https://doi.org/10.48047/AFJBS.6.5.2024.10577-10591

AFJBS

African Journal of Biological Sciences

DeepNourish: Optimized Deep Learning for Food Image Analysis and Dietary Evaluation

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Article History
Volume 6, Issue 5, 2024
Received: 22 May 2024
Accepted: 03Jun 2024
doi:*10.48047/AFJBS.6.5.2024.10577-10591*

ABSTRACT: DeepNourishis an optimized deep learning system designed for food image analysis and dietary assessment, leveraging convolutional neural networks (CNNs) and advanced optimization methods. It automates dietary evaluation by processing images of food items, encompassing data collection, CNN model training for food recognition, portion estimation, and nutritional analysis. Key innovations include optimization techniques enhancing model accuracy and robustness. Evaluation of diverse datasets shows promising results, highlighting its potential to revolutionize nutritional monitoring and promote healthier eating habits.

KEYWORDS: Image Recognition,Dietary Assessment, Nutrition Analysis,Food Computing, Feature Extraction.

I.INTRODUCTION:

Classification to the World Health, fatness and overweight are described as irregular or unneeded body fat growth that puts one's comfort at risk(1). Until now, no single country has had the opportunity to reverse it. the annual clinical cost of obesity-related diseases medical services, such as heart disease and diabetes(2), Kind 2 diabetes and specific kinds of disease cost an incredible 190.2 billion dollars, and the clinical price for those who are overweight(3) is $1,529 greater than for people who are normal weight. Moreover, a variety of factors can contribute to weight growth(4), including specific medications, severe topics such as stress, decreased activity and eating habits(5) - how people eat is often the significant issue indicates to weight gain. Energy proportions are represented by calories, as well as other food components such as fat, carbohydrate, and protein(6). Many people want to monitor their diet and nutrition to ensure they are eating healthily. To do so, it is crucial to have an accurate estimate of one's caloric intake. Additionally, the growth of the Internet of Things (IoT) and the continuous flow of data have greatly improved the virtual entertainment experience. (7). More and more people want to monitor their daily dietary intake and nutritional intake to determine whether they are following a healthy diet.Therefore, it will be crucial for wellbeing to estimate dietary calorie intake accurately(8). Even though this project currently has these gold-standard ways for reporting diet-related data, there is at least one flaw that we cannot ignore these methods are still biased(9).Thus, the subject is expected to calculate their own nutritional consumption(10). Participants often underestimate caloric intake when completing dietary assessments. Automated eating monitoring systems improve accuracy and reduce bias (11). In this study, paper look into a comprehensive pattern-built method to food identification and food evaluation. In example, we outline and carry out a methodology for food picture analysis(12), with aim to determine how much healthy elements each food item contains from photographs taken daily. In context of what you eat at lunch, an extensive dietary study report will be made. Calculating the precise quantity of dietary calories consumed is essential to evaluating the effectiveness of weight control programs(13). Currently, self-reporting and manually recorded approaches are utilized to evaluate diet. Although the 24-hour diet recall is the gold standard for reporting, bias is present since participants are asked to estimate their nutritional intake. In order to solve this issue, we provide a novel deep learning-based method for food image detection in this study. The proposed approach is based on a Convolutional Neural Network (CNN)(14), however it has been significantly improved. The effectiveness of our solution has been demonstrated by experimental results using two real-world datasets (15)and the advised strategy.

II.RELATED WORK:

The first field of related study focuses on technological advancements that can improve dietary measurement accuracy. As previously mentioned, mobile cloud computing(16) presents an unmatched opportunity for the discovery of novel biomarkers(17) and early predictors that will assist and facilitate intelligent care decisions on health issues(18), including nutritional assessment. Both mobile cloud health software programs and a wide variety of mobile health hardware are readily available(19). There are many ways to make dietary estimates for this significant population better. The second linked study field uses graphics to analyze nutritional data. Yang et al.(20) suggested a feature fusion method for detecting fast food while accounting for the relative spatial correlations between the local properties of the items(21). This procedure can only be used to a select few food kinds, and it is challenging to utilize it with composite or home-cooked meals (61 foods). To solve the problem of numerous food recognition, Matsuda et al. (22) proposed an approach based on a manifold ranking-based algorithm and co-occurrence data among food items.

