CALORAI: THE FOOD CALORIE ESTIMATOR

TEAM NAME: CALORAIZE

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1 CONTEXT

The problem we have identified and want to solve is accurately and conveniently estimating calories from meals using only images of the food. The goal is to create a system that is able to recognize and differentiate between different food items in an image of a meal and attempt to calculate the total calorie content of the meal.

A convenient tool like this can encourage healthier eating habits for many people who don't know where to start their healthy diets, and contribute to reducing the prevalence of conditions like obesity. With smartphone technology being readily available, this project can provide accessible nutritional information to a broader audience, including those without access to professional nutritionists or dietitians.

2 PROJECT DESCRIPTION

We hope to build a recognition model that is takes an image of a meal, recognize the composition and amounts of food that makes up the meal, and ultimately estimate the total amount of calories the meal contains.

To begin, the model takes in an image of a "standard" dinner plated meal (between 10" and 12" wide) as input. For this project, we want the meal to be composed of minimally processed food, such as tomatoes (fruits) and cabbages (vegetables). If time permits for the project, the meal ingredients can be extended to processed food. The model then processes the image to resize the image such that the plate takes up the entire image space. Afterwards, the model uses the processed image and feeds it to a convolutional neural network (CNN) to output a list of predicted ingredients. If time permits, its respective fine-tuned portion sizes. The specific details for each stages are described below:

Ingredient Identification
The model identifies all of the food ingredients given an image containing a plate of food as input. If there are no food items, the model is able to identify that there is no food.

Portion Estimation
The model is able to estimate portion sizes (in grams) of each food items in the input image.

Calorie Estimation
The model outputs a value that represents the estimated calories that the food in the image contains, restricted to constraints such as calories of a whole ingredient or part of an ingredient. May also include a range for standard deviation for uncertainty and a confidence level.

Mathematically, given an input plated food image U_i, the model should identify the j food items contained on the plate, denoted $F_i = (f_1, f_2, ..., f_j)$, and estimate the portion size $P_i = (p_1, p_2, ..., p_j)$ (in grams) of each food item f_j, the model then retrieves the calorie data (f_j, c_j) from the database and calculates the total calorie of the food based portion size p.

3 DATA

3.1 DATASETS

Food Type Detection
We will use the **Food 101** dataset which contains food images U_i, and a list of j food types $F_i = (f_1, f_2, ...f_j)$ within that image.

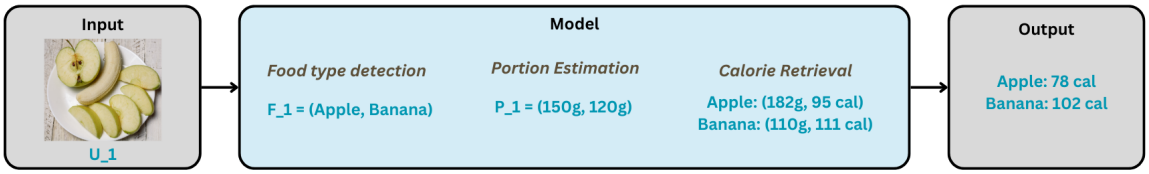

Figure 1: Given input image U_1, the model determines the food types in the image which are apple and banana, estimates the food portion of $150g$ and $120g$ respectively, and retrieves the calorie information of the food types. The model then outputs the calculated calories.

Food Calorie Database
In order to estimate the amount of calories in a given food, we will be using the **Food and their calories** dataset, which contains multiple different types of food f along with their calories c given their portion size p. This will help us convert any food we are able to recognize from the images into calories.

Portion Arithmetic
We will take new, manually labeled data to map food images to portion sizes (in grams). This dataset will contain simple food images U_i, the j food items contained $F_i = (f_1, f_2, ...f_j)$, and j portion sizes $P_i = (p_1, p_2, ...p_j)$.

3.2 Inputs and Outputs

Inputs: Images of meals, dishes, or food items taken from a perspective directly above. The food should be on a standard dinner plate, which has a width between 10" and 12". The images should be in common image file formats, such as .jpg, .png, or .tif.

Outputs: Firstly, we want to identify the foods present in the input images. The model should output recognized food items (e.g., "Pizza", "Salad"), with an estimated calorie count for each item. Following this, we expect the model to calculate the total estimated calorie count (e.g., "500 kcal"), and display this as well. The final calorie count should sum up the estimated calories for each food identified in the image, and give a calorie estimate for the whole meal. The estimate should be within $\pm$ 100 calories of the actual caloric content of the meal.

4 State of the Art (SOTA)

The Azumio's Food Lens AI is the current SOTA in the food recognition technology that is not only able to recognize various dishes from around the world, but it can also differentiate between presentation styles, preparation types, and regional differences. Its database contains more than 5000 dishes Azumio (2011).

However, the DoingLab FoodLens is the SOTA that is most relevant to the scope of this project. Their AI solution provides 17 types of information with just one image: including food name, calorie, carbohydrate, protein, fat, cholesterol, dietary fiber, calcium, saturated fat, sodium, sugar, trans fat, vitamins, etc. They analyze over 7 millions of images per month and can properly recognize over 3 millions DoingLab (2019).

5 Evaluation

Objective: we want to evaluate the model's ability to accurately identify ingredients, estimate portions, and calculate calories.
Ingredient Identification Accuracy: Metric: Top-1 and Top-5 classification accuracy for identifying food components.
Portion Estimation Accuracy: Metric: Mean Absolute Error (MAE) between the predicted and actual weights of ingredients.
Calorie Estimation Accuracy: Metric: Percentage error between predicted and actual calorie content.

REFERENCES

Azumio. Food lens ai overview, 2011. URL https://www.azumio.com/solutions/food-lens/overview.

DoingLab. Foodlens product description, 2019. URL https://www.doinglab.com/product/foodlens.