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FOOD IMAGE PROCESSING FOR DIABETES PATIENTS

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Abstract

Computer vision-based food recognition could be used to estimate a meal's carbohydrate content for diabetic patients. This study proposes a methodology for automatic food recognition, using CNN based features as well as the Bag of Features model. We will not only have images of the food in our Bag of Features, but also images of the food's relative states to make image recognition easier and more accurate. Atleast 15 different food categories were considered and entered into the data set along with 11 of its relative states. The images are grouped together using the k-means clustering method and are classified using linear support vector machine classifier. The food images will be clustered together on the basis of the properties of the picture. CNN architectures are experimented on three different recognition tasks: food categories, food states, and both food categories and states. Our dataset is also compared with other available datasets to test its food image recognition accuracy and relevance. This solution that we have provided is more applicable to the real world as it takes into account different categories of food as well as their relative states which makes our solution more efficient and practical for users with diabetes. On scanning a food image, the user receives the carbohydrate content as well as the amount of calories present in the food.

Keywords: CNN based features, Bag of Features model, k-means clustering, dataset of relative states of food, food recognition, image classification

1) Introduction:

Diabetes mellitus is a term for a group of disorders that cause elevated blood sugar (glucose) levels in the body. Glucose is a critical source of energy for your:

- brain
- muscles
- tissues

When you eat, your body breaks down carbohydrates into glucose. This triggers the pancreas to release a hormone called insulin, which acts as a "key" that allows glucose to enter the cells from the blood. If your body doesn't produce enough insulin to effectively manage glucose, it can't function or perform properly. This leads to symptoms of diabetes.

Diabetes that's not well managed can cause serious complications by damaging blood vessels and organs. It can increase the risk of:

- heart disease
- stroke
- kidney disease
- nerve damage
- eye disease

1.1) Types of diabetes:

Prediabetes: Blood glucose levels are higher than what's considered normal, but they're not high enough to qualify as diabetes.

Type 1 diabetes: The pancreas produces no insulin.

Type 2 diabetes: The pancreas doesn't make enough insulin, or your body can't use it effectively.

Gestational diabetes: People who are pregnant are unable to make and use all of the insulin they need.

Over 420 million people in the world have some form of diabetes. People living with diabetes have a long to-do list when it comes to managing their condition and the day-to-day diabetes care really falls on the patient. While diabetic patients have adequate resources to help them, people newly diagnosed with the disease can find it overwhelming to manage at first.

2) Problem Statement:

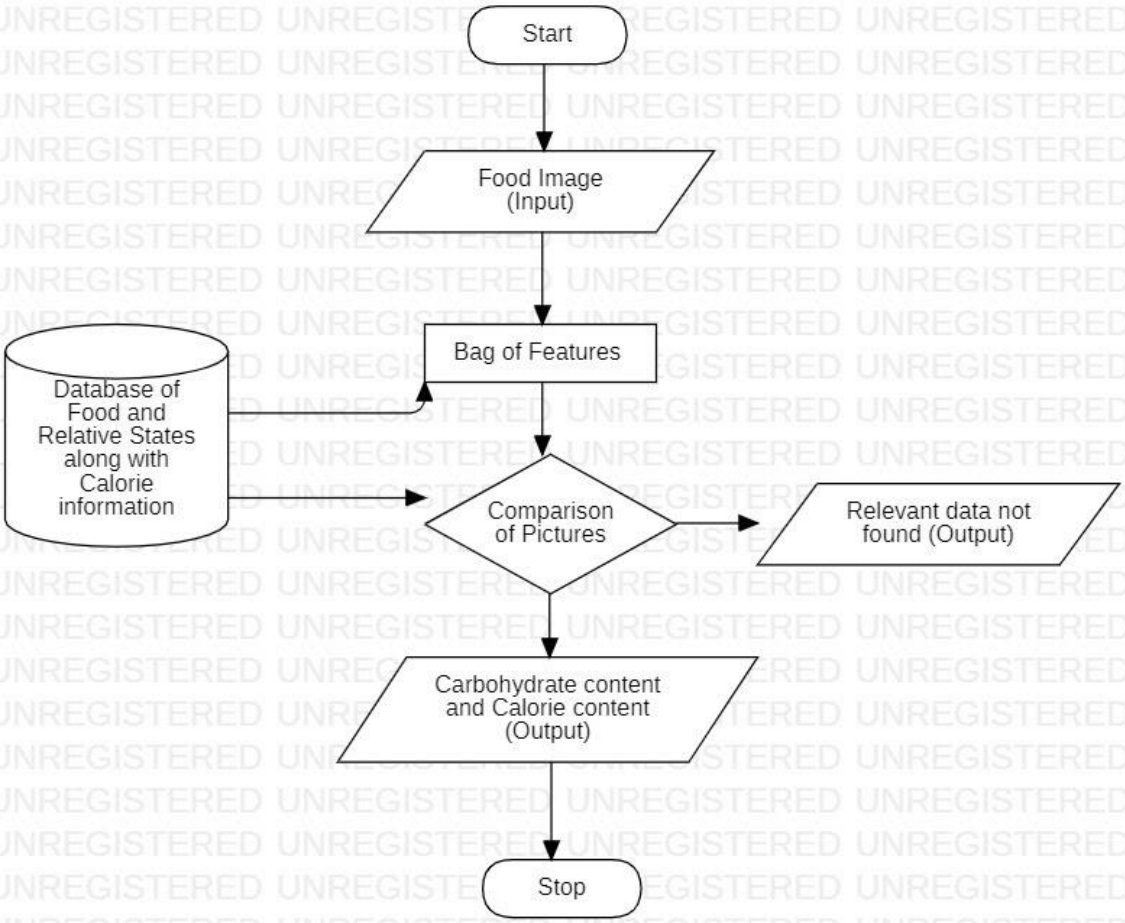
Diabetic patients have to visit doctors/nutritionists regularly to keep their health in check. But, frequent visits to a nutritionist is time consuming and a waste of money. It is also difficult to maintain healthy eating habits regularly as patients are unsure of the content of the food. They also have to keep track of the calorie intake each day which is difficult to do considering the poor resources available in homes.

3) Objective:

This study proposes a methodology for automatic food recognition based on Bag-of-Feature model (BoF) to estimate a meals carbohydrate content for Type – 1 diabetic patients. We will also use CNN based features for image processing. Under the CNN model, we will use the Hand-Crafted Features as well as the Deep-Learning Features. The images will be grouped based on food image properties using the k-means clustering method.

4) Proposed Methodology:

4.1) Work Flow Diagram:



4.2) Bag-of-Features:

Bag of Features (BoF) methods have been applied to image classification, object detection, image retrieval. In simple terms, a BoF model is a database that contains information. In our case, the information will be pictures of food and their relative states. The system will reference an input picture and compare to find relevant pictures from the Bag. Once it finds a match, it will relay the carbohydrate and calorie information to the user.

4.3) k-means Clustering:

