Proposal for CSE 190 Spring 2011: Identifying the Cuisine of a Plate of Food

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1. Introduction

Food is an indispensible part of our lives. In today's globalized market, food from different geographical regions show remarkable variations in the choice of ingredients and the ways to prepare them. Some cuisines have ingredient choices unimaginable to customers habituated to other cuisines, but still present surprisingly tasty dishes. Besides unique ingredients, even the same ingredients, depending on the preparation process, may end up preserving different fractions of the nutritional value and very different calories.

If restaurant networks provide a mobile app that can aim at a photograph of a plate of food and report its cuisine, the composing ingredients, and list other similar dishes, it could be a good marketing strategy. In addition, restaurants of a specific cuisine can also refer to other cuisines' use of ingredients to sparkle ideas for more creative dishes that utilize similar ingredients in new ways.

One core component of such an application is to recognize the cuisine and ingredients on a plate of food. Then the information may later be used to compare cuisines and find a network of common ingredients in the dishes.

2. Qualifications

- CRA-W supported research at the University of Washington in summer 2010. Used OpenCV, wrote SVM spatial pyramid kernel, created new hierarchical feature descriptor for a database of 4700+ insect images in 29 species, and listed as co-author to IEEE WACV 2011 [5]. Wrote final report for CRA-W http://www.cs.washington.edu/homes/mezhang/finalPaper.pdf.
- Took AI courses at the University of Edinburgh, United Kingdom. Introduction to Vision and Robotics used MATLAB and Kepera robot to apply computer vision on visual survoing, among other robotics tasks; Introduction to Applied Machine Learning (received credit for CSE 150/151, has a syllabus similar to ECE 175) analyzed different machine learning classifiers such as SVM, neural networks, etc. and used Weka on databases [4].
- Courses taken at UCSD: CSE 151, CSE 167, CSE 87 freshman seminar in robotics, will be taking CSE 152 concurrently in Spring 2011.
- Some experience with IEEE MicroMouse at UCSD, Winter 2010.
- Three years of research experience in Calit2 Immersive Visualization Lab, mostly in graphics and virtual reality. Preparing paper of virtual reality application for VRST 2011.

3. Questions to Answer

3.1. Identify ingredients on the dish

Color and texture are the most obvious properties that human use to identify food. Bolle *et al.* have successfully classified produce using color, texture, and other features [6]. A recently published food recognition work by Yang *et al.* also identifies each ingredient on the plate before determining the category of the food, such as sandwich or salad [7].

We need to have an algorithm that roughly identifies the ingredients on the dish, before it can start to classify the cuisine that the plate belogns to.

3.2. Robust Handling of Different Lighting Conditions

Photographs taken in the home, restaurant, and outdoors may have different shades of ambient color depending on the lighting. The algorithm needs to be able to handle different lighting conditions so as to not affect the color it perceives as the ingredients' color.

3.3. Robust Segmentation of the Image

In order to separate the ingredients on the plate, an effective segmentation process needs to distinguish between the boundaries of food in a dish. Because of differing textures and the nature of food appearance, we foresee potential problems in accurately segmenting the boundaries of ingredients. For example, segmenting a plate with rice and curry sauce each on a half of the plate is less difficult than segmenting a plate of stir fry noodles with mixed vegetables.

3.4. Find an effective feature descriptor to identify the cuisine

Yang *et al*.'s method first identified the ingredients, gave each ingredient a probability label, and then used pairwise local features among the ingredients to determine the food category, by calculating the distance, orientation, and other properties between each pair of ingredients [7]. The features were used across 61 categories of food, where 7 categories were analyzed in more detail [7].

Identifying cuisines is different from identifying the specific food, because different cuisines may have different typical arrangements on the plate that is recognizable without necessarily knowing all the ingredients composing the dish. For example, one does not have to know the composites of a piece of sushi to be able to tell that a dish is Japanese. Some dishes have unique ingredients, such as red ginger, that are indicative of the cuisine; however, some other dishes use commonly-seen ingredients, and it is the particular preparation process that brings forth a characteristic appearance. For example, rice may be compressed into tight round and triangular shapes in Japanese cuisine, but eaten loose in most Indian and Chinese dishes, dyed in yellow in Indian dishes, and appear orange in Mexican dishes.

Given that each cuisine can have a variety of plate layouts, we will assume a typical appearance known to the mass. Since not very much literature focuses on food recognition, there are possibly unexplored feature descriptors that can yield promising results specifically to cuisines.