Food Image Recognition:

"Food Recognition from Images Using Deep Learning" by Salman H. Khan, et al. (2016)

"Deep Learning-Based Food Recognition" by Yoshitaka Ushiku, et al. (2016)

"NutriNet: A Deep Learning Food and Drink Image Recognition System for Dietary Assessment" by Olivier Drouin, et al. (2018)

Portion Size Estimation:

"Automatic Food Portion Estimation Using Deep Learning" by Yaniv Lustig, et al. (2015)

"A Review of Computer Vision and Image-Based Analysis for Dietary Assessment" by David J. Albers, et al. (2017)

"A Survey on Deep Learning-Based Approaches for Action and Gesture Recognition in Image Sequences" by Vincent Sitzmann, et al. (2019)

Dietary Assessment and Nutrition:

"Automated Dietary Assessment: A Review of Computer Vision and Machine Learning Techniques" by Seyed Ali Bahrainian, et al. (2019)

"Advances in Dietary Assessment and Diet Quality Measurement" by Colin D. Rehm, et al. (2018)

"Recent Advances in Dietary Assessment and Their Implications for Cancer Epidemiology" by Amy F. Subar, et al. (2018)

Deep Learning Techniques:

"Deep Learning for Image-Based Dietary Assessment" by Mengdi Yao, et al. (2018)

"Deep Learning in Object Detection and Recognition" by Bharathkumar Ramachandra, et al. (2020)

"A Comprehensive Survey on Transfer Learning" by Qianru Sun, et al. (2020)

III.PROPOSED APPROACH:

This article presents a new method for detecting food images using deep learning. We endorse Convolutional Neural Network-based approaches due to their superior modeling and convolution techniques. In the first subsection, we will discuss the context and objectives of this strategy, followed by a comprehensive explanation of the suggested course of action.Our proposed system can identify food items, display their names, required ingredients, and nutritional information, such as the amount of fats, carbohydrates, proteins, vitamins, etc. Additionally, our project offers a dietary plan for individuals based on their gender, age, height, and weight by calculating their basal metabolic rate. Experimental results demonstrate the accuracy of our system in recognizing food items. Our project efficiently generates a dietary assessment report, which provides users with a clear understanding of their healthy diet. Our project also offers guidance on daily recipes to improve overall health and wellness.Convolutional Neural Network (CNN) is a three-dimensional matrix that receives an input feature map with the first two dimensions corresponding to the length and width of the images in pixels and the third dimension corresponding to the three channels of color images: red, green, and blue. Each CNN module consists of three operations and utilizes multiple filters to perform the convolution process in a convolution layer. To obtain the convolved feature matrix, the filter matrix is moved over the image and computes the dot product.

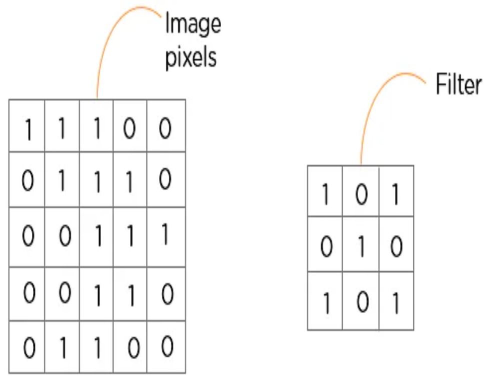

Figure-1 input images to filter conversion

- ❖ **ReLU Layer:**

ReLU is the abbreviation for the rectified linear unit. After being retrieved, the feature maps must next be transferred to a ReLU layer. ReLU performs an action, turning all the negative pixels to 0 by doing so element by element. A rectified feature map is the end outcome, and it lends the network non-linearity. Below is a graph of a ReLU function:

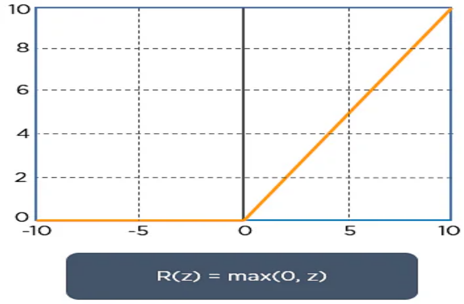

Figure-2 ReLU Scenario

❖ **Pooling Layer:**

The down sampling process of pooling lowers the feature map's dimensionality. To create a pooled feature map, the rectified feature map is now passed through a layer of pooling. STRUCTURE OF THE CONVOLUTION NEURAL NETWORK:

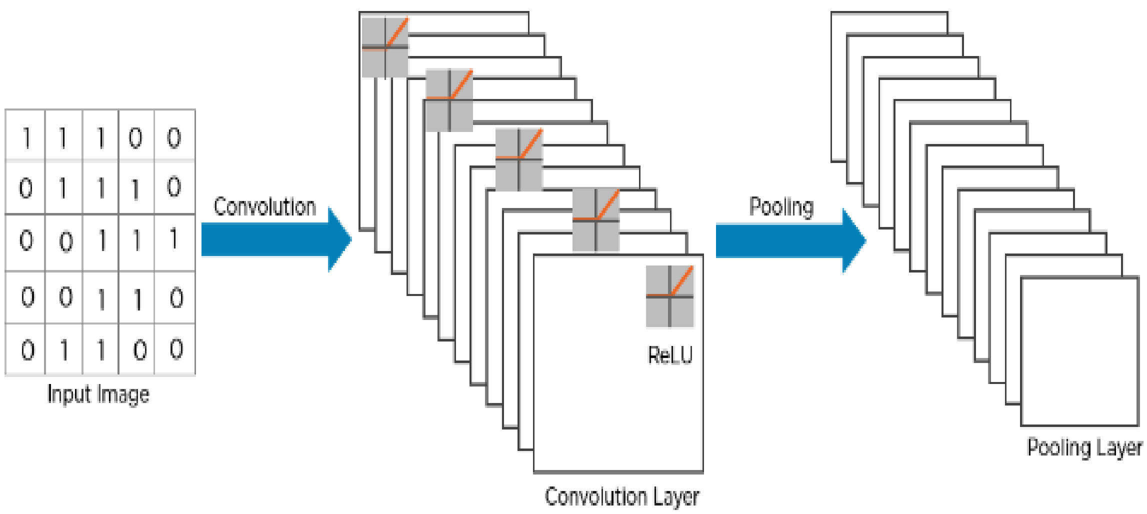

Figure-3-layer overview

❖ **System Design:**

In order to distinguish between the food photos based on their attributes, convolution neural networks (CNN) are used. To create and evaluate CNN models, food datasets are used. The trained model is implemented using Keras.

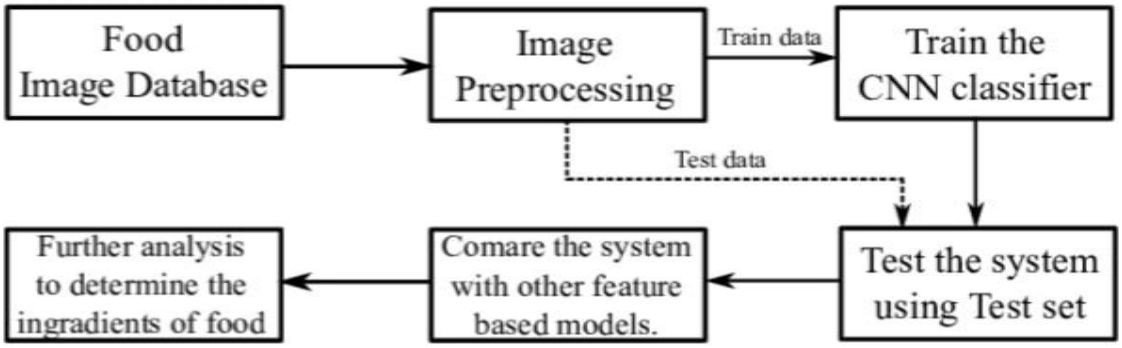

Figure-4 Architectural Overview

DATA SET:

Listed below is a dataset called "food-101" that includes photos of 101 distinct food classifications. For the model's training, we used 101000 photos. In order to enhance the appearance, rotation, color, and precision of complexity recognition, images were obtained from freely accessible online resources. The image only shows one food item.

BASAL METABOLIC RATE CALCULATOR:

The term is basal metabolic rate, or BMR. Your basal metabolic rate, also referred to as your metabolism, is the quantity of calories needed to keep your body operating while at rest. Your BMR will rise as a result of anything that accelerates your metabolic rate. This includes physical movement, fear, worry, and sickness. Your body mass, age, height, and weight all affect your

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BMR. Your gender has an impact, as does the fact that men normally need a few more calories than women.

Table-1 Comparison of Existing Model with Proposed R-CNN

Sno	**Title**	**Technique**	**Remarks**	**Dataset**
1	Food Image Recognition	Deep Learning	Does not provide Dietary Assessment	SGFood724
2	Food Image Analysis and Dietary Assessment via deep model	Deep Learning	--	FOOD101
3	Food Recognition for Dietary Assessment/Calorie Measurement	Machine Learning		UEC-FOOD256
4	A New Deep Learning-based Food Recognition System for Dietary Assessment on An Edge Computing Service Infrastructure	Deep Learning		UEC-FOOD101

IV. RESULTS:

Food is essential for survival, but eating the right foods is equally important. Dietary analysis can be essential for people's general health and, in some cases, for the prevention and control of chronic, life-threatening disorders. This type of application is a needed one for the people to keep an eye on their daily intake of food.

