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Nutrifit Vision: Smart Diet and Fitness Management System

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Abstract: **A growing need for effective dietary management tools has arisen due to an increasing prevalence of obesity and dietrelated diseases. Here, a novel ML-based approach is introduced for food calorie detection. We leveraged large datasets with images of different types of food, along with the associated caloric value. Using machine learning algorithms, we trained models to predict food calories based on visual features. We also applied data preprocessing steps like image augmentation and normalization to improve model accuracy [10]. Model accuracy was then tested through established metrics with high accuracy within caloric estimation. Here we are proposing a Convolutional Neural Network algorithm called YOLOV8, which is mostly used for object detection, to detect the food items. The goal of this project is to develop model which recognizes the food item and estimates the calorie values in it. This system provides a platform where users can estimate the number of calories in a food item by just providing picture or videos of the food item and hence they can track the number of calories in their diet These results suggest that our machine-learning framework can help users make better dietary decisions through real-time calorie data from food images. This study adds to the growing body of literature looking at nutritional technology as a means of scaling up calorie tracking and helping people eat healthier [8]. Future research would be directed toward diversifying datasets and modeling to enhance precision and usability across a wide variety of food and culinary classes [2].**

1. INTRODUCTION

According to the World Health Organization (WHO), unhealthy diets are responsible for about 20% of deaths worldwide. In 2016, 39% of adults aged 18 and older were overweight, and 13% were obese. Most people live in countries where being overweight and obese cause more deaths than being underweight [9].

A person's calorie intake and energy expenditure are out of balance, which is the primary cause of obesity. Obese people are usually defined as having a Body Mass Index (BMI) of 30 or higher [3]. A high body mass index raises the chance of major health issues like diabetes, heart disease, and other ailments [5].

The energy content of food is measured in calories, and controlling calorie consumption is crucial to overall health [7]. People's health has become more crucial than ever in the hectic world of today. The existing calorie-counting techniques, however, have drawbacks, particularly when users must manually enter information like the weight or volume of their food, which might result in errors [5].

A completely automated calorie measurement system is being proposed to make this process simpler and more precise [6]. People may more simply and precisely track their caloric intake with the use of this device, which would enable them to make healthier dietary choices [8].

In order to create a system that can recognize the type of food and calculate its calories and nutrients from images, this project will use machine learning models, [4]. We plan to build a large and diverse dataset that encompasses a broad range of food types so that the system can work for any diet or cuisine [10].

The goal of this study is to significantly improve public health, not just help consumers monitor their food consumption. By making restaurant menu item calorie information readily accessible, we hope to promote healthy eating habits [14].

This could help fight obesity and related health problems. In this introduction, we emphasize the importance of the issue, how machine learning can help with personal diet management, and give an overview of our project, which will lay the foundation for explaining our methods and results in detail [14]

2. LITERATURE REVIEW

In this section, we'll look at some of the popular methods used in recent years to calculate food intake. Many people take pictures of their food before they eat and share them online [9]. It's important to be able to figure out the calorie content of these pictures by identifying the food and estimating its size using deep learning technology [12].

In the studies by Joutou et al. (2009) and Hoashi et al. (2010), they pulled out features like color, texture, slope, and filter highlights from food images. Then, they built a separate classifier for each feature. After that, they combined these classifiers and adjusted their importance using different algorithms.Their system was able to correctly identify 61.3% of 50 types of Japanese food and 62.5% of 85 types, using 9 and 17 features, respectively, with 5-fold cross-validation on a dataset of 8,500 images. However, the system still had some challenges in accurately identifying food items from images. The dataset used contained 8,500 food pictures in total [1].

In the 2018 study by Subhi et al., the authors created a model that can recognize food items using a Convolutional Neural Network (CNN). They also introduced a new dataset with local Malaysian foods, which includes 11 food categories and 5,800 images.They employed two datasets for their model: their own Malaysian food dataset, which was used to group distinct food items, and the FOOD-101 dataset, which was used to classify food vs. To classify food photographs, they used a powerful CNN model with 24 layers. The model was more complex because it had several convolutional layers before the final layer. The results showed that a deeper network improved the model's ability to accurately identify visual elements [5].