4. Timeline and Milestones

The timeline is in two stages. In the first stage, the aim is to set up and implement the rough identification of the ingredients on a plate, using existing methods. The results do not need to be exact, as explained previously in 3.4. In the second stage, results from the first stage and other features will be used to generate feature descriptors to identify the cuisine of a plate of food.

4.1. Week 1 (03/28 - 04/03), Milestone 1

03/28: Organizational meeting

Write script to automatically retrieve images from database e.g. Flickr [1]. Decide on the size of the entire database and retrieve images. Build the database, and then select some samples to form a small database for testing.

Organize the dataset into directories easily maintainable according to the class. Generate lists of file names and labels to feed the data into the program. Directories should be maintainable such that each directory has a unique label.

Install OpenCV, and use MATLAB as a backup [2]. Write a preliminary toy program to set up the input from the database and the output of test results.

4.2. Week 2 (04/04 - 04/10), Milestone 2

Decide on a method, drawing on existing references, to identify the ingredient on the plate. Use color and texture as the features, most likely. Decide on a classifier.

Start implementation.

4.3. Week 3 (04/11 - 04/17)

Continue implementation and test on a small dataset. Modify code until it works as expected.

4.4. Week 4 (04/18 - 04/24), Milestone 3

Continue testing on identifying food on the plate. Run the test on the entire dataset and collect visual results for report.

Algorithm should be able to identify food ingredients on the plate. This need not be "perfect", as it is not the core objective. A rough probability score should be good enough for cuisine identification later.

4.5. Week 5 (04/25 - 05/01), Milestone 4

Decide on a feature descriptor(s) and classifier to identify the cuisine. Start implementation.

4.6. Week 6 (05/02 - 05/08)

Continue implementation and change the algorithm as initial test results show unexpected outcomes.

Use Weka to test results from different classifiers if helpful.

4.7. Week 7 (05/09 - 05/15), Milestone 5

Test the cuisine feature descriptor. Continue adjusting the algorithm.

When the algorithm is ready, do a trial run on the entire dataset, and decide on what to keep, what to throw out, and what to add. Collect visual results for report.

4.8. Week 8 (05/16 - 05/22)

Tests probably failed. Research more on what other feature descriptors may be effective, and implement them into the algorithm.

Change and/or increase the small test dataset with more images from the entire database, and retest on the newer dataset. When most failed test cases in the small dataset work, test again on the entire dataset, adjusting algorithm according to shortcomings observed in the results. Collect visual results for the report.

Start drafting final report.

4.9. Week 9 (05/23 - 05/29), Milestone 6

05/23: Rough draft of final report due

Continue modifying and testing algorithm. Aim for a conservative accuracy depending on the results so far.

Algorithm should be able to roughly identify the cuisine of a plate of food, to a resonable accuracy.

Prepare final presentation.

4.10. Week 10 (05/30 - 06/05)

06/01 and 06/03: Final project presentations

Finalize algorithm to an acceptable state.

Finalize report.

4.11. Week 11 (06/06)

06/06: Final reports due

5. Software and Dataset

5.1. Software

- OpenCV - First choice of software [2].
- MATLAB - Use as backup and reference.
- Weka - Use as reference if have machine learning data that need a quick analysis [4].

5.2. Dataset

- Flickr has a good variety of photographs of food items [1]. They are easily and freely downloadable with automated scripts, such as JavaScript via Yahoo YQL.
- Other image search engine results may also be freely obtainable via scripts.
- A fallback is the PFID, Pittsburgh Fast-Food Image Dataset [3]. This dataset is limited to fast-food items.

References

[1] Flickr http://www.flickr.com/. 2, 3

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[4] G. H. l. B. P. P. R. I. H. W. M. Hall, E. Frank. The weka data mining software: An update. *SIGKDD Explorations*. 1, 3

[5] M. Z. L. G. S. N. Larios, J. Lin and T. G. Dietterich. Stacked spatial-pyramid kernel: An object-class recognition method to combine scores from random trees. *WACV 2011*. 1

[6] N. H. R. M. G. T. R. M. Bolle, J. H. Connell. Veggievision: A produce recognition system. *WACV 1996*. 1

[7] D. P. R. S. S. Yang, M. Chen. Food recognition using statistics of pairwise local features. *CVPR 2010*. 1, 2