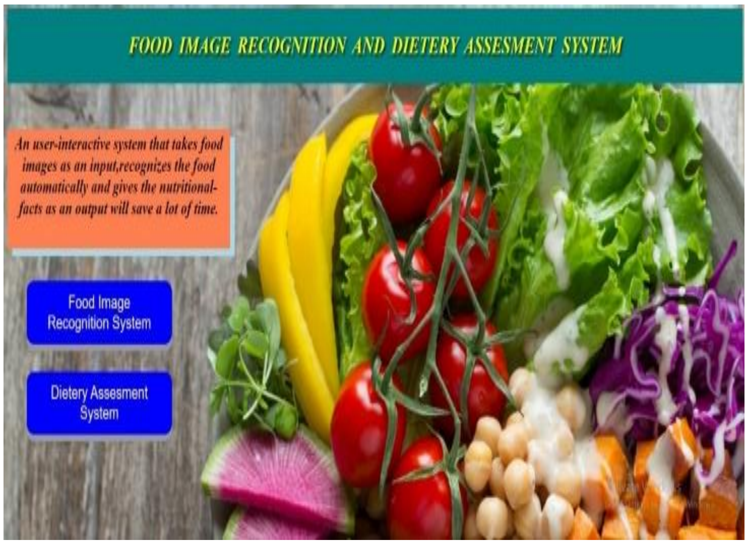

Figure 5: Overview of the home page of the application

This application is user-interactive and very easy to use. User just need to click an image of the food item to which they want to know the nutritional values. And just upload it using the dropdown box provided and then click on recognize.

Figure 7: Uploading the food image

The results will be displayed on the screen just as shown in the below figure (5). It will give many types of nutritional details such as fats, fibers, carbohydrates, proteins and many more. On seeing this the user came to an idea of the amount of unnecessary food he/she is taking and there is a chance of avoiding those unnecessary nutrients in the diet (like much amount of fats). It will also tell if any necessary nutrients are lacking so that the user can add them.

Taking healthy food is not the only criteria but taking it in the correct amounts is also crucial. Some people are not experts in selecting food items which comprises a balanced diet. So, for that kind of people this system also contains a dietary assessment (in Figure 6) that suggests a balanced diet for the people by entering few details of them.

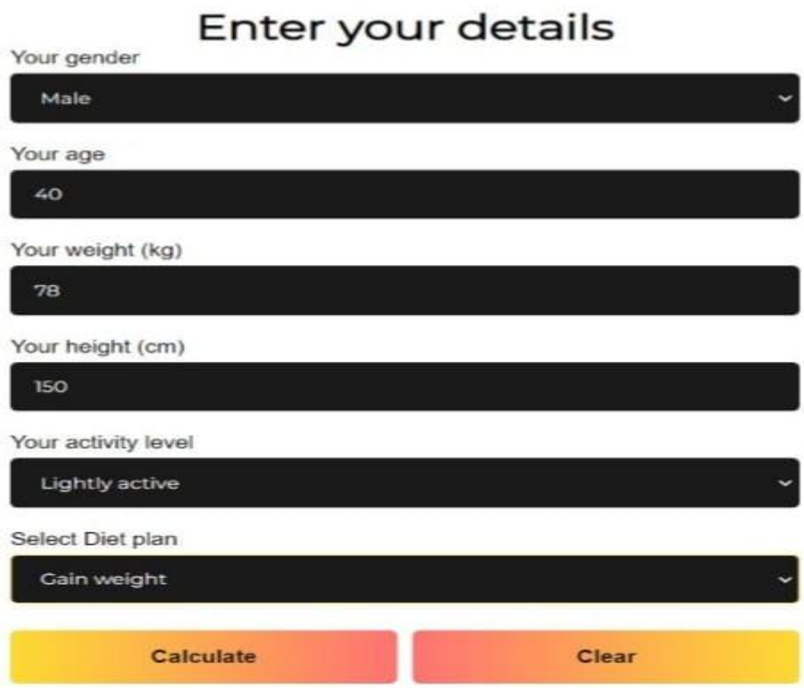

Figure 8: Suggesting a dietary assessment for the individuals by entering their details

V.CONCLUSION AND FUTURE WORK:

In this study, we use sophisticated learning approaches to tackle the problem of food recognition and dietary evaluation. To better understand item identification and food investigation, we use state-of-the-art, innovation-based nutritional evaluation technologies. We also assess the food's durability and provide a summary of the feast report. To assess the efficacy and applicability of our system, we conduct extensive research. The fact that our paradigm has been adopted widely demonstrates that it may enable dependable and sensible food recommendations. Later, we would continue to improve the handling times and location framework accuracy. The more thorough method of ingredient prognostication makes dietary assessment interesting. The arrangement also incorporates a pre-programmed diet number cruncher to guarantee a healthy diet. In the future, it is in the plan to keep working to speed up processing and increase the precision of our detecting system.It would be ideal to have a more thorough meal analysis plan that includes weight projection. Additionally, an automatic diet calculator is included in the plan to offer a balanced diet.

ABBREVIATIONS

CNN-Convolutional Neural Network

RNN-Recurrent Neural Network

BMR-Basal Metabolic Rate

ReLU-Rectified Linear Unit

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