Deng et al. [8] delivered the ImageNet gadget, a especially influential and effective image dataset constructed on the muse of the WordNet shape, which serves as a big-scale visual database designed to assist diverse pc vision tasks. ImageNet is taken into consideration one of the maximum comprehensive and extensively used photo datasets in the area of deep gaining knowledge of and laptop vision because of its large scale, range, and well-organized hierarchical structure [8].
The ImageNet device objectives to populate the majority of the eighty,000 synsets (synonym sets) from WordNet, with every synset containing a mean of 500 to 1000 first rate and absolutely annotated snap shots. This consequences in a big collection of tens of millions of categorised images grouped primarily based on their semantic relationships. At the time of its creation, ImageNet covered 12 sub-bushes, 5,247 synsets, and about three.2 million photographs in general. The dataset isn't only notably larger in scale but also greater diverse and accurate as compared to previous photo datasets. The quality of the photograph annotations and the sheer size of ImageNet make it an vital resource for education deep getting to know models in item reputation, picture classification, and different visual reputation responsibilities [8].

Building the sort of massive-scale dataset is a exceedingly complex and time-ingesting task, requiring cautious picture choice, annotation, and satisfactory manipulate. The researchers validated the usefulness of ImageNet via three primary applications: item recognition, image type, and automatic item clustering. The observe proved that the big scale, excessive precision, wealthy range, and hierarchical shape of ImageNet offer remarkable opportunities for researchers within the pc vision network and past [5].

One of the key benefits of the ImageNet framework is its capacity to facilitate pre-schooling models through allowing them to extract essential photo features which includes colorings, texture details, shapes, and high-stage summary representations. This pre-schooling process enables improve the overall performance of various deep mastering fashions, making ImageNet a cornerstone dataset for picture recognition and deep learning studies [5].

3. PROPOSED METODOLOGY AND DESIGN

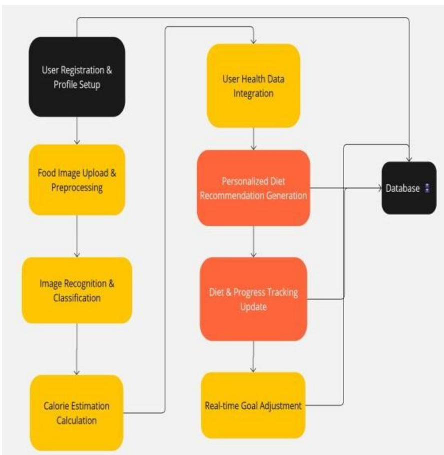

Fig 1: System Architecture

3.1 Explanation of steps involved :

3.1.1 User Registration & Profile Setup:
Users provide their personal details, including age, gender, weight, height, and dietary preferences, during the registration process. This information serves as the foundation for creating personalized diet plans tailored to each individual's needs. By considering these factors, the system can generate accurate and relevant dietary recommendations, aligning with the user's health goals and preferences.

3.1.2 Food Image Upload & Preprocessing:
Users upload images of their meals for analysis, which serves as the primary input for the system. Before processing these images for food recognition, the system applies preprocessing techniques like resizing, filtering, and noise reduction. These steps help standardize the images, ensuring better quality and consistency, which enhances the accuracy of food detection and classification in the subsequent stages. Proper preprocessing minimizes errors caused by variations in image quality, lighting, and backgrounds.

3.1.3 Image Recognition & Classification:
The system utilizes the YOLOv8 model, a state-of-the-art object detection framework, for accurate food detection and classification. This model is capable of identifying multiple food items within a single image, making it effective for analyzing complex meals with various components. YOLOv8's speed and precision allow the system to quickly and accurately detect food items, regardless of variations in size, shape, or placement, ensuring reliable recognition for calorie estimation and nutritional analysis.

3.1.4 Calorie Estimation Calculation:
Based on the recognized food items, the system estimates the calorie count to provide users with valuable insights into their dietary intake. In addition to calories, the system extracts detailed nutritional information, including macronutrients like carbohydrates, proteins, and fats. These calculations are performed using a pre-established nutritional database that matches the identified food items, ensuring accurate and reliable estimations. This detailed nutritional data helps users understand their food consumption patterns, enabling better decision-making for maintaining a balanced diet.

3.1.5 User Health Data Integration:
The system integrates the recognized food data with the user's health information, such as weight goals, dietary restrictions, and preferences. This personalized approach ensures that the dietary recommendations align with the individual's unique needs, making them more effective and practical. By considering factors like target weight, health conditions, and specific dietary requirements, the system tailors meal suggestions to support the user's overall health and wellness objectives. This integration helps users achieve their goals while adhering to their dietary limitations and preferences.