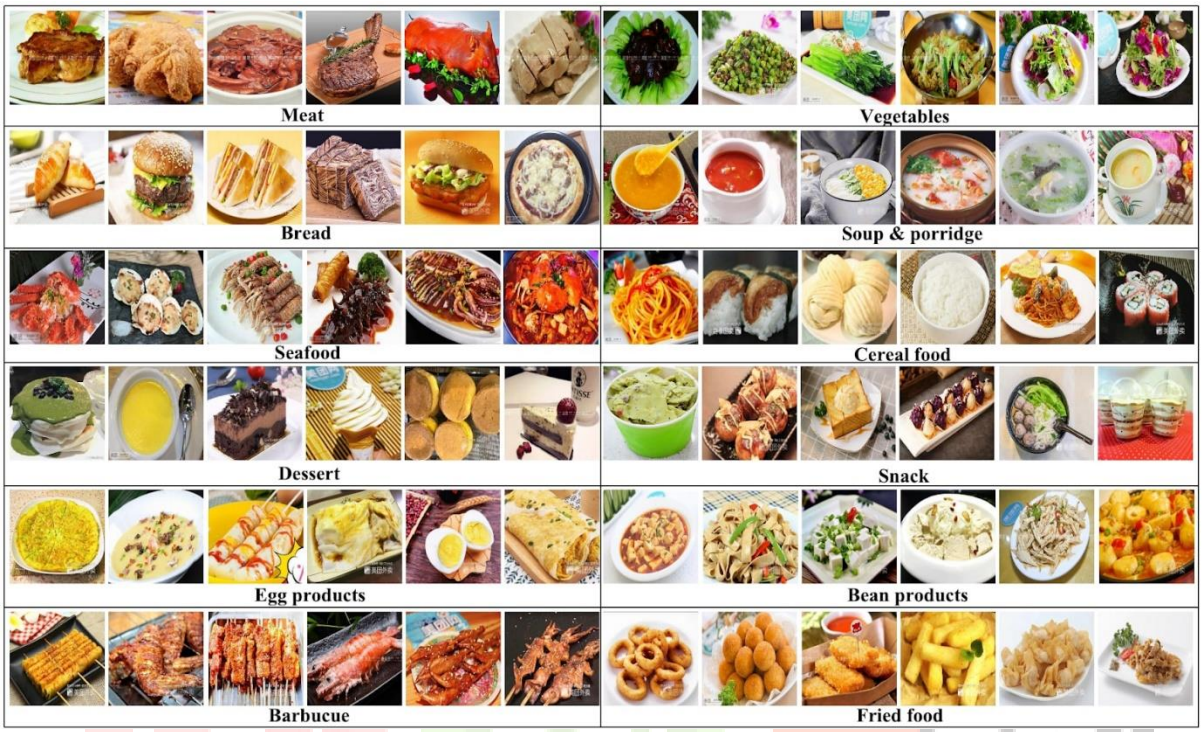
K-means clustering is an unsupervised learning algorithm which aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest centroid. K-means clustering algorithm computes the centroids and iterates until we it finds optimal centroid. We are using this method to group images in the bag by performing k-means clustering over all the vectors. It categorizes the images using a linear support vector machine classifier and groups them into clusters containing similar properties. Certain groups are selected based on some kind of similarity in the data with the number of groups represented by K. The objective of K-Means clustering is to minimize the time taken to search and compare data to find optimum result. Food recognition can differ from the information derived from the place where the food is consumed for example, restaurants, hotels, services etc. The image descriptors are based on colours and both Local and global features are tested. The arrangement of food ingredients is also a possible cue for food recognition.

4.4) Deep Learning:

Deep learning is part of a broader family of machine learning methods based on artificial neural networks with representation learning. For increased accuracy, image classification using CNN is most effective. Classification methods will be used in 14 different colour and texture descriptors and evaluated. Using the CNN architecture, we can experiment on three different recognition tasks: food categories, food states, and both food categories and states.

4.5) Dataset:

The existing dataset was updated by adding the relative states of food. Around 10 different states were identified and updated. Some of the states we identified are: mashed, juiced, diced, minced etc. We will focus on identifying only the different types of fruits and vegetables and their states in the food image that is inputted.



5) Conclusion:

In this paper, we updated an already existing database to contain images of not only the food but also their relative states thereby resulting in an efficient and detailed output of the food and state image. It can identify and categorise food items of a single image and provide user with the calorie amount in the food. Accuracy of prediction also increased and solution is applicable in real world datasets.

7) Future Enhancements:

Our solution right now looks only at helping Type-1 diabetes patients. In the future, it will cover and be applicable for all types of diabetes patients. More information about food like carbohydrate content etc will shown to user and updates will be given to dataset to include not just fruits and vegetables but also poultry and other food types.

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