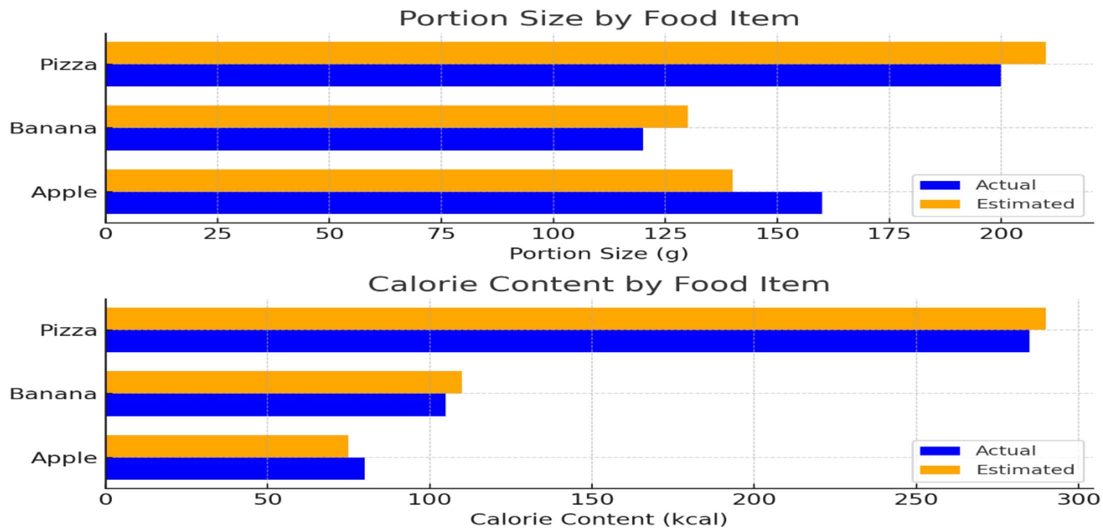

Figure 5.3 Portion and calorie estimation

The figure contains two bar graphs appearing on the same side of the value of real and estimated value of different foodstuffs including apples, bananas, and pizza. The size of the serving of the top chart is the measure that is measured in grams, and the bottom one is the measure of the amount unit in the content of calories in the food that is portrayed in kilocalories. The blue color of the two charts is expected to convey the meaning of actual value, and the orange color to give the meaning of estimated value. In the portion sizes, the estimated values are near the unit of measurement where Apple is lacking in the values and Banana and Pizza very much than the values. Similarly, in the example of the chart that describes the content of calories, the estimated one could be supposed to also take place within a similar pattern. Pizza and banana are overestimated, but apple is more assessed in regarding the actual estimation. The tests will be utilized to specify whether the system of the quantity and energy value of different foods could be predictable.

Food Item	**Actual Portion (g)**	**Predicted Portion (g)**	**Actual Calories (kcal)**	**Predicted Calories (kcal)**	**Prediction Accuracy (%)**
Pizza	200	190	520	495	95.19%
Chicken Biryani	250	240	292	280	95.89%
Apple	150	145	78	75	96.15%
Banana	120	125	89	92	94.38%

Chicken Curry	180	170	110	104	94.54%
Veg Biryani	220	215	206	201	97.57%
White Rice	210	205	242	236	97.52%
Burger	180	170	261	249	95.40%

Table 5.1 Experimental Result

6. Conclusion

In conclusion, Identification of the food items and approximating their caloric values are key to ensuring healthier food choices and overall well-being in diet. With proper nutritional data, such systems enable individuals to choose what they eat more wisely, which contributes to improved health management as well as awareness of lifestyle. As the health issue has increased due to wrong eating habits and excessive calorie intake, there is a high demand for easy and useful tools to assist people in controlling their food intake. This project provides a deep learning-powered solution with Convolutional Neural Networks to automatically identify food from images and deliver precise calorie and nutritional data. By enabling users to simply take a photo of the food, the system simplifies tracking and comprehending the daily intake without tedious manual calculation. This benefits both those with medical conditions and anyone who wishes to pursue a healthy lifestyle. Overall, the system promotes healthy eating and offers a clever means to assert control of personal health using.