3.1.6 Personalized Diet Recommendation:
Using the Decision Tree Classifier along with the user's health data, the system generates a personalized diet plan tailored to the individual's unique needs. The classifier analyzes the user's health goals, preferences, and dietary restrictions to recommend suitable meal options that align with their objectives. By evaluating various factors like calorie requirements, nutritional balance, and personal preferences, the system offers practical and customized diet recommendations. This approach ensures that the suggested meal plans are not only nutritionally appropriate but also compatible with the user's lifestyle and health goals.

3.1.7 Diet & Progress Tracking Update:
The system enables users to monitor their progress by tracking key data such as daily calorie intake, weight changes, and adherence to the recommended diet plan. This tracking feature allows users to evaluate their dietary habits over time and assess their progress toward achieving health and fitness goals. By regularly monitoring this data, users can make informed adjustments to their eating patterns, stay motivated, and maintain accountability. The system's ability to visualize progress encourages users to stay committed to their dietary plans while making necessary modifications for better results.

3.1.8 Real-time Goal Adjustment:
If users deviate from their goals, the system suggests adjustments to help them stay on track. For example, if a user exceeds their calorie limit, it may recommend lighter meals or increased physical activity. These adjustments are personalized, ensuring continued progress toward health objectives.

3.1.9 Database Integration:
A central database stores all user information, meal data, calorie calculations, and progress logs, ensuring that the data is consistent, secure, and easily accessible. This organized storage system enables

efficient retrieval of information, allowing the system provide accurate and personalized recommendations while tracking user progress effectively.

3.2 Working of YOLOV8 Algorithm:

3.2.1 Input Image:

When you deliver an photograph to the set of rules, it first modifications its size to in shape what the device wishes. This allows the model procedure the picture well. The exact length depends on how the machine was designed to work.

3.2.2 Dividing the Image into a Grid:

The set of rules splits the photograph right into a grid, like a checkerboard, with S x S small sections. Each segment (grid mobile) is responsible for detecting objects that seem inside its location.

3.2.3 Drawing Boxes Around Objects:

Within each grid cell, YOLO predicts multiple bounding boxes. Each bounding box is defined by five attributes: (x, y, w, h, confidence). The (x, y) coordinates represent the center of the bounding box relative to the grid cell, while w and h represent the width and height of the box. The confidence score indicates how confident the algorithm is that the box contains an object.

3.2.4 Class Prediction:

Along with the bounding box predictions, YOLO also predicts the probabilities of different classes for each box. The number of class probabilities depends on the dataset being used. These class probabilities represent the likelihood of each class being present in the bounding box.

3.2.5 Confidence Thresholding:

YOLO applies a confidence threshold to filter out low-confidence predictions. Bounding boxes with confidence scores below the threshold are discarded as false positives.

3.2.6 Non-Maximum Suppression (NMS):

To eliminate duplicate detections and improve accuracy, YOLO applies non-maximum suppression. NMS removes redundant bounding boxes that have significant overlap and keeps only the most confident one. The overlap threshold for suppression is typically determined by a predefined Intersection over Union (IoU) value.

3.2.7 Final Output:

The output of the YOLO algorithm is a set of bounding boxes, each associated with a class label and confidence score. These bounding boxes represent the detected objects in the input image.

We tried using yolo model to detect the food items and estimate the number of calories in them, to track the number of calories in our meal in order to avoid Obesity. Here we are using YOLOV8 object detection model to detect the food items. The implementation of the project using YOLOV8 is done as stated below:

Downloading dataset from Roboflow and importing YOLOV8

```
!pip install roboflow

from roboflow import Roboflow
rf = Roboflow(api_key="JPYKmiIWJb9BVdXCc7yQ")
project = rf.workspace("indianfoodnet").project("indianfoodnet")
dataset = project.version(1).download("yolov8")
```

Fig 2: Downloading dataset from Roboflow and importing YOLOV8

TrainingYOLOV8model

```
!yolo mode=train model=yolov8m.pt data='/content/drive/MyDrive/food/IndianFoodNet-1/data.yaml' epochs=1
```

Fig 3. Training YOLOV8 model

Streamlit is an open-source Python library designed to help builders create and set up statistics-driven internet programs simply. It simplifies the system of constructing interactive and user-friendly interfaces for information analysis, gadget mastering, and records visualization. One of its biggest advantages is that it lets in developers and records scientists to awareness at the core capability of their programs while not having to fear about the complexities of web improvement. Because of its simplicity and fast improvement workflow, Streamlit has grow to be a popular device among statistics scientists, device mastering engineers, and builders who want to create interactive dashboards, records exploration gear, and system studying prototypes quickly and effectively.

In this task, Streamlit is used to create an interactive net utility that allows customers apprehend food objects in an image and estimate their calorie content. The system begins with training a deep getting to know version to become aware of extraordinary meals objects. This is achieved the usage of the YOLOv8 set of rules, a powerful item detection version able to recognizing diverse gadgets in pics with high accuracy.

To educate the model, a dataset from Roboflow is used, which includes five,446 pix spanning 30 distinct classes of food gadgets. Each photo is processed via the YOLOv8 algorithm at some stage

in schooling so that the model learns to locate and classify food objects efficaciously. After the education procedure is whole, the model generates a weights report, which shops the learned parameters required for meals popularity.
Once the model has been educated, the next step is checking out it with real-global pictures. This is where Streamlit plays a vital role. A consumer-friendly net interface is built using Streamlit, allowing customers to add an picture of any food.
The skilled model, connected to this interface, then analyzes the uploaded image, detects the food gadgets present, and estimates their calorie content based totally on a predefined calorie chart. The calorie estimation is accomplished by using figuring out the sort of meals in the photograph and calculating the range of calories in line with gram.
To make the procedure clean to apprehend, the execution steps are documented with non-stop screenshots, showing how an image is uploaded, analyzed, and processed to show the outcomes. This ensures clarity in demonstrating how the machine works—from meals item popularity to calorie estimation—assisting users better understand their dietary consumption.

3.3 Result Analysis

The development process involved designing and implementing a Food Recognition and Calorie Measurement System using YOLOv8 for food detection and a Decision Tree Classifier for personalized diet recommendations. A Flask-based web application was created to provide a user-friendly interface, allowing users to upload meal images, receive accurate calorie estimations, and track their dietary progress. The system uses a central database to store user profiles, meal data, and nutrition information, ensuring data consistency and efficient access. Rigorous testing and model training were performed to optimize the YOLOv8 model and improve detection accuracy. The platform's effectiveness was evaluated based on recognition accuracy, user feedback, and the relevance of personalized diet plans.

4 FUTURE SCOPE

AI-powered food reputation era is poised to revolutionize the destiny, bringing a wave of improvements that might redesign how we apprehend, manipulate, and have interaction with meals. This present day era opens the door to a huge variety of opportunities, which includes extra correct dietary analysis, automated detection of meals allergens, and seamless integration with clever kitchen appliances. These innovations have the capability to reshape our notion of vitamins, offering smarter techniques to show dietary behavior and make more healthy life-style alternatives [9].

As part of this imaginative and prescient, we have evolved our very own AI-primarily based meals recognition version able to describing, detecting, and figuring out diverse meals kinds from exceptional areas and cuisines. Our model is designed to understand a numerous variety of dishes with high precision, making it adaptable to the wealthy variety of global culinary traditions. Additionally, we're operating on building an intensive dataset so that it will function a massive collection of meals kinds, further improving the version's accuracy and reliability across a extensive spectrum of cuisines. This initiative is a large step towards developing a more shrewd and personalized technique to nutrition control[14].

5 CONCLUSION

The purpose of our task is to create a machine that can properly estimate the content of the calorie content of food from images, to compete with people with diet and weight problems, diabetes and coronary coronary coronary coronary heart disorder to reduce the risk of conditioning problems such as coronary coronary heart disorder.. By imparting particular nutritional statistics, the device empowers clients to make knowledgeable alternatives approximately their day by day food consumption. We achieved the YOLO (You Only Look Once) set of tips, seemed for its tempo and accuracy in object detection obligations, to end up privy to severa food and estimate their calorie content material cloth material in our internet-based totally totally completely software program software.
Despite its effectiveness, the machine faces challenges, inclusive of trouble distinguishing visually comparable meals and reduced accuracy when pix are captured from positive angles. These boundaries have an effect on the accuracy of food identity, however our model has shown promising effects normal. With in addition enhancements, this machine may want to emerge as a precious tool for promoting healthier consuming conduct and improving high-quality of lifestyles.

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