7. Future Enhancement

It can also be transformed into a system where it is operated using a mobile application to make it convenient and easy. This is to enable the users to get information at different locations so that they can sustain a healthy lifestyle even when they are at home, restaurants or in some kind of travel. They also stand a chance to be in the system. Educate a person and bring into this system other sources of food, i.e., other culture and traditional food. It will be used whereas there are more meals that are familiar to the application. In addition, the AI-based mechanisms of the process of the segmentation calibration can be used to allow the system to carry out the determination of the necessary amount and the portion of the food that the individual will use as per the visual reports, which will necessitate the increment of the consumption of the calories. Besides this, it would enhance the way the user would interact with the system by incorporating AI services to the personalized nutritional coaching to help the user reach certain of the nutritional goals using his history and interest. Such a type of innovation would render the application intelligent, trustworthy, and available to customers that desire to be informed about what and the quantity they consume as well as customers that wish to lead healthier lifestyles. Such innovation would not only improve the perfection of the system; additionally, it would enable convenient access, and consequently, it would be used by people willing to alter their nutrition and health.

References:

[1] Mohammed, A., & Al Garni, F., “Deep Learning for Food Recognition: A Comprehensive Review”, 2020.

[2] Mrs. M. Saranya, Chandini Varalakshmi Malladis, Kothari Teja Sri, Oduri Devi Sri Naga Jyothi, Puram Setti Ravi Kiran, Meduri Ajay Kumar., “Food Calories Estimation and BMI Prediction using Deep Learning”, March 2023.

[3] Paulus, R., Fu, C.Y., & Meyers, A., “Deep Food: Deep Learning-Based Food Recognition”, 2017.

[4] Pang, G., Shen, C., & van den Hengel, A., “A Survey of Deep Learning Techniques for Object Detection in Images”, 2019.

[5] Priya N V, Preetam Kumari, Poorvika N, Sanjana R, Dr. Hema Jagadish., “Indian Food Image Recognition with MobileNetV2”, International Research Journal of Engineering and Technology (IRJET) 08, Aug 2021.

[6] Mrs. Srilatha Puli, Mrs. S. Sunitha Sarape, K. Prajitha, A. Shreshta, G. Nikhil Reddy, K. Vijay Simha Reddy., “Food Calories Estimation Using Convolutional Neural Network”, 2023.

[7] Ardhendu Bandhu, Sanji ban Sekhar Roy., “Classifying multi-category images using Deep Learning: A Convolutional Neural Network Model”, 2017.

[8] Mrs. Sophia, Ahammed Moin Nawaz, Deepak R, Ankush B R, H G Uttam., “Food Recognition and Calories Measurements Using Artificial Intelligence”, International Journal of Research Publication and Reviews, June 2023.

[9] Horea Muresan, Mihai Oltean, “Fruit Recognition from Images Using Deep Learning” ACTA Univ. Sapiential, Informatica, 2018.

[10] B. Preeti Kumari, Dr. G. Wiselin Jiji, “Food Calories Estimation Using SVM” International Conference on Emerging Trends in Application of Computing, 2017.

[11] P. Pouladzadeh, P. Kuhad, S. V. B. Peddi, A. Yassine, and S. Shi Mohammadi, “Food calorie measurement using deep learning neural network,” in Conference Record - IEEE Instrumentation and Measurement Technology Conference, 2016.

[12] Y. Liang and J. Li, “Computer vision-based food calorie estimation: dataset, method, and experiment”, May 2017.

[13] N. O. M. Salim, S. R. M. Zeebaree, M. A. M. Sadeeq, A. H. Radie, H. M. Shukur, and Z. N. Rashid, “Study for Food Recognition System Using Deep Learning”, July 2021.

[14] Priya Gupta, Shikha Gupta, “Hybrid Algorithm for Food Recognition, Calorie Estimation & Dietary Enforcement”, November 2018.

[15] P. B. Deshmukh, V. A. Metre and R. Y. Pawar, "Calorie meter: Food Calorie Estimation using Machine Learning," 2021.

[16] R. Dinesh Kumar, E. Golden Julie, Y. Harold Robinson, S. Vimal, Sanghyun Seo, “Recognition of food type and calorie estimation using neural network”, The Journal of Super computing, Jan 2021.

[17] Z. Huang, "A CNN-based implementation of fruit recognition", Highlights in Science, Engineering and Technology, 2024.

[18] Kali Varaprasad B, Prasad M.V.D, Naveen Kishore Gattim, "Deep Learning-based Food Calorie Estimation Method in Dietary Assessment: An Advanced Approach using Convolutional Neural Networks," International Journal of Advanced Computer Science and Applications, 2024.

[19] A. Ramdani, A. Virgono, and C. Setianingsih, "Food Detection with Image Processing Using Convolutional Neural Network (CNN) Method," 2020.

[20] S. A. Ayon, C. Z. Mashrafi, A. B. Yousuf, F. Hossain, and M. Hossain, "Foodie Cal: A Convolutional Neural Network Based Food Detection and Calorie Estimation System," Highlights in Science, Engineering and Technology, 2023.

[21] V. B. Kasyap and N. Jayapandian, "Food Calorie Estimation using Convolutional Neural Network," 2021.